BIOFUELS – PUTTING TOGETHER THE GREEN JIGSAW

Report on

Capacity Building in South Africa, Namibia and Ghana to Create Sustainable Bio-oil Supply Chains

Selected Biofuels Case Studies from Ghana

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April, 2013

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1.0 BACKGROUND

This study was commissioned by the partners executing the African, Caribbean and Pacific Group of States (ACP) Science & Technology (S&T) project titled "Sustainable Non-Food Sources of Oil". This study was commissioned in March, 2013.

For each partner country some selected biofuels industries reflecting the situation in that particular country. For the current study, initially, six (6) companies were selected, three (3) to reflect the biodiesel supply chain and the other three (3) for the biogas supply chain. However, following the presentation of the preliminary data collected at the Second Accra Workshop (2^{nd} – 4^{th} April, 2013) it was agreed that the data was not comprehensive enough and therefore a search for more stakeholders were to be pursued especially via telephone and allied facilities. Out the numerous contacts made, only two (2) more companies were able to respond to the interview on phone and complete questionnaires were dispatched. The data have been added as such making the overall number of companies studied nine (9).

2.0 SCOPE OF WORK

The following activities formed the basis for achieving the results:

1. Orientation and training for interviewers
2. Scheduling and interviewing the identified stakeholders on the farms and facilities to ascertain the state of affairs at first hand.
3. Presentation of summary of findings at the Second Accra Workshop
4. Compilation of draft report
5. Submission of final report

3.0 SELECTION OF INTERVIEWERS

Two research assistants (RAs) who are attached to The Energy Centre (TEC-KNUST) were selected based on their readiness to travel across the country in the short time needed and at the same time be available for presenting the study outcome at the said workshop.

The names of these persons are highlighted at the cover page of this report.

4.0 THE INTERVIEW PROCESS

For method of interview was preferred to be that of person-to-person and at the locality of the action. This tended to give a wealth of information and understanding surpassing the telephone based approach. For the reason enumerated, the interviews travelled to the locations of all the farms and biogas plants on pre-arranged terms for the interviews.

These discussions or interviews were digitally recorded both in the audio format and some also in the video format. In addition, some still pictures taken of which some are incorporated in this report.

5.0 SUMMARY OF REPORTS

The detailed reports for each company interviewed have been compiled in the various cases presented below (i.e. Case 1 to Case 9).

Out of the nine (9) companies whose representatives were interviewed, four (4) are in the biogas supply chain namely:

1. Biogas Engineering Company Limited
2. Beta Construction Limited and
3. Institute of Industrial Research (IIR)
4. Biogas Plant Tema International School

These companies are all wholly owned by Ghanaians. The activities of these companies include design and construction of anaerobic digestion systems for treatment of varied feedstocks. The digester sizes range from domestic to institutional dimensions incorporating public and community systems.

The remaining five (5) companies were biodiesel supply chain companies and these are:

1. Biofuels Africa Limited
2. Jatropha Africa Limited
3. ScanFuel Limited
4. Tropical Agricultural Marketing Consultancy Service (TRAGRIMACS) and
5. KIMMINIC Company Limited.

Two (2) out of these five (5) companies are wholly foreign-owned, specifically, from Norway whiles another three (3) are wholly Ghanaian owned with the other one being a partnership between a Ghanaian and a foreign companies.

With the exception of TRAGRIMACS which cultivates sunflower, all the other companies are into *Jatropha curcas* cultivation. The models used by each of the companies differ from the other for example, some acquire long-term leaseholds over land whilst others negotiate for the landowners to have shareholding in some of the products from the farms rather yet others explore the co-operative system.

Generally, the biodiesel –based companies are facing financial constraints mainly due to the relatively reduced interest in crop-based biodiesel in the European market coupled with the relatively non-existence of local consumption of biodiesel in Ghana.

It can be deduced that whilst biogas industries appear to the do well in terms of technology diversification, adoption and dissemination, the biodiesel inclined companies have diversified

into food production or is storing its seeds awaiting the next good tide of financial breakthrough or increase in crude price.

Case 1 : Biofuels Africa Limited

Name of reporter: **Mr. George Appiah**

Contact details: **Research Assistant**

The Energy Center

College of Engineering

Kwame Nkrumah University of Science and Technology

Kumasi, Ghana.

Email: **jorgeappiah@onlineta.org**

Period of interrogation: **1 hour**

Methods used in interrogation: **Face to Face**

Voice recorder

Questionnaire

Video recorder

Camera

Stakeholders interviewed- **Mr. Adam Awal**

Land Acquisition Manager

BioFuels Africa Limited,

Tamale, Ghana.

Any permissions / restrictions on use of information- **No restriction**

The Biofuel/energy supply chain

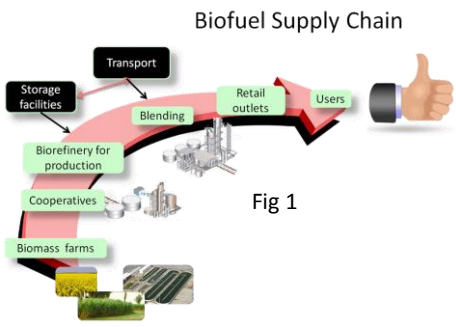


Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Biomass feedstock

Biofuels Africa has their farms located in the Northern and Volta regions in Ghana. In the Northern Region they are located in Tapa, a small community located off the Yendi Road and in the Volta region in Sogakope. They have a total land size of 500 hectares which is

used to cultivate Jatropha. The varieties of seeds were acquired from both India and locally.

Transportation

8 months after their first planting season, the dried fruits were harvested and pressed for the oil. The oil was then sent to Bosbel Oil Company Limited in Tamale for further processing into biodiesel. Farm tractors were used for these transportation activities.

Key technologies used in biorefineries

Farming was purely mechanized from land clearing stage to planting stage. The tractors and other machinery were imported. Up from the beginning of the project there was no contract signed in relation to equipment and machinery. Part of the company's vision was to establish biorefinery plants to process the extracted oil into biodiesel.

Retail outlets and end-users

Biofuels Africa did not get the chance to sell any of their products being it the harvested seeds, the pressed oil or the biodiesel but they had plans and partners in Norway, BioDiesel Norge AS, to deal with the biodiesel sales in Norway.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

BioFuel Africa Ltd. (Ghana), now a subsidiary of Solar Harvest As in Norway which was originally established in 2005 as BioDiesel Ltd. and BioFuel Ltd. Thereafter, BioDiesel Norge AS was established in 2006 to handle planned downstream biodiesel sales in Norway. Further, BioFuel AS was established when Norfuel AS (today Perennial Bioenergy AS) entered as shareholder in 2007. The funding provided by Norfuel enabled the company to secure land, develop a test farm and carry out early-stage project development for large-scale farming.

In March 13, 2009 BioFuel AS filed for bankruptcy. Two of the original founders of the Biofuel group: Mr. Arne Helvig and Mr. Steinar Kolnes purchased all the debt from the liquidator and took over the Ghana operations. The company now operates exclusively as Solar Harvest AS, Norwegian-based parent company to its operating arm in Ghana

called BioFuel Africa Ltd.[1]

In all, the Jatropha plantations and operations lasted for 3 years; from 2007 to 2010.

Contract involved for lease for 154,778 hectares (382,464 acres) of managed land was signed between the Paramount Chief of the Yendi Traditional Area represented by his lawyer and BioFuel Africa.

BioFuel Africa became the first company in Ghana to secure Environmental Protection Agency (EPA) approval for the planting and cultivation of Jatropha. All new agriculture projects more than 40 hectares in size required EPA approval. After assistance and permission from the EPA, the company was able to obtain the desired land. The EPA permit number acquired was CA002080104 comprise 23762.45 hectares (58718.29 acres) and was registered at Lands commission as 10,696.32 hectares (26,431.18 acres) in April 2009. This goes to show that the company acquired everything legally.

The ambition of the company was to cultivate 17,000 hectares (42,000 acres) by end of 2011. It was expected to yield 35,000 metric ton (MT) per annum Jatropha oil when trees are fully mature in 2013 (equivalent to 652 barrel per day oil production).

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

During the period of crude oil price fluctuation in 2006 and the demand of oil increased, the European companies were looking for alternative oil invested massively in biofuels in Ghana. Biofuels Africa was also driven by this motive of finding alternative source of energy through biofuels. The oil prices then also made it economical feasible for such venture. The company did not have any external motivation or drive their set up apart from fuel drive.

The company were not affected by any external drivers whether positively or negatively.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

The company did not get any support from any investment promotion agency, export promotion agency or trade associations. They did however get some support from the Environmental Protection Agency during that start up stage that is the acquisition of the land.

BioFuel Africa enjoyed support from the Ghana Free Zones Board (GFZB) due to its

exporting activities. GFZB is the exporting agency mandate to enable the establishment of free zones in Ghana for the promotion of economic development, to provide for the regulation of activities in free zones and for related purposes.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

The project was planned to employ a lot of people from the locality. Approximately 400 people were employed initially. Had it not been the collapse of this project more people would have been employed to cater for the growth and demand for more workers. The area in which more hand would have been required was in the production unit that was going to be set up. The company employed women for diverse operations on the farm. Five women were trained tractor operators and one as a mechanic.

The workers were paid very well by the company. They were paid beyond their minimum wage. Security personnel took GH₵ 85. The tractor operators were paid GH₵ 170. Some workers were paid GH₵ 200 and over. Officers were taking home from GH₵300 to 400 and the managers took GH₵1,000 and over.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

The company primary target was to grow Jatropha, process it into biodiesel and export it to other countries to earn foreign exchange. They were not able to get that far before the company collapsed.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

The employees were trained in diverse areas and for different jobs by experts some of which were from Norway. Some of the general training that was not job specific were, how to fight fire and how to protect the farm from such a hazard, how to keep the site clean.

The other trainings which were job specific included training of tractor operators, mechanics, security personnel, and other farm hand. There was no specific training manual that was used to do the training. Mostly they did on the job training. Some were trained to drive and were given drivers licences afterwards. The managers were trained in a series of training by experts from Norway. Most of the sectors were managed by the said people except the area of land acquisition which was managed by a Ghanaian, a local from that area.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

The land belongs to the community, but held in custody by a traditional chief system. Also called stool land (or more correct skin-land in the North region of Ghana) All contracts a subject to an internal consultation between chiefs, elders and opinion leaders.

The local stakeholders involved in this project were included the local chief, the paramount chief and the overlord of Dagbon and the people in the community there were other governmental stakeholders like the Environmental protection Agency (EPA), the Forestry Commission of Ghana, Yendi Metro Assembly, Ministry of Food and Agriculture (MOFA). The local stakeholders were involved in the acquisition of land and the governmental bodies were involved to make sure that that the right policies were being followed accurately.

The communities were represented by the chiefs and the farmers whose lands were sought were led by selected representatives to speak for them. Meetings were held whenever it was necessary until the lands were acquired.

Before the farming started, the land was cleared and bare. It was used by local farmers. The land had been exhausted. As it is in practice when a farmer clears a land n leaves it for a long period of time and later sees that the land is being used, the farmer usually comes forward to claim the land. The heads of the company saw Tapa chief explained to him their intent and they were directed as to how to proceed. The company organized a land owners training and the chief attended. They proceeded to the paramount chief where agreements were signed him and his lawyer. The lawyer prepared the lease agreement and it was sent to Overlord for approval. Therefore land acquisition was legal. According to the EPA, in acquiring a land, one has to do a community forum and in view of that a bus was rented and the people were transported to the venue. The governmental stakeholders were all invited and were present. After the EPA permit the company was granted the right to operate.

When the company started there were conflicts among the people on land issues and these were solved. And there was also an issue of how the people were employed. Some complained that the staffs were from one particular community and it brought a conflict and because of that the company introduced a number of community company committee where two people represented the community. There was a total of 8 communities plus 2 representatives of Biofuel Africa ltd created a committee of 18 representatives. This curbed the conflict because when more people were to be employed, this committee was contacted and people from each community were brought

forward to be employed.

There was an existing farmers' conflict. When the Jatropha farms were started, these farmers started farming on the land and it is part of the EPA requirement to deal with existing farmers. There was a meeting to resolve the issue. They were relocated to lands with rich soil. The lands were cleared and ploughed for them. The farmers had to select two people to lead them and send their grievances to the management.

The other benefits to the local people included; Job opportunities, water dams, plowing new land for indigenous farmers, maize grinding mill, water dams, plowing new land for indigenous farmers, maize grinding mill, spin-off micro industries.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

The establishment of the Jatropha farm did not record any negative impact on the availability or prices of food on the market. Food production was improved because larger lands were ploughed for farmers whose lands were used to grow Jatropha and had to relocate to another site. Farmers with 2 acres ended up getting 5-10 acres of land to farm on. Crops produced were maize, rice, ground nut and yam. No one complained of shortage of food.

This Jatropha farm remained the only farm at the start to the end of the project. The other farmland owned by individuals continued to be used for its intent that is to grow food crops

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

The BioFuel dream did not materialize and unfortunately the company collapsed during the Global crisis season from 2008 to 2009. Every operation on the farm was mechanized and everything went well. If the company gets enough funding the project will pick up from where they left off. The only constraint will be to assure the chiefs all over again because when the project stopped they thought it was for a brief season and things will be back on track. They were all disappointed because they had anticipated a comeback.

Also recommendation was made for the drafting and implementation of a biofuels policy. This he believed will allow, attract and protect foreign investments into the biofuels sector. As it stands right now the country appears unpopular for chasing out investors in the biodiesel industry with unfair criticism as claimed by some of the foreign investors. The former CEO of Biofuel Africa, Mr. Steinar Kolnes was quoted saying that civil society organizations in Ghana had scared away investors with "unfounded allegations" about how the land was acquired.

"We have not taken anybody's land by force," he said in a telephone interview. "We buy the lands from the chiefs and the real owners based on transparent negotiations."[2]

This was after coming empty-handed after a recent search for European investors in his Ghanaian Jatropha enterprise.

Case 2 : KIMMINIC Company Limited

Name of reporter: **Mr. George Kwadwo Appiah,**
Research Assistant,
The Energy Center,
College of Engineering,
Kwame Nkrumah University of Science and Technology
Kumasi, Ghana
+233249336773

Email address: jorgeappiah@onlineta.org

Time of interrogation: **1 hour and 30 minutes**

Methods used in interrogation: Face to Face
Phone conversation
Emails

Stakeholders interviewed – i) Mr. Agyei,
Senior Farmer manager
ii) Mr. C. Marfo,
General manager
Kimminic Corporation
+233200796635

Any permissions / restrictions on use of information

The Biofuel/energy supply chain

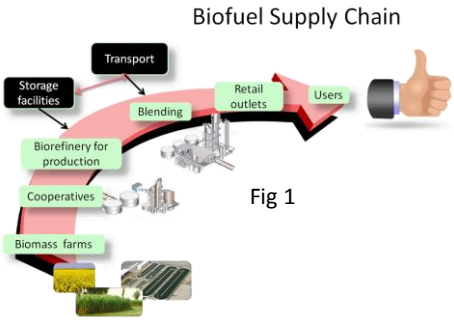


Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Biomass feedstock

KIMMINIC Oil Ghana Limited is into the cultivation of Jatropha plants for the production of biodiesel. They were obtained from Onua Amoah's Jatropha company in the Central region. The farms are located in Bredi, Yeji, Pran, Atebubu and Dormaa Kesse, all in the Brong Ahafo region of Ghana.

Transportation

The harvested seeds are transported by trucks to their various warehouses for storage. Three of the warehouses are located on their farm in Bredi and two at Yeji.

Key Technologies Used in Biorefineries

The company had established a factory in Yeji in the Brong Ahafo region and was preparing to further process the seeds into biodiesel.

Retail Outlets and End-users Including and International Export Market

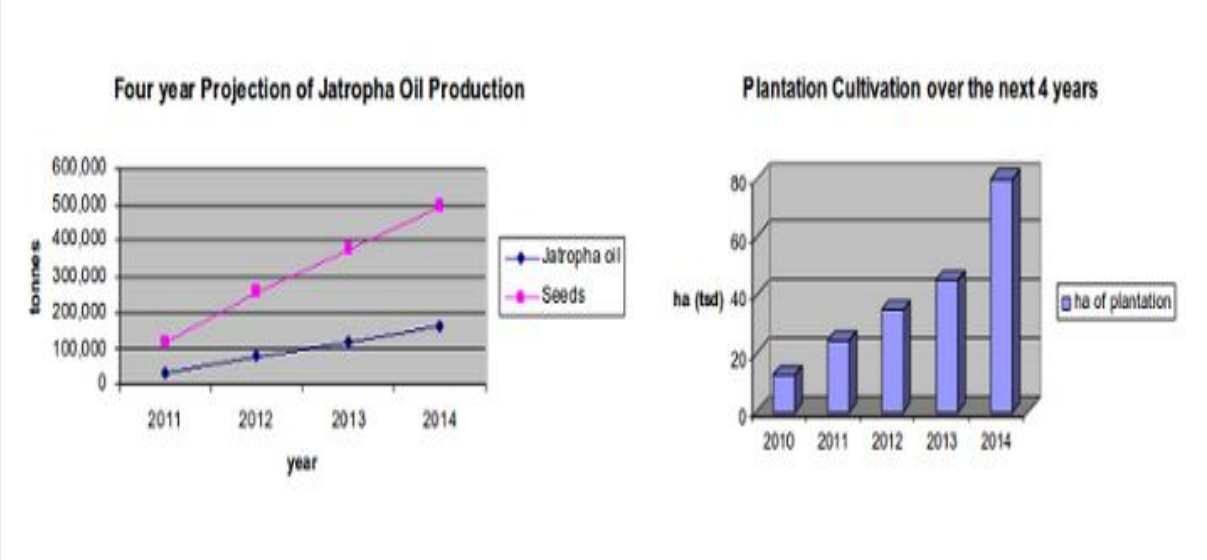
The company did not have the chance to sell or export any of the products.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

KIMMINIC is one of Africa's largest Jatropha biofuel enterprises. The company, whose head office is located in Canada, was incorporated in 2007--the same year that plantation operations commenced in Ghana. The company was financed by the CEO, Dr. George Amposem.

KIMMINIC Corporation, through its wholly-owned subsidiaries; Kimminic Estates Limited, Kimminic Oil Limited and Kimminic Logistics Limited cultivates, extracts, produces and transports crude plant oil, biodiesel and organic fertilizer from the non-edible perennial plant *Jatropha curcas*. The business model was that each subsidiary is independent meaning they have their own management and earn their own profit. For example if KIMMINIC Logistics transports the seed to the factory, it will be paid by the production unit.

KIMMINIC plantations are designed and developed to comply with European standards and with the Global Roundtable Conference on Sustainable Biofuel. To date they have close to 10,000 hectares planted (15 million trees) on wooded savannah land. The management had plans of expanding to 65,000 hectares (97 million trees) over the next four years. They had anticipated that the biodiesel production will grow from 30,000 tonnes in the first two years of operation to ultimately more than 150,000 tonnes annually. But these visions were not met since the company has paused production due to a short term financial crisis. Below is a graph that showed their projections over a four year period.



The company started the plantation in Bredi in 2008. Then moved on to develop another one in Pran in 2009 and then to Yeji. In the last two years, they planted in Atebubu and Dormaa Kesse. They have five plantations in all and each has their own equipment to work with.

The equipment used for the whole production was purchased and imported into the country by the CEO and management.

KIMMINIC is committed to utilizing the entire value chain of their Jatropha operations; this includes generating "green" electrical energy to power the oil extraction and biodiesel refining plants. Safety, the environment, and sustainable development are their primary goals.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

There was nothing like external drivers that aided in the progression of the company.

The company was well aware of the environmental footprints and their main concern was with the agricultural land.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

KIMMINIC did not receive any support from investment promotion agencies, export promotion agencies, trade associations.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

The company had the initial plan of creating jobs for the people in the areas that the farms were located. In the Bredi farm, they employed 500 workers, both casual and permanent workers over the period of operation.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

KIMMINIC had one aim and this was to create wealth for stakeholders, shareholders, employees, customers, and the business community and provide economic and environmental sustainability to rural communities in Ghana where our plantations are based.

Since the time it started up to now, the company did not make any profit from their venture. No seeds or oil have been sold for returns on investment.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

The company trained their permanent workers. The casual workers however were not trained. It was mainly on-the-job training that was offered to the latter hence there were no training manuals**.**

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased price

KIMMINIC operates a unique model of joint plantation ownership with the local communities in the Brong Ahafo region of Ghana.

Acquisition of land was through negotiations with the chiefs of the towns. The land was not bought but rather the chiefs have a 25% share in the income when the seeds are sold. Unfortunately no seeds were sold so the chiefs have not made any profit from the land they leased. During the land clearing if there were existing farmers on the land, their farms were left for them so there are food crop farmers within the entire plantation.

Major conflicts of land acquisition and food security were quite minimal due to the engagement of right stakeholders and the proper channel used to acquire the lands.

Existing small scale sustainable farmers whose lands were now been occupied were employed by the company if they wish so or allowed to keep on with their farming activities but with the company benefiting from them as members of bush fire watchdogs.

The locals in the communities where the plantations were established had some good things to say about the company and the venture as a whole. They confess to improvement of the living standards through the jobs which the venture created, directly and indirectly. They also expressed hope and believe of the Jatropha venture to alleviate them from poverty.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices

Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

Since the beginning of this project, there has been no complaint of food shortage or change in market prices for food. There has not been any change in the farm land which is still being used to grow Jatropha. However some parts of farm in Bredi suffered from bushfires.

The other farmers still continue to grow their crops and there is no conflict between food production and growing Jatropha for the production of biodiesel.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

The company plans on resuming production as soon as the financial issues are resolved. In view of that, the seeds are stored until the crisis is over.

Case 3 : Jatropha Africa Limited

Name of reporter: **Miss Rosa Monique Emefa Djangba**

Research Assistant,

The Energy Center,

College of Engineering,

Kwame Nkrumah University of Science and Technology,

Kumasi, Ghana.

Contact details:+233269711265

Email address: larosamongh@yahoo.com

Period of interrogation: **30 minutes**

Methods used in interrogation: **Voice recorder**

Questionnaire

Telephone conversation

Stakeholders interviewed- **i) Mr. Kwabena Yeboah Ampadu**

Administrator

Jatropha Africa

+233249453333

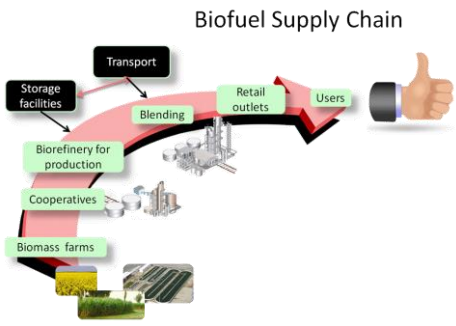
ii) Mr. Ohene Akoto,

Director,

Jatropha Africa

Any permissions / restrictions on use of information

<u>The Biofuel/energy supply chain</u>



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Include details of

a) Biomass feedstock – locations of biomass farms,

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c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Jatropha Africa is into the cultivation of *Jatropha carcus* plant for the production of biodiesel. Their farms are located at Kadealso in the North Kintampo District of Ghana.

After harvesting, the seeds are transported by a ferry using the inland ports in Buipe and Yapei in the Northern region of Ghana to Akosombo and Ada then transported by road to their warehouse in Pokuase in the Greater Accra Region. This is cheaper than using the road from the farm to the warehouse directly.

The company processes the Jatropha by extracting the oil and refining it. They use the heat pressing system whereby the seeds are toasted before the extraction of oil is carried out.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

Jatropha Africa is a Biofuel feedstock company. Their commercial activities include supplying Jatropha seeds for cultivation and for oil expelling. They are not in the business of the processing of the oil into biodiesel. They rely on another company by name Pure Plant Oil for the processing.

The company has a total land size of about 15,000 acres.

The business was created in 2006. The company started in UK. The founding company is Lion Bridge in the UK. The idea for setting up the company was to promote biodiesel in Ghana since it was growing vastly in the developed countries. The company was funded by the CEO to a tune of US $830,000

The seedlings are nursed in nurseries before they are transplanted to the field. The whole plantation practices intercropping. Jatropha can be intercropped with diverse food crops. The company grows groundnuts, pepper and sorghum.

The company adopted a technology from The Netherlands transesterification of its oil.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression e.g. government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

The company did not benefit from any external drivers. Everything they did was supported by the parent company in the UK. Nonetheless, the company benefitted from tax exemptions by virtue of it being a free zone board company.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

The company did not get support from any agency. They are however involved in an African, Caribbean, Pacific (ACP) Science & Technology project which is still on-going.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

The company anticipated job creation for the citizens and this was fulfilled. The company created jobs for about 120 people in the community at the start-up. These workers included both permanent and casual workers. Currently, it employs 20 permanent staff and an unlimited number of casual workers depending on the stage of the production.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

The company has made some returns on its investments and has provided energy access to the poor communities in its catchment area. The company created wealth for the community where they sited their farms.

This business was created to help solve issues of climate change which it is still in the process of attainment.

The company managed to export some of the seeds to another company in Japan. However, it is yet to achieve its business goal and targets.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

The workers for the company were trained in their various disciplines. The training however was on the job. They did not develop any manual or used a pre-existing one. Both men and women were trained.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

The stakeholders that were involved in the beginning of the project were the land owners and the people in the community. The land owners became the equity shareholders of the company after the rightful documents have been signed. Any profit that was accrued was to be shared amongst the shareholders. Their involvement in the operation was very commendable. One of the two managers on the farm was the son of one of the land owners

The people in the community were represented by their chiefs. Communication with the people was made possible as and when it was needed. The citizens were very excited to be part of the project. They anticipated so much from it and they were not disappointed. Jobs were created and some of the previously unemployed were recruited and earned some income.

The setting up of the farm did not bring any conflict amongst the people. Everything was done in the right way and guidelines and procedures were followed.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

Due to the fact that the company practices intercropping the Jatropha with food crops, there was no shortage of food on the market. Food prices did not go up either. The food crops are given to the workers as incentives and this goes a long way to reduce the money they spend to buy food.
There was no prominent change in the usage of the land. No new farms were established in view of this company's enterprise

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth*

The company intends to continue with growing Jatropha. They are however beginning the production of cassava under new management. This new venture is still going to help in the biofuel industry since they intend to sell the cassava to Guinness Ghana Limited to manufacture beer and the residue can be fed into a biogas plant to produce gas.

Setting up a biodiesel company is capital intensive and so before anyone goes into the business that person should have the necessary funding.

Case 4 : ScanFuel (or ScanFarms) Ghana Limited

Name of reporter: **Mr. George Kwadwo Appiah,**

Research Assistant,

The Energy Center,

College of Engineering,

Kwame Nkrumah University of Science and Technology,

Kumasi, Ghana.

Email: jorgeappiah@onlineta.org

Period of interrogation: **1 hour**

Methods used in interrogation: **Voice recorder**

Questionnaire

Video recorder

Camera

Stakeholders interviewed- Mr. Michael Eshun

Chief Operations Officer

ScanFarm Ghana Limited

6th Avenue, House No. 27, Block C

P.O. Box 15

Agogo, Asante Akyim, Ghana

Tel: +233 26 214 6770

+233 20 434 2694

Email: me.scanfarm@gmail.com

Permission was given for voice recording, visitation to the farms and the use of other media recordings.

<u>The Biofuel/energy supply chain</u>

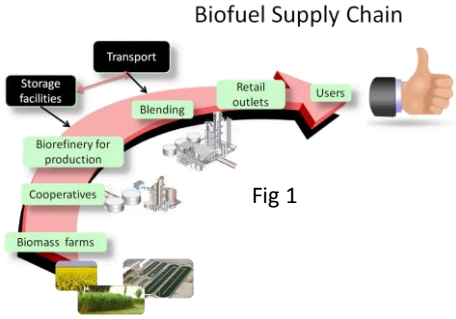


Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

ScanFuel Ghana Limited (ScanFarm) as the company was formally known could be classified as a biomass feedstock producer (farmers) on the biofuel supply chain. With the objective of further processing the seeds into biodiesel (biorefinery).

The company is located at Agogo in the Ashanti Region but the farms were located at Dukusen also in the Ashanti region. The main feedstock used was Jatropha, a Malaysian variety.

The harvested seeds were transported for storage and further to the harbour for export by the use of vehicular transport.

ScanFuel initially planned of using mechanized farming, they invited experts from France to do some feasibility on the use of the mechanised farming. Planters were used for the initial planting of the Jatropha seeds but upon further studies it was realised that the plants were mechanically shocked which affected their yield compared to the ones planted manually. About 350 hectares were manually planted. The experts from France also tried to find ways which they could harvest the fruits mechanically but recommended the use of human labour after considering all options available.

Processing plants were not purchased therefore no biorefinery technology was involved.

The investors from Norway were from oil based industries so the whole idea was to have the plantation, process and export the crude oil to Norway where the was an existing market for the biofuel. After one year of operation only one export of Jatropha seeds was made to Norway.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

ScanFuel Ghana is a private, limited liability company incorporated in Ghana under the Companies Code, 1963 (Act 179). Its office is now in Agogo, Ashanti Region. The primary objective of ScanFuel is to invest, build and operate large plantations to produce biofuels, vegetable oils and food products.

The Norwegian company, ScanFuel AS Norway was co-founded by Thor Hesselberg and three others in 2007 and had its Ghanaian subsidiary, ScanFuel Ghana Ltd, registered the same year. The founders and investors are from the Norwegian oil & gas sector. The company has able to raise $12m for the initial seed funding.

The company planned of investing more than $500m in Ghana in the next 10 years. ScanFuel's operation started in November 2008.

Through its Ghana subsidiary, ScanFuel Ghana Ltd., acquired 400,000 hectares* of land in the Asante Akim North Municipality of the Ashanti Region to plant Jatropha for the production of biodiesel for export. About 60 percent of the 400,000 hectares* of land was reserved for biofuel production, "not less" than 30 percent for food production and the remainder for biodiversity buffer zones [2].

Initial lease contract or agreement was signed between ScanFuel and the Paramount Chief of Agogo, Nana Akuoku Sarpong. All of its operations and permanent employees were all signed on contract.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these*

may have influenced the way in which the project has developed.

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

During the period of crude oil price fluctuation in 2006, the European companies looking for alternative oil invested massively in biofuels in Ghana. ScanFuel was also driven by this motive of finding alternative source of energy through biofuel. The oil prices then also made it economical feasible for such venture. The company did not have any external motivation or drive their set up apart from fuel drive.

Ghana has no policy, regulations nor structures in place for the biofuels industry now and then making it had to support and regulate the biofuel industry.

The major constraining factor which influenced their operations was mechanised farming. Much land could not be developed on a large scale. Also land acquisition issues and concerns about food security from non-governmental groups. The size of land that could be developed was limited due to the cost of labour that will be needed and the efficiency of use labour force. Planting and harvesting has to be done by hands (manually). These really slow down development of the operations of ScanFuel.

Land acquisition and resettlement of old farmers hampered the early set up and growth of the company. Extra money and time had to be spent on compensating of farmers originally on the land.

Finally the acquisition of such a huge land triggered the debate about food security and pressure from NGOs. This made the venture appear bad in the eyes of the people.

The huge investments from parent company including foreign partners into the venture and the willingness and support from local chiefs really helped to push the ScanFuel Ghana's operations despite all these constraints.

The main technology driver at that stage of land development and farming has to do with mechanised farming. Heavy machines were used to clear the land which made the clearance easily but same cannot be said of planting and harvesting. They have to be done manually which slowed down operation and greatly reduced effectiveness and efficiency.

The main environmental footprint has to do with food security and the amount of land allocated for development. Even though ScanFuel claimed that the lands were marginal land and was not being used or abandoned as at the time of development, they were met with stiff opposition from the local media, some of the local residents and NGOs.

There were claims by some local residents and some of the media that ScanFuel uses heavy agric machinery to clear everything in its way including human settlements, crop farms and economic trees [3].

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

ScanFuel enjoyed support from the Ghana Free Zones Board (GFZB) due to its exporting activities. GFZB is the exporting agency mandate to enable the establishment of free zones in Ghana for the promotion of economic development, to provide for the regulation of activities in free zones and for related purposes.

Also, Ghana Investment Promotion Center (GIPC) helped in the initial set up of the company. They are mandated to encourage, promote and facilitate investments in all sectors of the economy except mining and petroleum. They also in charge registering and keeping records of all enterprises and assisting investors by providing support services including assistance with permits required for the establishment and operation of enterprises.

ScanFuel also claimed Environmental Protection Agency (EPA) was aware of their activities. Any company cultivating land size more than 10 hectares is required to conduct an Environmental Impact Assessment (EIA) for approval by the Environmental Protection Agency (EPA).

No direct helped was received from trade association and the government directly.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

The anticipated jobs expected to be created from the project was estimated from 1000 to 1500. During it one year of operation as a feedstock producer, ScanFuel employed around 300 to 400 workers. Mostly locals from the Agogo community. About 150 of these workers were permanent and the casual workers were estimated to be around 250 to 300.

The supervisors and managers were trained agronomist. Their training was not specific to Jatropha so some foreign experts were brought in to train them. 70 out of 150 permanent workers were trained and farmhands were not trained.

For the overall permanent staff, 15% were women and the casual workers were women dominated.

The project had huge private investment so all the activities were paid for including compensation of local farmers.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

By 2015, ScanFuel intended to produce, when it comes to oil, 5,000 barrels per day, roughly 300,000 metric tonnes of crude oil (equivalent) per year.

But after first harvest, they did not get much feedstock/harvest. The turnout was not sufficient to even pay for the cost of labour and maintenance making the venture not profitable.

The biofuel project brought employment to the people of the area and helped to improve their standard of living.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

The supervisors and managers were trained agronomist. Their training was not specific to Jatropha so some foreign experts were brought in to train them. 70 out of 150 permanent workers were trained and farmhands were not trained. For the overall permanent staff, 15% were women and the

casual workers were women dominated.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

There were a lot of stakeholder meetings held at the paramount chief's palace with the local stakeholders made up of paramount chief, sub chiefs, area community leaders etc. Stakeholders involved also included World Vision, the Forestry Commission, Ministry of Food and Agriculture (MOFA),The Centre for Research and Technology (CERTH). A public forum was held where the stakeholders briefed the participants on the company and with all the necessary information.

Meetings with local stakeholders were done as and when there were issues. These meetings helped in resolving differences and issues.

The major conflicts have to do with food security and land acquisition. Food security issues brought a lot of conflicts and criticisms from both local and international media including NGOs like Friends of the Earth. Their concern was the large stretch of land been used to grow a non-edible crop and that the Jatropha also degrades land.

ScanFuel was also tagged as land grabbers by some locals and NGOs. They were accused of driving locals from their settlements and destroying their farms. This did not really go down well with some foreign investors and partners but was later resolved.

Land compensation issues per the original agreement were to be handled by community stakeholders i.e. the traditional rulers. This agreement was not followed by the traditional rulers so ScanFuel had to handle the conflicts itself because it was delaying its operation. Payments and compensation paid to farmers was then deducted from annual rents paid to the traditional rulers.

Initially though there were mixed feelings about the whole project. Some people argued that their lands were been grabbed and those who were for the project said that the land had been abandoned for some time now and were used so should be allowed to be developed for revenue and employment.

Some of the unintended consequences of the project was the sudden upspring of food market by women to sell food to the workers on the farmers. This also creates another source of income and

employment for the locals. Some women were also trained as tractor operators.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

Before the Scan fuel started operation there were no active farming going on the assigned lands. These lands as claimed by ScanFuel were abandoned and that their operations did not affect the availability of food.
Friends of the Earth, an NGO group, had different thoughts about it and were worried about the size of land to grow a non-edible crop and that the Jatropha degrades land.
There was no evidence to back their claims and also that of availability of food price or increase in its prices.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

In 2009-2010 the prices of crude oil went down and its demand was vanishing. The seeds that were sold did not yield enough money for maintenance. A company in Burkina Faso that bought some of the seeds wanted ScanFuel Ghana to operate the farms for them when they decided to quit but they declined because it was not economically viable. ScanFuel Ghana was willing to let them have the farm and give them a percentage of the earnings but the companies did not also agreed to that.

ScanFarm as the company is known now doubt and strongly believes that there is no way it will be persuaded to go back to biofuels plantations. They advised individuals or companies willing to venture into biofuel should be care of land acquisition and it related issues citing that our land tenure is not the best. They also advised that mechanised farming should be opted for if individuals or companies seek to maximise profit.

Case 5 : Tropical Agricultural Marketing Consultancy Service (TRAGRIMACS)

Name of reporter: **Miss Rosa Monique Emefa Djangba,**

Research assistant,

The Energy Center,

College of Engineering,

Kwame Nkrumah University of Science and Technology,

Kumasi, Ghana.

+233269711265

Email address: larosamongh@yahoo.com

Time period of interrogation: **30 minutes**

Methods used in interrogation: **Face-to-Face Interview**

Voice recorder

Questionnaire

Video Camera

Telephone conversation

Stakeholders interviewed- **Mr. Issah Sulemana**

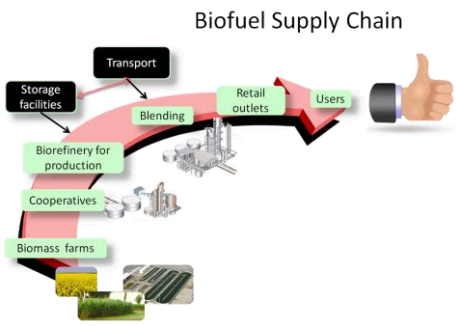
Chief Executive Officer

Tropical Agricultural Marketing Consultancy Service (TRAGRIMACS)

+233208135861

Any permissions / restrictions on use of information

<u>The Biofuel/energy supply chain</u>



With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Fig 1

Tropical Agricultural Marketing Consultancy Service (TRAGRIMACS) is solely into the cultivation of sunflower for biodiesel production. Therefore, sunflower the main and only feedstock. The farms are located in the Northern and Central regions (specifically in the Gomoa East district) of Ghana. The headquarters is located however located in Accra. After harvesting, the seeds are threshed and winnowed on site and then transported via a vehicle to the headquarters for further processing. Oil is then pressed from the seeds using screw press. The oil is converted into biodiesel using transesterification process. The end product (i.e. biodiesel) has not been so far sold on commercial basis. The production so far has been on a pilot program basis. The oil was sent to the Ghana standard board for testing and proven as such by meeting the standards thereof. Some of the biodiesel is used to fuel the tractors on the farms. Also the Energy Commission of Ghana also has been supplied with some for fuel testing demonstration purposes. The Volta River Authority (VRA) was given some to power their machinery which proved successful. The challenge that was emanated from that exercise with VRA was that the request for constant supply of a certain quantity of the biodiesel could not be met by the

company because the latter does not have capacity to meet the demanded supply.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

TRAGRIMACS was created in 2003.

The CEO, who is the brain behind the company, has a degree in agronomy so the sunflower is only one aspect I am a commercial farmer both plantation and field crops. When the sunflower production started, the initial plan was to supply the extracted oil to the fish processing companies that uses sunflower oil to prepare fish flakes for export. As time went on, the focus shifted to mitigating against climate change thereby producing biodiesel from the oil rather. The company therefore collaborated with the Global Environmental Facility (GEF) in Ghana. It was a small grant project worth US$25,000.00.

The money was used to buy the biodiesel processing plant for the pilot project. But even the money for the reactor was not enough and the company had to generate about the same amount as that provided by the grant to push the pilot programme further.

Before planting began, a lot of trials were carried out with Ghana's Council for Scientific and Industrial Research (CSIR) and Crop Science Department of the University of Ghana. In developing agronomic practices, disease and pest controls. These were used to implement the project. In the processing of the oil, the company collaborated with the Departments of Chemistry and Chemical Engineering at Kwame Nkrumah University of Science and Technology (KNUST) for the biodiesel production.

The company plant about 500 acres a year. The banks were not ready to support the project. Getting the funding was very difficult for the company and the CEO had to resort to personal funds.

The project is self-financed through the companies own resources. The company was able to sell some of the oil and the pressed cake to poultry farmers to prepare chicken feed.

TRAGRIMACS did not go into any form of agreement with any equipment suppliers. The only document that was involved here is the warranty that comes with the equipment purchase.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression e.g. government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

There was nothing like external drivers that aided in the progression of the company.

The company was well aware of the environmental footprints and their main concern was with the agricultural land. They used the project to reclaim land because sunflower does well on marginal lands. In the central region for example, the land there are degraded lands the people have worn out. After harvest, the residue is ploughed back into the soil which is a source of nutrients. Inorganic fertilizer is applied to the crops during planting.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

TRAGRIMACS did not receive any support from investment promotion agencies, export promotion agencies and trade associations. The only government agency they were involved in was the Ghana's GEF which helped with the grant of US$25,000.00.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe*

whether the mix of paid and unpaid activities changed after the project began

The company planned on creating jobs for the people in the areas that the farms are located. In view of this, at any given time during the production cycle (i.e. from the cultivation stage to the biodiesel production stage) the company employs at least 40-50 people.

Overall, the company has staff comprising of 4 permanent and 400 casual workers. The 4 permanent workers were trained on the various project units and some of the casuals workers were trained as tractor operators.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

There have not been any biodiesel sales. It was at early stages of the company's life that the extracted oil was sold to the fish processing industry and the pressed cake sold to poultry farmers.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

The company trained its permanent workers. However, most of the casual workers however were not trained formally. The form of training was mainly hands-on or on-the-job training and hence there were no training manuals.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

The lands that are used for farming are all family lands. The families pay homage to the chiefs so they do the negotiations on behalf of the families. There have been conflicts and sometimes the company had to threaten to take them to court because there has been a transaction between the company and these individuals in the form of payment

of sums of money. There is no signed agreement that the land has been leased the company. There have to be meetings as times as is needed to resolve each case.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

Since the beginning of this project, there has been no complaint of food shortage or change in market prices for food in the farming localities. There has not been any change in the farm land and the same lands are still being used to grow sunflower. The other farmers still continue to grow their crops and there is no conflict between food production and growing sunflower for the production of biodiesel.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

"If I was to do this again I will make a lot of changes on the planning. I have learnt a lot from the pilot scale activities of the company. The company is envisage to go commercial now and needs bigger equipment but the funding is now the problem"

If the decision is taken to use palm oil as feedstock for biodiesel production, then owing to the fact that a gallon of palm oil costs GH¢12 and a litre is approximately GH¢3 . If this is compared to the cost of diesel now (approximately GH¢2.07 per litre), it can be deduced that it is not economical. Considering, Jatropha as the feedstock, it can be realized that the oil content is not competitive with other feedstock and the crop itself has agronomic problems that makes it difficult for cultivation on a large scale. The yield is low and it does not grow on marginal soils. Furthermore, Ghana does not grow much groundnut and the citizens prefer to chew coconut instead of using the copra oil to produce fuel. For sunflower the oil content is 35-40% with a gestation period of 3 months and it is drought tolerant. In view of all of these, this company strongly recommends the cultivation of sunflower for the production of biodiesel.

Case 6 : Biogas Engineering Limited

Name of reporter: **Miss Rosa Emefa Djangba,**

Contact details: **Research Assistant,**

The Energy Center,

College of Engineering,

Kwame Nkrumah University of Science and Technology

Kumasi, Ghana

Time period of interrogation

Methods used in interrogation: **Voice recorder**

Questionnaire

Stakeholders interviewed- Dr. Elias Aklaku,

Chief Executive Officer,

Biogas engineering Limited (BEL),

Kumasi, Ghana

Permission was given for Voice recording and its usage.

<u>The Biofuel/energy supply chain</u>

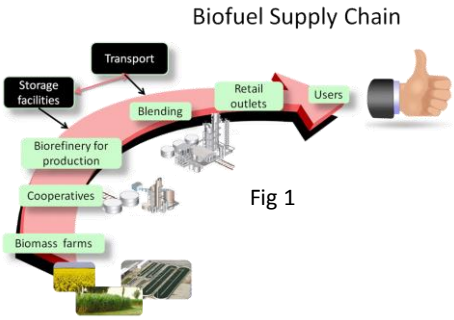


Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Biogas Engineering Limited (BEL) is involved in a number of biogas projects in the country mostly as a consultant or constructor. However they have their own biogas plants located in Bole, in Northern Ghana and in Accra, at the Food Research Institute.

The biomass feedstock used for the biogas plant at Bole is the waste from the production of shear nut. Other biogas projects like the Adieso HPW in the Eastern region uses waste from pineapples, mangoes, bananas and coconuts as feedstock. This enables the company, Adieso HPW, to generate enough biogas to run its generators. BEL also has a similar plant at Natures Best, another fruit processing company.

As the feedstocks are produced mostly at the same location as the biogas plant, the workers just carry the feedstock with head pans to the plant. They also have a tractor with trailer which they use

to go around similar companies who do not have a biogas plant and they bring the waste to their plant.

The key technology used in the biogas production is the anaerobic digestion of biomass feedstock. The overall process is achieved with modification to the already existing biogas technology.

BEL has a number of end-users who contracted them for the construction of the biogas plant and it also in a number of partnership deals with other institutions. Some these include HPW AG, Natures Best (Ghana) and Cocoa Research Institute of Ghana (CRIG).

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

Biogas Engineering limited (BEL) was established in 2002 by Dr. Elias Aklaku with main purpose of converting waste into energy. With over 20 years knowledge and experience gained from lecturing at the Kwame Nkrumah University of Science and Technology, he started BEL. BEL has already installed 18 biogas plants and with a partnership ownership of one plant Bole with CRIG which also serves as a learning centre. BEL mostly uses brick-based digesters to install fixed dome and bio-toilets.

Focusing on its plant at Bole for this case study, the plant was constructed in 2007 on a pilot basis with an estimated size of operation being two bags of kernel per day. Each bag weighs 80 kg which producing 24 kg per bag of shear butter. The price per bag is 3 Dollars per kilo. This generates 47,550 US dollars per year.

The total size of the plantation is 6,700 hectares. The plantation belongs to CRIG with BEL owning the biogas plant and the learning centre. There exists a written agreement to back legally the joint partnership. The partnership is known as Private public partnership.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

BEL was started with the sole motive of turning waste to energy without much external drivers to push for its establishment. Without, external drivers and support from the government barely exists.

The popularity of the founder in the biogas industry and his academic background seems to be his main advantage in securing funds for projects and contract for biogas construction. BEL also have the reputation of designing and constructing relatively cheap plants which is a major advantage for the company considering the high cost of a biogas plant. In Ghana, the cost of building biogas plants range from GH¢2,200 – GH¢4,000 (USD 1,549–2,817) for a 6m^3 digester, and from GH¢3,000– GH¢6,000 (USD 2,113–4,225) for a 10 m^3 plant. From the preceding information, the unit cost of biogas plants roughly lies within the range Gh¢333.3– GH¢633.3 (USD 235–446) per

cubic meter.

The constraining factor of BEL which is hampering further development as a company is the fact that the founder is still not yet into full scale biogas dissemination due to other commitments.

BEL cited its unique adaption of the existing biogas technology as its main advantage in the biogas industry in Ghana. And for the Bole project, where the biogas exists as part of a shear butter processing venture, one of the company's aim was to eliminate the use of firewood, something which has been achieved. They generate energy from the waste which gives them the competitive edge over above their competitors in the shear butter industry because they have to look for energy for processing the shear butter.

This also helps in preventing pollution of water bodies and the environment as a whole due to indiscriminate dumping of the waste.

The company cited that their improved processing technology which has been accepted worldwide is now getting funding for its implementation across the three northern regions of Ghana.

And as a matter of fact, the adapted improved technology and methods used at Bole has won a World Bank award for poverty alleviation and its environment impact.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc. that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

Through the Community Based Rural Development Project (CBRDP), a project funded by the Government of Ghana and International Development Association (IDA), BEL has enjoyed some sustainable financial support.

Also, BEL has applied to Council for Technical, Vocational Education & Training (COTVET) Skills Development Fund to upgrade the learning centre at Bole. It will enable them in training women from all the three northern regions of Ghana.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

BEL currently employs 10 permanent staff at the shear butter processing and biogas plant at Bole. About 8 of the workers are women with two males. The males mainly attend to the manning of the biogas plant. The expectation is to upgrade their capacity to train more women in the shear butter business with the appropriate knowledge about the technology being used. The company also has a number of workers at its various constructed biogas plants across the country.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

The company has plans of expanding its operations. The CEO plans of retiring from academia soon, which will facilitate and enable him to be more committed to the biogas business.

With the plant at Bole, the company seeks to spread its recognised and improved processing technology across the three northern regions of Ghana, where shear nut is cultivated. With plans of getting COTVET on board with funding for training, the CEO believes they can help to improve the lives of many in the northern parts of Ghana where most of the people are poor.

So far, the lives of most of the people involved in the business have improved. Some of them can

even afford to buy motor bikes something which was very difficult for the women to do previously.

The shear butter produced by BEL, as claimed, are grade A which is being used to supply the international cosmetic industry.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

BEL has a learning centre together with its shear butter processing and biogas plant at Bole. People are trained in the practise of their technology spanning shear nut processing to the treatment of its waste to produce energy.

The CEO, Dr. Elias Aklaku was a Senior Lecturer at the Agricultural Engineering Department, Kwame Nkrumah University of Science and Technology (KNUST) with immense experience in agricultural engineering and biogas practises. He is an expert in biogas technology, well-known and respected in that field worldwide.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

The focus of BEL's Bole project is women-centred because the processing of shear nut/butter mainly involves women. The women tend to serve as the main local stakeholders. With the help of CRIG, who had already established themselves at Bole, involvement of the women was not difficult to establish. BEL is not directly in involved with the cultivation of the shear nut but rather its processing. The company is not directly involved in land acquisition with other stakeholders at the moment. But as they seek to spread the technology to other parts of the northern region, they will eventually need to also deal with local stakeholders like land owners, chiefs etc. apart from the farmers and the women.

The community sees this project as an avenue for facilitating the production of shear butter and also an improvement to the old methods of processing of shear nut which they were used to and have to spend a lot of money on purchasing firewood. But now, they can generate the needed energy from the waste produced and thereby keeping the communities clean.

The project has already helped to empower a lot of the women economically and helped to prevent environmental pollution especially water pollution and land pollution.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

The availability of food has not been affected in anyway by this project. Rather, the project has helped the people to reduce their cost of production and the reducing the pollution hitherto being created due to the waste generation. The use of firewood has dropped drastically, helping to reduce the cost of firewood and also to save the little savannah forest.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

BEL seek to expand its operation in the biogas industry in general and train more people mostly students who are interested the biogas industry.

For its operation at Bole, the company plans of spreading their technology across the northern part of Ghana to have the "McDonald's effect" that is, multiplication effect.

Fig. 1: An underground Anaerobic Digester located behind the Processing Hall.

Fig. 2: Left: Section showing connections from the biogas pipeline through the gas meter into the converted dual-fuel engine.

Right: The converted dual-fuel engine showing the gas valve for regulating the gas consumption rate of the engine.

Fig. 3: Processing hall showing some of the processing equipment and sorted shear kernels spread on the floor for aeration before processing.

Case 7 : Beta Construction Engineering Limited (BCEL)

Name of reporter: **Miss Rosa Monique Emefa Djangba**

Research Assistant,

The Energy Center,

College of Engineering,

Kwame Nkrumah University of Science and Technology,

Kumasi, Ghana.

Contact details:+233269711265

Email address: **larosamongh@yahoo.com**

Time period of interrogation: **1 hour**

Methods used in interrogation: **In person (i.e. One on One)**

Stakeholders interviewed- **Nana Kofi Ntiamoah Ahenkorah**

Chief Operation Manager

Beta Construction Engineering Limited,

Accra

Any permissions / restrictions on use of information- **No restriction**

<u>The Biofuel/energy supply chain</u>

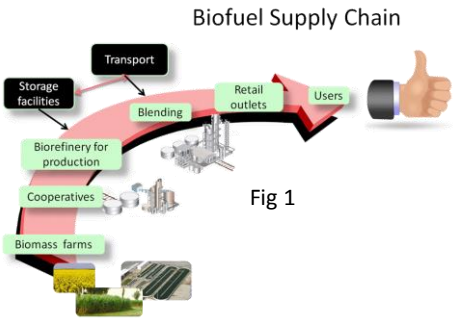


Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Biomass feedstock

The commonest feedstock used is human excreta. Most of the biogas plants constructed are connected to places of human residence. Greywater, waste water generated from domestic activities such as laundry, dishwashing and bathing enter the dome through pipe connections. There are a few numbers of domes that use poultry waste and cow dung. Usually these are combined with human excreta. A lot of experiments have been conducted using over ripe fruits like pawpaw and oranges. There have also been trials involving green grass.

Transportation

The company does not transport the feedstock. It is generated at the site of the dome. There is however a client whose dome is fed with both human excreta and poultry waste. The client visits the poultry farm, fills pick-up truck with poultry waste and every week fills his biogas plant with 75 kg.

Key Technologies Used

There are a lot of biogas technologies available. Beta construction limited uses the Puxin technology originating from China. This technology is a mesophylic system and it involves anaerobic digestion of the feedstock under ambient temperature.

End Users

The end users of the biogas technology supplied by this company are diverse. From individual households to people in a whole community and finally schools and offices.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

The founder of this company, Nana Kofi Ntiamoah Ahenkorah was trained in China by experts in the Puxin technology in 2006. Later and in the same year the biogas business was established. The company has been operating this technology for 6 years now.

With the Puxin method, the biogas plants is composed of a concrete digester and several glasses, fibre reinforced plastic gas holders. The whole system is composed of:

1. The feeding system

2. The biogas purify system (the desulphurization tower)

3. The dehydration tower, the biogas storage and delivery system.

4. Biogas appliances or generators.

Some of the features of the Puxin plant include:

(1) High reliable: no mechanic movement, no mechanic failures.

(2) Wide range of application. The plant can be built both under and above ground. The plant is suitable to handle both liquids (sewage, human and animal manure) and solids (grass, straw, and food waste).

(3) Low maintenance cost: very few workers are needed, almost no maintenance for rust prevention and mechanic repair are needed.

(4) Durable: The concrete digester which can withstand strong acid and alkali can last over 40years, the glass fibre gasholdercanlastover10yearsanditis replaceable when it is worn out or broken.

From the year it was established up to the year 2011, the company established 53 biogas plants and still counting.

The financing of the project was by the founder. Some assistance was received from some people who were interested in the technology. The company being involved in other construction businesses pulled money from those areas as business. Banks were unhelpful in generating the money.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

The company did not enjoy any benefits from the any external drivers neither from the initial stage nor after the business developed. They have themselves been the driving force right from the planning stage.

Knowledge of greenhouse gases and it effect on the atmosphere has been a contributing factor to the companies goals in the sense that they have put in safety measures not to release any gas into the atmosphere. The effluent is taken to the labs at the CSIR to test for its composition. The pH of the gas is also tested using pH indicator.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export*

promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.

The company did not enjoy and support from these said agencies. They however had individuals contacting them to promote and advertise their company for them. However these offers have been put on hold so as to help the people we are working with to understand the concept before the company is advertised.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

On the onset of the project, the head of the company had it in mind to create jobs for people in the areas where the domes are located. They have created jobs for about 1000 people though they have just about 20 salaried workers. Some workers are employed on contract basis hence they are paid specifically do a certain kind of job and after the job is over they leave the company. The company employs casual workers too.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

The project was initiated and financed by a private individual, the difficulty of the project was banks refusing to help generate the needed resources for the project and as a result

the stakeholder had to resort to friends to support the project who were also mostly not helpful. All things going well it is profitable. Challenges with profitability are related to technology transfer. Biogas requires a lot of precision and the current crop of artisans are not trained to do so. This limits the level of profitability and the payback period. Profit was not the focus of this company in the first two years. The focus was drive for acceptability first then refocusing on introductory to growth stage. As a company grows, the financial analysis increases.

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

People are employed where ever the company goes to construct a dome. These workers range from casual workers to permanent ones. There is no training for the casual workers since their job does not involve much.

The permanent workers are trained in their various disciplines. Example is the masons who build the dome.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices.

Stakeholders are engaged in some projects, depending on whom the project is been implemented for. If it is a private person the stakeholder is an individual, if it is a public or an institutional based project, then the project will involve a lot of stakeholders. For instance in a school project there will be a lot of stakeholders like financiers, land owners, depending on the scale of the project there are stakeholder.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.
The impact in the lives of the people varies from person to person. The people are very excited. It is exciting to see your client happy and satisfied. We have given them a good product and they are

content. It is just left with the fertilizer side we have a system where the sludge is dewatered where we get a high solid concentration, we dry them on a sand bed, bag it and sell it to farmers.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

After working with clients for some time, the CEO realised that most of them were not able to specify the design needs and provide him with false information to design the plant. These bring about a lot of difficulties and reduce the effectiveness of the biogas plant. What he intends to do is to put in more factors of safety to improve the life span of the plant.

Case 8 : Institute of Industrial Research (IIR) Biogas Venture

Name of reporter: **Miss Rosa Emefa Djangba,**

Research Assistant,

The Energy Center,

College of Engineering,

Kwame Nkrumah University of Science and Technology,

Kumasi, Ghana.

+233269711265

Email address: larosamongh@yahoo.com

Time period of interrogation: **1 hour and 10 minutes**

Methods used in interrogation: **One-on-One interview**

Voice recorder

Questionnaire

Camera

Telephone conversation

Stakeholders interviewed- **Mr. Gilbert Salomey,**

Research Scientist,

Institute of Industrial Research

Council for Scientific and industrial Research

Ghana

Permission was given for Voice recording and its usage.

<u>The Biofuel/energy supply chain</u>

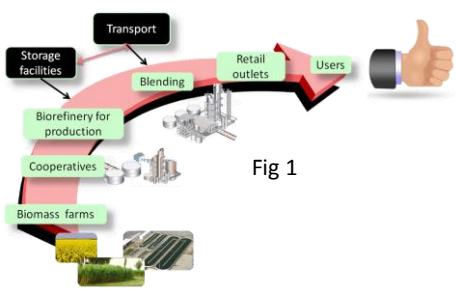


Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

The Institute of industrial Research (IIR) is a subsidiary of the Council for Scientific and Industrial Research and on the biofuels supply chain they can classified as a stakeholders involved in the strategic and operational planning through the mandate for their establishment. They can also be classified under Biogas installers (biorefinery) due to their recent involvement in the construction of biogas for governmental institutions, non-governmental institutions and private homes.

The main feedstock for the biogas production for most of their plants is human excreta. There are also plans of using cow dung for some of the plants especially those with a low yield of the gas.

Currently, IIR have major plants/sites at Adenta community school in Accra, Ankaful Maximum Security Prisons around Cape Coast and Accra Abattoir in Accra. They have also constructed personal plants for some homes in Ghana.

The system has been designed to be self-emptying and self - means, a network is created where the feedstock is convey directly into the dome without human/vehicular carriage and the gas produced is transported into the storage tank through laid pipes.

The key technology used in the biogas production is that of anaerobic digestion. The system is called the mesophylic system because operation takes place under normal temperature 30-40^{0}C.

The end-user is the kitchen for the prisoners at Ankaful site. The gas is channelled into the kitchen though pipes. The system is currently not in full operation due to lack of adequate regular amount of feedstock from the prisoners' waste. The Ankaful prison was designed for 4000 prisoners but as at now there are only 240 hence the waste is not enough to generate the needed gas. The little gas that has been produced so far is stored inside a gas holding chamber and occasionally used in the kitchen for cooking. Recommendation has been made to the owners to try co-charging by adding cow dung with the human excreta since the dung produce more gas than the human excreta and they have a lot of cattle there.

In the case of the Adenta Community School, Rotary Club Ghana (the funders) was interested in producing gas for cooking for the school feeding program. IRR converted the already existing septic tank system into a bio-septic by installing bio-digester system which diverts the waste into the digester but septic tank was kept there so that the bio-fertilizer will be conveyed there. That is another self-charging system.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

The CSIR is a semi-autonomous Corporation with the mandate to pursue the implementation of Government policies on scientific research and development; encourage coordination of scientific research for the management, utilisation and conservation of the natural resources of Ghana; and to advise Government on scientific and technological advances likely to be of importance to national development. Established in its present form in October 1968 as Ghana's premier S & T Research and Development organisation, the CSIR now operates under the mandate of CSIR Act 521 of 1996, which among other things, empowers it to commercialize its research activities. From its Head Office in Accra, the CSIR oversees and co-ordinates the activities of 13 research institutes spread across the country.

The mandate of IIR is to undertake research into process and product design and development, and to promote adaptive technology, scientific instrumentation and calibration, as well as repair of precision equipment. The Institute aims to drive national development and global competitiveness in industry through scientific and technological research.

IIR was established in 1986 and has currently installed about 22 biogas plants and the type of the digester is mostly fixed dome for biotoilets systems [1]. IIR has over 20years experience in the biogas industry. The business model, designs and technology been used has existed for some years. This designs and technology are currently been used in the writing proposals for projects and bidding.

They do the initial design construction of the dome and buy the rest of the needed equipment from Beta Construction Engineers Limited who happens to be the local representative of Shenzhen Puxin technology company in China.

Funding of projects are from either government as in the case of the Ankaful project or private companies as in the case of the Adenta community schools.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

IIR is a government agency, a subsidiary of the CSIR therefore has government mandate for most its operation. They also enjoy financial support for governmental projects like that at Ankaful. Even though they are complains from competitors about whether IIR are mandated to fully participate in the business aspect of the industry apart from research, they see the business aspect as a venue for growth and to make the agency financially stable.

The constraining factor in terms of operations and growth has to do with is tag as government agency and possibly conflict of interest. These factors tend to affect the further development of the business aspect of the institution.

IIR has a team of well qualified engineers, research scientists and industrial designers etc. giving them the competitive edge and the initial customer trust for them to deliver a good work. They also enjoy monetary support from the government.

The adopted technology is that of anaerobic digestion. This is used internationally for most fixed domes and biotoilets. The system is called the mesophylic system because operation takes place under normal temperature 30-40^{0}C.

In terms of curbing sanitation, the operations of IIR have help to improve the sanitation levels in

most houses and institutions where the system has been installed. The system has them deal effectively with the human excreta, helping to keep their communities clean and from pollution. Even though the initial cost for the installation of the system is high, most of the customers confessed that is have been a blessing to them.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

The support enjoyed by IIR is that of a normal governmental support for the daily administration of the institute as a research centre. During government projects, the extra funds that comes in from the government is to finance that particular project which are mostly not enough for profit making.

No other support is received from the any private or no-governmental agency for IIR sustainability.

Profit from the execution of private contracts or consultations on the construction of a biogas plant happens to be their only source for additional income for the sustainability and growth of the institution's business model and its operations.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

As a research centre, information and data obtained on technologies and methods are mostly shared with the other government agencies and private companies interested in the biogas industry. This is really important for individuals setting up a biogas company. This information and data sharing help IIR to indirectly create jobs in the biogas industry.

The institution itself also employs about 10 permanent workers for the three major projects; 5 for Ankaful, 2 for Adenta and 3 for the Accra Abattoir. These workers are all men. They were all trained by professionals from the institute on how to adequately work on the system and manage it efficiently.

Most of the women are employed as casual workers and they are mostly employed during mini projects at the northern part of Ghana to assists in fetching water and the blocks.

The institute has plans of employing more workers as it looks to expand its operation.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

The institute was not initially set up for business in the biogas industry so they do not have a clear business targets and wealth creation plans. Their operation have helped indirectly to improve the lives of many people through the improvement in sanitation levels and the gas generated for cooking which helps to reduce dependency on other fuels like firewood and Liquefied petroleum gas (LPG).

Training.*Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

For construction purpose, masons and technicians by IIR are trained by professionals from the institution on how to adequately work on the system and manage it efficiently. They do not use manuals but sketches on the designs and plans for the biogas system.

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

For community based project, IIR before it starts construction and operation, they meet with District assembly officials of that particular area, these officials will then to lead them to meet with the chiefs of the land for to permission and consultation on their intended project.

Preliminary meetings were organized to inform them about the technology and later followed by site selections before the work starts.

Communication are done mostly by visitations and local stakeholders' durbar. The frequency of the visits depended on the stage of the work.

No conflict has been encountered so far as the right stakeholders were consulted and the right channels were followed.

The expectations of the community and private investors on improvement on sanitary issues and the need of the gas as a fuel have been met so far.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

There is no direct negative effect on agricultural practice and availability of food as the system deals mostly with existing latrines or planned latrines which uses human excreta as feedstock. The land used are not that huge to have a significant effect on the agricultural practice and the availability of food.

The positive effect will be the production of biofertilizers which can be used to improve farming yield.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

IIR has lot of plans about expanding the biogas business venture. It seek to take advantage of the new technologies are created every day in the biogas industry to expand it operation and make

them more efficient and cheap. This, they believe will really help improve the general sanitation problems in Ghana and also help to reduce dependency on other fuels like firewood and Liquefied petroleum gas (LPG).

Case 9: Biogas Plant (Tema International School – Ghana)

Name of reporter

Contact details

Time period of interrogation: *3 hours*

Methods used in interrogation: *One-on-one interview, phone interview, and email correspondence.*

Stakeholders interviewed- title, position in organisation:

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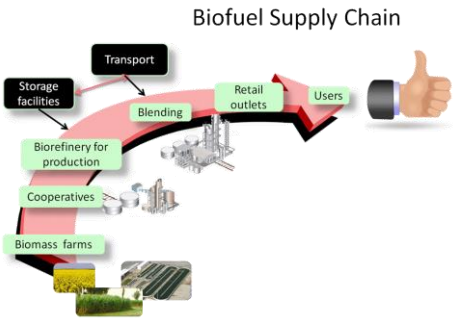
<u>The Biofuel/energy supply chain</u>



With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.

Include details of

a) Biomass feedstock – locations of biomass farms,

b) transportation methods to ship biomass to processing units;

c) key technologies used in biorefineries / blending operations;

d) Retail outlets and end-users, including any international export markets involved.

Tema International School (TIS) is located at Community 22 in Tema (off the Tema - Akosombo road), in the Greater Accra Region. The company, Biogas Technologies Africa Limited, was contracted by TIS to install a biogas plant on the school's premises. The

technology employed for the plant is anaerobic, which results in the production of biogas.

The plant is located within the school's car park (see figure 1 below). The feed stock used by the digester is sewage (from the flush), which is transported via polyvinyl chloride (pvc) pipes from the school's hostel and homes into the digester. The biogas (methane) produced as a result of the anaerobic digestion is stored in a storage tank (balloon; refer to figure 2). The biogas generated is pumped back to the end user through a piping system (copper pipes fixed/embedded into pvc pipes (see figure 3).This biogas is used in the school's kitchen for cooking and also in the school's laboratory.

Currently, neither the liquid fraction nor the solid fraction of the digester biogas is used by the school. Rather, the liquid fraction is allowed to drain way.

Figure 1: A Google map showing the location Of Tema International School and the Biogas Plant

Figure 2: A picture showing the Biogas storage tank (balloon, the digester is located below the tank.

Figure 3: A picture showing a portion of the piping system (arrowed) used to transport the biogas to the school's kitchen and labs.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

The biogas plant was built by Biogas Technologies Africa Limited and funded by the Tema International School. The project took nine (9) weeks to complete. A total of ten (10) workers were employed during the constructional phase of the biogas plant. Out of persons employed, nine (9) were male with one (1) female. The plant has been in operation for the since November 2010 on an experimental basis, while some teething challenges are still being addressed.

The day to day operation of the plant is by the school, specifically the maintenance officer; however, with faults or challenges which cannot be addressed by the maintenance officer, Biogas Technologies Africa Limited is called in to help resolve it.

On average, 30kg of biogas is produced (per day) from 300kg of human waste and 1800 litres of waste water on a daily basis as per the design.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was

local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint

The biogas plant consists of an inlet chamber to the digester, the digester, an expansion chamber and a filtration bed. The installed anaerobic digester, according to the design, needs 300kg of human waste and 1800 litres of waste water in order to generate 30kg of biogas per day. Currently, the carbon dioxide produced is not captured. The school was encouraged to adopt the use of biogas, since it would support the use of liquefied petroleum gas (LPG gas), and reduce the costs of emptying/dislodging the school's septic tank. Furthermore, the use of biogas helps the school carry out their operation in an environmental friendly manner.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

The installation was funded by the school.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

The project took nine (9) weeks to complete with a total of ten (10) paid workers whom were employed during the constructional phase of the biogas plant. Out of persons employed nine (9) were males with the remaining one (1) being a female. On completion of the biogas plant, the everyday operation is by the maintenance officer whom is a regular employee of the school.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*

The installation of the biogas plant has helped the school reduce their cost of operation, with a smaller budget for the purchase of LPG Gas, and the cost of regularly emptying out the original two septic tanks the school had.

Training. *Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*

Expert opinion was sought from Biogas Technologies Africa Limited, (a company which specialises in the construction of waste management systems which process organic waste into energy and fertilizers for use on farms). The company was responsible for the design and the construction of the biogas plant, and the subsequent installation of biogas stoves in the school's kitchen and labs. Upon completion of the project, a manual prepared by Biogas Technologies Africa Limited was given to the maintenance officer to aid him in the operation of the facility.

There was no need to train the kitchen staffs on how to use the bio gas stoves, since it operate on the same principle as stoves which utilised liquid petroleum gas (LPG).

Local community stakeholder groups.

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.

Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.

Describe how frequently case study operatives engaged with community stakeholders.

Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.

Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.

Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

In this case study, the local community stakeholder group(s) were not engaged during the project.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

Currently, the biogas plant is used solely for the production of biogas for the Tema International School. The liquid and solid fractions of the digester are not currently being used as bio fertilizer.

Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*

- Another plant has been constructed in bungalows/flats for the staff of the school. Efforts are currently under way to refine/reduce the smell of the biogas so that, occupants would be encouraged to use the bio gas for cooking in their respective kitchen.

- The design of the toilet system in the school is being looked at, to minimize the amount of water that is used in the flush, and improve the output of the digester.

- Plans are underway to design a more energy efficient biogas stove.