TOILET BOARD COALITION

THE SANITATION ECONOMY IN AGRICULTURE

Sector Level Opportunities, New Toolbox, and Case Study

A THOUGHT PIECE FROM THE TOILET BOARD COALITION IN COLLABORATION WITH THE ETHICAL TEA PARTNERSHIP

NOVEMBER 2018

Ethical Tea Partnership

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Contents

The Circular Sanitation Economy provides the opportunity for private sector innovation, new technologies, new sources of water, energy, nutrients, and information about human health and behaviour, that will attract commercial investment and contribute to sustainable economic growth.

Foreword

Sanitation in Agriculture

Sanitation systems have a material impact on agriculture - on the soil, on the water, and on the people who work and live on plantations.

Improving sanitation in agricultural businesses will:

- Improve the health of workers and their families, increasing well-being and productivity
- Eliminate open defecation and environmental contamination of soil and ground-water
- Reduce climate change impact through reduction of methane emissions

The Ethical Tea Partnership is a not-for-profit organisation with over 50 members from the tea industry.

*"At the Ethical Tea Partnership, we tackle the root causes of a range of social issues to improve the lives of tea communities and one area where more needs to be done is water and sanitation. Solutions need to be found that work well for communities, that can be implemented at scale, in a manner that ensures facilities continue to be valued and maintained effectively in the long-term, which is why working with partners on pioneering projects is crucial. Ensuring that users input their ideas into new sanitation system developments is an essential component of solving some of the sanitation challenges facing tea communities across the globe." - **Sarah Roberts, Executive Director, Ethical Tea Partnership***

Sandy Rodger
Chief Operations Officer

TOILET BOARD COALITION

Sarah Roberts
Executive Director

Ethical Tea Partnership

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TATA TRUSTS

Circular sanitation systems have the potential to unlock significant economic social and environmental benefits for agricultural plantations and their local communities.

Toilet Resources are a valuable and currently undervalued resource. Systems that capture Toilet Resources can produce feedstock to create organic fertilisers and energy, leading to cost savings for operations, cost recovery for initial infrastructure investments, even potentially new sources of revenue. Circular sanitation systems have multiple environmental benefits – reduced carbon emissions and water pollution, and potentially improved soil health and reduced fertiliser.

Toilet and treatment choices on plantations have differing environmental, social and health impacts. Pit latrines are widely utilised across plantations, as sewers are in cities, but neither are universally the optimal solution in the Circular Sanitation Economy. New toilet designs and resource recovery technologies offer plantations new choices. The economics are especially favourable considering the triple bottom line of economic, social, and environmental factors. Building Circular Sanitation in from the start will maximise returns by avoiding costly retrofits.

Clean, safe, sanitation on plantations could improve the livelihoods, and health, of the 78% of the world's poor working in agriculture[1] Improved health, supported by improved information, is a behavioural driver for communities. Implemented appropriately within plantation communities, this could create new incentives for residents to use toilets, and new motivation for plantations to maintain the system. Smart sanitation approaches have the potential to capture data and information about the health of users to inform preventative health and disease monitoring.

In the tea sector in Assam, India, the Toilet Board Coalition (TBC), together with the Ethical Tea Partnership (ETP), have been assessing Circular Sanitation Economy approaches for plantations, with new technologies, business models and infrastructure.

This report outlines initial findings from our work with the tea sector in 2018, building a compelling economic case for Circular Sanitation Economy approaches in agriculture.

This report is in three parts:

- **The Opportunity** - a broad explanation of the Circular Sanitation Economy applied in agriculture
- **Case Study** - assessment of the Hathikuli tea plantation, in Assam, India, applying selected dimensions of economic, social, and environmental assessment
- **Toolbox** - A preview of a new methodology for assessment of Circular Sanitation systems on plantations, which can be developed for wider application

What do we mean by Toilet Resources?
Human waste needs a new name. Containing nutrients, energy, water, and even providing data, these materials have real value. The Toilet Board Coalition has adopted a new name – **Toilet Resources.**

The TBC plans to broaden these findings to other locations, and across agricultural sectors.

This initial work was completed with the kind co-operation of leading organisations in the tea industry – the Ethical Tea Partnership, Tata Global Beverages (including their Assam based subsidiary, Amalgamated Plantations), Taylors of Harrogate, with review and input from Unilever. Thanks also to the staff and residents at the Hathikuli plantation who contributed to the research.

The tea industry is actively improving worker conditions, including sanitation, and simultaneously faces economic pressures, with low margins for tea growers. So there is great attraction to solutions which can provide safely managed sanitation, and at the same time reduce costs and improve environmental sustainability.

There is an opportunity now for agricultural business leaders to evaluate Circular Sanitation Economy approaches on plantations, as a new business imperative to mitigate current risks and to enable sustainable growth into the future.

"Hygiene, being the most important ingredient for health, acts as a catalyst for education and the overall development of maternal and infant mortality key performance indicators. Thus the development of an efficient sanitation system is the most basic and crucial need and we at APPL are committed to enhancing the abilities of our workers communities to meet their most basic needs – water, energy, sanitation." ***- Jagjeet Kandal, Managing Director of Amalgamated Plantations***

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THE OPPORTUNITY - The Circular Sanitation Economy

Sanitation - from unaffordable cost to untapped business opportunity

The Circular Sanitation Economy is one of the three elements that make up the Toilet Board Coalition's transformational vision for sanitation – the Sanitation Economy. The others are the Toilet Economy, which covers the building and operation of toilets together with a wide variety of related services, and the Smart Sanitation Economy, which adds digital capability to the whole system, enhancing efficiency and adding additional information for citizens, business, and government.

These create a mutually reinforcing combination of **new technologies, new business models, new resources and data.** Together, these have the potential to transform sanitation from an unaffordable cost to an untapped business opportunity.

Triple Benefits – Triple Wins for Business. Within the Sanitation Economy, the private sector plays an important role, with businesses bringing innovative, economically viable solutions throughout the sanitation system. Because these solutions have to work as business models, they become affordable and financially sustainable, at the same time delivering the social necessity of sanitation plus environmental improvements. This is business acting beyond CSR – instead it is core business activity which also yields social and environmental benefits.

The Circular Sanitation Economy closes the loop of the biological and water cycles. Polluting waste with multiple costs becomes a renewable resource with a value. This should mean ultimately that biological waste, from throughout the production and consumption of food, flows back into agriculture as nutrients and clean water, being used safely for producing food crops.

Natural as this may be, the re-use in food production of "human waste" (better described as Toilet Resources) carries understandable real and perceived safety concerns. Even if the real risks can be fully mitigated, the "yuk factor" can still prevail. So culturally the circular approach remains a challenging proposition, for workers and for food consumers, and therefore for all the organisations in the food supply chain.

The Toilet Board Coalition is building evidence that the circular approach is technically and economically practical, as well as safe both for agricultural workers and food consumers. **This could encourage both better sanitation provision in agricultural communities, and widespread re-use of nutrients and water from sanitation in both urban and rural areas.**

THE CIRCULAR SANITATION ECONOMY IN AGRICULTURE

ECONOMIC CASE

- PROCESSING MULTIPLE BIOLOGICAL WASTE STREAMS MAGNIFIES THE BENEFITS
- RESILIENCE IS INCREASED BY MITIGATION OF ENVIRONMENTAL EXTERNALITIES
- MITIGATION OF HEALTH IMPACTS LEADS TO INCREASED PRODUCTIVITY
- CIRCULAR ECONOMICS INCENTIVISES SUSTAINED COMPLETE SANITATION SYSTEMS
- IMPROVED SOIL INCREASES CROP YIELDS
- VALUE FROM RESOURCE STREAMS OFFSETS OPERATIONAL COSTS

ENVIRONMENTAL CASE

- ENHANCED SOIL HEALTH REDUCES POLLUTION, IMPROVES WATER RETENTION AND SUSTAINS NUTRIENT LEVELS
- CLEAN RENEWABLE ENERGY SOURCES REPLACE FOSSIL FUELS
- EFFECITVE COLLECTION AND TREATMENT REDUCES LAND & WATER CONTAMINATION
- SANITATION SYSTEMS CAN SOLVE WIDER WASTE PROBLEMS
- CIRCULAR SANITATION ENABLES WATER RECOVERY
- HARMFUL METHANE EMISSIONS ARE REPLACED BY USEFUL ENERGY
- THE CIRCULAR APPROACH BUILDS GREATER ENVIRONMENTAL

SOCIAL CASE

- SANITATION IMPROVES HEALTH & REDUCES INFECTIOUS DISEASES
- SANITATION ENABLES IMPROVED MENSTRUAL HEALTH PRACTICES
- SANITATION IMPROVES SECURITY FOR WOMEN & GIRLS
- SANITATION IMPROVES GENDER EQUALITY & HUMAN RIGHTS
- SANITATION MAY ENABLE EARLY DETECTION & MONITORING OF DISEASE AND OTHER HEALTH ISSUES
- SANITATION REDUCES REPUTATIONAL RISK

Collection of biological waste
- Toilet Resources
- food waste
- agricultural waste

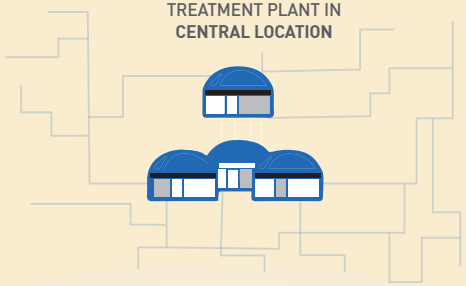
Resident biological waste
- Toilet Resources
- kitchen waste
- animal waste
- other compostable materials

Biological waste from nearby communities
- Toilet Resources,
- food / market waste,
- agricultural & food waste
- farm waste
- other compostable materials

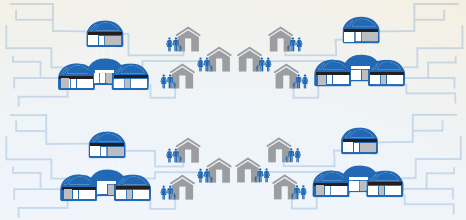
Food Supplies to Residents

EXTERNAL FOOD

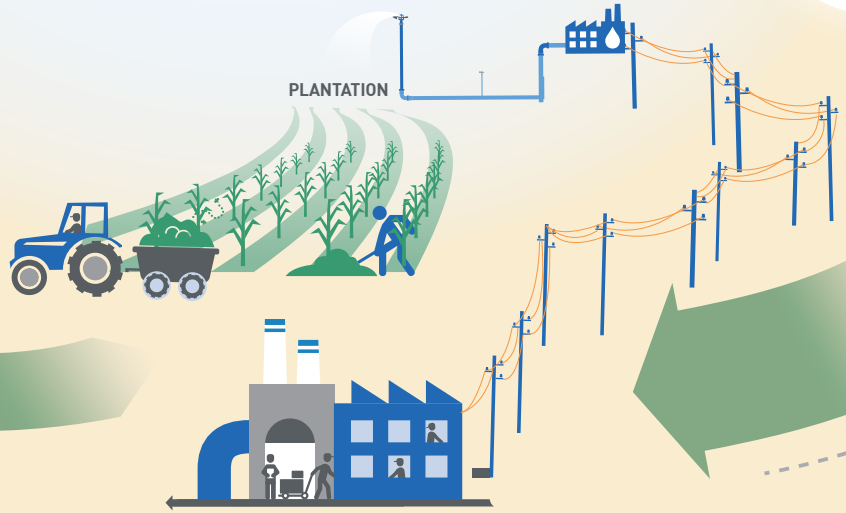
TREATMENT PLANT IN CENTRAL LOCATION



MINI TREATMENT PLANTS:
For one or more homes



PLANTATION



PROCESSING PLANT

PRODUCT 1
Agricultural products
Compost, organic fertilisers, nutrients such as nitrogen and phosphorus

PRODUCT 2
H_2O
Water
Water recovery and purification of wastewater

PRODUCT 3
Energy products
Fuel, electricity, heat

PRODUCT 4
Protein rich materials such as oils and protein meal

PRODUCT 5
Health data & information
Sampling and monitoring Toilet Resources can produce valuable basic health data

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TOILET BOARD COALITION

The Circular Sanitation Economy in Agriculture

Source: The Sanitation Economy in Agriculture- www.toiletboard.org

The Economic Case

Circular sanitation systems create a new biological resource system, with compelling evidence of multiple economic benefits compounded by a triple bottom line approach.

1. VALUE FROM RESOURCE STREAMS OFFSETS OPERATIONAL COSTS

Resource recovery creates value by displacing existing purchases like energy and fertiliser, and could even create a saleable product or service. This value can offset sanitation operations & maintenance expenditures (see case study), and in some cases may fund the capital costs at least of treatment systems. This helps ensure sanitation provision is financially sustainable.

2. IMPROVED SOIL INCREASES CROP YIELDS

Organic material returned to the soil increases water holding capacity, builds structure, reduces erosion, provides a source of slowly released nutrients[2] and could increase crop yield compared to using fertiliser alone.

3. CIRCULAR ECONOMICS INCENTIVISES SUSTAINED COMPLETE SANITATION SYSTEMS

Value from re-use products is created at the end of the sanitation value chain, and is only realised if the whole chain works – toilets maintained and used, Toilet Resources collected without contamination, and treatment operational. This system is self-reinforcing – the economics incentivises its continuing operation, and its continuing operation ensures not only toilet use but also treatment as well[3]

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4. PROCESSING MULTIPLE BIOLOGICAL WASTE STREAMS MAGNIFIES THE BENEFITS

Circular systems can derive value from other biological waste streams, such as kitchen waste, that would otherwise require transport and disposal (see case study). This increases the quantity and potentially the quality of resource recovery, and magnifies all economic and environmental benefits. At the same time this encourages a cleaner living environment, and is a service that can be offered to the nearby community as well as plantation residents.

5. RESILIENCE IS INCREASED BY MITIGATION OF ENVIRONMENTAL EXTERNALITIES

By improving the soil and reducing deforestation due to firewood collection (if compost and solid fuel, respectively, are the chosen re-use products), circular systems help protect the local environment on which agricultural businesses and livelihoods depend, and address climate change mitigation and adaptation. Toilet Resources are a reliable source of energy and nutrients, replacing imported commodities such as fossil fuels and fertilisers (see case study). This can be a buffer from disruption to transport and fluctuations in supply and cost.

6. MITIGATION OF HEALTH IMPACTS LEADS TO INCREASED PRODUCTIVITY

Capturing Toilet Resources for re-use removes waste from society, mitigating risks to human health and safety – the core benefit of sanitation. This reduces the community's exposure to untreated waste, with proven health benefits[4]. This is valuable to the individuals and their families, while reducing the impact of illness, and thus lost productivity, for the employing company and the wider economy[5]. Plus, accessible and adequate toilet facilities further improve the productivity of the community[6], while reducing queuing and transit times.

The Environmental Case

Circular sanitation systems provide significant environmental benefits affecting land, water and air. These help in sustaining the agricultural system and residents' living conditions, in mitigating climate change, and in reducing the need for costly adaptation to environmental changes.

1. ENHANCED SOIL HEALTH REDUCES POLLUTION, IMPROVES WATER RETENTION, AND SUSTAINS NUTRIENT LEVELS

Resource recovery creates value by displacing existing purchases like energy and fertiliser, and could even create a saleable product or service. This value can offset sanitation operations & maintenance expenditures (see case study), and in some cases may fund the capital costs at least of treatment systems. This helps ensure sanitation provision is financially sustainable.

2. CLEAN RENEWABLE ENERGY SOURCES REPLACE FOSSIL FUELS

Organic material returned to the soil increases water holding capacity, builds structure, reduces erosion, provides a source of slowly released nutrients[2] and could increase crop yield compared to using fertiliser alone.

3. EFFECTIVE COLLECTION AND TREATMENT REDUCES LAND & WATER CONTAMINATION

Sanitation systems, provided they include treatment as well as toilets, reduce pollution in the form of direct contamination from human faeces, whether from open defecation itself or from contamination leaching from latrine pits into groundwater.

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4. SANITATION SYSTEMS CAN SOLVE WIDER WASTE PROBLEMS

Sanitation Economy systems typically process a wide range of biological materials, not only Toilet Resources. This magnifies the other benefits since the whole system functions with higher volumes, and may help to solve other local problems, for example preventing food waste going to landfill.

5. HARMFUL METHANE EMISSIONS ARE REPLACED BY USEFUL ENERGY

Evidence is emerging that the environmental costs, principally methane emissions, of pit latrine systems is significant over the lifespan of the technology9. Circular Sanitation systems prevent these emissions and can instead produce useful renewable energy.

6. CIRCULAR SANITATION ENABLES WATER RECOVERY

Extraction and consumption of freshwater for irrigation can be reduced by utilising nutrient-rich water recovered from Circular Sanitation systems[10]. This reduces the costs and energy use associated with extraction while protecting this resource.

7. THE CIRCULAR APPROACH BUILDS GREATER ENVIRONMENTAL RESILIENCE

Environmental risks affect business sustainability. Deforestation and soil erosion will impact rural communities and agricultural businesses the most. Circular Sanitation protects the environment that the agricultural sector depends upon. Reduced reliance on imported resources and protection of soil and water-bodies improves environmental resilience.

The Social Case

Circular sanitation systems improve health and livelihoods, catalysing sanitation behaviour change and mitigating reputational risks. Improved health, and information about health, are important to communities and workers. There is new potential to advance preventative health approaches informed by data from the sanitation system.

1. SANITATION IMPROVES HEALTH AND REDUCES INFECTIOUS DISEASE

Sanitation is a public health issue. A functioning sanitation system improves the health and well-being of a community, by reducing disease transmission[5]. This is the core objective of sanitation.

2. SANITATION ENABLES IMPROVED MENSTRUAL HEALTH PRACTICES

Effective toilet provision benefits women and girls in particular by making it easier to manage menstrual hygiene[12]. Lack of adequate sanitation provision greatly effects the daily lives of women and children. A well maintained and clean toilet provides women with a safer and more hygienic space to use.

3. SANITATION IMPROVES SECURITY FOR WOMEN & GIRLS

Providing secure, lockable, and well-lit sanitation facilities can reduce the risk women face when using insecure toilets, or a spot to defecate, far from their homes or working areas. In addition to the physical assault, attacks lead to increased anxiety, a sense of powerlessness and hopelessness, marginalisation and stigmatisation[11].

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4. SANITATION IMPROVES GENDER EQUALITY & HUMAN RIGHTS

Ensuring adequate access to sanitation leads to a more productive and educated workforce. Women in particular suffer disruption to participating in education and livelihood activities due to poor access to sanitation[11].

5. SANITATION MAY ENABLE EARLY DETECTION & MONITORING OF DISEASE AND OTHER HEALTH ISSUES

Sanitation systems may become an early-warning mechanism for health, identifying diseases and other health conditions to enable effective and efficient preventative health care[12]. Sanitation systems could provide health information of a community by measuring pathogen and disease indicators in Toilet Resources.

6. SANITATION REDUCES REPUTATIONAL RISK

Social issues from lack of sanitation directly affect business. A business may suffer reputational and legal damages if sanitation provision for its workforce is not sufficient, or is perceived as such. Poor sanitation can easily become a news story, directly affecting product sales, and making it difficult to add value through strong trusted brands.

Technology Choices

Designing for circularity enables new choices for sanitation infrastructure

The Circular Sanitation Economy envisages an affordable, flexible "New Grid"[13]. This extends the options from traditional grids (sewers) and off-grid solutions (pits) towards a hybrid system where a range of technologies enable value-adding flows of materials, water, energy, and data. The time to consider these options is now - building Circular Sanitation in from the start will maximise returns by avoiding costly retrofits.

Pit latrines and sewers are no longer the only option. In many rural areas, the current focus on sanitation is simply to provide toilets with a simple form of containment, typically a pit latrine. Even if the toilets themselves are used - which in many contexts is not the case due to cultural beliefs, poor maintenance or accessibility issues - sanitation thinking often does not extend beyond the toilet itself. As a result, it does not include how the Toilet Resources will be removed from the pit latrine, how they may come into contact with people or the environment, or how they can become a resource for the plantation.

At the other extreme, investing in centralised collection and treatment technologies such as sewers can make resource recovery more difficult, as the Toilet Resources have to be dewatered and may be contaminated. Even where income can be generated from these systems, the high level of investment required is very difficult to recover during the system lifespan (see Case Study).

Design choices matter to realise benefits. While pits are a proven system offering rapid and inexpensive toilet provision, they can have longer-term consequences:

- Pit emptying costs can be high for these systems, particularly in less densely populated agricultural settings. In practice, pit emptying can be subject to cultural taboos, and may be conducted unsafely, or not at all, and may stigmatise sanitation workers. Yet the emptying process is vital for any resource recovery.

- Evidence is emerging that pit latrines carry significant environmental costs, principally methane emissions[9].

New sanitation infrastructure options are available today. Alternative designs of toilets, collection, and treatment systems are rapidly emerging, which can combine effective resource recovery with safe practices, and moderate capital cost. But this opportunity is missed, or becomes very expensive, if pits or sewers are built first. The toolkit being developed can aid agricultural businesses in planning and realising these benefits. (See Toolkit)

A sample of the options available is shown opposite, many of them being operated by entrepreneurs in the Toilet Board Coalition's network – some are high tech, some are very simple.

A Sample of Circular Sanitation technology options available today

TOILETS

- **Container toilets** with urine diversion
- **Dry-composting toilets**
- Toilets with on-site small **biogas reactors**
- Toilets with **automated cleaning systems**

TREATMENT AND REUSE

- **Collection trucks with built-in dewatering systems**
- **Anaerobic digestion producing biogas** plus residual soil conditioner or organic fertiliser
- **Gas engines converting biogas to electricity**
- Solar-powered conversion of **Toilet Resource into fuel briquettes**
- Air drying of **compost in windrows**
- Struvite reactors **producing fertiliser from urine**
- Community-Scale production of **compost and clean water using tiger worms**
- **Production of proteins (animal feed) and oil** using black soldier fly larvae
- **Pyrolysis suitable for contaminated waste** yet still yielding water and biochar

CASE STUDY: Hathikuli Plantation, Assam, India

Social, environmental and economic factors studied to produce recommendations for tendering and investment in a demonstrator Circular Sanitation installation

Tata Global Beverages and Amalgamated Plantation, in association with the TBC and ETP, have completed a feasibility study in July 2018 to understand the benefits of implementing a Circular Sanitation Economy system in a tea plantation. This study addressed the social, environmental and economic components of implementing new sanitation infrastructure and technology that would collect Toilet Resources and convert them into new valuable resources for the plantation.

Located in North India in the state of Assam, Hathikuli is an organic tea plantation operated by 4330 workers. The estate provides residential houses for its permanent workers and their families, each provided with a toilet shelter and pit latrine. The plantation management are committed to improving the sustainability of the plantation and quality of life for its workers.

The study methodology is detailed later in this report, as a step by step toolbox. This was created to collect and analyse the information needed to implement a Circular Sanitation Economy approach. This assessed the feasibility and potential for resource recovery, and evaluated a range of toilet, collection, and treatment options. The toolbox is adaptable to quantifying the broad benefits to agriculture described previously. However this initial study was focused on the specific needs of Hathikuli.

TATA GLOBAL BEVERAGES

AMALGAMATED PLANTATIONS

	METHOD OF ANALYSIS	INITIAL FINDINGS
SOCIAL Community response to collection, and to re-use products at home and at work	**40 Workers** Individually Interviewed[A]	• Current methods of emptying pit latrines could be improved. • Re-use products that come in contact with food or have to be handled by hand (i.e. compost, biogas and water) have large social taboos preventing their use. • Only electricity derived from Toilet Resources could accepted for use in the home. • The desire to be better informed about an individual's own health was seen as a huge benefit by the community, and could increase the usage of toilets if used as a behaviour change incentive.
ECONOMIC Capital and operational costs, value of re-use products	**Financial Analysis** (Net Present Value and Monte–Carlo simulation)[B]	• There are widely varying capital costs associated with each treatment technology. • Re-use products utilised for industrial processes on the plantation can potentially cover the operational and maintenance costs of the collection and treatment and in some cases the capital is recoverable over the lifespan of the technology. • There is high demand for the energy products such as biogas or briquettes.
ENVIRONMENTAL Carbon emissions	**Carbon Emissions Study**	• Technologies that offset combustion of solid fuels have the most significant impact on the reduction in carbon emissions. • Environmental benefits should not be considered in isolation – for example, the use of cleaner sources of fuel may improve health by reducing exposure to smoke.

TOOLBOX: Assessment Methodology

How can plantation owners evaluate Circular Sanitation?

During the assessment at Hathikuli, a toolbox was developed which allows for the combined assessment of economics, behaviour change, and environmental impact.

These factors are closely interconnected, so a stepwise approach was used to efficiently assess and synthesise the information.

1. **Assess the possible amount of Toilet Resources produced:** Toilet Resource Calculator
2. **Compare and select re-use product(s):** Quantification of Resource Streams
3. **Determine the type of toilet and Toilet Resource transportation needed for selected re-use product(s):** Feasibility Choice Matrix
4. **Include social and environmental factors:** Feasibility Choice Matrix
5. **Final synthesis:** Comparison Chart

ADDED VALUE TRIPLE WIN

This toolbox is intended to become more widely applicable:

- Adding additional validation from further case studies in varying conditions
- Adding additional dimensions of economic, environmental and social assessment
- Adding additional technology options for toilets, collection, treatment, and re-use products
- Beyond the tea sector, across other agricultural businesses

We haven't shared the full methodologies here. Please contact us for more information: secretariat@toiletboard.org

The Toilet Resource Calculator only assesses production of a single re-use product. Some technologies allow the output to be split between two products - this would be calculated separately.

1 Toilet Resource Calculator

Quick assessment of re-use product potential

The purpose of the calculator is to give businesses a preliminary estimate of the potential volumes of re-use products on their specific plantations.

The population of the community is entered into the Toilet Resource Calculator. Any time period can be selected.

The calculator then estimates the amount of Toilet Resources produced. It currently provides estimates for the following Re-use Products:

- **Biogas (Electricity and Heat)**
- **Biochar**
- **Compost**
- **Nutrient Recovery (Nitrogen, Phosphate, Potassium)**
- **Water**

The Toilet Resource Calculator only assesses production of a single re-use product Some technologies allow the output to be split between two products - this would be calculated separately.

INPUT

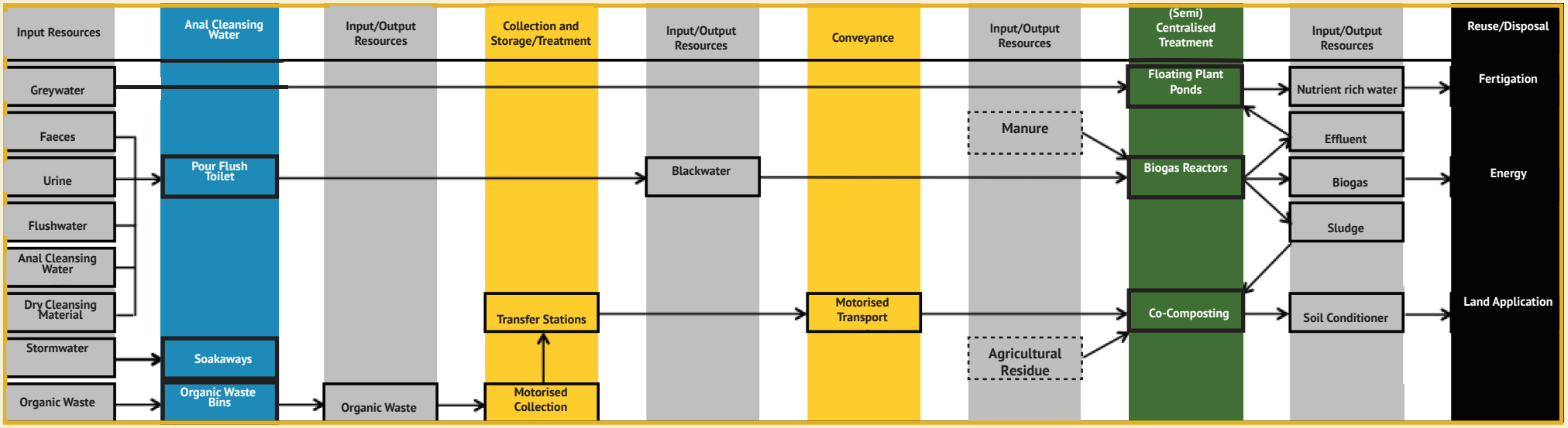
Population Size	**1000**
Time	**365 Days**

OUTPUT

Electricity Produced from Biogas		
DESCRIPTION	**APPROXIMATE OUTPUT**	**UNIT**
Electricity (Biogas)	4600-770	kWh of Electricity
Heat Produced From Biogas		
DESCRIPTION	APPROXIMATE OUTPUT	UNIT
Energy (Heat)	20100	kWh
Ash Free Biochar		
DESCRIPTION	APPROXIMATE OUTPUT	UNIT
Biochar	29100-67900	kWh
Compost		
DESCRIPTION	APPROXIMATE OUTPUT	UNIT
Compost Created	18100-30400	kg of usable compost
Nutrient Recovery		
DESCRIPTION	APPROXIMATE OUTPUT	UNIT
Nitrogen - Feces	3650	kilograms
Nitrogen-Urine	40150	kilograms
Total Nitrogen	43800	kilograms
Phosphate- Feces	1825	kilograms
Phosphate-Urine	5110	kilograms
Total Phosphate	6935	kilograms
Potassium- Feces	3650	kilograms
Potassium-Urine	3650	kilograms
Total Potassium	7300	kilograms

2 Quantification of Resource Streams

Detailed analysis of resource flows through each technology option. *(Biogas and Soil Conditioner example shown here)*



Using the calculations of the amount of Toilet Resources produced, the amount of re-use products produced is further refined in the **Quantification of Resource Streams.** The potential resource streams can be quantified using a **Material Flow Analysis,** which highlights the required steps from production to reuse.

This process also highlights **opportunities** for **potential resource recovery.** This links sanitation to other organic material for both **energy** and **nutrient recovery**.

In the Hathikuli case study, biogas, compost and fuel briquette technologies were further refined in the **Quantification of Resource Streams.** Technologies that are not seen as viable or an appropriate option for the plantation can be removed from further analysis.

3 and 4 Feasibility Choice Matrix

Each option is assessed for the degree of behavioural change and a similar format is used to assess environmental impact (Example based on options assessed at Hathikuli)

	Current House Toilets (500 Toilets)					
Toilet Option	**A**	**B**	**C**	**D**	**E**	**F**
Toilet	Dual Pit	Dual Pit	Biogas Reactor	Biogas Reactor	Septic Tank	Septic Tank
Collection / Transportation	Low Tech Hand Pump	Low Tech Hand Pump	Vacuum Pump	Vacuum Pump	Vacuum Pump	Vacuum Pump
Conversion Technology	Fuel Briquettes	Compost	Biogas + Soil Conditioner	Biomethane + Soil Conditioner	Fuel Briquettes	Compost
Social Change For Toilet Users	No change with how the user interacts with the current toilet structure.	No change with how the user interacts with the current toilet structure.	The user would have to be comfortable with a small treatment facility close to home. The user would have to abide the new system's rules and not place trash in the toilet		As the tank would fill up faster than a honeycomb pit, the user would have adapt new maintenance and cleaning habits.	
Difficulty of Change for Users	🟢	🟢	🟡	🟡	🟡	
Social Change related to Conversion Process	A few workers comfortable with burning briquettes in tea factory	Large staff comfortable with applying compost on the tea garden	Families would have to accept cooking with gas derived from their toilet.	More staff would be needed and trained on how to maintain a scrubbing system	The community would have to get used to more smells from their toilet and new automated methods of emptying the septic tanks.	
Difficulty of Change	🟡	🔴	🔴	🟡	🟡	

Scoring

🟢 - No Challenge 🟡 - Some Challenge 🔴 - Significant Challenge

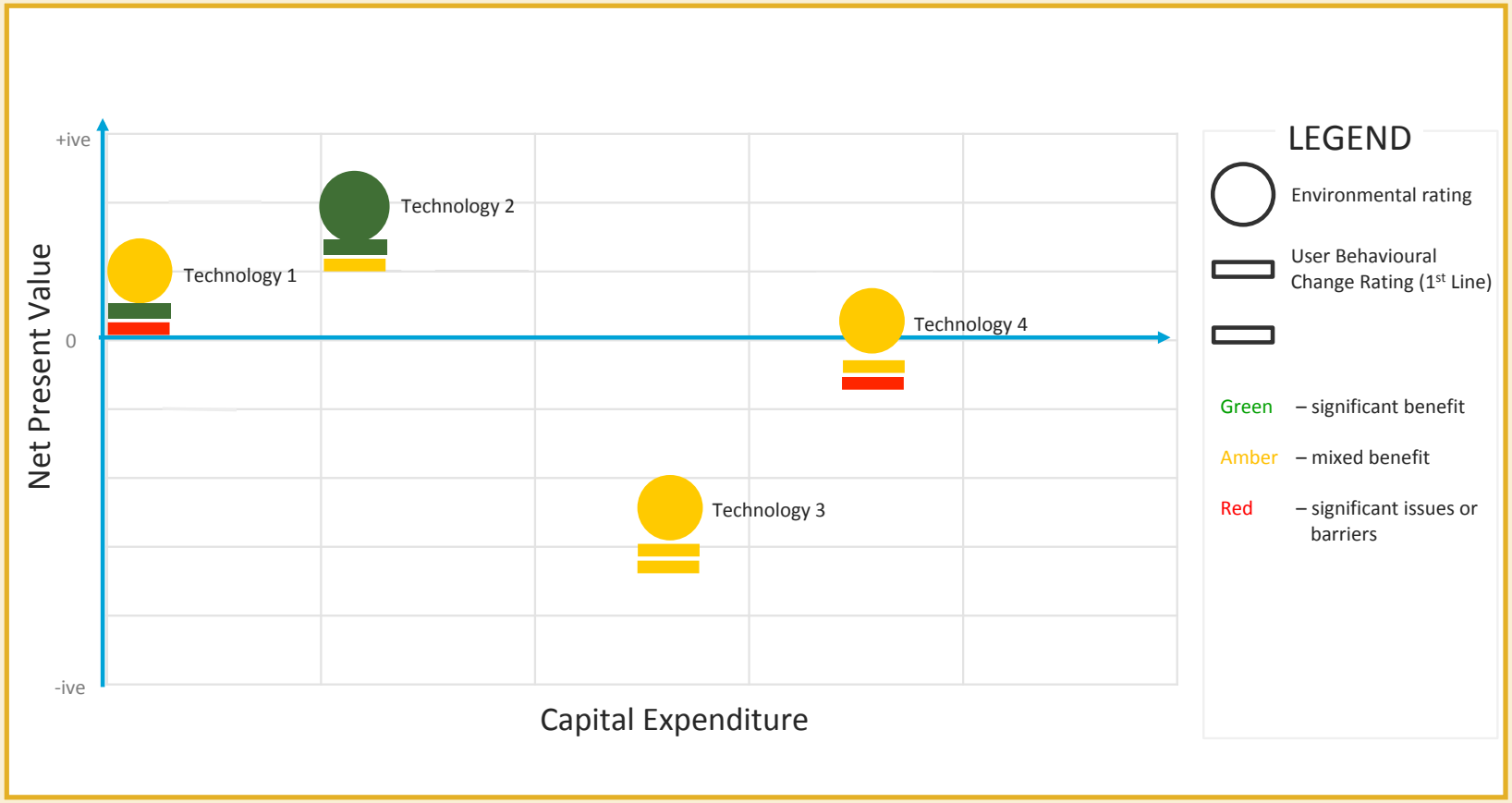
Taking into account the existing toilet structures, the various combinations of toilet design and Toilet Resource transportation needed for each treatment are compiled. Any combination that was not feasible or favourable based on local parameters was removed.

Based on community consultation, each combination of toilet design, transportation and treatment option is then assessed in terms of the social change required for the user when using the toilet, as well as the change requirement to adopt the re-use product at home or in the workplace.

The environmental benefits are added in a similar way with a red-amber-green colour coding. In the Hathikuli case only CO^2 emissions were calculated (because of the initial focus on energy products) but other factors can equally be assessed.

5 Comparison Chart

Each option is shown on a graph, positioned to show the economics, and colour coded to show social and environmental factors



The indicative results are displayed in this final chart that synthesizes the financial information, behaviour change components and environmental benefits into one graphic, to aid a plantation's ability to come to an appropriate decision. This chart was first used to assess 10 options, then to narrow down and refine the two leading options.

Wider Application in Agriculture

An invitation to get involved and enhance your agricultural system

The Sanitation Economy is not yet a familiar part of today's business landscape, typically omitted from resource planning and risk assessments, whether in agricultural systems or in cities. If that changes, not only does society benefit from sanitation itself, but from a wider range of social, economic, and environmental improvements.

The Toilet Board Coalition seeks to accelerate that transition, by building evidence of the benefits of the Sanitation Economy - and in this case the Circular Sanitation Economy.

The intent with the existing project is to progress demonstrator projects based on the feasibility work, adding further similar projects at other locations, in tea or possibly other crops. **This may be done with the existing participants in the tea sector, or by adding new participants.**

To enable this, the calculator tool and assessment toolbox will also be shared, and the intent is to develop it to be a robust and widely applicable toolkit. **Therefore partners are sought to continue the co-development and validation of these tools.**

PLEASE CONTACT US IF YOU WOULD LIKE TO GET INVOLVED, OR TO EXPLORE CIRCULAR SANITATION IN YOUR SECTOR.

We haven't shared the full methodologies here. Please contact us for more information: secretariat@toiletboard.org

About the Toilet Board Coalition

Founded in 2014, the Toilet Board Coalition (TBC) is a unique business-led partnership with the ambition to address the global sanitation crisis by accelerating the Sanitation Economy. The TBC is enabling private sector engagement, connecting large and small companies, and ensuring close collaboration between private, public and non-profit sectors with the common goal to achieve Sustainable Development Goal 6 (SDG6), universal access to sanitation. The TBC runs the Toilet Accelerator, the world's first Accelerator Programme dedicated to sanitation entrepreneurs in low-income markets. The members of the Toilet Board Coalition believe that accelerating the Sanitation Economy will deliver significant impact to business and society.

About the Ethical Tea Partnership

ETP's mission is to improve the lives of people in tea communities and the environment in which they live and work. Throughout our history we have pioneered new and innovative ways to achieve this.

Our focus is on convening tea companies, development agencies, governmental and non-governmental organisations to improve the lives of communities within the tea sector. Our priority is to tackle complex deep-rooted issues through longer term social impact programmes. These include working in partnership to tackle the underlying issues that are holding back the sustainability of the sector such as improving the incomes and well-being of workers and farmers, improve living conditions, nutrition on tea estates; create opportunities for women and reduce gender-based violence; improve the lives of young people in tea communities and increase climate change resilience.

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NOTES ON METHODOLOGIES:

A. Sanitation Survey - draws on survey developed by Myles Elledge (Biomass Controls, formerly with RTI International)

B. Financial Model Assumptions- 1 unit of energy from Toilet Resources is assumed to offset 1 unit of energy from traditional sources. The financial benefits from energy recovery are based on this assumption, as their value is derived from this saving. Social and environmental benefits have conservatively not been attributed a financial value in the current model. Probability of achieving a range of financial outcomes can be modelled by using a further step in the methodology, which uses a Monte-Carlo simulation to assess the probability density of a range of outcomes. This can be useful where reliable cost or resource data is not available.

Additional resources can be found online at **http://www.toiletboard.org/resources**

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