Project report

Circular economy in sanitation for agriculture – Faecal sludge management with co-composting for vegetables cultivation in the Nilgiris

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1 SUMMARY

Project title	Circular economy in sanitation for agriculture – Faecal sludge management with co-composting for vegetables cultivation in the Nilgiris
Funders	• Securing Water for Food programme (USAID; Dutch Ministry of Foreign Affairs; SIDA; Government of South Africa) • FINISH Mondial programme (Dutch Ministry of Foreign Affairs)
Partners	RDO Trust; WASTE; Ketti Town Panchayat; Adigarahatty Town Panchayat; LEAF; Canara Bank; BORDA; Horticulture Department; Agricultural Engineering Department; Chennai Testing Laboratory Private Limited; Thirumalai Septic Tank Cleaners; Palanisamy Septic Tank Cleaners; Horticulture Research of Tamil Nadu Agriculture University.
Organisation type	Public Private Partnership
Project's objectives	1. To ensure safe and high quality production of co-compost for agriculture from faecal sludge management and solid waste management 2. To establish market-linkage and business case for faecal sludge management with co-composting in cooperation with local governments 3. To establish market-linkage and mobilize private finance for women vegetable farmers for cultivation and sales of crops from MFIs and agri-marketing companies 4. To establish access to safe sanitation and solid waste management services for at least 11,450 people in the Nilgiris 5. To establish a local circular economy model in sanitation for agriculture that is scalable and autonomous with mobilisation of private finance and market-linkage approach to advance green growth in the Nilgiris
Project status	Project started in May 2017. • The faecal sludge treatment plant at Ketti Resource Recovery Park started operating since January 2018. • The faecal sludge treatment plant at Adigarahatty Resource Recovery Park started operating since September 2018.
Locations	The Nilgiris, Tamil Nadu • Ketti Resource Recovery Park (Receiving inputs from Ketti Town Panchayat) • Adigarahatty Resource Recovery Park (Receiving inputs from Adigarahatty, Hulical and Jagathala Town Panchayats)
Total population and households	The Nilgiris, Tamil Nadu (780,000 inhabitants) • Ketti Town Panchayat (9,000 households; 45,000 inhabitants) • Adigarahatty, Hulical and Jagathala Town Panchayats (17,306 households; 86,530 inhabitants)
Waste input type	• Municipal solid waste (MSW) • Faecal sludge
Values offer	• Faecal sludge and MSW collection, transportation, treatment and reuse services • Co-compost (faecal sludge and organic waste treatment and reuse) as soil improver for vegetable farmers • Segregated dry waste for buyers of recyclables (*in the pipeline*) • Entrepreneurship development in sanitation and solid waste management

	• Organisation of women farmers into Farmers Producer Companies or Groups • Market-linkage of Farmers Producer Companies or Groups with an agri-marketing company • Greywater recycling for irrigation during critical period
Technologies used for faecal sludge management	• Constructed wetlands • Co-composting
***Current* scale of operation**	Ketti Resource Recovery Park • Processes 50,000-60,000 litres of raw faecal sludge/month • Processes 52.5 tonnes of MSW/month and 22.5 tonnes of wet waste/month • Produces 30 tonnes of co-compost/month or 360 tonnes of co-compost/year Adigarahatty Resource Recovery Park • Processes 60,000-80,000 litres of raw faecal sludge/month • Processes 82.5 tonnes of MSW/month and 30 tonnes of wet waste/month • Produces 30 tonnes of co-compost/month or 360 tonnes of co-compost/year

2 CONTEXT AND BACKGROUND

2.1 PROGRAMMES' OBJECTIVES

Securing Water For Food (SWFF) is a programme supported by USAID, SIDA, the Ministry Foreign Affairs of the Netherlands and the Government of South Africa, to promote science and technology solutions that enable the production of more food with less water and/or make more water available for food production, processing and distribution.

Financial Inclusion for Sanitation and Health Mondial (FINISH Mondial) is a programme supported by the Ministry of Foreign Affairs of the Netherlands that aims for the scaling of sanitation services across India, Kenya, Bangladesh, Uganda, Tanzania and Ethiopia. The programme has achieved construction and use of 1,000,00 sanitation systems in India (and has leveraged EUR 120 million of local financing).

Both programmes complement each other to achieve the overall objective of **establishing a local circular economy model in sanitation for agriculture that is scalable and autonomous with mobilisation of private finance and market-linkage approach to advance green growth in the Nilgiris.**

2.2 PROBLEM ANALYSIS

India is the second largest vegetable producer in the world. Groundwater is used extensively for flood irrigation of vegetables (6,000- 8,000 m^3/ha) in the Nilgiris. **Climate change has resulted in limited water availability** for 4-6 months in each year, which discourages the farmers from vegetable farming during the dry season. **Soil fertility is declining due to excessive application of chemical fertilisers** and pesticides.

The need to effectively use co-compost organic manure and recycled water has been of great consequence with climate change affecting monsoon precipitation pattern in the Nilgiris. The water requirement for both human consumption and agriculture comes from the two monsoon seasons June-August and October-December. The remaining six months are dry months. The average rainfall during the South West Monsoon in Nilgiris is 759.9 mm and the expected rain is 691 mm but the actual rain received is 498.8 mm in the year 2018 with a 30% deficit in one rainy season. Similarly, during last year's North East Monsoon the forecast was 444 mm of showers for the Nilgiris, compared to the average of 367 mm and the actual precipitation was 580.9 mm. This unpredictable pattern lays heavy emphasis on better management of the water resources and demands for more effective use and recycling of water.

Faecal sludge treatment is a significant challenge in rural India, where flush toilets with septic tanks are the most popular form of toilets. Generally, **the faecal sludge collected gets dumped in open spaces, streams and river s**urreptitiously by owners and operators of honey suckers and therefore, environment is adversely affected.

In Nilgiris and Kerala, **there is a huge market for exotic vegetables due to the growing hospitality industry**. A number of international schools also serve as a market for exotic vegetables. It raises the demand for innovation to increase water conservation and use efficiency with a focus on improving productivity.

2.3 INNOVATION

2.3.1 TECHNICAL INNOVATION

A. FAECAL SLUDGE MANAGEMENT WITH CO-COMPOST PRODUCTION

Faecal sludge is collected from households by private entrepreneurs and transported to the closest Resource Recovery Park (RRP), where faecal sludge treatment plant is already established.

The RRP is owned by local town panchayat and operated by women Self-Help Group (SHG) members currently hired by the Town Panchayat.

At the RRP, municipal solid waste (MSW) is received and segregated between dry and wet waste. **The dried form of faecal sludge gets mixed with wet waste for co-compost production to be used for soil application by women farmers**.

Benefits to vegetable farmers from co-compost application:

1. Improved crop quality and consequently higher sales price
2. Improved soil water holding capacity as a measure of climate adaptation in agriculture

Benefits to women SHG members at the Resource Recovery Parks:

1. Improved technical and business capacity in sanitation and solid waste management
2. Improved health and safety aspect of the operation with the provision of safety and equipment and training

B. Greywater recycling for irrigation

Greywater is wastewater generated from bathroom sinks, showers, tubs and washing machines.

The greywater is collected from households, treated and stored at farm ponds for use as irrigation water during critical period.

Benefits to farmers from using recycled greywater:

1. Enable them to extend crop season by using recycled greywater for irrigation during the critical period
2. Enable them to sell the crops grown during the critical period at higher price (due to lack of supply in the market)
3. Enable landless labourers to get gainful employment in farm sector during the dry season

2.3.2 Business model innovation

A. Business model for solid waste management and faecal sludge management with co-composting at RRPs

The innovation under this business model includes the followings:

1. The RRP is owned by local town panchayat and operated by women Self-Help Group (SHG) members currently hired by the Town Panchayat. In close cooperation with the local Town Panchayats and women self-help groups, **cooperative or group-based business model in solid waste management and faecal sludge management with co-composting is being explored**. That is, where women self-help groups are institutionalised into a cooperative/social enterprise and the Town Panchayat outsource the operation activities at the RRPs to the women-led cooperative/social enterprise.
2. In addition to co-compost, business model revolving dry waste (e.g. plastics, glass, paper) is also being explored to strengthen the sustainability of the operation.
3. We also work with the Government to integrate the co-compost into their subsidy schemes.

B. Business model for vegetable farmers

The innovation under this business model includes the followings:

1. Organisation of the vegetable farmers (mainly the women farmers due to the gender focus of the programmes) into Women Farmers Producer Companies and Groups. The co-compost produced at RRPs are directly promoted via these channels (direct marketing).
2. Linkage of Women Farmers Producer Companies and Groups to access to loans by MFIs (e.g. Canara Bank) for procurement of agricultural inputs (incl. co-compost)
3. Linkage of Women Farmers Producer Companies and Groups to agri-marketing company (e.g. LEAF) for direct procurement of their crops (to establish direct market-linkage and eliminate middle-men)

Overall, the innovations aim **to establish a local circular economy model in sanitation for agriculture that is scalable and autonomous with mobilisation of private finance and market-linkage approach to advance green growth in the Nilgiris**.

FIGURE 1 WOMEN VEGETABLE FARMERS

2.4 Gender

The model focuses to encourage women farmers to move towards agri-business by organising them under Women Farmers Producer Companies and Groups. Under this structure, women farmers are deliberately being appointed as Board of Directors to have more say in the activities.

By organising women farmers under this structure, it gives chance to women-headed households to have required support. Skill training activities are organised for women farmers for improvement in agricultural practices and consequently leading to value addition (processing, packaging, grading, etc) so that they can deal directly with the market and ensure sustainability of the system as a whole.

2.5 Results

After the **two-years of running the programme**, the activities have led to the following results:

1. A total of 1,353 vegetable growing farmers have benefitted from the use of co-compost or recycled greywater; where 384 farmers use recycled greywater and 969 farmers use co-compost in their vegetables cultivation.

2. The participating farmers have been brought under the umbrella of four women Farmers Producer Companies and 49 Women Farmers Groups which have been linked with financial marketing and development institutions like Canara Bank, LEAF and Horticulture Department. This synergy has enabled them to increase production and realize better prices for the vegetable produced thereby paving the way for improved livelihood of the farmers.

   In order to enable the farmers to have a better understand of the functioning of these Farmers' Groups, the support extended by the Department of Horticulture, and the need for Sustainable Agriculture practice through collective farming and organic agricultural practices, training programmes have been organised in key villages with a greater number of vegetables growing farmers participated.
3. A total area of 447 hectare of vegetable cultivation has been brought under the adoption of co-compost and recycled greywater.
4. A total of 135.45 tonnes of co-compost was produced at two Resource Recovery Parks (Ketti and Adigarahatty Resource Recovery Parks), and distributed to 969 vegetable farmers.
5. A total of 41,896 m^3 of greywater recycled from the ten greywater recycling units and reallocated for irrigation by 384 vegetable farmers.

   The greywater recycling units have been established to process greywater from 505 households and one hostel with 178 students in eight villages.
6. A 15% increase in crop yield and 20% increase in annual income supplemented with the application of either co-compost or recycled greywater. Farmers are encouraged to cultivate during dry season with the effort of recycled greywater. As a result of this, the vegetable production is going up and farmers are earning additional income. The landless labourers are getting gainful employment during dry season.
7. A total of 13 partners in the consortium: RDO Trust, WASTE, Ketti Town Panchayat, BORDA, LEAF, Canara Bank, Horticulture Department, Agricultural Engineering Department, Adigarahatty Town Panchayat, Horticulture Research of Tamil Nadu Agriculture University, Chennai Testing Laboratory Private Limited, Thirumalai Septic Tank Cleaners, Palanisamy Septic Tank Cleaners.
8. At least a total of $231,445 of matching funds have been raised from public and private sectors including from Canara Bank, LEAF, Horticulture Department, the Dutch Ministry of Foreign Affairs.

   This number has not included the capital investment contribution by the Town Panchayats.

3 Circular economy in sanitation for agriculture in the Nilgiris

3.1 Resource Recovery Parks

Resource Recovery Parks (RRPs) are government-owned waste management sites designed to receive, process and treat community's wastes into resources.

Under the joint programmes, there are two RRPs in which faecal sludge treatment plants with co-composting have been established:

1. Ketti Resource Recovery Park (KRRP)
2. Adigarahatty Resource Recovery Park (ARRP)

Both KRRP and ARRP are government-owned and operated by women SHG members hired by the Town Panchayats.

FIGURE 2 KETTI RESOURCE RECOVERY PARK

BOX 1 CURRENT SCALE OF OPERATION

Ketti Resource Recovery Park

- Processes 50,000-60,000 litres of raw faecal sludge/month
- Processes 52.5 tonnes of MSW/month and 22.5 tonnes of wet waste/month
- Produces 30 tonnes of co-compost/month or 360 tonnes of co-compost/year

Adigarahatty Resource Recovery Park

- Processes 60,000-80,000 litres of raw faecal sludge/month
- Processes 82.5 tonnes of MSW/month and 30 tonnes of wet waste/month
- Produces 30 tonnes of co-compost/month or 360 tonnes of co-compost/year

3.2 TECHNOLOGY AND PROCESSES FLOW

3.2.1 CONSTRUCTED WETLANDS

Faecal sludge treatment plants at both KRRP and ARRP consist of:

1. Constructed wetlands and
2. Co-composting technologies.

Private honey sucker operators collect faecal sludge from households and go to RRPs to safely dispose the faecal sludge into the constructed wetlands. Since the collected faecal sludge comprises of a mixture of raw sewage, partially digested sewage, and some fully digested sewage, a conventional sludge drying bed may not be effective. While there are several technologies to be selected from for treatment of sludge of this nature, the one selected is **constructed wetlands technology**.

The constructed wetland consists of two parts:

a) **The first part is a vertical constructed wetland for treatment of sludge**. This constructed wetland comprises of gravel and sand, and is planted with native marsh plants that are tolerant to a wide range of environmental conditions (varying humidity, salinity). The sludge is loaded on the bed and dewatered by percolation and by evapotranspiration through the plants. The root system of the plants maintains the permeability of the sludge layer and sludge can be added continuously. Sludge has to be removed only once every few years.

   The long solids retention period favours further mineralisation and pathogen die-off. Percolate quality considerably improves but may still require a polishing treatment. The filter and drainage system of constructed wetlands is similar to a drying bed.

   Outputs:
   - The filtered wastewater continues to flow to the horizontal constructed wetland for further treatment.
   - The dried sludge is removed from the bed and gets mixed with organic waste for co-composting process.

b) **The second part is a horizontal constructed wetland for treatment of the filtered wastewater from the vertical constructed wetland**. It consists of a sand-gravel matrix (sealed at the bottom) planted with wetland plants like *Phragmites*, *Typha*, *Scirpus*, etc.

   Horizontal flow soil filters are commonly found, and easier to construct than vertical flow filters, but they are less efficient at eliminating nitrogen. Wastewater is treated through several processes, in which bacteria and fungi play important roles.

   Output:
   - The treated wastewater can be reused for composting process or irrigation

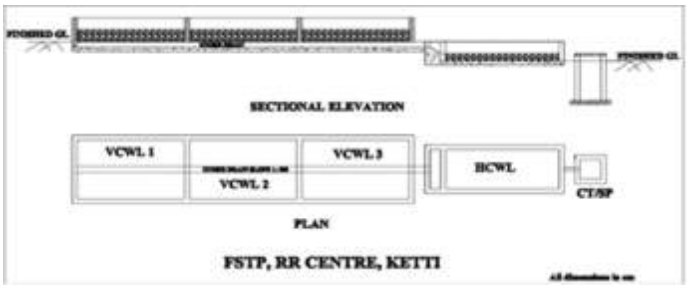

FIGURE 3 A SCHEMATIC OF THE CONSTRUCTED WETLANDS AT KETTI RESOURCE RECOVERY PARK (VERTICAL AND HORIZONTAL CONSTRUCTED

BOX 2 DIMENSIONS OF CONSTRUCTED WETLANDS

Constructed wetlands at Ketti Resource Recovery Park:

- Vertical constructed wetlands
  - Number of chambers: 3
  - Treatment capacity per chamber: 8,500 litres of faecal sludge/day
  - Total treatment capacity: 25,500 litres of faecal sludge/day
  - Dimension: 10.5 m of length x 4 m of width x 1 m of height (34.5 ft of length x 13 ft of width x 3.5 ft of height)
  - Area requirement: 42 m^2
- Horizontal constructed wetlands
  - Number of chamber: 1
  - Dimensions: 4.5 m of length x 2.5 m of width x 1 m of height (15 ft of length x 8 ft of width x 3 m of height)
  - Area requirement: 11.25 m^2

Constructed wetlands at Adigarahatty Resource Recovery Park:

- Vertical constructed wetlands
  - Number of chambers: 4
  - Treatment capacity per chamber: 11,000 litres of faecal sludge/day
  - Total treatment capacity: 44,000 litres of faecal sludge/day
  - Dimension: 16 m of length x 4.5 m of width x 1 m of height (54 ft of length x 15 ft of width x 3.5 ft of height)
  - Area requirement: 42 m^2
- Horizontal constructed wetlands
  - Number of chamber: 1
  - Dimensions: 4.5 m of length x 3 m of width x 1 m of height (15 ft of length x 10 ft of width x 3.5 m of height)
  - Area requirement: 13.5 m^2

FIGURE 4 VERTICAL CONSTRUCTED WETLAND

FIGURE 5 PARTNERSHIP WITH A PRIVATE FAECAL SLUDGE TRUCK OPERATOR

FIGURE 6 FEEDING OF FAECAL SLUDGE INTO VERTICAL WETLAND

FIGURE 7 VERTICAL WETLAND AFTER FEEDING OF FAECAL SLUDGE

FIGURE 8 VERTICAL WETLAND (TOP) AND HORIZONTAL WETLAND (BELOW)

FIGURE 9 HORIZONTAL CONSTRUCTED WETLAND (VIEW FROM THE TOP)

3.2.2 Co-composting

Co-composting is the controlled aerobic degradation of organics, using more than one feedstock (faecal sludge and organic solid waste). Faecal sludge has a high moisture and nitrogen content, while biodegradable solid waste is high in organic carbon and has good bulking properties (i.e. it allows air to flow and circulate). By combining the two, the benefits of each can be used to optimise the process and the product.

At the RRP, municipal solid waste (MSW) is received and segregated between dry and wet waste (biodegradable solid waste). **The dried faecal sludge from vertical constructed wetland gets mixed with wet waste for co-composting process**.

Output:

- Co-compost used as soil improver by vegetable farmers

FIGURE 10 WINDROW PILES

FIGURE 11 SIEVING OF MATURED CO-COMPOST

FIGURE 12 BAGS OF CO-COMPOST READY FOR DISTRIBUTION

FIGURE 13 VEGETABLE FARMERS BOUGHT CO-COMPOST AND TRANSPORTED THE BAGS IN A TRUCK

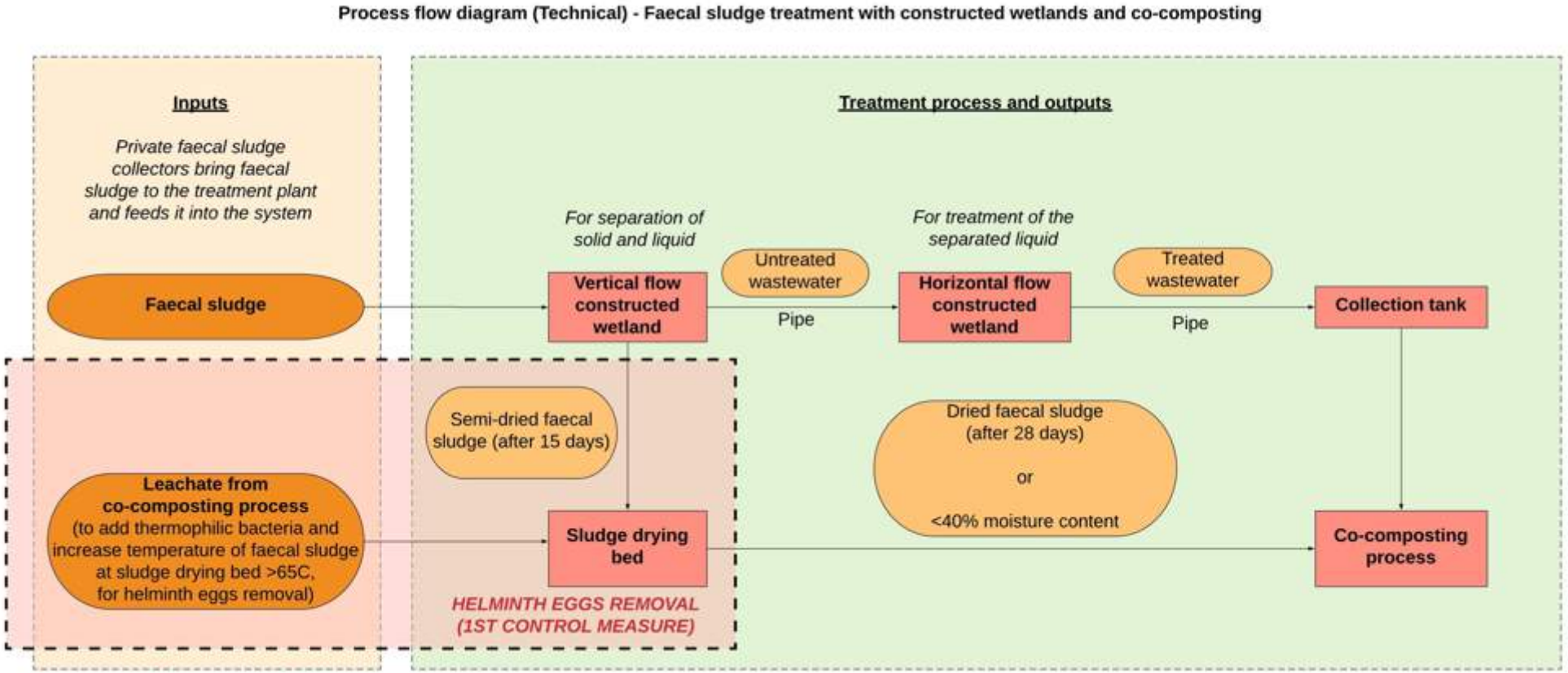

FIGURE 14 PROCESS FLOW DIAGRAM (TECHNICAL) - FAECAL SLUDGE TREATMENT WITH CONSTRUCTED WETLANDS AND CO-COMPOSTING

3.2.3 CONTROL MEASURES FOR HELMINTH EGGS

No.	Control measures	Description	Frequency	Status
1	Undertake testing for soil of farmers who has not applied co-compost yet on the presence of helminth eggs	We do testing for soil of farmers who has not applied co-compost yet on the presence of helminth eggs. The purpose of this test is to get the baseline data about the number of helminth eggs that is present in the environment.	Bi-annually	First lab result shows 3 helminth eggs are present in the soil
2	Undertake survey on health status of adopting farmers who took the co-compost	We do this health survey for the purpose of confirming the health of the farmers who received the co-compost	Once within the period of 6 months after the distribution of the batch	We have already undertaken the survey. No health hazard incidence has emerged.
Control measures of helminth eggs at constructed wetlands				
3	Increase in temperature of faecal sludge (above 65 C) at sludge drying bed by adding leachate from co-composting process	Leachate from windrow co-composting process has thermophilic bacteria. Adding such thermophilic bacteria to the faecal sludge consequently increases the temperature of faecal sludge. This high temperature destroys microbiology organisms (e.g. helminth eggs) during the process. See Figure 14 'Process flow diagram (technical) – Faecal sludge treatment plant with constructed wetland and co-composting'.	Daily	We recently identified the presence of helminth eggs in the latest sample. We are taking this corrective action and will do another lab testing to understand the effectiveness of the corrective action.

4	Longer drying period of faecal sludge at sludge drying bed (minimum 28 days or 40% of moisture content)	Lower moisture content of the sludge will not serve as a conducive environment for microbiology organisms (e.g. helminth eggs to grow). See Figure 14 'Process flow diagram (technical) – Faecal sludge treatment plant with constructed wetland and co-composting'.	Daily	We recently identified the presence of helminth eggs in the latest sample. We are taking this corrective action and will do another lab testing to understand the effectiveness of the corrective action.
Control measures of helminth eggs during co-composting process				
5	Allow temperature of windrow pile to increase (above 65 C) at the maturation phase by not adding water	At maturation phase of the co-composting process, we want the temperature to be higher than 65 C degrees. For this reason, we do not add water and allow temperature to increase above 65 C. This high temperature destroys microbiology organisms (e.g. helminth eggs) during the process. See Figure 15 'Process flow diagram (technical) – Co-composting'.	Daily	We recently identified the presence of helminth eggs in the latest sample. We are taking this corrective action and will do another lab testing to understand the effectiveness of the corrective action.
6	Undertake monitoring of temperature of windrow pile	During decomposition phase (Phase 2), we want the temperature to be in between 45-65 C degrees. During maturation phase (Phase 3), we want the temperature to be above 65 C degrees. In order to maintain control of the temperature, regular monitoring of temperature should take place	Daily	Daily monitoring of temperature is ongoing
7	Continuation of testing on co-compost	In order to know the impact of the corrective actions, testing on the co-compost should be ongong.	Every batch, before distribution	We are taking the corrective actions mentioned above and will do another lab testing to understand the effectiveness of the corrective actions.

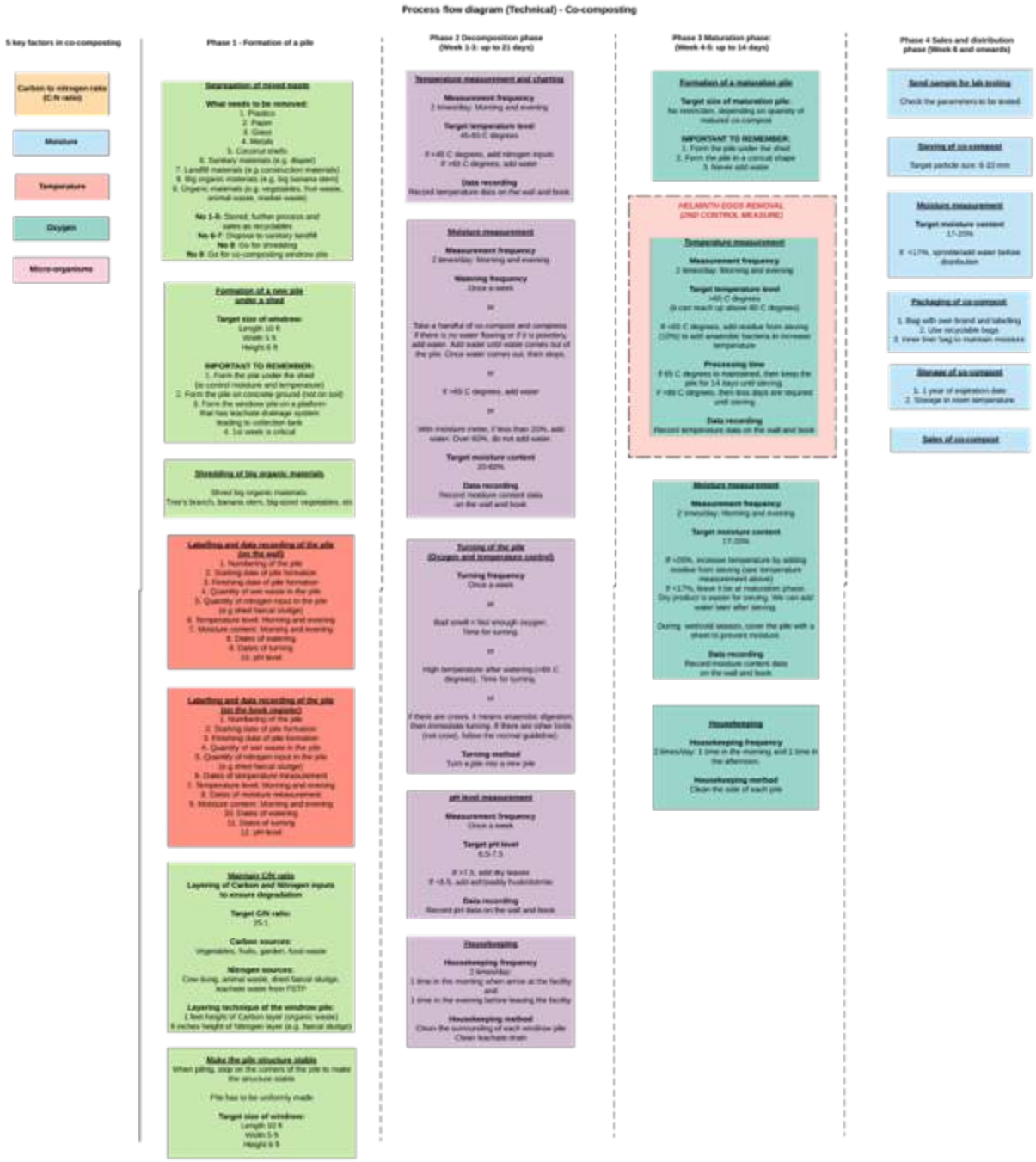

FIGURE 15 PROCESS FLOW DIAGRAM (TECHNICAL) - CO-COMPOSTING

3.2.4 Policy on faecal sludge management for agriculture: Quality standards and parameters of co-compost

Despite of the fact that there is no policy that discourages the use of faecal sludge for agriculture in India, however **there are also currently no set quality standards of co-compost in the country**. For example, helminth eggs standard is not mentioned under the Fertiliser Control Act standards of compost from the Indian Ministry.

For this reason, we are developing our own customised quality standards of co-compost that use a combination of Bureau Indian Standards and international standards. Table 1 shows that in addition to standards from Bureau Indian Standard, we are also using international standards outlined by WHO, European Union and US Environmental Protection Agency wherever not available from the Indian Standards.

We are partnering up with Chennai Testing Laboratory Private Limited to undertake our regular testing of co-compost.

TABLE 3 QUALITY STANDARDS AND PARAMETERS OF CO-COMPOST

No.	Characteristic	Requirement	Unit	Standard
1	Bulk density	1.00	g/cm3, *Max*	Bureau Indian Standard, 2013
2	Moisture	25	percent by mass, *Max*	Bureau Indian Standard, 2013
3	pH	6.5-7.5	#	Bureau Indian Standard, 2013
4	Conductivity	4.0	dsm-1, *Max*	Bureau Indian Standard, 2013
5	Total organic carbon	14	percent by mass of total dry mass, *Min*	Bureau Indian Standard, 2013
6	Total nitrogen (N)	0.8	percent by mass of total dry mass, *Min*	Bureau Indian Standard, 2013
7	Total phosphorus (P2O5)	0.4	percent by mass of total dry mass, *Min*	Bureau Indian Standard, 2013
8	Total potassium (K2O)	0.4	percent by mass of total dry mass, *Min*	Bureau Indian Standard, 2013
9	Sum total of total nitrogen (N), total phosphorus (P2O5) and total potassium (K2O)	1.5	percent by mass of total dry mass, *Min*	Bureau Indian Standard, 2013
10	C:N ratio	20:1	*Max*	Bureau Indian Standard, 2013
11	Faecal coliform	<1,000	MPN/g of dry solids	US Environmental Protection Agency 503, 2010
12	E. Coli	100	MPN/g of dry solids	European Union, 2002
13	Salmonella	0	number of salmonella cells/25 g	European Union, 2002
14	Helminth egg	<1	egg/g TS	World Health Organisation, 2006
15	Arsenic (As2O3)	10.00	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013
16	Cadmium (Cd)	5.00	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013

17	Chromium (Cr)	50.00	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013
18	Copper (Cu)	300.00	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013
19	Lead (Pb)	100.00	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013
20	Nickel (Ni)	50.00	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013
21	Zinc (Zn)	1000	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013
22	Mercury (Hg)	0.15	mg/kg on dry mass basis, *Max*	Bureau Indian Standard, 2013

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TEST REPORT

Report Number and date	**CTL/CH/N-10749/2018-19 & 23.10.2018**		
Sample Number	**N-10749/18-19**		
Customer Name & Address	**M/s. Rural Development Organisation,**		
	No. 313, Gramya Bhavan, P.B. No. 7, Aruvankadu - 643 202, Nilgiris.		
SAMPLE DETAILS			
Sample Description By Customer	**Co-Compost**		
Quantity Received	250g	**Sampled By**	Customer
Date of Receipt	11.10.2018	**Sample Condition**	Good & Received in Packed Condition
Analysis Starting Date	11.10.2018	**Analysis Completion Date**	23.10.2018

Test Results:
The above sample tested as received, and results are as follows:

S. NO	PARAMETERS	METHOD	UNITS	RESULTS
1	Bulk Density	Schedule -IV-Part D (3) of FCO 1985	g/cm^3	0.74
2	Moisture	Schedule -IV-Part D (2) of FCO 1985	%	15.7
3	pH	Schedule - IV, Part D(1) of FCO, 1985	-	6.5
4	Conductivity	Schedule - IV, Part D(4) of FCO, 1985	dsm^{-1}	5.48
5	Total Organic Carbon	Schedule -IV-Part D (5(ii)) of FCO 1985	%	27.9
6	Total Nitrogen as N	Schedule - IV, Part D(6) of FCO, 1985	%	2.60
7	Total Phosphorus as P_2O_5	Schedule - IV, Part D(8) of FCO, 1985	%	0.91
8	Total Potassium as K_2O	Schedule - IV, Part D(9) of FCO, 1985	%	0.08
9	C : N Ratio	Schedule - IV, Part D(7) of FCO, 1985	-	10.7
10	Sum of Total Nitrogen, Total P_2O_5 & Total K_2O	By Calculation	%	3.59
11	Arsenic (as As_2O_3)	Schedule -IV-Part D (12) of FCO 1985	mg/kg	BDL (DL:0.1)
12	Cadmium (as Cd)	Schedule -IV-Part D (10) of FCO 1985	mg/kg	BDL (DL:2.0)
13	Chromium (as Cr)	Schedule -IV-Part D (10) of FCO 1985	mg/kg	BDL (DL:5.0)
14	Copper (as Cu)	Schedule -IV-Part D (10) of FCO 1985	mg/kg	136.21
15	Lead (as Pb)	Schedule -IV-Part D (10) of FCO 1985	mg/kg	24.78
16	Nickel (as Ni)	Schedule -IV-Part D (10) of FCO 1985	mg/kg	46.59
17	Zinc (as Zn)	Schedule -IV-Part D (10) of FCO 1985	mg/kg	387.64
18	Mercury (as Hg)	Schedule -IV-Part D (11) of FCO 1985	mg/kg	BDL (DL:0.2)
Microbiology:				
19	Faecal Coliform	CTL/SOP/MB-SL/011	MPN/g	110
20	*E.coli*	CTL/SOP/MB-SL/005	MPN/g	70
21	*Salmonella*	CTL/SOP/MB-SL/007	per 25g	Absent
22	Helminth Eggs	CTL/SOP/MB-SL/014	eggs/g TS	< 1

BDL - Below Detection Limit; DL - Detection Limit

END OF REPORT

For Chennai Testing Laboratory Pvt ltd

Authorised Signatory

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FIGURE 16 LAB RESULT SAMPLE OF CO-COMPOST

3.3 Current model (2017-2020)

3.3.1 Business model canvas of resource recovery park (operated by town panchayat)

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments

• RDO Trust
• Town Panchayats
• Women Self-Help Group members
• Women Farmers Producer Companies and Groups
• Private faecal sludge collector
• Chennai Testing Laboratory Private Limited
• WASTE
• Horticulture Department
• Agricultural Engineering Department
• Canara Bank
• Horticulture Research of Tamil Nadu Agriculture University
	Town Panchayats:
	• Collection and transportation of municipal solid waste
	
	Private faecal sludge collector:
	• Collection and transportation of faecal sludge
	
	SWFF-FINISH Mondial projects:
	• Hand-holding support on the process
	  ○ Segregation of dry and wet solid waste (biodegradable solid waste)
	  ○ Processing of faecal sludge and wet waste with co-composting
	  ○ On-site monitoring (e.g. temperature, water, pH)
	  ○ Sending samples of co-compost (and others including raw faecal sludge, dried sludge) to lab
	  ○ Packaging of co-compost
	  ○ Marketing of co-compost
	  ○ Sales and distribution of co-compost
	• Administration and financial management
		• Faecal sludge and MSW collection and transportation service
		
		• Co-compost (faecal sludge and organic waste treatment and reuse) as soil improver
			Co-compost
			• Promotion of co-compost at Women Farmers Producer Companies and Groups
			• Give out samples in the beginning at discounted price
				Co-compost
				• Farmers Producer Companies and Groups
				• Individual farmers

	Key Resources • Land • Financial resources: CapEx and OpEx • Human resources • Relationships between the Municipality, households, entrepreneur, farmers and NGO		**Channels** Co-compost • Direct sales • Farmers Producer Companies and Groups	

Cost Structure
• Capital expenditure: Land, infrastructure and vehicles (Covered by Town Panchayats and projects)
• Operational expenditure (Covered Town Panchayats and projects):
  • Salaries
  • Daily wage labour
  • Fuel and maintenance
  • Others (e.g. health and safety materials)
			Revenue Streams
			• Household collection fee @ Rs 250/year
			• Sale of co-compost @ Rs 4.2/kg (discounted price as an introductory price at the beginning of the initiative)
			• Faecal sludge tipping fee @ Rs 200/trip
			• *Ad hoc sales of dry waste*	

3.3.2 VALUE CHAIN AND POSITION

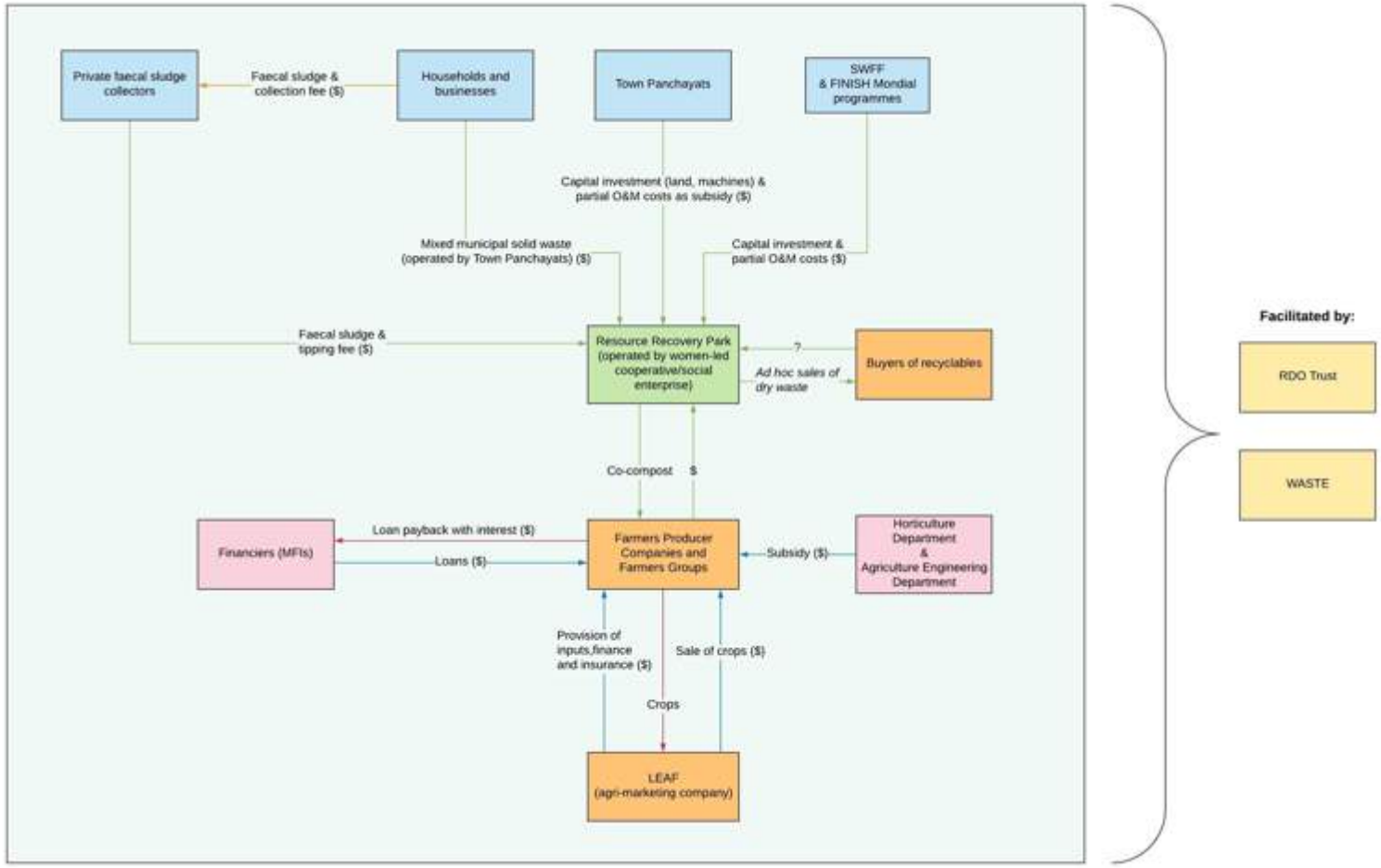


FIGURE 17 VALUE CHAIN AND POSITION (RESOURCE RECOVERY PARK OPERATED BY TOWN PANCHAYATS)

3.3.3 FARMER'S FEEDBACKS ON THE USE OF CO-COMPOST

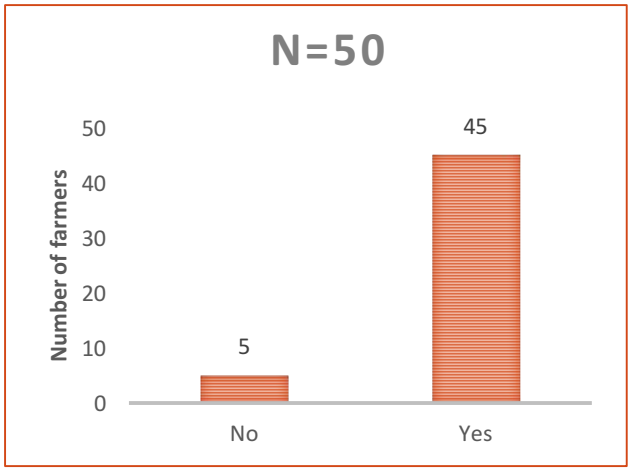
3.3.3.1 OVERVIEW – FIELD EVALUATION IN 2019

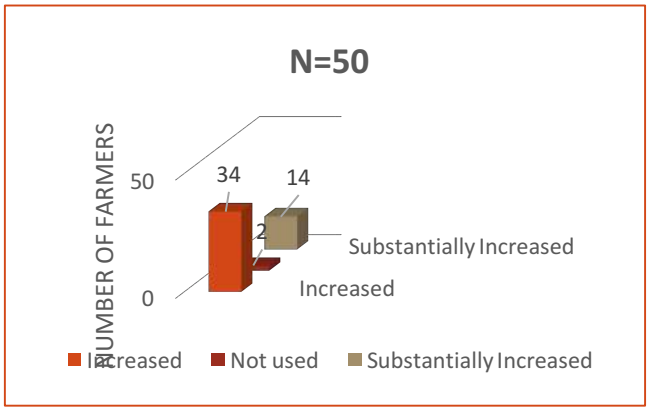
A field evaluation was conducted in July 2019 by an external evaluator to capture the farmers' experiences after the usage of co-compost. The data was collected through individual interviews with 50 farmers, comprising eight villages of Dhoodhany, Oranalli, Thilluvaluvar Nagar, Salamoor, Kecketti Hada, Shanthoor, Jendamedu and Ketti Palada spread across the Nilgiris district. All interviews were conducted in-person by monitoring and evaluation intern in local dialect of Tamil Nadu with the help of a translator. The villages were chosen depending upon the usage of innovation for the duration of 3-36 months. The farmers were chosen through randomized list.

Below sections provide the overview of farmers' experiences of co-compost on their crops.

FIGURE 5 QUALITY OF BEETROOT WITHOUT CO-COMPOST (LEFT) AND WITH CO-COMPOST (RIGHT)

3.3.3.2 OVERALL FARMER'S EXPERIENCE





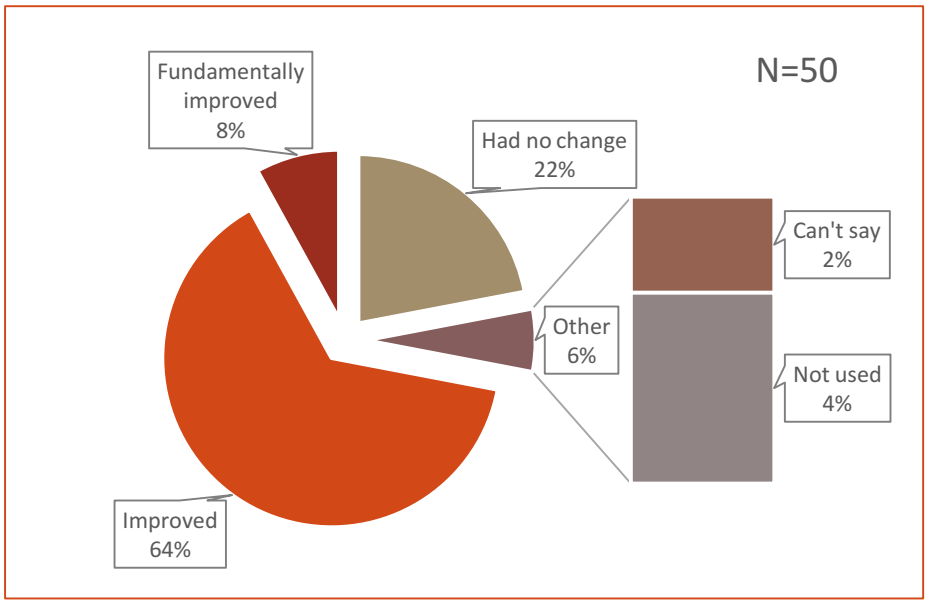
- 90% (45 out of 50) responded positively on using co-compost. Farmers felt that there was better quality of their crops. Most important crops (carrot, beetroot and potato) observed better quality yield in terms of better, greener, fresher and qualitative crops
- Rest 10% farmers informed that they will be using the co-compost generated from the innovation in the next agriculture cycle.

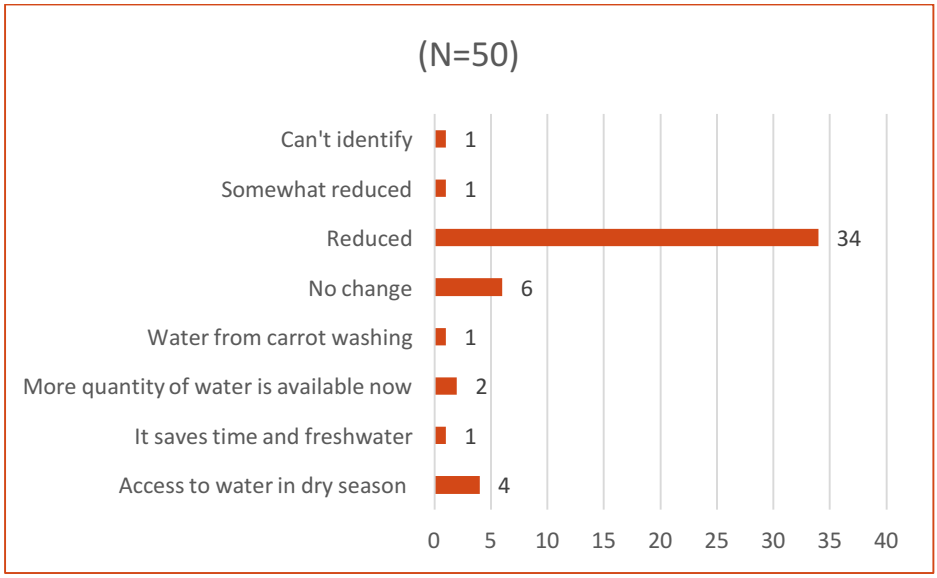
3.3.3.3 YIELD, QUALITY AND CROP DIVERSIFICATION

	Carrot	Radish	Beetroot	Garlic	Peas	Beans	Potato	Cabbage	Cauliflower	Broccoli	Zucchini	Flowers	Strawberry	Capsicum	Fenugreek
Number of crops grown before Innovation	35	2	13	12	1	4	19	4	1	3	1	0	0	0	0
Number of crops grown after Innovation	42	4	19	13	1	10	18	5	2	6	3	1	1	1	1

- Farmers have observed better yield in terms of size, color, skin and taste of the vegetables.
- Carrot, the golden crop of the Nilgiris, has performed well with 14% increase in the production after using innovation.
- Beetroot saw an increase of 12% in production whereas garlic and potato only saw an increase of 2%. Other crops such as beans, cabbage, radish, cauliflower, broccoli, zucchini also witnessed increase in the production.
- Crops like flowers, strawberry, fenugreek and capsicum were introduced which were not produced before the access to innovation. Production of peas remained same.

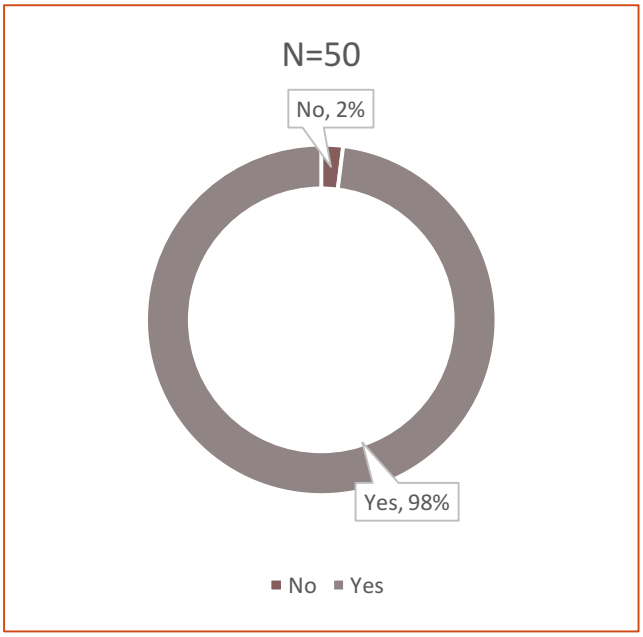
3.3.3.4 WATER USAGE REDUCTION





- Co-compost has likely to increase the moisture retention in the soil making it viable to use less water.
- Approximately 70% of farmers feel the change in water usage after using co-compost
- It supports them to practice farming even in dry seasons.

3.3.3.5 SURVIVAL RATE



- 98% of farmers felt that there is increase in survival rates after the use of co-compost.
- Majority farmers states they can observe moisture retention in the soil, and using co-compost automatically reduces the usage of fertilizers which finally enhance the survival rate of the crops.

3.3.3.6 INCOME BENEFITS

Income change	Number of farmers	% of farmers
Positive	13	26%
Negative	3	6%
No Change	2	4%
Can't Say	32	64%
Total	50	100%

- Reportedly, farmers believed the income benefit from the innovation lay in reducing expensive agricultural inputs, such as seeds and pesticides.
- Some farmers stated that, since the crops from the innovation were of better quality, it was easier to sell them.
- The Farmers Producer Groups and Companies that are formed within the initiative were also considered part of benefit they enjoyed, as they also gained new knowledge about farming practices which was considered a contributing factor to their income

TABLE 4 EXAMPLES OF FARMER'S FEEDBACKS ON THE USE OF CO-COMPOST ON THEIR VEGETABLE CROPS (THE NILGIRIS SAMPLE, 2018-2019 BY WASTE-RDO TRUST)

Name of farmer	Location	Land size	Variety of Vegetables grow	Quantity of Co-compost used	General texture and composition of Co-compost	Comments on standard parameters	Comments of yield/quality after use of co-compost
Sivappa	Oranalli	0.50 Acre	Garlic	1900kg	Small Grains, Soft to handle	Nil	Garlic size increased. When they use other manure the leaf colour will be changed as yellowish after used co - compost the yellowish colour will be reduced
Jayadev	Oranalli	0.50 Acre	Beetroot	1000kg	FSTP Dry sludge well mixed with compost	Nil	Beetroot is very shiney and good colour. The hole will be reduced in the leaf after using co – compost.
Mala Ranjith	Thiruvalluvar Nagar	0.50 Acre	Carrot	1000kg	Soft to handle, Moistorised	Nil	Carrot size incresed, its colour was good
Vennila	Shanthoor	0.50 Acre	Garlic	300kg	Small Grains, Soft to handle	Nil	Garlic size increased, Get good market price. When they use other manure the leaf colour will be changed as yellowish after used co - compost the yellowish colour will be reduced.
Krishnakumari	Thiruvalluvar Nagar	1 Acre	Garlic	800kg	Moisturised, FSTP Dry sludge well mixed with compost	Nil	Garlic size inceased. When they use other manure the leaf colour will be changed as yellowish after used co - compost the yellowish colour will be reduced.
Anchi	Mission Compound	0.20 Acres	Garlic	150kg	Small Grains, Soft to handle, Moistourised	Nil	Garlic size increased, Get good market price. When they use other manure the leaf colour will be changed as yellowish after used co -

							compost the yellowish colour will be reduced.
Savithiri	Shanthoor	0.10Acre	Carrot	150kg	Small grains	Nil	The carrot colour was good
Jhonson	Salamor	0.50 Acre	Beetroot	500kg	Soft to handle	Nil	Beetroot is very shiney and good colour. The hole will be reduced in the leaf after using co - compost
Sundhar Moorthy	Kattery	1 Acre	carrot	1000kg	Soft to handle, Moistorised	Nil	Carrot size increased, its colour was good
Ravi Mathew	Shanthoor	1Acre	Beetroot	2000kg	FSTP Dry sludge well mixed with compost	Nil	Beetroot is very shiney and good colour, Get good market price. The hole will be reduced in the leaf after using co – compost.
Sathish	Pragasapuram	1 Acre	Garlic, Beetroot	3000kg	FSTP Dry sludge well mixed with compost, Soft to handle	Nil	Garlic size increased. Beetroot is very shiney and good colour, Get good market price. When they use other manure the leaf colour will be changed as yellowish after using co - compost the yellowish colour will be reduced. The hole will be reduced in the leaf after using co - compost

3.3.4 Challenges

The consortium faced the following challenges during the implementation include:

1. Engagement with the Town Panchayats to understand what is required to establish a financially sustainable faecal sludge management and solid waste management
2. Establishment of a source-segregation and collection plan at household level in order to source segregated dry and wet waste coming into RRPs
3. Establishment of tipping fee as an additional revenue source for RRPs
4. Establishment of sales of dry waste as an additional revenue source for RRPs (due to Point No. 2)
5. Identification of the appropriate quality standards of co-compost for agriculture purpose in India
6. Streamlining of the technical aspects of the co-composting process at Resource Recover Parks
7. Initially, there were resistance by the vegetable farmers on the usage of co-compost made partially from faecal sludge
8. Social acceptance by the sanitary workers to use the dried faecal sludge for co-compost production

Taking these challenges into account, we have been trying to engage with the government in the following aspects:

1. To look at the business modelling of faecal sludge management and solid waste management, and to understand what is required to establish a financially sustainable faecal sludge management and solid waste management
2. To strengthen and support the sourcing of solid waste and faecal sludge inputs into RRPs
3. To enforce source separation and dry and wet waste segregation at household and commercial level
4. To enforce the penalty on private faecal sludge operators dumping faecal sludge into the environment
5. To enforce tipping fee as additional revenue source of RRPs
6. To enforce sales of dry waste as additional revenue source of RRPs
7. To support sales and marketing of co-compost at RRPs

3.3.5 Potential economic opportunities in circular economy in sanitation for agriculture and solid waste management (Tamil Nadu)

The Table below shows the potential economic opportunities in circular economy in sanitation for agriculture and solid waste management in the Nilgiris, taking into account the processing of **faecal sludge, wet waste and dry waste**. The figures **still exclude tipping/disposal fee which is another potential revenue source for the Resource Recovery Parks (RRPs)**.

The numbers in this table are drawn from the running RRP at Ketti town panchayat, in the Nilgiris. Ketti is a small town with fewer number of households than the Nilgiris average, hence **the numbers represent a conservative estimate of total co-compost produced and dry waste processing and revenue generated**.

	Monthly	**Yearly**
Faecal sludge & Municipal solid waste generation		
a. Faecal sludge (litres)	50,000	600,000
b. Municipal solid waste (kgs)		
Wet waste (A)	22,500	270,000
Dry waste (B)	30,000	360,000
Total municipal solid waste processed (kgs) (A+B)	52,500	1,500,000
Total municipal solid waste processed in (tonnes) (A+B)	52.5	1,500
Faecal sludge + wet waste processing		

Co-compost produced (kgs)	30,000	360,000
Amount of co-compost sold (kgs)	30,000	360,000
Sale price (INR/kg)	5	5
Total revenu from co-compost (INR) (C)	150,000	1,800,000
Dry waste processing		
Dry waste (kgs)	30,000	360,000
Minimum sale price (INR/kg)	10	120
Total revenue from dry waste (INR) (D)	300,000	3,600,000
Potential total revenue (1 Town Panchayat) (INR) (C+D)	**450,000**	**5,400,000**
Potential total revenue for 12 Town Panchayats in Nilgiris (INR)	**5,400,000**	**64,800,000**
Potential total revenue for 528 Town Panchayats in Tamil Nadu (INR)	**237,600,000**	**2,851,200,000**
Potential total revenue from tipping fee*	***tbd***	***tbd***

*The potential revenue can significantly increase with the enforced policy and regulation on tipping/disposal fee of faecal sludge at RRPs.

3.3.6 Partnerships

RDO Trust

RDO is a Nilgiris based organization who has done pioneering work in women's empowerment, agriculture, sanitation. RDO raised $7.8 mln from NABARD, Canara Bank, Bank of India, NDCC Bank, ICICI Bank, IDBI and Sanghamithra Rural Financial Service for sanitation. This work has earned RDO the respect of community members and Government. Their opinions are sought and their work closely with Government and other development organizations on national and international projects.

WASTE - Securing water for Food & FINISH Mondial programmes

WASTE is an NGO established in 1983 headquartered in Den Haag, the Netherlands. WASTE is specialised in business development and innovative financing in sanitation and solid waste management. WASTE has a substantial portfolio of multi-country projects in Asia and Africa of programme design, enterprise development, innovative financing and system design from collection to resource recovery and reuse of solid and liquid waste. WASTE's main approach is to establish linkage between demand, businesses, financiers and governments in order to establish a local structure and participatory process that increases the likelihood of sustainable sanitation and solid waste management.

LEAF

Leaf™ is India's premier fresh produce supply chain company. With support from Leaf™, farmers can earn more by increasing their yield and bypassing intermediaries. Our modus operandi is designed to empower every stakeholder in the value chain. Better margins for farmers, value added services for retailers, and fresh & safe products for consumers. Leaf™ has the expertise in community farming, agro-processing and integrated cold chain. Our integrated approach includes genetically superior planting materials, round the clock support to farmers, cold storage facilities to retain freshness and state-of-the-art infrastructure.

Chennai Testing laboratory Pvt. Ltd. & Centre for Science and Environment

Nutritional food, clean air & water, controlled emission and safe waste disposal have been our prime concern. We offer various environmental testing and food testing services in market under the standards set by various regulatory bodies.

Centre for Science and Environment (CSE) is one of Asia's biggest public interest research organizations engaged in research and advocacy in the field of environmental protection, including dissemination of information on best practices in pollution mitigation.

One of the main objectives of the partnership with laboratories is to test FSTP technologies and validate their performance. This partnership will certainly enhance the quality standard of the operation.

TOILET BOARD COALITION

Toilet Board Coalition is a business-led partnership and platform with the ambition to address the global sanitation crisis by accelerating the sanitation company. They work with large private companies such as Unilever and Tata Tea to explore business opportunities in sanitation. They are based in Geneva, Switzerland. In Assam (India), they are working together with Tata Tea to explore business opportunities in sanitation for their tea farming practices.

One of the main objectives of the partnership is to encourage and invite private sector participation in the field of circular economy in sanitation for agriculture, this includes for tea crop.

3.4 SUSTAINABILITY PLAN FOR 2020 AND ONWARDS

3.4.1 IN THE PIPELINE

The consortium has various developments in the pipeline as a strategy towards sustainability. These developments include the followings:

1. **Technical capacity in faecal sludge and solid waste management**
    - Streamlining of solid waste segregation-at-source (dry and wet waste) and collection and transportation to Resource Recovery Park, in cooperation with Town Panchayats.

      Rationale: The more wet waste is collected, the higher quantity of co-compost that can be produced. Also, the higher quality the segregated dry waste (without contamination from wet waste), the higher the market value.
    - Setting up of the infrastructure required to segregate and process dry waste (e.g. sorting belt, bailing machine, product-making machine)
    - Technical capacity building of women SHG members to take up the operation as a cooperative/social enterprise

2. **Institutionalisation and public private partnership**

Women cooperative/social enterprise:

- Institutionalisation of women SHG members into a cooperative/social enterprise
- Lobbying with the government on outsourcing the activities to the women-led cooperative/social enterprise
- Public Private Partnership contract between Town Panchayats and women cooperative/social enterprise is set-up, for women cooperative/social enterprise to take up the operation at RRPs
- Public Private Partnership contract between women cooperative/social enterprise and women Farmers Producer Companies is set-up, for direct market-linkage for the co-compost
- Public Private Partnership contract between women cooperative/social enterprise and buyers of segregated of dry waste is set-up, for direct market-linkage for the dry waste

Women Farmers Producer Companies and/or Groups:

- Institutionalisation of women farmers into Farmers Producer Companies and/or Groups
- Public Private Partnership contract between women Farmers Producer Companies with the Agricultural Marketing Department to operate the agri-processing facility

3. Business modelling of faecal sludge and solid waste management

Women cooperative/social enterprise:

- Integration of dry waste in the business model (e.g. plastics, glass, paper, metal), in addition to sale of co-compost
- Establishment of market-linkage with the buyers of segregated dry waste
- Pricing of co-compost towards at least Rs 7/kg
- Branding of co-compost
- Integration of co-compost sales in the government schemes
- Business capacity building of women SHG members to take up the operation

Women Farmers Producer Companies and/or Groups:

- Procurement of agri-processing facility from the Agricultural Marketing Department for value-addition activities (e.g. carrot washing) for the farmers who buy co-compost
- Business capacity building of the women farmers to take up value-addition activities

4. Leveraging local finance for sustainability of circular economy in sanitation for agriculture

Women cooperative/social enterprise:

- Mobilisation of finance from Town Panchayats to invest in capital investment (e.g. land, equipment, collection vehicles) and partial operational costs (e.g. fuel and maintenance of collection vehicles)
- Mobilisation of finance from private faecal sludge collectors from their tipping fees
- Mobilisation of finance from women cooperative/social enterprise themselves as a form of capital investment in the cooperative/social enterprise
- Setting up of revolving fund together with financial institutions (MFIs) to support entrepreneurship developmentin faecal sludge and solid waste management

Women Farmers Producer Companies and/or Groups:

- Mobilisation of finance from Horticulture Department to provide subsidies to Farmers Producer Companies or Groups
- Mobilisation of finance from farmers themselves as a form of capital investment in the Farmers Producer Companies
- Mobilisation of finance from MFIs (such as Canara Bank) to provide loans to Farmers Producer Companies or Groups
- Mobilisation of finance from agri-marketing companies (such as LEAF) via advance purchase order of crops from farmers who buy the co-compost

3.4.2 BUSINESS MODEL CANVAS OF RESOURCE RECOVERY PARK (OPERATED BY WOMEN COOPERATIVE/SOCIAL ENTERPRISE)

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• Town Panchayat • Women Farmers Producer Companies and Groups • Private faecal sludge collector • Chennai Testing Laboratory Private Limited • Horticulture Department • Agricultural Engineering Department • Canara Bank • Horticulture Research of Tamil Nadu Agriculture University	*Town Panchayats:* • Awareness creation at household level on solid waste segregation (dry and wet waste) *Private faecal sludge collector:* • Collection and transportation of faecal sludge *Women cooperative/social enterprise:* • Collection and transportation of segregated solid waste (dry and wet waste) • Segregation of dry and wet solid waste (biodegradable solid waste) • Processing of faecal sludge and wet waste with co-composting • On-site monitoring (e.g. temperature, water, pH) • Sending samples of co-compost (and others including raw faecal sludge, dried sludge) to lab • Packaging of co-compost • Marketing of co-compost • Sales and distribution of co-compost • Bailing of segregated dry waste • Sales of dry waste to buyers	• Faecal sludge and MSW collection and transportation service • Co-compost (faecal sludge and organic waste treatment and reuse) as soil improver • Segregated dry waste (e.g. plastics, glass, paper, metal)	Co-compost • Promotion of co-compost at Women Farmers Producer Companies and Groups • Give out samples in the beginning at discounted price Dry waste • Contract with buyers	Co-compost • Farmers Producer Companies and Groups • Individual farmers Dry waste • Buyers of dry waste (recyclables)

<table>
<tr><td rowspan="2"></td><td>• Administration and financial management</td><td rowspan="2"></td><td></td><td rowspan="2"></td></tr>
<tr><td>Key Resources

• Land
• Financial resources: CapEx and OpEx
• Human resources
• Relationships between the Municipality, households, entrepreneur, farmers and NGO</td><td>Channels

Co-compost
• Direct sales
• Farmers Producer Companies and Groups

Dry waste
• Direct sales</td></tr>
<tr><td colspan="3">Cost Structure

• Capital expenditure: Land, infrastructure, collectional vehicles, machinery (mainly covered by Town Panchayats and partly by women cooperative/social enterprise)
• Operational expenditure:
  • Rental to the Town Panchayat (20% of sales)
  • Salaries
  • Monitoring and evaluation (lab testing)
  • Fuel and maintenance
  • Admin and utilities
  • Miscellaneous</td><td colspan="2">Revenue Streams

• Sale of co-compost @ Rs 5-7/kg
• Sale of segregated dry waste @ various prices/kg (e.g. plastics, glass, paper, metal)
• Household collection fee @ Rs 250/year
• Faecal sludge tipping fee @ Rs 200/trip</td></tr>
</table>

3.4.3 VALUE CHAIN AND POSITION

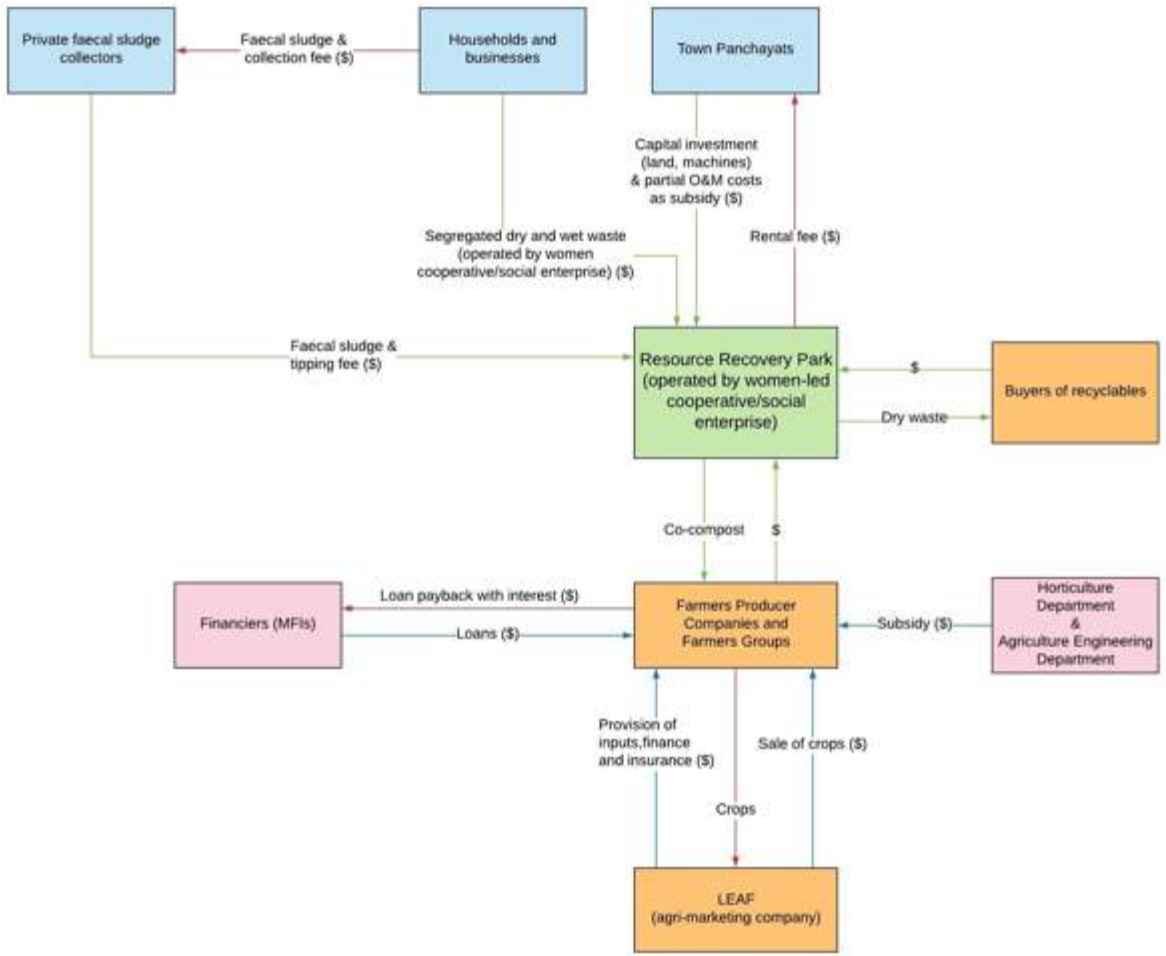


FIGURE 20 VALUE CHAIN AND POSITION (RESOURCE RECOVERY PARK OPERATED BY WOMEN COOPERATIVE/SOCIAL ENTERPRISE)

3.4.4 Financial projection

A. Cost structure

Costs	Unit	Rate	Year 1 #	Year 1 INR	Year 1 USD	Year 2 #	Year 2 INR	Year 2 USD	Year 3 #	Year 3 INR	Year 3 USD	Year 4 #	Year 4 INR	Year 4 USD	Year 5 #	Year 5 INR	Year 5 USD
Capital Costs																	
A. Land and building																	
Land	location	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Buildings (storage room, plastic recycling equipment)	lump sum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shed	bed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Faecal sludge treatment plant	unit	-	1	910,000	11,667	-	-	-	-	-	-	-	-	-	-	-	-
Sub total				**910,000**	**11,667**		-	-		-	-		-	-		-	-
B. Implements and machinery																	
Shovels, crowbars, baskets, plumbing, etc	lump sum	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shredder machine (Power operated)	unit	123,000	1	123,000	1,640	-	-	-	-	-	-	-	-	-	-	-	-
Sieving machine (Power operated)	unit	75,000	1	75,000	1,000	-	-	-	-	-	-	-	-	-	-	-	-
Weighing scale (100 kg capacity)	unit	75,000	1	75,000	962	-	-	-	-	-	-	-	-	-	-	-	-
Measurement tools (moisture, temp, pH)	unit	25,000	1	25,000	321												
Wheel barrows	unit	5,000	2	10,000	133	-	-	-	-	-	-	-	-	-	-	-	-
Plastic processing equipment (sorting belt, bailing machine)	unit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Safety and health and operational equipment	unit	102,000	1	102,000	1,360	-	-	-	-	-	-	-	-	-	-	-	-
Sub total				**410,000**	**5,256**		-	-		-	-		-	-		-	-
C. Transportation																	
Vehicles	unit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub total				-	-		-	-		-	-		-	-		-	-
D. Water provision	connection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Electrical provision	connection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Furniture & fixtures	lump sum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL CAPITAL COST				**1,320,000**	**16,923**		-	-		-	-		-	-		-	-

Costs	Unit	Rate	Year 1 #	Year 1 INR	Year 1 USD	Year 2 #	Year 2 INR	Year 2 USD	Year 3 #	Year 3 INR	Year 3 USD	Year 4 #	Year 4 INR	Year 4 USD	Year 5 #	Year 5 INR	Year 5 USD
Operational Costs																	
A. Input costs																	
Faecal sludge collection and transportation fee	year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solid waste collection and transportation fee (See Input	year	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub total				-	-		-	-		-	-		-	-		-	-
B. Human resources																	
Manager	year	180,000	1	180,000	2,308	1	180,000	2,308	1	180,000	2,308	1	180,000	2,308	1	180,000	2,308
Sales and marketing	person	150,000	1	150,000	1,923	1	150,000	1,923	1	150,000	1,923	1	150,000	1,923	1	150,000	1,923
Site worker	year	120,000	20	2,400,000	30,769	20	2,400,000	30,769	20	2,400,000	30,769	20	2,400,000	30,769	20	2,400,000	30,769
Sub total				**2,730,000**	**35,000**		**2,730,000**	**35,000**		**2,730,000**	**35,000**		**2,730,000**	**35,000**		**2,730,000**	**35,000**
C. Sales and marketing																	
Packaging (bags, labelling)	month	5,000	12	60,000	769	12	60,000	769	12	60,000	769	12	60,000	769	12	60,000	769
Transportation	month	2,500	12	30,000	385	12	30,000	385	12	30,000	385	12	30,000	385	12	30,000	385
Marketing activities	month	2,000	12	24,000	308	12	24,000	343	12	24,000	343	12	24,000	343	12	24,000	343
Sub total				**114,000**	**1,462**		**114,000**	**1,462**		**114,000**	**1,462**		**114,000**	**1,462**		**114,000**	**1,462**
D. Monitoring and evaluation (lab testing)	month	20,000	12	240,000	3,077	12	240,000	3,077	12	240,000	3,077	12	240,000	3,077	12	240,000	3,077
E. Fuel and maintenance	# truck/year	186,000	3	558,000	7,154	3	558,000	7,154	3	558,000	7,154	3	558,000	7,154	3	558,000	7,154
F. Admin and utilities																	
Rent to Town Panchayat	year	20% of sales	1	639,600	8,200	1	736,500	9,442	1	867,000	11,115	1	991,200	12,708	1	1,127,600	14,456
Electricity	month	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water	month	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accounting and audit	year	20,000	1	20,000	256	1	20,000	256	1	20,000	256	1	20,000	256	1	20,000	256
Sub total				**659,600**	**8,456**		**756,500**	**9,699**		-	-		-	-		-	-
G. Miscellaneous	month	1,500	12	18,000	231	12	18,000	231	12	18,000	231	12	18,000	231	12	18,000	231
TOTAL OPERATIONAL COST				**4,319,600**	**55,379**		**4,416,500**	**56,622**		**3,660,000**	**46,923**		**3,660,000**	**46,923**		**3,660,000**	**46,923**
TOTAL COST				**5,639,600**	**72,303**		**4,416,500**	**56,622**		**3,660,000**	**46,923**		**3,660,000**	**46,923**		**3,660,000**	**46,923**

B. Revenue structure

Sales price	Year 1		Year 2		Year 3		Year 4		Year 5	
	INR	USD	INR	USD	INR	USD	INR	USD	INR	USD
Co-compost (per kg)	5.00	0.06	6.00	0.08	7.00	0.09	7.00	0.09	7.00	0.09
Segregated plastic bottles (per kg)	15.00	0.19	15.00	0.19	15.00	0.19	15.00	0.19	15.00	0.19
Segregated plastic containers (per kg)	20.00	0.26	20.00	0.26	20.00	0.26	20.00	0.26	20.00	0.26
Segregated glass botttles and jars (per kg)	6.00	0.08	6.00	0.08	6.00	0.08	6.00	0.08	6.00	0.08
Segregated paper (recyclable)	10.00	0.13	10.00	0.13	10.00	0.13	10.00	0.13	10.00	0.13
Segregated cartons (recyclable)	10.00	0.13	10.00	0.13	10.00	0.13	10.00	0.13	10.00	0.13
Segregated metal (recyclable)	30.00	0.38	30.00	0.38	30.00	0.38	30.00	0.38	30.00	0.38
MSW household collection fee (per households/year)	250.00	3.21	250.00	3.21	250.00	3.21	250.00	3.21	250.00	3.21
Faecal sludge tipping fee (per trip)	200.00	2.56	200.00	2.56	200.00	2.56	200.00	2.56	200.00	2.56

Amount	Year 1	Year 2	Year 3	Year 4	Year 5
Co-compost (kg)	120,000.00	150,000.00	200,000.00	280,000.00	360,000.00
Plastic bottles (kg)	5,000.00	7,500.00	10,000.00	11,000.00	13,000.00
Plastic containers (kg)	5,000.00	7,500.00	10,000.00	11,000.00	13,000.00
Glass botttles and jars (kg)	5,000.00	7,500.00	10,000.00	11,000.00	13,000.00
Paper (kg)	5,000.00	7,500.00	10,000.00	11,000.00	13,000.00
Cartons (kg)	5,000.00	7,500.00	10,000.00	11,000.00	13,000.00
Metal (kg)	500.00	500.00	500.00	500.00	500.00
MSW household collection fee (# households)	9,000.00	9,000.00	9,000.00	9,000.00	9,000.00
Faecal sludge tipping fee (# trips)	140.00	300.00	300.00	300.00	300.00

Sales	Year 1		Year 2		Year 3		Year 4		Year 5	
	INR	USD	INR	USD	INR	USD	INR	USD	INR	USD
Co-compost	600,000.00	7,692.31	900,000.00	11,538.46	1,400,000.00	17,948.72	1,960,000.00	25,128.21	2,520,000.00	32,307.69
Plastic bottles	75,000.00	961.54	112,500.00	1,442.31	150,000.00	1,923.08	165,000.00	2,115.38	195,000.00	2,500.00
Plastic containers	100,000.00	1,282.05	150,000.00	1,923.08	200,000.00	2,564.10	220,000.00	2,820.51	260,000.00	3,333.33
Glass botttles and jars	30,000.00	384.62	45,000.00	576.92	60,000.00	769.23	66,000.00	846.15	78,000.00	1,000.00
Paper	50,000.00	641.03	75,000.00	961.54	100,000.00	1,282.05	110,000.00	1,410.26	130,000.00	1,666.67
Cartons	50,000.00	641.03	75,000.00	961.54	100,000.00	1,282.05	110,000.00	1,410.26	130,000.00	1,666.67
Metal	15,000.00	192.31	15,000.00	192.31	15,000.00	192.31	15,000.00	192.31	15,000.00	192.31
MSW household collection fee	2,250,000.00	28,846.15	2,250,000.00	28,846.15	2,250,000.00	28,846.15	2,250,000.00	28,846.15	2,250,000.00	28,846.15
Faecal sludge tipping fee	28,000.00	358.97	60,000.00	769.23	60,000.00	769.23	60,000.00	769.23	60,000.00	769.23
Total	3,198,000.00	41,000.00	3,682,500.00	47,211.54	4,335,000.00	55,576.92	4,956,000.00	63,538.46	5,638,000.00	72,282.05

C. PROFIT AND LOSS

Income	Year 1		Year 2		Year 3		Year 4		Year 5	
	INR	USD	INR	USD	INR	USD	INR	USD	INR	USD
Sales of product	3,198,000.00	41,000.00	3,682,500.00	47,211.54	4,335,000.00	55,576.92	4,956,000.00	63,538.46	5,638,000.00	72,282.05
TOTAL INCOME	**3,198,000.00**	**41,000.00**	**3,682,500.00**	**47,211.54**	**4,335,000.00**	**55,576.92**	**4,956,000.00**	**63,538.46**	**5,638,000.00**	**72,282.05**
Expenses	**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
	INR	USD	INR	USD	INR	USD	INR	USD	INR	USD
Capital cost	1,320,000.00	16,923.08	-	-	-	-	-	-	-	-
Operational cost	4,319,600.00	55,379.49	4,416,500.00	56,621.79	3,660,000.00	46,923.08	3,660,000.00	46,923.08	3,660,000.00	46,923.08
TOTAL COST	**5,639,600.00**	**72,302.56**	**4,416,500.00**	**56,621.79**	**3,660,000.00**	**46,923.08**	**3,660,000.00**	**46,923.08**	**3,660,000.00**	**46,923.08**
Profit/loss	**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
	INR	USD	INR	USD	INR	USD	INR	USD	INR	USD
Profit (before tax)	- 2,441,600.00	- 31,302.56	- 734,000.00	- 9,410.26	675,000.00	8,653.85	1,296,000.00	16,615.38	1,978,000.00	25,358.97
TOTAL PROFIT/LOSS	**- 2,441,600.00**	**- 31,302.56**	**- 734,000.00**	**- 9,410.26**	**675,000.00**	**8,653.85**	**1,296,000.00**	**16,615.38**	**1,978,000.00**	**25,358.97**

3.5 Replication plan

The innovation in Nilgiris can easily be replicated to other vegetable markets with a market size of $4-6.3 million/day. With stored recycled greywater, they have more crops for sale due to extended cropping season and the recycled black water in the form of co-compost has an impact on the soil nutrition and the increase in crop yield and income to the vegetable growers. The innovation is also replicable to water stressed areas as this will enable the production of more food with less water and make more water available for food production, processing and distribution.

Recently the Government order issued by the Municipal Administration and Water Supply Department of Government of Tamil Nadu for the construction of Faecal sludge treatment plants in the Resource Recovery Parks of 528 Town Panchayaths in 5 Phases was a welcome notification for the replication of our efforts at Ketty and Adigarahatty Town Panchayaths.

3.6 Relevance to sustainable development goals

In 2015, world leaders adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030. The model in scale addresses a number of these SDGs as outlined in the table below:

Sustainable Development Goals	**How the model addresses the respective SDG**
SDG 1: No poverty	The model improves livelihood by creating local green jobs in sanitation, solid waste management and agriculture. This ranges from faecal sludge collector, transporter, women SHGs who handle processing of dry, wet and liquid waste and farmers who are organised into women Farmers Producer Groups and Companies who are encouraged to take up value-addition activities (e.g. carrot washing).
SDG 2: Zero hunger	The model promotes sustainable agricultural practices with processing of waste into soil improver in which its application to soil improves soil fertility management and advances food security to meet growing population and demand.
SDG 3: Good health and well-being	The model scales up to eradicate open defecation to improve state of public health and environment with safe and proper management of faecal sludge and solid waste. In India, economic costs of poor sanitation and hygiene is over US$448 million per year due to health, water pollution, tourism, and other factors.
SDG 4: Quality education	The model partners up with Town Panchayats to educate households in solid waste segregation at source. Additionally, the model focuses on the capacity building of women SHG members to take up operation in faecal sludge and solid waste treatment and reuse, as well as capacity building of farmers under Farmers Producer Groups and Companies.
SDG 5: Gender equality	The model focuses on empowerment of women in the creation of jobs in sanitation, solid waste management and agriculture. This includes the institutionalisation of women farmers into Farmers Producer Companies and Groups and institutionalisation of women SHGs members into a cooperative/social enterprise. The purpose is to allow women to have more decision-making power in the business operation.

SDG 6: Clean water and sanitation	The model aims for circular economy in sanitation for agriculture, with market-linkage and financial inclusion. The purpose is to establish a local circular economy model in sanitation for agriculture that is scalable and autonomous with mobilisation of private finance and market-linkage approach to improve health and advance green growth.
SDG 8: Decent work and economic growth	The model creates businesses in sanitation, solid waste management and agriculture by development of local entrepreneurs, employment creation, cleaner environment, climate resilience improvement, and healthier society contributing to sustained economic growth.
SDG 9. Industry, innovation and infrastructure	The model offers innovation to advance agriculture industry waste-for-agriculture (co-ompost for soil fertility management). The Nilgiris District has also the mandate to become an chemical-free District by 2020.
SDG 11: Sustainable cities and communities	The model puts emphasis on integral components of smart cities with Smart Environment (water, waste, and sanitation) and Smart Governance (Public Private Partnership and employment generation) to advance towards sustainable cities and communities.
SDG 13: Climate action	The model takes actions in climate mitigation measure with soil application of compost that improves soil fertility and reduces crop water demand in times of water scarcity.
SDG 15: Life on land	The model restores soil fertility with application of compost generated from recycling of sanitation waste. This consequently leads to increased yields and improves soil water holding capacity. More importantly, fertile soil encourages biodiversity by increasing the variability among living organisms in the soil.
SDG 17: Partnership for the goals	The model revitalises global partnership for circular economy in sanitation with a growing partnership of over private, public, and civil society partners working towards common goals of clean water and sanitation, sustainable agriculture, equity and health.