Biofuels Situation in South Africa – Input to ICID TF Position Paper on Biofuels

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ABSTRACT

South Africa is a water stressed country that is generally characterized by low rainfall and high evapotranspiration. The average annual rainfall is considerably below the world average and ranges from less than 200 mm p.a. in some areas in the West of the country to greater than 800 mm p.a. in the East. The country generally has limited crop production potential with only about 16% (17 million ha) of land being arable. Although primary agriculture only contributes 2-3% to South Africa's GDP and 8.5% to formal employment, agriculture has a significant indirect role in the country's economy through forward and backward linkages. Biofuel production as an agricultural crop and which the strategy argues can have significant job creation benefits e.g. Department of Trade and Industry's Industrial Policy Action Plan suggests 125 000 direct jobs could be created should a 10% blending target be set. The rural landscape is typified by high levels of poverty with approximately 70% of the country's poor residing in these areas and a significant proportion of the total population experiencing food insecurity. Hence, as with other developing countries, food security at the household, community, regional and national level is of paramount importance.

The global debate on the potential negative impact of biofuels on food security informed the development of the Biofuels Industrial Strategy of South Africa in 2007. The goal of the 5 year strategy is a 2% biofuel penetration (400 million litres p.a. by 2013). The strategy identified sugarcane and sugar beet for bio-ethanol production and soya beans, sunflower and canola (rapeseed) for biodiesel production. Recent studies indicate that grain sorghum, especially the faster growing sweet sorghum variety with a shorter growing season, is an alternative that can be used in combination with sugar beet, which can only be grown in winter due to our hot summers. The primary focus of the strategy is rural development and opportunities for the poor as well as job creation, therefore under-utilized land in specific production (former homeland) areas have been targeted. Although the strategy does not exclude irrigated crops, it does recognize that the country's water resources will be severely impacted if there is widespread irrigation. It also acknowledges that irrigated cropping for biofuels will have to compete with other uses for the scarce resource. However, since the development of the biofuels strategy, the Department of Water Affairs has effectively issued a moratorium on irrigated crops for biofuel production. A recently completed Water Research Commission study on the water use of crops/trees for biofuels in South Africa mapped potential growing areas for crops identified in the Biofuels Industrial Strategy (BIS). The optimal growing areas for these crops, under dry land conditions, are mainly in the eastern and northern regions of the country. The study investigated the potential impact of producing these crops on water resources. With the exception of sugarcane, the study found that production of rain fed biofuel crops is unlikely to negatively impact on water resources. A second ongoing study seeks to strengthen assumptions made in this desktop study through field trials, where the water use and productivity of crops with good biofuel feedstock

potential are monitored and more detailed modeling will be undertaken. To date, the project has highlighted the risks associated with production of some of the crops named in the BIS, in particular sugar beet, which trials have shown to be low yielding and disease prone in South Africa's warm climate.

Significant challenges face the emerging biofuel industry with regard to natural, social, human, physical and financial capital. Effective co-operative governance among the various role players will be essential in ensuring a successful industry. Although the current biofuels strategy only supports the use of first generation feedstock and proven commercial processes, it encourages research on alternative feedstock and the development of second and third generation technologies.

Key words: Biofuels, Crop production, Water use, South Africa

1. Context and Background

South Africa is a water stressed country that generally experiences low, unreliable and insufficient rainfall and high evapotranspiration. The average annual rainfall of 465 mm is well below the world average of 857 mm p.a. (Mwenge *et al*., 2008). The rainfall ranges from less than 200 mm in some areas in the West of the country to greater than 800 mm in the East. Much of the country consists of grasslands, woodlands and shrubs with less than 20% of land being arable. Until 2006, South Africa was a net exporter of agricultural products. Primary agriculture accounts for 2-3% of GDP and 8.5% of formal employment, however the agricultural sector generally contributes 20-30% to the country's economy through forward and backward linkages (Vink and Van Rooyen, 2009; Water Research Commission, 2010).

Despite its status as a middle income country, South Africa has extremely high levels of absolute poverty. A large proportion of households are food insecure with one survey finding that 52% of 13.7 million households experience hunger and a further 33% are at risk (Hart, 2009; Labadarios *et al*., 2008). Food security and poverty alleviation are priorities at national, provincial and local levels. However, Government at all levels faces challenges in implementing food security programmes (Hart, 2009). The prime cause of the household food insecurity problem can be attributed to chronic poverty and unemployment (Altman *et al*., 2009; HRSC, 2007).

2. Particularities of Water, Bio-energy and Food security Nexus

The main reason for producing biofuel and bioenergy feedstocks is to produce fuel on a sustainable basis. However, one of the critical components in their production is feedstock water use. In South Africa, water availability is deemed more limiting to feedstock production potential than land availability. High yielding crops thus cannot be planted in areas with limited water resources. Feedstocks can however be planted in marginal environments where rainfall is limited and irrigation of feedstocks are not viable nor permitted. Some feedstocks may utilise more water than the natural vegetation and may therefore be declared a stream flow reduction activity in terms of the Water Act (Act 36 of 1998).

Irrigated energy crops are unlikely to compete economically with high-value irrigated food crops such as fruit and vegetables but may be able to compete with low-value crops such as small grains. The production of irrigated feedstocks for biofuels and bioenergy can therefore have a negative impact on food security and are not recommended by the Department of Water Affairs.

Agriculture has been viewed as one avenue to improve rural development and enhance rural livelihoods (Machete, 2004). South Africa has a dual agricultural economy consisting of a highly developed commercial farming sector as well as a resource-poor subsistence farming community. Most of the potential arable land of 17 million ha in South Africa is utilised for large-scale commercial rainfed crop production with commercial irrigated agriculture on 1.6 million ha. Smallholder crop production (mainly practiced by black farmers), which accounts for 18% of the potential arable fields and 6% of the irrigated land, lags far behind the commercial sector. (Backeberg and Sanewe, 2010; Vink and Van Rooyen, 2009). In 2006, 1.3 million rural households (10% of the population) had access to land for farming, but farming was not the main source of income (Vink and Van Rooyen, 2009).

It has been suggested that the significant poverty rate among the black agricultural population indicates the failure of agriculture to pull people out of poverty and that agriculture could reduce rural poverty when farming is commercialised (Machete, 2004; Pauw, 2007). A successful smallholder farmer has been classified as one who is highly productive and participates in markets and earns sufficient cash income, particularly from agriculture to enjoy a lifestyle that is free from poverty (Van Averbeke and Mohammed, 2006). The Land Redistribution for Agricultural Development (LRAD) programme was one of the ways in which Government sought to redress the imbalances of the past. LRAD was developed to provide the poor with land for residential and productive uses to improve their income and quality of life. The programme planned to improve nutrition and incomes of the rural poor who want to farm on any scale and to empower beneficiaries to improve their economic and social well being (DoA, 2001). Unfortunately, the LRAD programme has not achieved its desired outcome and in most cases the programme has failed (Vink and Van Rooyen, 2009; FAO, 2009). The Food and Agriculture Organization of the United Nations (FAO, 2009) report cites possible reasons for the widespread failure of the land reform projects including, amongst others, inadequate business plans, limited experience in commercial farming and financial management, and insufficient access to advisory services. Most rural households rely on government support through pensions and social grants as well as remittances (Van Averbeke, 2008).

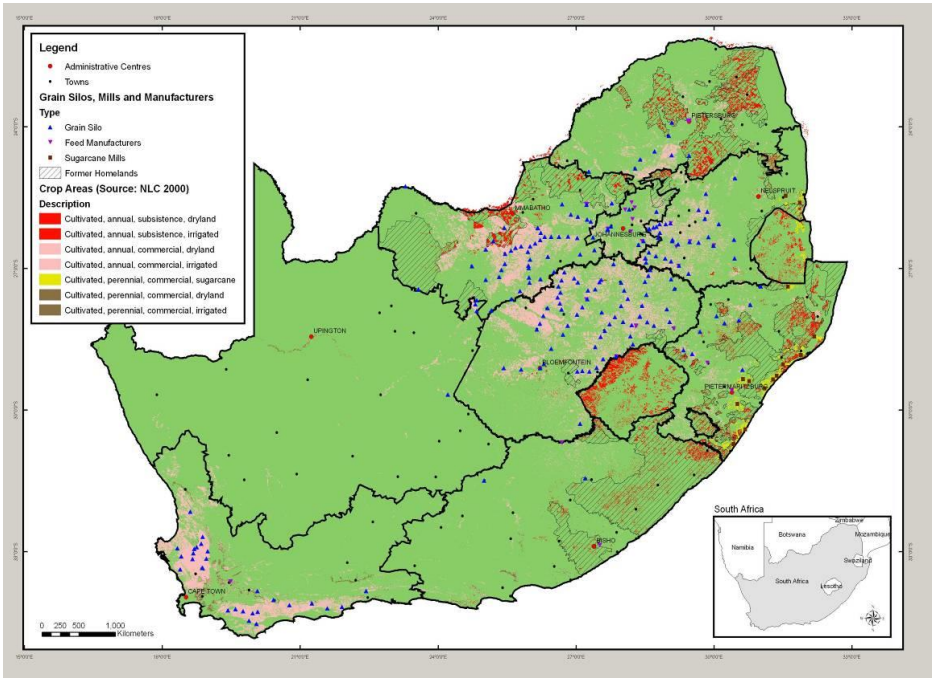
3. Bio-energy Production

According to the Department of Minerals and Energy (now Department of Energy), the production of biofuels can contribute to the objectives of land reform and restitution programmes by providing sustainable market access for farmers who benefit from these programmes (DME, 2007). The Biofuel Industrial Strategy of the Republic of South Africa, with its target of 2% biofuel penetration within five years, was primarily developed to address issues of poverty and economic development. Like many countries in Africa, developing a biofuels sector is seen as an opportunity to promote rural development, create jobs and provide opportunities to the poor (FAO, 2008). Its aim is to bridge the gap between the developed commercial farming sector and the resource-poor farming sector (historically disadvantaged under the previous government). It looks at creating commercial agricultural areas and providing firm opportunities for new and emerging farmers in the former homeland areas (DME, 2007).

The majority of black, mostly subsistence, farmers are in the former homeland areas (Figure 1) (Altman *et al*., 2009). The biofuel strategy identifies 3 million ha of under-utilised high potential land in the former homeland areas that can be used to grow crops for biofuel production although other reports suggest that 2 million ha is arable and 50% of this land is of moderate to high potential (Van Zyl and Van Rooyen, 1991; Botha and De Lange, 2005). One prospective area for development in the former homelands area is the Mzimvubu Economic Development Zone in the Eastern Cape which has a potential dryland crop production area of 500 000 ha. Most of this land, situated in rural areas plagued by poverty, unemployment, poor infrastructure and reliance on social welfare grants, has not been cultivated in the last 20 years (AsgiSA Eastern Cape, 2009).

The South African Government is of the view that almost all the previous productive land in the former homelands can be brought into full production once a firm market has been secured (DME, 2007). Consideration of certain feedstocks, currently excluded from the biofuel strategy, will only be entertained once certainty on the ability of the currently under-utilised land to produce has been ascertained.

Figure 1: Former homeland areas and commercial and subsistence crop production areas in South Africa



Source: Department of Minerals and Energy, 2009

4. Issues and concerns

As a result of the global debate on the potential negative impact of biofuels on food security, specific crops i.e. soya beans, canola and sunflower for biodiesel and sugarcane and sugar beet for bioethanol production were chosen. Staple food crops i.e. wheat and maize were excluded in the initial phase of development. The inclusion of alternative feed stocks, such as *Jatropha*

curcas, was also suspended pending further research. The strategy emphasizes that support will only be provided for proven commercial processes, i.e. first generation technologies.

Of the two crops mentioned in the biofuel strategy for bioethanol production farmers, both commercial and small-scale, are more familiar with sugarcane. Sugarcane is widely grown in the eastern regions of the country mainly in Mpumalanga and KwaZulu-Natal provinces. Production is mostly by commercial growers with small-scale farmers accounting for about 16% of the total area under production and about 0.1% of the total cane produced (Table 1). Very little sugarcane is currently grown in the former homeland areas under irrigation or dry land conditions. Almost all of the current sugarcane industry's production area falls outside the former homeland areas and therefore would not be supported by the biofuel strategy (Funke *et al*., 2009). However, knowledge about best management practices and advisory services for sugarcane growers is available within the country through the South African Cane Growers' Association and other organisations. On the other hand very little sugar beet is currently produced commercially in South Africa. Little local knowledge (with the exception of a few commercial farmers and researchers) is available on the production of sugar beet in South Africa and advisory services have limited experience in growing the crop.

Table 1. Area planted and tonnes produced in 2008/09 season of soyabeans, sunflower and sugarcane and area planted and tonnes of canola produced for the 2009 production season.

Crop	Tonnes	Hectares
Soyabeans[1]	516, 000	237,750
Canola[2]	40,350	35,060
Sunflower[1]	801,000	635,800
Sugarbeet*	Neg	Neg
Sugarcane – Smallholder[3]	1 727 185	68 357
Sugarcane – Commercial[3]	15 835 159	311 947

Source: 1. DAFF, 2010a
2. DAFF, 2010b
3. South African Cane Growers' Association, 2009
*Note: Production of sugarbeet in South Africa is negligible

5. Impact Assessment

On the whole field crop production in South Africa declined by 19% between 1991 and 2007 whilst the population growth increased by 32% during the same period (NAMC, 2007). South Africa has not demonstrated a long term ability to produce oilseeds or substantially increase production to meet human and animal requirements (GAIN, 2009). Currently limited quantities of canola are produced in the winter rainfall areas of the Western Cape, with very little production elsewhere in the country (Table 1). No change in production is projected in the medium to long term (BFAP, 2010). In contrast, the area under soyabeans increased from 165 400 ha and that of sunflower increased from 564 300 ha in 2007/08 (Table 1) (DAFF, 2008). Some reports indicate that South Africa will be a net exporter of sunflower and soyabeans in the foreseeable future (BFAP, 2010). The potential summer rainfall areas for soyabeans and sunflower production are in the eastern regions of the country with sunflower having the largest

potential growing area (Jewitt *et al*., 2009). Similarly, the potential growing area for dryland production of sugarcane is the eastern parts of the country and that of sugarbeet (with a much larger potential growing area) is the eastern and northern parts of the country. Although all the crops identified in the biofuel strategy can be produced in certain areas of the preferred regions (former homeland areas), very little production of these crops currently takes place. All three feedstocks in the biofuel strategy for biodiesel production are mainly produced by commercial farmers. It is estimated that South Africa will need at least 307 375 ha of land for crop production to meet its 2% biofuel penetration target (Von Maltitz and Brent, 2008).

A recently completed Water Research Commission scoping study mapped the potential growing areas of various crops for biofuel production in South Africa (Jewitt *et al*., 2009). The study showed that based on climatological drivers, the cultivation of canola, cassava, *Jatropha curcus*, soyabeans, sugarcane, sugarbeet, sunflower and sweet sorghum can be considered in suitable production areas. The scoping study also investigated the potential impact of dryland production of the crops on the country's water resources. The National Water Act (1998) requires that any land use shown to have a significant impact on the country's water resources should be declared a Stream Flow Reduction Activity (SFRA). The impact of land use change on water resources may be better assessed against the land use replaced; the impact will differ whether converting indigenous vegetation to croplands, intensifying production or using marginal or fertile land. The preliminary investigation on water use of crops for biofuels estimated the water use of various crops, using the ACRU Agrohydrological Modelling System (Schulze, 1995), relative to the natural baseline vegetation (Jewitt *et al*., 2009). The classification used for the natural baseline vegetation was the Acocks Veld Types (1988). The dominant Acocks Veld Types in the eastern region of the country is the Temperate, Transitional Forest and Shrub, the Pure Grassveld and False Grassveld (Acocks, 1988).

The study, based on climatological factors only, found that with the exception of sugarcane dryland production of soyabeans, canola, sunflower and sugarbeet would potentially use less water than the dominant Acocks Veld Type and is therefore unlikely to negatively impact on the country's water resources (Table 2). Sugarcane is currently considered a 'candidate crop' for SFRA. (Jewitt *et al*., 2009).

Table 2. Median annual streamflow reduction (water use) of crop relative to that of the dominant Acocks Veld Type

Biofuel	Crop (feedstock)	% Reduction
Biodiesel	Soyabeans	< -60 to > -20
	Canola	< -140 to > -50
	Sunflower	< -70 to > -15
Bioethanol	Sugarbeet	< -110 to > -40
	Sugarcane	< -10 to > 50

Source: Jewitt *et al*., 2009

Although the biofuel strategy does not specifically exclude irrigated crop production, it does recognize that the country's water resources will be severely impacted if there is widespread irrigation and that irrigated cropping for biofuels will have to compete with other uses for scarce water resources. In its report on "Biofuels: Prospects, risks and opportunities", the FAO (2008)

cautions that the irrigated production of biofuel feedstocks can have a great impact on local water resources balances, particularly in water stressed areas. This is the view of the Department of Water Affairs, who subsequent to the development of the biofuel strategy, issued official notification to the Department of Energy of its firm disapproval of any biofuel production from irrigated feedstock in the light of the country's limited water resources. Despite this concern a joint venture between the Industrial Development Corporation (IDC), the Central Energy Fund (CEF) and the Agrarian Research Development Agency (ARDA) has established a project to irrigate large areas of land for sugarbeet production in the Eastern Cape province. This collaboration with the Department of Rural Development and Land Reform (DRDLR) will result in sugarbeet being grown along the Fish River as feedstock for a bioethanol plant with a yearly capacity of 90 million liters. Over the past few months several farms in the province have been sold to the Department for the project (Farmer's Weekly, 2010).

6. Identified Risks

The Biofuel Industrial Strategy of South Africa has noble objectives with regard to poverty alleviation and rural development. However, the country faces significant challenges with regard to natural, social, human, physical and financial capital in implementing the strategy and establishing a sustainable biofuel industry.

6.1 Natural capital

Although the Water Research Commission study on the impact of crop production for biofuels on water resources indicates that dryland production of four of the five crops in the biofuel strategy will not be significant, its potential impact on biodiversity has raised concern. In a paper prepared for the Department of Environmental Affairs and Tourism (now Department of Environmental Affairs), it is reported that greater areas of productive land are likely to be required to grow bioenergy crops and therefore land currently supporting biodiversity may be converted to monoculture crops. Moreover, converting previously natural lands will disrupt ecosystem services ultimately impacting on the livelihoods of rural populations and biodiversity (Haywood, 2008). The potential negative impact of land use change on the environment has been widely reported (FAO, 2008; Von Maltitz and Brent, 2008; OFID, 2009). Best management practices with regard to soil and water management, pest and disease control whilst adapting to climate variability and climate change will be critical.

6.2 Human Capital

The biofuel strategy primarily seeks to empower previously disadvantaged black farmers and provide a market for their produce. The focus is on supporting emerging (commercial) farmers and not subsistence farmers. Sustainable production and harvesting of the crops mentioned in the strategy is critical in ensuring that planned biofuel processing plants have a constant supply of feedstock and are therefore economically viable in the long term. The challenges confronting smallholder crop production in South Africa were reported by Fanadzo *et al*. (2010) who observed the lack of technical skills among smallholder irrigation farmers in the Eastern Cape on aspects such as basic agronomic practices and water management. In its report on establishing emerging farmers in South Africa, compiled by local researchers, the FAO (2009) suggested that successful emerging farmers tend to have previous personal experiences in small-scale

commercial agriculture as managers and decision-makers or had relied mainly on small-scale agriculture for their livelihood. It further points out that South Africa largely lacks this type of farmer. It suggests that the general absence of peasant tradition among contemporary black people in the country is an important constraint to achieving a class of new small-scale black commercial farmers (FAO, 2009). Developing human capital will therefore be important in ensuring that farmers are able to produce good crops. Training and skills development for farmers as well as equipping advisory services i.e. extension services should be central to implementing the biofuel strategy. Fanadzo *et al*. (2010) recommend that farmers attend 'back to basics' training programmes in the areas of crop and water management. The biofuel strategy duly acknowledges that Government needs to ensure the training and capacity building of previously disadvantaged communities and emerging entrepreneurs. However, it is important that government initiatives to reduce poverty through smallholder agricultural development focus on those that are interested and/or have the capacity to farm successfully. Diverse strategies will need to be developed to ensure that specific farming areas, in the former homeland areas, are assisted to reach their agricultural potential (Machete, 2004).

6.3 Social capital

The biofuel strategy suggests that emerging farmers could organize themselves into co-operatives to maximize benefits and access to markets; the strategy also envisages contracts between farmer co-operatives and individual biofuel producers. However, the primary cause for many difficulties experienced in many collective projects is inadequacies in formulating the rights (and obligations) of individuals and the lack of attention to clearly defined arrangements governing individual economic incentives (FAO, 2009). Another limitation to smallholder crop production for biofuels in the former homeland areas of South Africa is the land tenure arrangements that do not encourage commercial production; therefore developing and implementing effective land tenure policies is essential (Raswant *et al*., 2008). Despite having access to land resources in communal areas, and elsewhere, many communities experience poverty. If farmers have secure rights they will have the decision-making power and will be active participants in the productive use of the land (Backeberg, 2010).

6.4 Physical capital

South Africa has no large-scale commercial bioethanol or biodiesel plant (GAIN, 2009). Only one license was issued to a manufacturer for commercial production of biofuels by the beginning of last year (DME, 2009). Several small-scale plants use waste vegetable oil as feedstock for biodiesel on farm whilst some large retail food stores use biodiesel from waste oil for their distribution vehicles. No significant changes are expected in the industry as biodiesel is relatively expensive to produce and better returns can be obtained by selling the vegetable oil into the human consumption market (BFAP, 2010). Several of the planned large-scale biofuel plants rely on the use of irrigated feedstock; irrigated sugarbeet for bioethanol production in the Eastern Cape has yet to receive the firm commitment of a significant number of the target group of farmers to produce the crop.

6.5 Financial capital

Inadequate incentives and commitments stipulated in the biofuel strategy have been reported to be insufficient to create a sustainable biofuel industry (GAIN, 2009; Funke *et al*., 2009). The

production of liquid biofuels in many countries is currently not considered economically viable without subsidies or incentives given the agricultural production and biofuel processing technologies and the comparative price of crude oil (FAO, 2009). Considerable upfront capital for infrastructure such as roads, rail and storage facilities are required in order to ensure production of crops for biofuels in the designated (homeland) areas. The cost of development of agricultural land is significantly more in the former homelands than in the developed commercial farming areas. It has been estimated that R4.7 billion (excluding roads and other related infrastructure) is required as initial investment to develop the 500 000 ha in the Mzimvubu Economic Development Zone in the Eastern Cape (AsgiSA Eastern Cape, 2009).

7. Mitigation of Risks

Active Government support is clearly vital in developing a sustainable biofuel industry in South Africa (Funke et al., 2009; GAIN, 2009). An important consideration in establishing the emerging industry will be how the biofuel production system will differ from the food production system to make it possible for the biofuel system to re-energise and sustain farming in the targeted smallholder areas. Options may include developing a support system which ensures the provision of services, inputs and markets, resulting in the selected biofuel crops progressively becoming the crops of choice among existing and possible new smallholder farmers. It may require encouraging joint venture agreements (contract farming) where rural homesteads make available their natural resources (land, water) in return for cash income. Land will be cropped by companies, which offer jobs, skills development and training to local people.

Co-operative governance involving several Government departments as well as other key role players such as the Industrial Development Corporation and the Central Energy Fund will be needed. Lessons learnt from the poor implementation of various well intended policies, strategies and programmes such as that for food security, land reform and water allocation reform will be valuable platforms on which to build a sustainable biofuel industry.

Biofuels as a new and emerging industry requires extensive research (Von Maltitz and Brent, 2008). Research and development of second generation technologies could significantly enhance the future role of biofuels (FAO, 2008). Although the current biofuel strategy only supports the use of first generation technologies, it does encourage research and development in alternative feedstock and second generation technologies. Technical barriers to commercial production of biofuels from cellulosic feedstock currently limit the economic viability of adopting these technologies at present (OECD/IEA, 2008; OFID, 2009). However, if the Government's long term primary focus of biofuel production in South Africa remains on job creation, rural development and creating opportunities for the poor, the development and use of second generation (and third generation) technologies will need to be aligned to national priorities.

Little information is available, at present, on the large-scale cultivation of some alternative feedstocks. According to the FAO (2010), decisions about planting *Jatropha curcas* in countries in South Asia and Sub-Saharan Africa have been made without the backing of sufficient science-based knowledge. They recommend that research on various aspects of *Jatropha curcas* production including genetic improvement of varieties, and on cultivation practices such as water conservation and integrated pest and nutrient management is needed. The impact of planting

Jatropha curcas on water resources was shown in a Water Research Commission study not to have negative effect on annual streamflow in South Africa, but its impact on biodiversity and its potential invasiveness remains in question (Holl *et al*., 2007). Invasive alien plants that are currently growing in the country have been suggested as possible feedstock for biofuels. Further research is currently being conducted by the Water Research Commission on the water use of crops and trees for biofuel production in selected bio-climatic zones in the country, following the initial scoping study. The six year research project aims to investigate in more detail the water use of, amongst others, currently grown and potential alternative first (such as sugarbeet and sweet sorghum) and second generation crops and cropping systems including annual and perennial crops/trees.

8. ICID Recommendation

Based on the South African experience, the following recommendations are made towards the compilation of an ICID position paper on the production of biofuels and bioenergy feedstocks:

- The rural population of South Africa, particularly in the former homeland areas, faces high levels of poverty and unemployment despite many communities having access to land and water for crop production. Much of the former homeland areas are suitable for dryland production of crops identified in the biofuels strategy, however very little productive activity takes place at present. The biofuel industrial strategy aims to improve rural development in previously neglected areas of the country and provide opportunities for smallholder (commercial) agricultural enterprises and employment.

- Crop production, which saw a decline over a 16 year period, is mainly practiced by large-scale commercial farmers. South Africa has not been able to sustain the production of oilseeds to meet its human and animal needs over the long term. Major challenges face the development of a sustainable biofuel industry and the establishment of significant numbers of emerging farmers in the former homeland areas to provide sufficient feedstock for manufacturers to invest in, and maintain, biofuel plants.

- Successful implementation of the biofuel strategy will require close inter-departmental relations and good co-operative governance. Government has a key role to play in creating an enabling environment for the emerging industry.

- The provision of training and skills development in crop husbandry and water management, amongst others, coupled with improvement to the current land tenure arrangements is essential.

- Further research on alternative feedstocks, their actual water requirements and biofuel processing technologies is required.

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