The social impacts of using black soldier flies for bioconversion: a preliminary assessment from South Africa

Prepared by Afton Halloran, PhD

GREEiNSECT: Insects for Green Economy

2018

Funding

This preliminary study was financed by the GREEiNSECT: Insects for Green Economy Research Project.

GREEiNSECT is a research project (2014-2017) supporting research capacity building and scientific studies on insect production systems.

Cite as:
Halloran, A. (2018). The social impacts of using black soldier flies for bioconversion: a preliminary assessment from South Africa. GREEiNSECT: Insects for Green Economy, University of Copenhagen, Denmark.

Contact information:
Afton Halloran (Consultant): aftonhalloran@gmail.com
Nanna Roos (GREEiNSECT PI): nro@nexs.ku.dk
Cameron Richards (AgriProtein): info@agriprotein.com
Marc Lewis (The BioCycle): info@thebiocycle.com

Table of Contents

"Most people put profit at the centre,
but I think that we need to
put the why – why are we doing this? – at the centre."
– Co-founder and CEO of AgriProtein, Jason Drew

Introduction

The use of a select number of insect species for animal feed has emerged as a novel and plausible strategy to address the multitude of challenges facing our food systems. Plundering of the world's oceans has reduced fish stocks (1) and the production of cheap soy has led to devastating deforestation (2). The unsustainable nature of the latter commodities has driven companies, researchers and international organizations alike in search of affordable and nutritionally competitive feed ingredients for livestock (3).

Hermetia illucens – also known as black soldier flies (BSF) – have been singled out as a promising species. BSF are ideal bioconverters as they can convert waste products into larvae that can be used in aquaculture and livestock feed. Furthermore, the process of bioconversion through *H. illucens* is a very attractive option, considering that it represents a valuable solution to two problems: food waste management by generating value and closing nutrient loops on the one hand and, on the other, the rising global demand for sustainable feed sources. Low-value waste streams can be turned into value-added, high-value proteins with co-products.

In Western Cape, the province in which the City of Cape Town is situated, approximately 2.9 million tonnes of organic waste are generated per annum. A 2017 provincial governmental ban will remove all organics from landfill within ten years, with a reduction of 50% over the next five years (4). Another major issue that South Africa faces, like many other countries in Sub-Saharan Africa, is access to sanitation facilities. Three in every four South Africans currently have access to at least basic facilities and 24% of the population uses latrines (5). However, even when access is provided, a growing population and more toilets will lead to an increased amount of human excreta needing to be treated. *H. illucens* pose a solution for the handling of millions of tonnes of organic waste that end up in landfills and the increased need to treat human waste from urine diversion toilets in South Africa each year.

Insects are more efficient at converting food into edible mass because of physiological and biological differences. This means that they emit lower amounts of greenhouse gases when compared to traditional livestock species. At present, seven life cycle assessments have evaluated the environmental sustainability of these production systems (3,4). However, regarding the other pillars of sustainability, no study has systematically evaluated the social sustainability of insect farming. A 2017 study in Thailand indicated that cricket farming provided farmers with an additional livelihood that was perceived as economically rewarding, easier to carry out than other agricultural tasks and suitable for a variety of ages and capabilities (5). Another study in Kenya found that 71% of cricket farmers are women and that insect farming can be a source of economic empowerment (6). Large-scale insect farming companies claim social sustainability and social responsibility but lack the scientific evidence to prove it.

Recognising the social impacts of food production systems is equally as important as the environmental impacts; however, measuring them is a challenge. A social life cycle assessment is a novel methodology that is used to evaluate the social sustainability of processes. However, the assessment of the social impacts of production processes is still at a development stage due to fragmentation and a lack of empirical foundation. A critical reason for this is the absence of general standardized indicators that reflect and measure the social impact of a business along product life cycles and supply chains. Building on this methodology is therefore critical to improving the social sustainability of the agricultural sector.

This report is a preliminary assessment of some of the social impacts of using black soldier flies to transform waste products. The assessment uses the case studies of two companies, AgriProtein and The Biocycle, to assess the social impact of black soldier fly production on workers, consumers, local communities and society. These data provide the foundation for a future social life cycle assessment of large-scale insect production facilities.

Methodology

Goal and scope

1. To understand the social impact of a company using *H. illucens* to convert waste into a valuable feed source;
2. To establish a framework examining the social impacts of commercial insect production that can be used in other contexts;
3. To identify areas of improvement in a new industry under development.

Framework

This study uses the guidelines set out in the *Handbook for Product Social Impact Assessment* (Version 3.0) by PRé Sustainability (6). The Handbook is used to evaluate the worker and community stakeholder impact categories. In addition, the societal stakeholder impact category is discussed in relation to the *Methodological sheets for subcategories in social life cycle assessment* by United Nations Environment Programme and SETAC (7).

This social impact assessment considers AgriProtein and The BioCycle together. The following social topics and sub-topics were included: 1) Impact on workers (health and safety, wages, social benefits, working hours, child labour, forced labour, discrimination, freedom of association and collective bargaining, employment relationship, training and education, work-life balance and employee satisfaction); 2) Impact on the local community (health and safety, local capacity building, community engagement and employment); 3) Impact on society (public commitment to sustainability issues, contribution to economic development, and technology development).

In addition to the stakeholder categories highlighted in the Handbook for Product Social Assessment, a hotspot analysis was conducted on the societal stakeholder group. Primary data were collected during interviews with key stakeholders in November/December 2017.

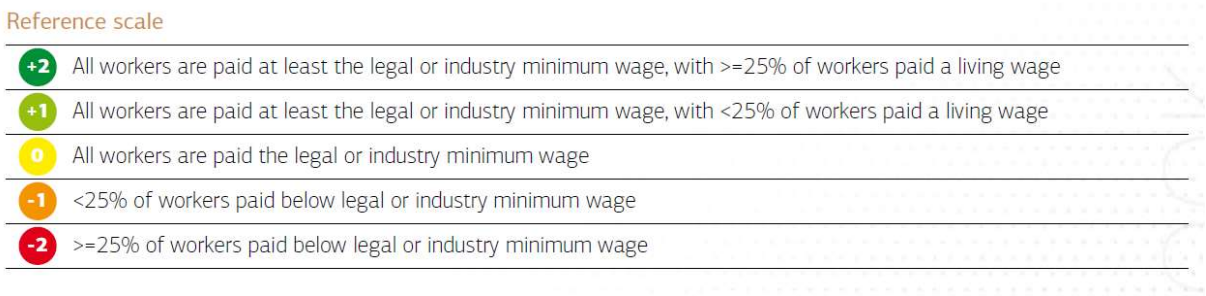
Data collection methods

Data were collected over the course of November and December 2017. A total of 25 open-ended interviews were conducted. Interviewees included: AgriProtein, BioCycle employees and mangement as well as NGO and municipal staff. Additional data came from observation, informal conversations, and reports.

The names of the respondents have been kept anonymous (except the AgriProtein CEO) in order to protect their identities and promote freedom of speech during the interviews.

Scoring

Scores were provided to the sub-topics of the following social topics: 1) Impact on workers and 2) impact on the community. A score was chosen based on which criteria in the reference scale was met. Scoring possibilities ranged from -2 to +2.



Reference scale	
+2	All workers are paid at least the legal or industry minimum wage, with >=25% of workers paid a living wage
+1	All workers are paid at least the legal or industry minimum wage, with <25% of workers paid a living wage
0	All workers are paid the legal or industry minimum wage
-1	<25% of workers paid below legal or industry minimum wage
-2	>=25% of workers paid below legal or industry minimum wage

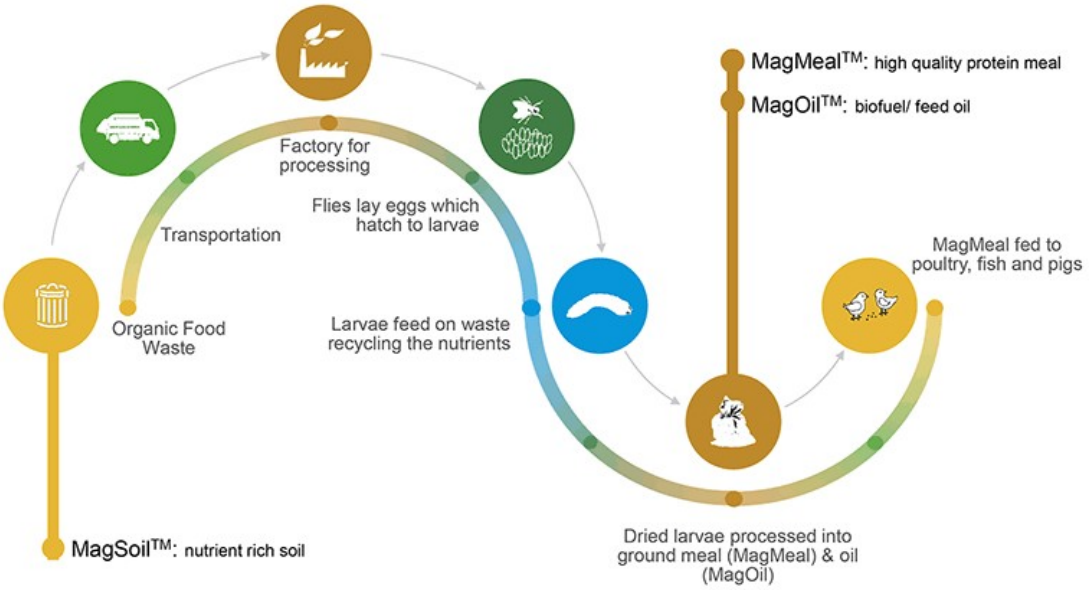
AN EXAMPLE OF THE REFERENCE SCALE. THIS PARTICULAR EXAMPLE IS THE REFERENCE SCALE FOR THE WORKER WAGES SUB-CATEGORY.

Scores could not be given to the 'impact on society' sub-topics as this topic is not covered by the Handbook for Product Social Impact Assessment (Version 3.0).

Background

AgriProtein

AgriProtein founders have built their business on an "eco-capitalist" ideology. From 2009 until 2015, the company invested its time and money in the research and development of techniques to farm *H. illucens* on a large-scale. In 2016, the company officially opened the world's first industrial-scale insect recycling site with the capacity to divert 100 tonnes of waste organics from landfill per day and produce over 2,000 tonnes of insect meal (or MagMeal™) per year. The company also produces MagSoil™ and MagOil™.



AN OVERVIEW OF THE AGRIPROTEIN PROCESS

AgriProtein is based in the heart of Philippi, a low-income human settlement in Cape Town, South Africa. Philippi is defined in part as a community with a complex social fabric and a lack of cohesion. It is comprised of predominantly black townships sandwiched between a coloured community and surrounded by an affluent white area. The informal settlements are often grouped by cultural divides. There are communities identifying themselves as isiXhosa and isiZulu as well as communities of immigrants from other African nations such as Nigeria, Democratic Republic of the Congo, and Zimbabwe.

Most of the housing in Philippi is informal and infrastructure is inadequate. Law enforcement in this historically disadvantaged community is insufficient. There is a high turnover of competent and effective police commanders and significant levels of violent crime, including gang and gun violence (8). Much of this, according to a community expert, is the 'ultimate price of unemployment', pushing people, especially youth, into a vicious cycle of disparity. A 2016 survey found that 93% of people in Philippi had experienced crime or violence in the last 12 months and 73% of people feel unsafe walking in their community during both the day and night (8).

The BioCycle

The BioCycle is a company that is developing a commercially viable and scalable process to bioconvert human faecal sludge into safe and valuable products using the AgriProtein biological technology.

The BioCycle is situated in eThekwini (Durban) Municipality in KwaZulu-Natal. A community-based production site was first established in the informal settlement of Klipheuwel, in the Western Cape. In 2016, a commercial scale pilot plant was built in collaboration with eThekwini Water and Sanitation. An industrial scale plant is planned to be built in 2019. Twenty-one percent of households in the eThekwini Municipality have poor or no access to sanitation/toilet facilities (9).

Results

Impact on workers

Social sub-topic	Score	Description of the general criteria met to achieve the score* (as per the Handbook for Product Social Impact Assessment (Version 3.0) reference scale) **Detailed information about each about how AgriProtein and The BioCycle meet or exceed these criteria can be found below this table.*
Health and safety	+1	The company or site complies with local regulations on workers' health and safety; The occupational health of the personnel is monitored. Adequate inventories and relevant information on health risks of all substances handled at the company or site are available; Health risk assessments are available for all concerned functions regarding the toxicity of all chemicals or products handled at the company or site; Measures based on the risk assessments are implemented to protect the health of workers; International occupational hygiene standards are used as occupational exposure limits when local standards are insufficient; Safer chemical alternatives - beyond compliance - have been implemented and, where needed, new installations are built
Wages	+2	All workers are paid at least the legal or industry minimum wage, with more than 25% of workers paid a living wage
Social benefits	+2	All workers are paid at least the social benefits required by law, with more than 25% of workers paid additional social benefits
Working hours	+2	Normal working week does not exceed legal limit or 48 hours for hourly workers. Overtime is voluntary and compensated at premium rate.
Child labour	+1	Policies against child labour, a compliance management process exists, and proof-of-age records are documented. In addition, employment and recruitment agencies are pro-actively monitored to avoid child labour
Forced labour	+1	Management does not retain workers' documents and/or salary, and workers are employed under reasonable terms and conditions which include their right to early termination of employment. In addition, employment or recruitment agencies are monitored to prevent forced labour
Discrimination	+1	Complaint procedure operational, equal pay for work of equal value and goals for staff diversity are set.

Freedom of association and collective bargaining	+1	Workers are not hindered in their attempts to exercise their right to organise themselves and bargain collectively and worker representatives do not face disciplinary action. In addition, workers are pro-actively informed about their right to organise themselves and bargain collectively and that their doing so will not result in disciplinary action.
Employment relationship	+2	All workers have documented employment conditions and more than 25% of workers have a permanent employment relationship
Training and education	+2	All workers are trained periodically
Work-life balance	0	Workers with direct family responsibilities are allowed to benefit from maternity protection, and to take maternity, parental or compassionate leave. In addition, less than 25% of the workers benefit from flexible working arrangements.
Employee satisfaction	+1	The company or the site did not have any lawsuit during the reporting period against workers. No case of breach within the company or the site in worker care (no access to social worker, no access to representative bodies, evidence of absence of dialog with the management); A non-formal survey is in place, and results are communicated to top management

Health and safety

New employees are provided safety training upon arrival. Safety equipment such as gloves, goggles and coveralls are provided to staff working in the R&D Department (AgriProtein and The BioCycle) and in the factory (AgriProtein and The BioCycle). Permanent staff are trained in first-aid. Formal health and safety protocols will be implemented but had not yet been finalised in December 2017 as the company is growing and changing very quickly.

> *"I know that the flies are harmless and that if I touch them, they won't hurt me because they are not touching dirty things. I got used to working with the flies and realised that we need to keep everything very clean. We need to wear masks. We have very strict regulations on cleaning agents." – AgriProtein employee*

> *"I have been worried because I don't know the kind of damage that this [the smell omitted from the factory] will be doing to my lungs. I use a mask, however." – AgriProtein employee*

Wages

South Africa experiences severe wage inequality: over 51% of the people in South Africa lived on less than R1,036.07 per month (68.75€) in 2016 (10). AgriProtein and The BioCycle pay their

employees a wage that is 70% above the national minimum. As of May 2018, the new national minimum wage has been set to R20 (1.32€) per hour.

Many staff members working in the factory felt that their salaries were still not enough to meet their basic needs. Of the staff members who were interviewed many of them noted that they were the only breadwinner in their family; in many cases, their incomes help support not only nuclear family members, but also extended family members. The current pay raise for junior employees (e.g. ground staff) in AgriProtein and The BioCycle is linked to food price inflation, which hits low-income households the hardest.

Social benefits

Payments are made to an Unemployment Insurance Fund and the company pays a skills development levy which allows employees to gain new skills (70% of the cost of training is refunded by the government). Temporary labourers do not receive social benefits.

Working hours

In accordance with the Basic Conditions of Employment Act, the national maximum working hours per week is 48 hours. Overtime is paid 1.5 times the normal wage and those working on Sundays receive double pay. Temporary labourers also follow the same conditions.

Child labour

In South Africa, employing anyone under the age of 15 is illegal according to the Basic Conditions of Employment Act. Children aged 15 to 18 may not be employed to do inappropriate work. AgriProtein and The BioCycle do not hire anyone below 18 years of age in their facilities. Personal information, including age and a copy of identification, must be presented before an employee is hired.

Forced labour

Employees are welcome to leave the company at any time if they no longer wish to work for AgriProtein or The BioCycle. If an employee should be released from their duties, they are given one week's notice if they have been working for the company less than three months and two weeks for those working longer. Temporary labour is vetted by an intermediary who lives in Philippi.

Discrimination

In South Africa, employers must prepare and implement and employment equity plan, which will help to reach employment equity in their workplace. Under the Employment Equity Act, employers must also make sure designated groups (black people, women and people with disabilities) have equal opportunities in the workplace. Currently, Agriprotein is underrepresented with females across all levels. To fill this gap, Agriprotein is committed to investing in the development of female employees for the purpose of succession planning. One key focus area for the next five years is to increase the ratio of female to male employees within the organisation. In top and senior management positions, AgriProtein is underrepresented by Females, Blacks, Coloureds and Indians. Plans are in place to develop employees into Top and Senior Management level positions over a five-year period.

Temporary workers are mainly male because they tasked with heavy lifting in the factory. Different ages of people work together in order to ensure that there are older and younger employees to mentor each other.

However, many goals laid out in the staff equity plan have been achieved or exceeded: five more females are in more senior positions, unskilled workers represent 50% of the staff and there is a budget in place for appointing new positions, and R60,000 (4,000€) has been put aside for external training.

In post-Apartheid South Africa, racism in the workplace is still rampant. AgriProtein Co-Founder and CEO and the company's management decided that they wanted to create a workplace built on the foundation of respect, rather than discrimination.

> *"Our bosses are not racist. This is what I like most about the people who are working here. This environment changes people" – AgriProtein employee (black female[1])*
>
> *"I only spoke English and Afrikaans before coming here, but now I have learned a lot of new languages by speaking with my colleagues." – Employee at AgriProtein*

Freedom of association and collective bargaining

The employees are not represented by a union but have all the rights of a union. If they wanted to establish a union, the majority of employees must be in the same union. Bargaining councils are industry specific, but AgriProtein and The BioCycle currently do not fit into any industry category, as they are changing from being an R&D facility to a manufacturer. The Company has also established an employee forum of which members were elected by their peers. This provides a forum through which grievances can be addressed.

Employment relationship

All employees have documented employment conditions no matter if they are temporarily or permanently employed. Eighty-nine percent of employees have permanent contracts.

Training and education

A general training and job-specific training is provided to all staff members when they start working. AgriProtein employs a Training Specialist and has a service agreement in place with a training provider. Weekly meetings determine where capacity building and training is needed. The training depends on which unit the staff member is working in. Individual skills assessments are made, and missing skills are identified. Those who are required to operate heavy machinery, or the weigh bridge, are sent for external training. Other staff have been sent on short courses on the topics of quality assurance, leadership and management. Temporary workers are also provided with extra training if they have been working with AgriProtein for more than a couple of months. This allows them to be invested in and potentially prepared to join the company on a permanent contract.

[1] This type of information which is otherwise omitted in this report has been provided because this woman represents a disadvantaged group on two accounts: black and female.

"They [the management] train people without capacity to do specialised work and they learn a lot on the job. Employees are also able to train to get a certificate, for example, to drive a forklift. They [the management] invest a lot into their employees to be specialised for their job. It's about developing the person, not just the company." – The BioCycle employee

Work-life balance

Each worker is entitled to three days of family responsibility leave annually. Paid maternity leave follows the national guidelines. Where operationally possible, employees benefit from flexible work arrangements; ten percent of employees have a flexible arrangement as they are working on the office/administration side of the company. The other 90% do not have flexibility due to shift work in the factory.

"If there are people in financial trouble or their family passed away, their situation would be understood and they could speak to their direct supervisor about their grievances. There is no need to wait for a higher authority. This motivates people." – AgriProtein employee

AgriProtein provides 100% paid maternity benefit to female employees. The company also provides counselling and support to employees at no cost.

Job satisfaction

There is no formal employee satisfaction survey in place. However, an anonymous suggestion box was put in place. The extent to which it was used was disputed among employees. Nevertheless, the company culture has established an open and informal feedback system under which many employees feel that their voices are heard.

"I like the work culture here. Everyone greets each other. I thought to myself, is that really the director?" – AgriProtein Intern

"Any major issues are taken seriously and easily resolved, you can see change happen and given chance to improve as a team and voice opinions to the managers. If we want to improve something and we look at how we need to improve identify problems. Proximity to management makes people proactive. This company is taking us somewhere." – AgriProtein employee

"Socially, we have a very open relationship. We speak to each other without having to go to the top manager. Communication channels are open… we can make mistakes and understand why we went wrong and this makes me feel valued. Opinions are gathered everyday as they need to know how people are doing on the ground and what they are doing. If something works well, you really have the chance to change it. We have a relationship between the top managers and the staff. If I see someone struggling, I can interfere and put this forward and have the issue addressed immediately. Then a change can be made in the future and change the way we work." – AgriProtein employee

Other initatives have also been implemented to maintain and improve employee satisfaction. These include monthly business updates, monthly social functions, easy access to human resources staff and an employee forum representative of all departments through which matters can be addressed.

A SIGN PLACED IN THE ENTRANCE OF THE AGRIPROTEIN FACTORY

Impact on the Local Community

Social sub-topic	**Score**	**Description of the general criteria met to achieve the score* (as per the Handbook for Product Social Impact Assessment (Version 3.0) reference scale)** **Detailed information about each about how AgriProtein and The BioCycle meet or exceed these criteria can be found below this table.*
Health and safety	+1	Risks and impacts on community health and safety are regularly monitored. Strategy to prevent and mitigate adverse impact is implemented.
Local capacity building	-1	Opportunities to build human capacities in the community are identified but no initiative which targets capacity building is undertaken
Community engagement	-1	Communication channels between the company or facility and the community are not formally established. Community queries are addressed on an ad-hoc basis; community grievances are addressed reactively, i.e. only if demanded by local authorities.

Employment	+2	Number of new jobs created > number of jobs lost. Number of new jobs created more than 2% of total number of jobs in the company or facility

Health and safety

An air quality assessment was made at the time of data collection. This issue was also addressed in the environmental impact assessment conducted by an external auditor. In both AgriProtein and The BioCycle operations, odour mitigation measures have been put in place by means of outdoor deodorizing sprayers. By nature, the BSF larvae reduce odors through the rapid bioconversion of the faecal sludge (11). Safety officers have conducted analysis on risks to occupational health at The BioCycle faecal sludge management plant. There are no complaints of smell at The BioCycle facility as they are located in a waste management plant.

> *"I brought up the smell issue to bosses because I walked around outside the factory and thought it was very bad. Action was taken immediately. We have to understand that the smell could destroy our relationship with the community." – AgriProtein employee*

Local capacity building

Local capacity is built through directly hiring people from the surrounding community. To do this, AgriProtein works specifically through an intermediary who helps recruit local labour for odd jobs. Many workers who were originally hired temporarily have eventually been given permanent contracts. Capacity is built through training the employees who are also community members.

> *"What I have noticed in our community that most people are not well educated, and they use this as an excuse to commit crimes. I tell them that they should use this as an opportunity. They should build their capacity while working for AgriProtein - find a course and develop a skill. It is always good to have a back-up plan. Everyone sees AgriProtein as an opportunity. AgriProtein is the only company in this area that has a local hiring plan" – Temporary employment intermediary*

However, not all employees are happy with the arrangement as they believe that the intermediary favours his own neighbourhood of Philippi over the other parts of the community.

The BioCycle also hires directly from the community. Young people are especially welcome to apply due to high youth unemployment rates.

Angy's Kitchen

Angy started working for AgriProtein in 2015 as an office assistant. Then, in 2016, she was given the opportunity to start making food for the employees. The AgriProtein co-founders provided Angy with the funds that were needed to set up a canteen at the AgriProtein factory. She has since employed five local women to run the canteen. Angy is now expanding her business to cater for meetings in the Central Business District.

"This place is a gold mine. They gave me space to set up my own business. They really go the extra mile to help me reach my goals. When you get such an opportunity in life, you need to seize it! Grab it!" – Angy

Community engagement

AgriProtein does not have a formal community engagement programme in place. Engagement with the community, to some extent, occurs through the Philippi Economic Development Initiative. AgriProtein has also established football (soccer) team that competes against other teams in the community. The company provides transport to the games and jerseys.

> *"If we can be a team on the football field, we can be a team at work."– Temporary employment intermediary*

The community surrounding The BioCycle has also not been formally involved. Collaboration between The BioCycle and the municipality exists. However, emptying the urine diversion toilets is the responsibility of the municipality. Nonetheless, The BioCycle wants to educate the people how to use the toilets properly in the future. Currently, some users are throwing garbage into them and The BioCycle cannot use this. This is deemed as an appropriate way to engage with the local community.

AgriProtein is also a part of a local business association trying to address the safety issues in Philippi as this is a challenge for the whole community.

> *"There were six break-ins in the beginning when the company started to work here. We have not had a break in four years now. I think that is attributed to the fact that we are seen as a valuable company in the community." – Co-founder and CEO of AgriProtein*

AgriProtein has also recently partnered with the local nursery school with the objective of establishing a safer, more nurturing environment for children in the community.

Employment

The official unemployment rate in South Africa is 27.7% (12). In Philippi, the unemployment rate is 38%, worse than the national average. the majority of the working population are low wage workers (13). Over the period of 2017, 15 permanent and one temporary job was created at AgriProtein. Seven new jobs were created at The BioCycle. The company will grow substantially in 2018; however, much of this growth will occur outside of South Africa.

> *"It's not easy to find a job in this community. Most other guys drive taxis and younger guys wash cars, sell fruits and cigarettes. Industrial jobs are few… working here has played a big role in my life." – Community member and employee at AgriProtein*

> *"If you go to the shops around the factory, people in the community recognize you as an AgriProtein employee. People are always looking for jobs here because of their impact that it has had on the community." – AgriProtein employee*

According to the Philippi Economic Development Initiative, 25% of salaries go to transportation costs for those members of the communities who work in the central business district. For members of the community who are employed by AgriProtein, this means that they can save this portion of their salary and put it towards other basic needs.

The company was initially driven by making a significant macro-environmental impact in developing markets. A key business driver is proximity to waste. Developing economies generate large volumes of waste. Lower income areas are often closer to waste disposal areas. Sourcing local labour, in turn, seemed to make sense. However, only 50% of the Philippi population has some secondary education (13).

> *"The ethos of the company was to reduce the impact of fishmeal on the seas. Subsistence fishing had been overtaken by industrial fishing changing the dynamics of the seas. People are also losing their jobs and this, in turn, causes migration. On the other hand, organic waste left in the ground at landfills produces methane and leachate can affect the groundwater, etc… the poor are the first to be impacted by this as they are often the located geographically close to landfills. Poor communities lie on the waste belt of the rich to the poor. These areas also happen to be cheaper and have more space than in the CBD. These are also the communities where people need jobs the most, but, currently, most people are commuting to the CBD in order to find work. Bringing the company here means that people can travel easily to work." – The CEO and co-founder of AgriProtein*

> *"AgriProtein cannot employ everyone in the community, but what I would hope for is that our community leaders would see the company as a leader and attract other companies like the AgriProtein to Philippi" – Community member and employee at AgriProtein*

The purposeful creation of a labour-intensive industry keeps the need for manual labour high. Within the current unemployment situation in South Africa, highly automated systems would not support job creation and lead to economic growth in disadvantaged communities.

"This solution is better suited to our economy. We need labour inclusive industries to grow our economy. We need solutions that create jobs both up and downstream." – Municipal waste expert

The work that is carried out at the AgriProtein and The BioCycle facilities is also unique as the mass-rearing of insects as a protein source is a novel industry. This means that no previous experience in rearing *H. illucens* exists. Unskilled labourers can be hired and trained on site.

"We train people from the local community with no scientific background. But because they are working with the process every day and because they have been trained, they have opened their minds and start thinking outside the box. They ask a lot of questions and they are actually improving our processes by finding solutions." – The BioCycle employee

"This company has plans for the future development of its employees. We are given the opportunity to build our careers. I didn't go to college, so this is a huge opportunity for me… There are not many jobs in this area and so you need to go to the central business district. But at the same time, it's hard to get a job there if you don't have experience." – Employee at AgriProtein

AgriProtein employs over one hundred people, with the majority coming from the surrounding community. One employee could only describe the trickle-down effect that AgriProtein has had on the community in her native language, Xhosa. *Ukunceda,* loosely meaning to help or assist one another, has meant that the creation of jobs in Philippi does not only impact those with the jobs, but also the children, spouses and extended family of the employees as well as the community.

During the grand opening of the AgriProtein plant in September 2017, the Minister of Trade and Agriculture noted that the company was "changing the geography of apartheid" by operating their business within a marginalised community and providing new employment opportunities.

Impact on Society

"A lot of companies think that social responsibility is just a box-checking exercise…"
– Chief Operating Officer of AgriProtein

Public commitment to sustainability issues

The waste management is a growing problem in many cities. The AgriProtein process reduces organic waste going to landfill will subsequently help stop the degradation of aquifers and water tables through inevitable landfill leachate. The Philippi site, which was operating at less than capacity in November/December 2017, has the capacity to handle 100 tonnes of organic waste per day (36,000 tonnes per year), which would significantly divert the waste from landfills. Nutrients are upcycled from the organic food waste in Cape Town and fed to the growing larvae.

"In terms of the best usage of waste, this is the greatest innovation. It is a stepping stone to achieving zero waste to landfill. The process is relatively low-tech too. Gasification and biogas have such high costs that make it difficult to use the technologies." – Municipal waste expert

"I believe that in 15 years' time anyone not recycling organic waste will look the same as throwing a plastic bottle on the ground. New processes are needed. Organic waste has a value." – Co-Founder and CEO of AgriProtein

"We are in an age where waste beneficiation is a burning issue for us and I think that we need to move away from the paradigm where we looked at waste as being waste. Waste has a Rand value and I think that this is a very good project that is actually the value chain behind waste. It actually shows you how you can take science and match it with waste of which we consider zero value and provide a very good economic chain as well." – Barlow Manilal, CEO of the Technology Innovation Agency (From the official opening of the Philippi AgriProtein factory on September 12th, 2017)

AgriProtein is strategically situated in the city to reduce the transportation between the collected organic food waste and the factory.

In 2013, an assessment conducted by a third-party on behalf of AgriProtein found that for each ton of fishmeal or soybean replaced by MagMeal™, respective environmental savings of $2,550 and $3,250 per tonne can be achieved in the form of avoided fossil fuel consumption, agrochemical/fertilizer use, fishing and land use as well as reduced water consumption and air/water/land emissions.

The BioCycle plant is a part of a long-term vision. Organic food waste is still a valuable substance but identifying alternative waste sources like faecal sludge will be another means of creating a circular economy. At maximum capacity, the plant could ensure that the nutrients in faecal sludge are recycled and profits are maximized. Once the final tweaks are made at the plant, it will be possible to roll this out on a national scale. The main objective of the plant is to create a blueprint that can then be copied by others.

"We need to move down the waste stream to more 'dirty' forms of waste over time… Investors are looking at what you are producing at the end, so the economics are based on the end-point and not the start-point." – Chief Operating Officer of AgriProtein

"Ten years from now, large companies may see a reduction in available food waste. Faecal sludge will be the most promising option." – Municipal waste expert

The difference in legislation in South Africa and Europe and other countries where large-scale facilities can be found is the legislation for the substrate/waste that can be fed to the flies. South Africa can therefore be an important test bed for alternative waste streams, giving AgriProtein a competitive edge as the industry develops.

Another indirect impact that AgriProtein and The BioCycle are having on South African society is raising awareness of the value that *H. illucens* have in recycling waste. The company has also been acknowledged internationally. For example, AgriProtein was awarded the BBC Food and Farming Award in 2017 and 'Excellence in the Field of Environmental Technology Research' Award during CleanEquity® Monaco 2017.

The placement of the factory in Philippi has also changed the way in which the surrounding community perceives flies and the social and environmental impact that they can have on society.

"When I started up I didn't understand the story behind the BSF, but then I understood what it could do. It removes the organic waste from the landfill and creates a safe environment. – AgriProtein employee

"I didn't know that the [black soldier fly] larvae could give something to us… waste can change our lives. The fly is like a friend to me now. I didn't think much about flies before coming here. We [workers at the Philippi factory] see waste in a very different way now. We dropped out of school when we were young, but now we can see that this is what science looks like" - Community member and AgriProtein employee

"I once worked for a major NGO in South Africa that were receiving funds from companies to implement environmental programmes, but I felt that nothing really changed. But what I can see now is very quick change and major potential for widespread social impact." – The BioCycle employee

Contribution to economic development

AgriProtein and The BioCycle have already developed successful business models that will be expanded well into the future. While it is difficult to say the exact contribution to economic development in South Africa at this time, these two companies are already setting the bar high for themselves with plans for the roll out of new factories in the future.

"…this innovation in agriprocessing is fully in line with the provincial government's strategy for accelerating growth and job creation." – Deputy Director General for Western Cape Department of Agriculture (from the official opening of the Philippi AgriProtein factory on September 12th, 2017)

Technology development

As of August 2018, over R1.7b (€105m) has been invested in AgriProtein and R2.7m (€170,000) in The BioCycle (including a management support fee of R550,000 from AgriProtein). Research and development has been a driving force behind AgriProtein and The BioCycle. AgriProtein has established research partnerships with the University of Stellenbosch and the University of the Western Cape. The BioCycle has established research partnerships with the University of KwaZulu-Natal, the Gates Foundation, and the London School of Hygiene and Tropical Medicine. Under these partnerships, research has been and is being co-produced, and the objective is to make it publicly available with a shared intellectual property.

The BioCycle technology improves sanitation and cuts sewerage treatment costs. It is a change from expensive sanitation treatment technologies into a simple biological process that provides a global health opportunity.

"Plants of this nature are plants of the future… we believe that happenings like this one we are celebrating today - our billion Rand start-ups. This company is the first in the world to put fly farming on the animal feed map. – Hon. Naledi Pandour, Minister of Science and Technology (from the official opening of the Philippi AgriProtein factory on September 12th, 2017)

"This company has brought a product into the community that we did not know before. We are the first in South Africa. I never knew that my children would be fed by the [black soldier] fly… I am

happy to see that our product is in demand. I really hope that this company expands." – AgriProtein employee

AgriProtein also invests in R&D through financing PhD projects that will contribute to their operations and breeding protocols. For example, AgriProtein has funded a PhD project investigating the genetic background of the BSF and what it may offer in helping to selectively breed this protein source. Understanding the genetic diversity of the different populations of BSF found around the world can help to breed a more robust and healthy fly. The PhD project also aims to uncover what role gene expression plays in the development of the fly and how it can be used to ensure sustainable future generations of BSF.

Conclusion

AgriProtein and The BioCycle represent a new way of thinking about resources which are often regarded as low-value or simply waste. However, they have also gone beyond their mission as "eco-capitalists" to create a business model which is inclusive, supportive of diversity, and impactful on local communities and the greater societal as a whole. As this study shows, both AgriProtein and The BioCycle are doing their part in changing the geography of apartheid in South Africa, a social-responsibility model which is both exemplary in nature but also possible for others to follow.

This preliminary study sheds light on the social impacts of insect farming. Future studies should go investigate the nexus between environmental, social and economic sustainability within industrial-scale insect production as well as the current and prospective impacts on society.

References

1. FAO. The State of the World Fisheries and Aquaculture [Internet]. Rome, Italy: Food and Agriculture Organization of the United Nations; 2018 [cited 2018 Aug 15]. Available from: http://www.fao.org/3/I9540EN/i9540en.pdf

2. FAO. State of the World's Forests. Rome: Food and Agriculture Organization of the United Nations; 2016.

3. Makkar HPS, Tran G, Heuzé V, Ankers P. State-of-the-art on use of insects as animal feed. Anim Feed Sci Technol. 2014 Nov;197:1–33.

4. GreenCape. Waste Economy – 2017 Market Intelligence Report [Internet]. Cape Town, South Africa: GreenCape; 2017 [cited 2018 Jan 19]. Available from: https://www.green-cape.co.za/assets/Uploads/GreenCape-Waste-MIR-2017-electronic-FINAL-v2.pdf

5. WORLD HEALTH ORGANIZATION. PROGRESS ON DRINKING WATER, SANITATION AND HYGIENE: 2017 update and sdg baselines. S.l.: WORLD HEALTH ORGANIZATION; 2017.

6. Fontes J. Handbook for product social impact assessment. Amersfoot, the Netherlands: PRé Sustainability; 2016.

7. UNEP, SETAC-Life Cycle Initiative. The methodological sheets for sub-categories in Social Life Cycle Assessment (S-LCA). Paris: United Nations Environmental Programme and SETAC; 144 p.

8. South African Cities Network. The State of Urban Safety in South African Cities 2017 [Internet]. Johannesburg: South African Cities Network; 2017 [cited 2018 Feb 3]. Available from: http://www.sacities.net/wp-content/uploads/2017/08/The-State_of_Urban_Safety_in_SA_Cities_2017_Report_WEB.pdf

9. Statistics South Africa. Provincial Profile Kwazulu-Natal - Community Survey 2016 [Internet]. Statistics South Africa; 2018. Report No.: 03-01–10. Available from: http://cs2016.statssa.gov.za/wp-content/uploads/2018/07/KZN.pdf

10. National Minimum Wage Panel. A National Minimum Wage for South Africa: Recommendations on Policy and Implementation [Internet]. Pretoria; 2016 [cited 2018 Feb 3]. Available from: http://www.treasury.gov.za/publications/other/NMW%20Report%20Draft%20CoP%20FINAL.PDF

11. Wang Y-S, Shelomi M. Review of Black Soldier Fly (Hermetia illucens) as Animal Feed and Human Food. Foods [Internet]. 2017 Oct 18 [cited 2018 Feb 3];6(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5664030/

12. Statistics South Africa. Quarterly Labour Force Survey: Q3 2017 [Internet]. Pretoria: Statistics South Africa; 2017 [cited 2018 Feb 4]. Available from: http://www.statssa.gov.za/publications/P0211/P02113rdQuarter2017.pdf

13. Anderson V, Azari S, Van Wyk A. Philippi Community Profile. Cape Town, South Africa: South African Education and Environment Project; 2014.