“Sustainable development: biofuels in agriculture”

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Sustainable development: biofuels in agriculture

Abstract

Biofuels are socially and politically accepted as a form of sustainable energy in numerous countries. However, cases of environmental degradation and land grabs have highlighted the negative effects to their adoption. Smallholder farmers are vital in the development of a biofuel industry. The study sought to assess the implications in the adoption of biofuel crops by smallholder farmers. A semi-structured questionnaire was administered to 129 smallholder farmers who were sampled from the Eastern Cape Province in South Africa. A binary probit model was used to investigate the determinants of smallholder farmers adopting biofuel crops. The empirical results showed that the variables, such as membership in association, occupation and incentives were statistically significant in influencing farmers' decision to adopt biofuel crops. Furthermore, it was discovered that the studied areas have a potential to grow biofuel crops.

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Introduction

Sustainable development is one of the driving forces towards the quest of renewable energy. This has been furthered by the depletion of fossil fuels and the destruction of the ozone layer due to greenhouse gases. Thus, sustainability can be achieved by diversifying energy sources, with a strong focus on renewable energy. In this case, it means revitalization of agriculture is a necessity if such a goal is to be achieved. Biofuels is one of the means in achieving this goal. They are defined as liquid fuels that are derived from materials such as plant waste and animal matter. There exist two classes of biofuels, namely first generation and second generation. According to Naik et al. (2010), first generation biofuels include biodiesel, bioethanol and biogas, and are resourced mainly from edible source of current food material such as maize, soybean, oil palm, sugar cane and cassava. Second generation biofuels are sourced from non-edible sources such as jatropha and algae. In developing countries, biofuels have become central in debates due to their potential to improve social development. Growing evidence has also revealed that biofuels can have a positive impact in improving energy security and reducing greenhouse gases. However, to date, our knowledge on using energy policy to contribute to growth is very limited (Costa-Campi et al., 2015). Yoon and Sim (2015) and Morrison et al. (2016) claimed that the biofuels industry has struggled to be viable despite immense technological developments. As pointed out by Boucher et al. (2014), biofuel policy is developed with limited participation from industry and stakeholder.

South Africa has been facing a number of challenges in energy security with the country now contemplating building nuclear reactors to improve this situation. Recently efforts have shifted to biofuels production as an alternative because of its potential to improve energy security, reduce climate change and reduce emissions. Moreover, biofuels present an opportunity to increase rural employment (Takavarasha et al., 2005). In line with the potential threats faced in energy sector, the South African government launched the Biofuel Industrial Strategy Policy (BIS) in 2007. The policy was launched in order to address some challenges such as smallholder productivity, upliftment of agriculture using surplus land, promoting sustainable development and improving energy security (DME, 2007).

Numerous researchers point out that biofuels development is an important path towards rural development and food security. Furthermore, biofuels may support agriculture by providing job opportunities, new investment and revitalization of rural areas (Klenschmit, 2007). Arndt et al. (2010) found that biofuels production increased economic growth by a half a percentage point each year highlighted that developing countries can take this as an opportunity to promote development. While there is a growing body of literature on the usefulness of biofuels, a number of criticism have been recorded as well. Critics against biofuel production point out that it is detrimental to the sustainability path, harmful to the environment and the society as a whole. For instance, Ajanovic (2011) points out that independence from fossil

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fuels cannot be achieved by using farmlands to grow grains that would be later on used for biofuels. Numerous scholars (Ajanovic, 2011; Koh and Ghazoulm 2008; Lankoski and Ollikainen, 2011) point out that biofuel production has different outcomes to the environment, for example, wildlife habitat, landscape, diversity and soil. In the US, it was found that ethanol targets increases nitrogen loading by 10-34 percent (Donnar and Kucharick, 2008). Thus, it appears that biofuels provide both opportunities and challenges to the policy makers. Biofuels production is dependent on the farmers providing feedstock supply, thus, policy makers should prioritize opportunities that enhance production of biofuels by farmers.

In this paper, we do not focus on biofuels impacts (De Gortehr et al., 2015; Zhang et al., 2013), nor do we explore various ethical arguments that have been drawn in literature. Furthermore, we do not engage in arguments on why biofuels production may be of benefit to a number of proponents. Rather we further the discussion surrounding a biofuel economy by drawing lessons from a number of reports and views from different scholars. Our focus on South Africa is driven by the appetite that numerous smallholder farmers do not understand how a biofuels industry operates, as pointed out by Cheteni et al. (2014). This paper furthers its discussion by exploring a survey focusing on the likelihood of smallholder farmers to adopt biofuel crops. Smallholder farmers in South Africa usually face challenges that impede their ability to grow and contribute to agriculture. The Department of Agriculture Forestry and Fisheries (DAFF) (2012) pointed out that some challenges faced by smallholder farmers include lack of access to land, inadequate infrastructure and institutional challenges. Consequently, they struggle to pay for farm inputs. Therefore, with the BIS, they are expected to benefit generously through farming biofuel crops. Our survey data were collected in the Eastern Cape province, where a number of smallholder farmers are expected to benefit from this policy because of the number of proposed biofuels projects that would be launched in the province. Furthermore, the province has vast underutilized lands (DAFF, 2012). These lands were identified as potential areas where biofuel crops can be grown (DME, 2007). Therefore, the production of biofuel crops is expected to create jobs for the province. In order for this BIS policy to succeed and achieve its objectives, it is worth noting the possibilities and challenges that surmount the Eastern Cape province. By so doing, the study aims to identify the challenges and opportunities that can be encountered in creating a sustainable biofuels market for smallholder farmers in the Eastern Cape province.

The paper is set as follows: the next section provides an overview of biofuels in South Africa, highlighting the capacity and barriers faced in establishing the biofuels market. Thereafter, the methodology and data collection techniques are explained, and the results follow. Finally, conclusion and recommendations sum up the paper.

1. Biofuels in South Africa

The Biofuel Industrial Strategy Policy launched in 2007 by the Department of Minerals and Energy (DME) was necessitated by the government's quest to address challenges facing smallholder farmers. The strategy targets 14 percent of arable land in rural areas that is underutilized (DME, 2007). In the early stage of implementation of the strategy, it is proposed that for production of biofuels, maize be excluded until such a time when there is certainty on the ability of the current underutilized land to develop. Canola, soy beans, sunflower, groundnuts, sugar cane, sugar beet, and sorghum are the most suitable or favored crops for biofuel production, as envisaged in the Biofuels Industrial Strategy Policy. Farrell et al. (2006) highlighted that although wheat is one of the largest produced crops in South Africa, it is not targeted for biofuels, because it is widely used in value added products such as bread, which are an important part of the South African diet. However, up to date, the biofuels policy has not been implemented due to a myriad of problems in terms of pricing the feedstock, as well as biodiesel and ethanol.

1.1. The land use debate. Sugrue and Douthwaite (2007) conducted a study to assess the level of land use in agriculture in South Africa. The findings were that agriculture production rose by 70 tons per hectare on leased plots, higher than organized small scale farming that was 30 tons on average. However, it was less than commercial farming that stood at 120 metric tons per hectare. Although it was discovered that commercial farming dominates in output, it was established that the overall output in agriculture has grown. Therefore, Sugrue and Douthwaite (2007) are of the view that maize should not be used for energy, instead, they suggest that jatropha or moringa tree are to be used. Jatropha can produce 2.5 metric tons of biofuels per hectare, which is better than soya that produces 0.8 tonnes per hectare on average. However, proponents of sustainability favor the development of a food forest that includes different types of plants and species. They contend that the arable land available for farming is degraded; therefore, planting food crops would stabilize and improve soil fertility in the longrun, subsequently, helping smallholder farmers and communities who own a lot of arable land. In contrast, the Renewable Energy and Energy Efficiency Partnership (2007) were of the view that increased agricultural production has the potential to conflict with a number of resources, not only land. Their line of reasoning was that increased agricultural production would increase inputs including water, fertilizers, agricultural chemicals and these may have a negative

impact on the production system through a loss of soil fertility, soil biodiversity, and available quality of water. Although social and environmental benefits may be realized through agricultural diversification and energy, as well as rural development using the land productively, nevertheless, land use remains one of the most sticking issues in the creation of a biofuels market in South Africa. Certain sections of government policies suggest that the land can be allocated to people with inadequate housing because they are backlog of people who need houses.

1.2. The biofuels and food debate. A growing body of literature is in disagreement over the impact of biofuels on food consumption. Hochman et al. (2008) and Coyle (2007) opine that the rapid growth of biofuels production has a potential negative effect of diverting food crops to biofuels, and consequently pushing commodity prices higher, which would have a serious effect on global food and related markets. Similarly, Pingali et al. (2008), Rosegrant et al. (2008), Elobeid and Hart (2007) are of the view that food items constitute significant in consumption bundles of low-income earners, and high prices may have an adverse effect on the poor. Furthermore, inadequate food security, food deficits, and undernourishment make the poor more vulnerable and volatile to prices changes in commodities, hence, any increase in biofuels production is expected to have an adverse effect on them. A deeper look into literature suggests that there is a consensus about maize not being used to produce ethanol, as it has a huge effect on food prices and poor communities. Cassman and Liska (2007) noted that the sub-Saharan region relies heavily on cereal import, hence, it is the most vulnerable to price shocks. FAO (2013) stated that food prices are likely to remain volatile in the period of 2011–2020, thus, any move that would destabilize prices further would be borne by the vulnerable communities, consequently, increasing poverty and promoting poor standards of living in the end. However, Harrison (2009) argued that there is growing evidence that shows that higher maize prices contribute to inflated food prices in the form of higher feed prices, especially animals that depend on corn as feedstock for poultry, beef, pork and others. Nonetheless, another school of thought challenges the above view. Pingali et al. (2008) point out that an adverse effect may be realized as a positive supply response that may help small scale farmers to emerge. Of the same view is Schmidhuber (2006) who posits that benefits may increase producer prices and biofuel production, which may uplift rural economies.

It can be deduced that as much as literature has different opinions concerning biofuel crops in agriculture, a growing body of literature believes that, as long as traditional crops such as maize and wheat are withdrawn from production, there are greater chances that biofuels production would uplift impoverished communities.

1.3. Current biofuel development in South Africa. Since the BIS policy was launched, little has been achieved up to date (DoE, 2014), the major reason being that biofuels projects are not financially attractive at the prevailing feedstock and crude oil/liquid prices. The government has been having marathon meetings with commercial farmers who are likely to be displaced when the BIS policy starts to be implemented. The major challenge is that traditional commercial farmers would need to compete with smallholder farmers for the same biofuels market. Yet, smallholder farmers would be given subsidies or special preference. Nevertheless, the government has started issuing licences for companies that will be processing biofuel crops. To date, eight companies have been offered operation licences (DoE, 2014). Table 1 shows the status of the licenced companies and their potential in biofuel blending.

Table 1. Biofuels licence status as of 2014

Company name	Crop/Feed stock	Capacity (million litres/yr)	Location	Licence status
Bioethanol				
Mabele Fuels	Sorghum	158	Bothaville, FS	Issued
Ubuhle Renewable Energy	Sugar cane	50	Jozini, KwaZulu Natal	Issued
E10 Petroleum Africa cc	Sugar cane and other crops	4.2	Germiston, Gauteng	Granted
Arengo 316 (Pty) Ltd	Sorghum and sugar	180 (in two phases of 90 each)	Cradock, Eastern Cape	Granted
Total Bioethanol capacity		392.2		
Biodiesel				
Rainbow Nation Renewable Fuels	Soy bean	288	Port Elizabeth, Eastern Cape	Issued
Exol Oil Refinery	Waste vegetable oil	12k	Krugersdorp, Gauteng	Granted
Phyto Energy	Canola	>500	Port Elizabeth, Eastern Cape	Granted
Basfour 3528 (Pty) Ltd	Waste vegetable oil	50	Berlin, Eastern Cape	Granted
Total biodiesel capacity		850		

Source: Department of Energy (2014).

It can be seen from Table 1 that sorghum, sugar cane, sugar beet, soy bean, canola and waste vegetable oil are currently the only feedstock that is expected to be used by the licenced companies to produce fuel. To note are projects located in the Eastern Cape province in Cradock, Berlin and Port Elizabeth that are the projected to produce over 900 million litres of biofuel in total. The total capacity of the projected biofuels plants is expected to be about 1.262 million litres per annum, which is way above the targeted 2 percent level of biofuels in the national liquid supply (DoE, 2014). Although the targets set by the Department of Energy seem achievable, it is worth mentioning that none of the licenced projects has been commissioned because of a lack of an appropriate biofuel pricing mechanism (DoE, 2014).

1.4. Challenges to biofuels development. Biofuels development may offer growth in agriculture. However, there are two concerns that have reinforced barriers to biofuel crops production.

Firstly, the possibility of requiring additional land and water resources means biofuel crops may pose a threat to those resources, for instance, biofuel crops like sugar cane are water intensive and produced under monoculture (Liao, de Fraiture and Giordano, 2007). In order to meet water requirement, irrigation withdrawals may have to increase by 20 percent even under optimistic conditions (de Fraiture et al., 2007). Secondly, the likely competition with food is one of the growing concerns about biofuel crops. Pimentel (2003) noted that while price increase in food may benefit farmers, it have adverse effect on urban and landless poor. Raswant, Hart and Romano (2008) pointed out that as food prices increase and staple foods become more expensive, it will lead to alternatives getting expensive as well, leading to food insecurity.

In 2007, the United Nations Department of Economic and Social Affairs (UNDES) undertook a study on small-scale production of biofuels in Southern Africa region. The findings were as follows:

- Feedstock awareness – it was discovered that there is a limited experience in choosing the right feedstock to be used for small-scale farming.
- Land ownership – land patterns are inconsistent in many nations. Land ownership rights may become a thorny issue, as biofuel cultivation competes with agricultural land. This situation is set to lead to diversion of cash crops being diverted to biofuels cultivation.
- Policy support – it was discovered that there is a lack of policies to support small-scale biofuels development at the local level. Also, in cases where biofuels policies exist, they tend to focus on the commercial side of the biofuels production. Hence, the potential for biofuels development to fulfil local energy needs has not been recognized.
- Financing – a serious barrier that was said to affect many smallholder farmers was the issue of financing or accessing affordable financing. This challenge affects smallholder farmers who need to buy seeds and equipment for the production of biofuel crops.
- Institutional awareness and capacity – the study noted that in sub-Saharan Africa, there is a lack of awareness in small-scale production of biofuels, as well as the capacity to improve or develop production.
- Market development – the findings also revealed that for any small-scale biofuels market to exist, it is necessary to understand needs and establish supply chain for product delivery, servicing and financing. Therefore, a number of smallholder farmers do not have business models to sustain their production of biofuel crops.

The findings by the UNDES give a glimpse of the challenges currently facing many African nations in creating a sustainable biofuels industry. South Africa is one of the nations that is faced by many challenges that were identified by the UNDES, partly because of the transition of the agricultural sector from the apartheid era to the black majority. Nonetheless, in terms of sustainability, the effect of biofuels production is multidimensional as pointed throughout the study.

2. Methods and materials

2.1. Study areas. We used data that were collected in two municipalities (Chris Hani district municipality and the OR Tambo district municipality) in the Eastern Cape province. The province has high levels of poverty and is underdeveloped (OR Tambo IDP, 2013). Unemployment rate is pegged at 40.8 percent at the OR Tambo municipality. At the Chris Hani municipality, 79 percent of people reside in rural areas or homelands, with the remainder residing in urban areas. In terms of subsistence farming, most smallholder farmers are located in rural areas or former homelands.

2.2. Sampling technique. A purposive sampling technique was used to select smallholder farmers in both municipalities. In sum, 79 farmers were identified at the OR Tambo municipality and 50 smallholder farmers were from the Chris Hani municipality. The farmers were selected based on their activity in terms of farming. Anecdotal evidence pointed out that numerous smallholder farmers were struggling to farm because of a lack of inputs.

2.3. Econometric model. Our study used a binary model to estimate the potential of smallholder farmers adopting biofuels production. The model takes the following form:

Prob(Event) = Prob (*Y*, represents *i*th farmer adoption of biofuel crops, and 0 otherwise)

$$Z_i=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots\ldots\ldots\beta_n+\mu_i, \quad (1)$$

where: Z_i = is the dependent variable; β_0 = intercept term; β_1, β_2, β_3....β_n = slope of the parameters of the model; X_1....X_n = factors that explain adoption of biofuel crops.

The variables used in this study and the expected signs are shown below in Table 2.

Table 2. Variables used in the study

Variable	Definition	Type	Unit of measurement	Sign
Dependent variables				
ADOPT	Adoption of biofuels	Binary	1 = aware & 0 otherwise	
Independent variables				
Gender	Household gender	Binary	0 = Female & 1 = Male	+/-
Age	Household age	Continuous	years	+/-
Qualification	Household education	Continuous	Level	+/-
Utiland	Utilization of land	Binary	0 = yes & 1 = no	+/-
Farmexpe	Level of farming experience	Continuous	years	+
Hhincome	Household income from agriculture	Binary	0 = yes & 1 = no	+
Memberass	Member of association	Binary	0 = yes & 1 = no	+
Contactext	Contact with agriculture extension agents	Binary	0 = yes & 1 = no	+
District	Municipalities	Binary	0 = OR Tambo & 1 = Chris Hani	-/+
Incentives	Whether a farmer receive incentives	Binary	0 = yes or 1 = no	

3. Results and discussions

The study revealed that the sampled farmers who were males made 53 percent of the sample, and the remainder were females. This represents the general norm in Africa where most households are male headed or dominated. This finding is consistent with Torimiro and Oluborode (2006) who discovered that male gender usually dominates in rural areas because of farming occupations, and this is a result of the energy demand needed or required by the farming occupation. Similarly, Cheteni (2014) noted that male gender household dominated in the Eastern Cape province. This observation is similar to Montshwe (2006) who discovered that males still dominate in the agricultural sector in South Africa. At least 52 percent of respondents interviewed were between 35 and 50 years and there was presumable driving household decision-making process on the adoption of biofuel crops. The implication is that most households falling in this economically active group are a critical component in the adoption process considering that many youth in South Africa shun agricultural. The majority of respondents had at least a primary education. A total of 54 percent respondents stated that they were members of agricultural associations or societies. Being a member of an association serves as a network where valuable information pertaining to agriculture can be exchanged.

The factors affecting or influencing household decisions on adoption of biofuel crops were measured using the Probit model. The Log Likelihood Ratio (LR) was statistically significant at 1 percent level. This suggested that the model had a proper fit and captured what it intended to measure. This is shown in Table 3.

Table 3. Probit model results

Variables	Marginal effect	Std. err.	z	P>z	[95% Conf.	Interval]	Odds ratio
Age	.0216799	.0385309	0.56	0.574	-.0538392	.0971991	1.275204
Gender	-.006876	.0485206	-0.14	0.887	-.1019747	.0882227	.9960737
Qualification	-.0571195	.0634147	-0.90	0.368	-.1814099	.067171	.4413069
Contactext	.0451892	.0579	0.78	0.435	-.0682927	.1586711	1.885321
Memberass	.0951573	.0562374	1.69	0.091*	-.015066	.2053806	2.633257
Incentives	.1703407	.0477424	3.57	0.000***	.0767672	.2639141	6.827314
District	.050376	.0205909	2.45	0.014***	.0100187	.0907334	1.784115
Utiliseland	-.133808	.0922208	-1.45	0.147	-.3145574	.0469415	.2418014
Hincome	-.0040134	.0221103	-0.18	0.856	-.0473488	.0393219	.9799214
Farmexpe	.107785	.081088	1.33	0.184	-.0511446	.2667146	3.354477
*Note. ***significant at 1% level; **significant at 5% level; *significant at 10% level.*							

LR chi2(11)	49.67
Prob > chi2	0.0000***
Log likelihood	-50.429226

We fit a Probit model on the decision to adopt biofuels on the household and farmer characteristics such as age, gender, contact with extension, membership in association, occupation, incentives and district. The model is statistically significant with a p-value of less than 0.05. Unsurprisingly, the variables such as membership in association, district and incentives given are statistically significant in influencing farmers' decision to adopt biofuel crops.

The coefficient for farmers who are members in agricultural association was positive 0.09 meaning that farmers who were members in association were 9 percent likely to adopt biofuel crops. The coefficient conformed to the expected *priori*, since it was positive in influencing the decision to adopt biofuel crops. The marginal effects imply that farmers who are members in agricultural association have a 9 percent probability to adopt biofuel crops. The odds ratio of farmers who are members in agriculture associations is 2 to 1, meaning that the chances of a farmer adopting biofuel crops are 2 compared to a farmer who does not belong to any association.

The variable representing incentive to adopt biofuels was strongly significant at 1 percent level and with a positive coefficient of 0.17. The marginal effects of the decision to adopt biofuels when given incentives is 17 percent higher in probability. This means that a farmer is 17 percent highly likely to adopt biofuel crops when given incentives, as compared to the one who has not given anything. Similarly, the odds ratio of adopting biofuel crops to a farmer who has given incentives is 6 to 1 meaning that a farmer with incentives is 6 times likely to adopt biofuels than the one with no incentives. Cheteni (2016) found that a number of farmers in Eastern Cape province were willing to adopt biofuel crops, although they were not aware of how the biofuels industry operates.

The marginal effects (0.050376) of the district show that respondents from the Chris Hani district municipality were likely to adopt biofuel crops compared to the OR Tambo district. Furthermore, the odds of a farmer from that district is 1.8 to 1, meaning the farmer is 1.8 times likely to adopt biofuel crops. The major reason of this finding is that the Chris Hani district is one of the targeted semi-arid area for biofuels production. Thus, it may be possible that a number of farmers are aware of biofuel crops proposal, and have made up their minds about producing them.

3.1. Challenges faced by smallholder farmers. Table 4 shows a number of challenges faced by smallholder farmers in the study areas. A total of 98 percent stated that they had inadequate water for farming. This was also limiting their potential to farm a number of crops. Moreover, drought was prominent, especially in Chris Hani municipality. Overall, 85 percent of respondents had met drought before. Some of the respondents had problems in accessing farming equipment. Hence, pest and weeds destroyed their crops. At least 70 percent of respondents stated that they failed to secure a reliable market for their produce or output. Hence, this challenge was reducing their potential to grow in farming. At least 89 percent respondents identified arable land as a big obstacle. The respondents pointed out that without arable land, they will keep struggling to increase their output. The problem of collateral security was evident in a number of respondents, 40 percent of the respondents identified finance as a challenge. Many lending houses or banks were not willing to help farmers without collateral security. This situation contributed to limited output.

Table 4. Challenges faced by respondents

Category	Number of respondents %
Water	98
Labor	68
Finance	40
Arable land	89
Farming equipment	80
Theft	75
Drought	85
Climate change	65
Reliable market	70
Old age	10
Pipes	17
Pest and weeds	82

Reliable market and drought have been an obstacle to farmers for some time. Farmers stated that the distance they travelled to sell their produce was great and this affected their profits. Smallholder farmers usually struggle to access markets, as compared to commercial farmers. Consequently, they stated that usually they sell the produce locally, in many cases, through barter trade. Few farmers identified irrigation pipe shortages as a big problem, especially those staying close to water body sources. The problem they encounter most was fetching water for their farms. They stated that it was a costly exercise and tiresome, because it requires a good deal of labor, which is always scarce, if not expensive.

3.2. Incentives for the adoption of biofuel crops. Farmers identified a number of incentives that they think would improve the adoption rate of biofuel crops. Table 5 illustrates that a total of 93 percent of farmers identified knowledge as a key factor in adoption of biofuel crops. They stated that small scale farmers do not know biofuel crops, hence, one cannot adopt something he/she does not know.

A number of farmers sought more knowledge on a proper description of biofuel crops. Eighty seven (87) percent stated that, if given, farming equipment such as hoes, tractors and so on would adopt biofuel crops. A number of farmers who borrow equipment for agriculture were of the view that the government should chip in and help them. A total of 45 percent farmers identified arable land as the key to adoption of biofuel crops, because the current farmlands were not arable enough. Therefore, an incentive that would increase their land capacity or fertility would be welcome. A deep insight also revealed that land was one of the most important things to smallholder farmers. A number of them pointed to the issue of ownership which they believed affected their level of willingness to adopt biofuel crops. Some were of the view that land tenure security was the main incentive that would improve their chances of adoption, because they did not own the land they farm on.

Table 5. Incentives needed by respondents

Category	Number of respondents, %
Equipment	87
Stable market	63
Arable land	45
Sponsor	67
Labor	50
Knowledge	93
Finance	73

Sixty seven percent of respondents stated that if they get someone to sponsor them, they would be more than willing to adopt the biofuel crops. However, the view was that the government can do this, since the biofuel policy is a government driven process. Furthermore, they identified lack of resources as a serious obstacle affecting them in securing seeds and pesticides; therefore, any sponsorship would be welcome. Apart from this, at least 63 percent of respondents wanted a stable market for their produce in order to adopt biofuels. The grounds were that if the market was unstable, they run the risk of losing more, since they are not sure how the crops will perform. Moreover, having a stable market increases confidence when farming, hence, it is a crucial factor to consider when adopting biofuel crops. Lastly, 50 percent identified labor as a motivator. The notion was that if they got labor, they might use the underutilized land to produce biofuel crops.

Conclusion and recommendations

Biofuels production has the potential to supplement South Africa energy needs if properly executed. However, to fulfil the current mandates as targeted by the BIS, the government needs to focus on adoption of biofuel crops. Focus should be on exploring small-scale production with the view of catering for local energy needs. Land use changes and increases in ozone pollution may be the output of commercial biofuels production. Therefore, localized biofuels production may be of great use to villages in the rural areas.

Secondly, large scale adoption of biofuels leads to land grabbing. Given the complex nature of the land reform in South Africa, the outcomes of such a scenario may be devastating in the long run. The government should consider that biofuels production should not compete with food production. Therefore, biofuels production can focus on second generation biofuels, since the first generation biofuels can add strain in terms of food demand leading to high market prices.

Thirdly, it would be prudent for the government to adopt viable legislation that would ensure that biofuels development is in line with sustainable development. The focus should be on improving the economy, environment and society as a whole. It can be concluded that with regards to biofuels production, South Africa has the capacity to pull a functioning industry especially if when the mandatory blending requirements and prices are sorted. The country has vast sugar plantations that produce surplus of sugar or sugar beet that can be fully maximized. Apart from this, a number of sugar plantations are owned by emerging black smallholder farmers. Therefore, the current route taken by the government is plausible, although empirical results point to a number of omission from the government side. Evidence from the survey pointed that challenges that affect smallholder farmers like lack of inputs have not been properly addressed. Consequently, this may have a negative effect to smallholder farmers, yet, the biofuel industrial policy targets them.

The development of a sustainable biofuel industry in South Africa continues to be accompanied by policy debate on the likely impacts on the society wellbeing. While, this debate has been more dominating in academic circles than elsewhere, it has found some grounding because of the food and fuel nexus. This generally means that in order for the biofuels market to function well, the government needs to iron some problems faced by farmers and create a support structure specifically for smallholder farmers who wish to do biofuel crops. In its quest to support smallholder farmers producing biofuels, the government should not neglect other smallholder farmers rowing non-biofuel crops. By so doing, the government would be reducing chances of diverting food crops to biofuels production. Brazil is a good example of a country that managed to strike a balance between biofuel crops farmers and those not growing biofuel crops. Therefore, learning narratives from other successful countries can help in drawing policies that would create a sustainable biofuels market in South Africa.

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