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project	**An exploration of opportunities to utilise urban organic waste for the livelihood improvement of rural and urban communities in Bangladesh and India**
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List of Abbreviations

ACI	Advanced Chemical Industries
ADB	Asian Development Bank
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
BSS	Bangladeh Sangbad Sangstha
CBO	Community Based Organization
CCDB	Christian Commission for Development in Bangladesh
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CMES	Centre for Mass Education in Science
CMA	Centre for Management in Agriculture at the Indian Institute of Management
FAO	Food and Agriculture Organisation (Bangladesh)
FMO	Dutch Development Bank
GKSS	Grameen Krishok Shohayak Sangstha
GOB	Government of Bangladesh
GOI	Government of India
GRAMUS	Grameen Monobik Unnoyan Shanstha
IPNM	Integrated Plant Nutrient Management
MoA	Ministry of Agriculture (Bangladesh)
MOUD	Ministry of Urban Development (India)
MSW	Municipal Solid Waste
NATP	National Agricultural Technology Project
NGO	Non-Government Organisation
NPOF	National Project for Organic Farming (India)
PPP	Public Private Partnership
RDA	Rural Development Academy (India)
RDRS	Rangpur DIialpur Rural Service
RDF	Refuse Derived Fuel
3R	Reduce, Re-use, Recycle
RUSTIC	Rural Unfortunates Safety Talisman Illumination Cottage
SWM	Solid Waste Management
UNCRD	United National Centre for Regional Development
UOW	Urban Organic Waste
VAT	Value Added Tax
WTE	Waste to Energy

Contents

1 Executive summary

This SRA project set out to assess opportunities to utilise urban organic waste for the livelihood improvement of rural and urban communities in Bangladesh and India.

The objectives of the project were to:

1. Analyse the organic waste policy contexts of Bangladesh and India
2. Document the state of knowledge of the urban organic waste situation of Bangladesh and India
3. Explore current practices in organic waste recycling and composting in rural and urban areas of Bangladesh and India
4. Identify innovative practices in organic waste recycling and composting in Bangladesh, India and other developing countries

In exploring these objectives, it is clear that:

- A supportive policy and regulatory framework exists in both countries
- The issues of urban organic waste management are well understood
- The scale of Municipal Solid Waste issues in large metropolitan areas creates a number of logistical barriers for organic waste recycling projects
- There are examples of urban organic waste being successfully composted and returned to agriculture in both countries
- Use of composting, vermiculture and other organics recycling techniques are gaining popularity in both conventional and organic farming practices.

Despite the potential, only 2% (Bangladesh) and 6% (India) of urban organic waste is currently being diverted and composted. Using composted urban organic waste in agriculture on any large or systematic scale remains aspirational as the systems for collection, processing, transport and application are yet to be fully realised. Successful working models do exist in each country and these are worth exploring further for scalability and replicability.

There is evidence of innovation and progress in each country particularly in regard to agricultural extension work, community composting in India, and farm based vermiculture and small scale nutrient cycling projects in Bangladesh.

Notably absent are any specific programs, research or trial work to clearly demonstrate the impact of using composted urban organic waste to produce food.

While there is considerable scope for recycled organics in agriculture, a number of challenges would need to be overcome:

- Compost produced by waste processors is generally low quality
- Quality standards are not generally enforced
- Supply chain issues would need to be resolved (volume, transport, storage).

Overall, unrecovered organic waste represents a vast river of resources that could be tapped into by farmers. This potential is clearly reflected in the public policy and regulatory frameworks in both countries.

The key finding from this report is that use of urban organic waste for livelihood improvement of rural and urban poor is worthy of further investigation and investment.

2 Introduction

This SRA project examines opportunities to utilise urban organic waste for the improvement of livelihoods of rural and urban communities in Bangladesh and India.

The objectives of the project are to:

1. Analyse the organic waste policy contexts of Bangladesh and India
2. Document the state of knowledge of the urban organic waste situation of Bangladesh and India
3. Explore current practices in organic waste recycling and composting in rural and urban areas of Bangladesh and India
4. Identify innovative practices in organic waste recycling and composting in Bangladesh, India and other developing countries

The first part of the project involved Australian-based desktop research. The topic of urban organic waste to agriculture spans multiple disciplines including environmental science, engineering, public health, public administration, natural resource management, agriculture and sustainability. For this reason multiple databases and generic search engines were utilised. The methods used include key word searches on electronic library data bases and Google Scholar. Materials were downloaded or accessed on-line. Published materials unavailable on–line were purchased directly by the University of Canberra Library. After an initial analysis of the published literature, secondary online searches were initiated to locate international conference proceedings, on-line information hubs, subject matter experts, key informants and key organisations.

As a result of this process, 36 published journal articles, 38 reports, papers and other documents, 2 published books and 11 government documents were collected and assessed as directly relevant to the research questions. Published statements regarding the status, or otherwise, of existing composting facilities or urban organic waste recycling projects were triangulated with internet searches and searches of social media platforms. Informal information regarding on-line resource hubs, community groups and on-line networks were gathered from Google, YouTube and Facebook. While not primary sources for this report, these resources provide a valuable counterpoint to the published material. A list of relevant websites and online resources has been collated for each country.

Based on these initial findings, the project team commissioned further in-country research to triangulate the published material located to date and to gain deeper in-country knowledge of the situation in both countries. . The focus of this research was:

- Further exploration of current practices in on-farm composting in Bangladesh & India (Objective 3)
- Gathering deeper information about organics recycling and organic waste to agriculture in rural and peri-urban areas in Bangladesh (Objective 3)
- Gathering deeper information about the use of organics recycling and organic waste by agri-business in India (Objective 3 & 4)
- Gathering deeper information on innovative programs and practices in agricultural sector in India (Objective 4)
- Gathering deeper information on innovative programs and practices in agricultural sector in Bangladesh. (Objective 4)

In country research was commissioned from:

Dr Tariq Bin Yousuf (Bangladesh)

Dr Md. Mofakhrul Islam Shah (Bangladesh)

Dr Anuradha Singh and Dr Mahesh Venkataramaiah (India)

Findings from the desktop research and in-country reports have been integrated into this SRA report. The first part of the report focuses on Bangladesh and the second on India. The final section summarise the key findings for both countries and offers a series of recommendations for further investigation.

Full reports from the in country researchers are included in a separate addendum to this report.

3 Project Overview

Table 1 provides a summary of the project objectives, activities, methods and research questions.

Table 1 Summary of Project

Objectives	Activities	Methods	Research Questions
1. Analyse the organic waste policy contexts of Bangladesh and India	*Policy search* in each country to identify, list and provide copies of policy frameworks or statements and the key regulatory measures relating to management of organic waste and use of recycled organic waste in agriculture	*Policy identification and analysis* Identify national policies and key regulatory measures relevant to management of organic waste and use of recycled organic waste in agriculture.	What is the policy and regulatory context? Where are the opportunities or drivers within the policy context?
2. Understand the state of knowledge of the urban organic waste situation in Bangladesh and India	*Literature search* Summary of existing research and reports from India Summary of existing research and reports from Bangladesh	*Urban organic waste knowledge situation stocktake.* Summarise existing knowledge and data regarding urban organic waste in Bangladesh and India.	What do we know about urban organic waste in India and Bangladesh? What are the drivers for change?
3. Explore current practices in organic waste recycling and composting in rural and urban areas of Bangladesh and India	*Practice mapping and analysis* 1 *Summary* of current practices in on farm composting and composting in agriculture (not necessarily urban waste related) 2 *Situational analysis* of current practices in organic waste recycling	*Composting and organic waste practices analysis* 1. Document current practices of on-farm and other composting in agriculture. 2. Document current organic waste practices.	How is organic waste currently being recycled? How are farms using compost and composting technologies already? What systems and processes are currently being used? What is common practice?
4. Identify innovative practices in organic waste recycling and composting in Bangladesh, India and other developing countries	*3 India: Business case study* *4 International innovative program search*	3. Identify innovations and/or potential models for pulling urban organic waste out of waste stream for benefit of farmers and urban poor.	What are innovative practices that engage the poor, esp. women and youth? What are the enablers and barriers for urban organic waste recycling and use of recycled urban organic waste by farmers?

4 The Organic Waste Policy Context of Bangladesh

4.1 The policy and regulatory context of Bangladesh

The following table (Table 2) lists the policy and regulatory context for organic waste in Bangladesh. It demonstrates that there is a positive policy and regulatory environment and good integration between the waste and agricultural policy sectors.

Table 2 Policy and Regulatory Context for Bangladesh

POLICIES	COMMENTS
National Environment Policy 1992	Restricts use of chemical fertilizers and pesticides that pollute water or damage ecosystem Encourages the use of organic fertilizers and promotes organic farming Discourages daytime collection of waste and transportation in open trucks. Discourages storage of waste in open places
National Policy for Water Supply and Sanitation 1998	Includes Solid Waste Management States measures should be taken for recycling of waste as much as possible. Organic waste should be used for compost and biogas generation Outlines measures that should be adopted to prevent contamination of ground and surface water in solid waste management facilities Assigns responsibility for solid waste management to city corporations and municipalities. Identifies role of private sector in provision of solid waste management services
Urban Management Policy Statement 1998	Includes some references to Solid Waste Management (SWM) Supports private sector participation in SWM and recycling services
National Urban Sector Policy 2006	Proposes public utilities adopt user pays principle to extend services and reduce burden on municipal budgets Government support for recycling by imposing user fees for waste disposal, encouraging composting and formalizing the function of waste pickers/informal sector Supports establishment of Public Private Partnerships (PPPs) for providing urban environmental services and recommends inclusion of NGOs, CBOs and the informal sector in service models
National Agriculture Policy 1999	Promotes use of compost and organic fertilizer by farmers to improve soil productivity and food security

LEGISLATION	COMMENTS
Fertilizer Act 2006	Promotes the use of compost in conjunction with fertilisers Makes provisions for the development of a compost standard, which was completed in 2008
Bangladesh Environmental Conservation Act 1995	Identifies need to control discharge, disposal and dumping of solid and other tyres of waste which may cause harm to the environment Enacts “polluter pays” principle whereby originator of the pollution must pay for mitigation Allows for formulation of environmental guidelines and rules for control and mitigation of environmental pollution, conservation and improvement of the environment
Bangladesh Environmental Conservation Rules 1997	Specifies disposal standards for landfills and composting operations
National Solid Waste Management Handling Rules 2010 (draft)	National Solid Waste Management Handling Rules were drafted in 2010 under the provisions of the Environmental Conservation Act 1995. The rules have not yet been ratified. Identifies the following objectives for SWM in Bangladesh: • Ensuring the protection of public health and environment • Promoting of environment-friendly and cost effective SWM. • Encouraging recycling, resource conservation and recovery • Encouraging private sector participation and citizen participation in SWM Identifies responsibilities of residents, municipal authorities and Department of Environment Source Segregation: Encourages reduction of waste at the source, and highlights segregation of biodegradable, non-biodegradable and hazardous waste at source to assist in recycling Makes specific recommendations on segregation of waste, collection, storage, transfer stations, transportation, processing and landfilling Identifies national standards for waste processing, leachate quality and compost Includes processes for application and approval of waste processing, operation of disposal facilities, monitoring and review and accident reporting
Fertilizer Management Rules 2007	Emphasizes fertilizer quality management and standardization.

STRATEGIES	COMMENTS
National 3R (Reduce, Reuse and Recycle) Strategy for Waste Management 2010	Provides clear direction and guidance for reduction of waste, recycling and diversion of waste from landfill. Guiding principles include: • Waste as a resource • Source separation of waste • Selection of appropriate, affordable and emission reducing technology • Industrial symbiosis and by product exchange • Polluters Pay Principle and Take Back provisions • Environmental Management Systems • Public Private Partnerships • Collaboration with Scientific Research Bodies • Linking service provision with payments (user pays) • Supporting informal sector • Gender sensitive approach. Lists examples of preferred models, better practice and lessons that have been learned so far including • Source separation of Waste at Household Level • Community Based Urban Solid Waste Management (composting) • Composting in Slums, Schools and Educational Establishments • Medium and Large Scale Commercial Composting projects • Agricultural Waste in Biogas Generation and cook stoves projects • Development of EMSs • Establishment of Recycling Training Centre Identifies the key stakeholders and respective roles and responsibilities Requires local governments, industries, NGOs, trade bodies and other relevant stakeholder groups to develop 3R Action Plans
Poverty Reduction Strategy Paper (PRSP) 2005 & Sixth Five Year Plan (FY2011-2015)	Promotes pro-poor CDM projects in waste sector. Emphasis on source segregation and 3R approach Emphasis on increased use of compost and farm yard manure for increasing soil fertility and agricultural productivity
National Clean Development Mechanisms (CDM) Strategy 2005	Promotes pro-poor CDM projects, especially composting projects, and leveraging carbon financing
National Sanitation Strategy 2005	Goal to achieve 100% sanitation coverage by 2010. Resource recovery and recycling as alternative to disposal identified as key to improving urban sanitation

PLANS	COMMENTS
National Environmental Management Action Plan (NEMAP) 1995	Promotion of waste reduction and recycling of waste Implementation of community based composting pilot projects in Dhaka and Khulna as part of the Sustainable Environment Management Programme (SEMP)
Environmental Management Plan 2005	Waste reduction and recycling identified as a priority
OTHER	**COMMENTS**
Circular to promote compost by the Ministry of Agriculture (MoA) 2008	Promotes use of compost by farmers
Private Sector Housing Development Guidelines 2005	Recommends spaces for composting and other waste recycling are designed into new housing developments
Compost Standard 2008 (Under Fertiliser Act)	Bangladesh compost standard.
Private Sector Infrastructure Guidelines 2004	Identifies waste management sector as growth area for private investment
South Asian Association for Regional Cooperation (SAARC) Dhaka Recommendation on Waste Management 2004	SAARC Countries agreed to promote community based source separation of waste with separate organics collection and resource recovery systems over incineration and other unproved technologies.

SOURCES: (Yousuf, 2014) (Department of Environment, 2010) (Asian Development Bank, 2011)

4.2 The opportunities or drivers within the policy context in Bangladesh

The policy and regulatory context established over the last 5 – 10 years in Bangladesh is very supportive of organic waste to agriculture. There is a clear policy directive for source separation of organic waste. Organic waste to agriculture is a clearly articulated policy goal. The policy and legislative framework supports municipal governments to enter into partnerships with the private, NGO and informal sectors to establish integrated waste management systems. Bangladesh has developed standards for compost and a system for processors to gain certification and approval to market their compost to farmers. Composts made from recycled urban organic waste cannot be marketed without certification. Agricultural policies support the use of composts made with organic waste in agriculture and the use of compost in Integrated Nutrient Management approach[1]. Links exist between environmental, waste management, municipality, and poverty reduction policy frameworks.

[1] *Integrated plant nutrient management is an approach that incorporates both organic and inorganic fertilizers to attain higher crop productivity and prevent and/or repair soil degradation.*

5 The State of Knowledge of the Urban Organic Waste Situation in Bangladesh

Significant work has been done in the area of Municipal Solid Waste (MSW) and Urban Organic Waste (UOW) in Bangladesh to fully scope and analyse the urban organic waste situation. The state of knowledge about urban organic waste is reflected in the well-developed policy, legislative and strategic planning frameworks. There are a number of in country and internationally funded reports and resources which provide a current and comprehensive overview of the situation regionally and locally.

Key published resources include:

Municipal Solid Waste Management in Asia and the Pacific Islands – Challenges and Strategic Solutions, edited by Agamuthu Pariatamby and Masaru Tanaka. This book was published by Springer in September 2013. The resource provides an up-to-date regional overview of the urban waste situation, including organic waste, and specific chapters on Bangladesh and India. The Bangladesh chapter was written by Dr Tariq Bin Yousuf, who completed the in-country research for this SRA.

Toward Sustainable Municipal Organic Waste Management in South Asia: A Guidebook for Policy Makers and Practitioners. This book was published by the Asian Development Bank (ADB) in 2011. It was funded by the Australia Government. The book is comprehensive, practical and solution-oriented.

Additionally, Dr Tariq Bin Yousuf recently completed an overview of the composting sector in Bangladesh for the International Water Management Institute[2] (IWMI). This constitutes a valuable, in country assessment and analysis of the organic waste situation and the work that is being done to progress organic waste to agriculture in Bangladesh.

5.1 Urban organic waste in Bangladesh

Bangladesh generates 4.9 million tonnes of solid waste per year, of which 78% is organic matter[3]. This equates to 3.8million tonnes of organic waste per year[4]. Based on a conversion rate of 25%, Bangladesh has the potential to produce 3.8 million tonnes of compost per year[5].

Currently in Bangladesh 88% of waste is untreated, 10% is disposed of in sanitary landfills and only 2% is composted[6].

Between 75-85% of the total municipal waste stream is generated by householders, the rest is generated by business, institutes, commercial enterprises and other municipal services[7].

Where regular collection services exist, mixed waste is generally collected through a community bin service or increasingly, through fee for service door-to-door collections. Recyclables are generally removed from the waste stream after it has been collected through a predominantly informal recycling sector. Almost all recycling is done by the informal waste sector.

[2] *(Yousuf, 2014)*
[3] *(Asian Development Bank, 2011, p. 5)*
[4] *(Asian Development Bank, 2011, p. 5)*
[5] *(Asian Development Bank, 2011, p. 7)*
[6] *(Asian Development Bank, 2011, p. 3)*
[7] *(Yousuf, 2014, p. 6)*

Apart from a number of small pilot and demonstration projects, an increase in user pays door-to-door services, and a supportive policy and regulatory context, almost all organic waste enters the mixed waste stream and is disposed of in open dumps or landfills[8].

The total **potential** market value of recycled organic waste at current market values in Bangladesh is estimated at around US$192.88 million per year[9].

5.2 The drivers for change in Bangladesh

There are a number of drivers for change that support the diversion of organic waste into agriculture in Bangladesh. These include "push" drivers associated with an increasing need to divert organics away from the waste stream and send it somewhere else, and "pull" drivers associated with a need to put organic matter back into agricultural soils.

From a "push" perspective, solid waste is a significant and pressing environmental issue in urban Bangladesh[10]. Piles of waste left uncollected in the streets are a major public health risk and can block drainage channels and exacerbate flooding. Waste dumped in channels and waterways results in significant environmental pollution and public health risks to those living near or depending on rivers[11]. Solid waste generation is increasing per capita due to changing consumption habits. As the population increases, and waste per capita also increases, pressure to divert organic waste from the waste stream will also increase.

The practice of landfilling un-recycled waste requires large tracts of land. The social, public health and environmental impact of waste management in Bangladesh creates pressure on governments and municipalities to replace unmanaged open dumps with engineered and managed landfills. Diversion of the organic fraction of the waste stream extends the life of existing and future landfills and reduces environmental and social impacts of decomposing waste. Diversion of organic waste from the current waste stream would result in an annual saving of around 2.85 million m^3 of landfill space each year[12].

The shift from unmanaged to engineered landfills, increasing land values and competition for land places upward pressure on the cost of building and managing landfills. In time, rising costs of landfilling organic waste will outweigh the cost of investing in organics recycling systems.

From a "pull" perspective, the need to address soil degradation, particularly in relation to food production provides a significant driver for change. Issues of soil degradation in Bangladesh are well documented[13]. Average soil organic matter levels in agricultural land in Bangladesh have dropped from around 2% to 1% over the last 20 years due to intensive cultivation[14]. There is general recognition of the diminishing returns from conventional fertilizer. Depletion of organic matter in soils as a result of intensive cultivation and chemical fertilizer use is a significant issue that could be addressed through application of composted urban organic waste. There is strong regional and national policy support for composted urban organic waste to be used in agriculture to improve soil health, agricultural productivity and food security[15].

[8] *(Yousuf, 2013)*
[9] *(Asian Development Bank, 2011)*
[10] *(Yousuf, 2014, p. 3)*
[11] *(Bhuiyan, 2010, p. 125)*
[12] *(Asian Development Bank, 2011)*
[13] *(Hasan & Ashraful Alam, 2006, p. 20)*
[14] *(Asian Development Bank, 2011, p. 8)*
[15] *(Asian Development Bank, 2011, p. 8)*

6 Current Practices in Organic Waste Recycling and Composting in Rural and Urban Areas of Bangladesh

6.1 Current organic waste recycling in Bangladesh

Organic waste is the largest component of the waste stream in Bangladesh. Currently most organic waste enters the mixed waste stream. Most composting projects are then attempting to separate the organic fraction from residual waste once it has entered the mixed waste stream[16]. Organic material recovered from mixed waste streams will have higher concentrations of physical and chemical contaminants. Processing costs will be higher and the quality of the end product will be lower.

Within that context, there are a number of demonstration projects and successful models being developed.

Waste Concern

The most established and well-known of these is the work of Waste Concern[17] and the Waste Concern Group. Waste Concern is an established social enterprise comprising a range of for-profit and not–for-profit activities based in Dhaka. Waste Concern was founded in 1995 and has worked extensively with the Government of Bangladesh and international development agencies to champion organic waste recycling in Bangladesh. The purpose of the Waste Concern Group is to "*contribute to waste recycling, environmental improvement, renewable energy, poverty reduction through job creation and sustainable development*".

Waste Concern is Bangladesh's largest compost manufacturer (>15,000 tonnes / year) and has established and continues to operate numerous small, medium and one large scale composting operation across Bangladesh. More recently they have begun to assist other countries to implement similar models. Waste Concern was the first composting operation to be granted approval under the Clean Development Mechanism (CDM) which allows the project to claim certified emission reductions (CER) through the United National Framework Convention on Climate Change[18]. Compost produced by Waste Concern at the >15000 tonne site has achieved government certification and is able to be marketed as certified compost. (Additional information regarding Waste Concern's relationship with ACI and the value-add and distribution chain is included at Appendix 1).

Approximately 75% of revenue for the medium scale facility comes from compost sales, the rest from collection fees and certified emission reductions (CERs)[19]. Waste Concern provides open source resources and information for others seeking to establish organics recycling projects and offers consulting, training and laboratory services. (See website for more information[20].). The projects are financed by a range of donors including the Dutch Development Bank (FMO), High Tide Investments of the Netherlands and Dutch Bank of Bangladesh. Most Waste Concern composting projects involve workers separating organic waste from mixed waste. The >15,000 tonne site point of difference is that the municipal government pays Waste Concern a collection fee to collect source separated food waste from local markets. As a result, compost from this facility is able to meet quality and certification requirements. It is a clear example of the importance of source separation to the quality and saleability of the finished product.

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[16] *(Yousuf, 2013, p. 65)*
[17] *See http://www.wasteconcern.org/index.php*
[18] *(Asian Development Bank, 2011, p. 33)*
[19] *(Yousuf, 2014, pp. 26-27)*
[20] *See http://www.wasteconcern.org/index.php*

In addition to the pioneering work of Waste Concern, the following list of organic waste projects at various stages of implementation has been identified.

3R Pilot Project - Dhaka and Chittagong

The Department of Environment has commenced a 3R Pilot Project which includes collection of **source separated** organic waste at the household level and composting of organic waste in a number of locations in Dhaka and Chittagong city. There are reports however that reports that problems with secondary collection and intermediate treatment processes has meant that the project has stalled[21].

3R Pilot Project - Kushtia

A UNCRD supported 3R Pilot Project involving source separation and composting has been implemented in Kushtia municipality.

GoB Climate Change Trust Fund CDM project

The Government of Bangladesh, through the Climate Change Trust Fund is implementing a Clean Development Mechanism (CDM) project that includes composting of organic waste in 64 districts. To date composting facilities have been established in Mymensingh, Naraygong, Gazipur and Cox Bazar.

Urban Public Environmental Health Sector Development Project

Six City Corporations under the Urban Public Environmental Health Sector Development Project funded by ADB, will be constructing composting plants each capable of processing 20 tonnes per day as part of the GOB Integrated Waste Management Project.

Urban Government Infrastructure Improvement Project

As part of the Urban Government Infrastructure Improvement Project, composting projects able to process 1-5 tonnes/day will be constructed in 30 municipalities.

UNICEF Environmental Sanitation, Hygiene and Waste Supply Project

Under a UNICEF funded Environmental Sanitation, Hygiene and Water Supply Project, 11 compost plants were constructed in urban slums and fringe areas. Recent advice suggests that some of these sites have either stopped or scaled down due to difficulties in gaining certification of the finished compost[22].

Value for Waste Project - Baridhara

The Value for Waste Project in Baridhara residential area, with technical support provided by Swiss Contact, has implemented an organic waste project involving household **source separation** and composting. The project models an intensive community engagement program. To encourage source separation householders have access to free compost for their gardens.

SUNYA-Towards Zero Waste in South Asia

A European Union supported SUNYA-Towards Zero Waste in South Asia[23] project has been established in Dhaka as part of an international project to close the loop of organic material through the use of a rotary composter, roof top gardening and rainwater harvesting.

GRAMUS GMTS Eco Compost project - Mymensingh

[21] *(Yousuf, 2015)*
[22] *(Yousuf, 2015b)*
[23] *http://www.sunyaproject.org/*

In Mymensingh municipality, under the technical support of Practical Action[24] and funded by GIZ, Grameen Monobik Unnoyan Shanstha (GRAMUS) has been operating a composting plant that processes urban organic waste since 2009. The facility produces 4 tons of compost per day under the brand name GMTS Eco Compost. The compost was tested in trials conducted by Bangladesh Agriculture University. Recently GRAMUS has gained certification for marketing their compost.

The list above shows that urban organic waste projects have been established across the country with various levels of success. These programs are supported by a wide cross section of policy portfolios, NGOs, government agencies and donors. Despite the supportive policy and regulatory context, comprehensive diversion of organic waste to agriculture is still in a fledgling state. The main challenge for composting projects in Bangladesh appears to hinge on finding economic models to finance source separation.

There are three main composting methodologies employed in Bangladesh for the processing of urban organic waste.

1/ In small scale facilities, *box composting*, using the methodology developed by Waste Concern, allows organic waste to be composted in contained structures. With this method multiple rectangular brick “boxes” are constructed to hold feedstock material. Perforated pipes are inserted into the compost to facilitate aeration. Contents are periodically turned. Box composting is labor intensive and works well in urban areas with limited space.

2/ Drum Composting is a similar small scale composting method often used in community based composting projects. Perforated drums of various sizes are used to receive, hold and process organic waste during the composting process. See Appendix 2 for photos and more information.

3/ Larger facilities generally use *open windrowing*. Organic material is formed into large windrows and turned periodically. Land requirements include areas for unloading, sorting, mixing, screening and bagging. Mechanical forced aeration is planned to be used at larger facilities.

6.2 Current compost and composting technologies in Bangladesh

Small scale on-farm composting of manures, crop residues and food waste has a long history and is common practice in rural Bangladesh[25], particularly on small farms. Farm produced composts are commonly used to maintain soil fertility and for cultivating winter vegetables such as tomato, brinjal, cabbage, cauliflower and radish[26]. Farmers commonly make and use compost to increase soil organic matter and therefore tilth, water holding capacity and fertility[27], protect their soil from the ill effects of chemical fertilizer, avoid high prices of inorganic chemicals and to beneficially reuse a variety of available organic waste[28].

Traditionally on-farm composting is practiced using a “trench and pit” system or a static pile methodology. Inputs into on-farm composting generally include crop residues, kitchen scraps, fruit and vegetable peelings, grass clippings, dry twigs, hay, ashes, cow dung, farmyard manures and wastes from poultry and animal shelters[29]. These inputs are available close by and at no cost.

[24] http://practicalaction.org/
[25] *(Shah, 2015)*
[26] *(Shah, 2015)*
[27] *(Shah, 2015)*
[28] *(Shah, 2015)*
[29] *(Shah, 2015)*

Vermicomposting

While fairly new to Bangladesh, on-farm vermiculture[30] is gaining popularity. Small scale on-farm vermicompost is being used and promoted among farmers as a cost effective alternative to chemical fertilizers with additional soil health benefits. The Bangladesh Vermi-Compost Producers Association was formed in January 2015 to support and promote vermicompost production and use as low cost fertilizer alternative that provides additional soil health and disease resistance benefits[31]. Inputs into on-farm vermicompost operations are typically cow manure, crop residue and other farm waste.

Current examples of good practice can be found in Meherpur district (west part), Mymensigh district (middle) and Rangpur district (north)[32]. The Department of Agriculture extension program actively supports farmers to produce and apply vermicast[33]. Vermiculture is currently being practice by farmers in 27 districts of Bangladesh under the National Agricultural Technology Project and Integrated Agricultural Productivity Project of the Department of Agricultural Extension (DAE)[34]. As part of the project, DAE provides materials such as cement rings, sheeting and worms to poor farmers for preparing vermicompost.

NGOs are also working with poor farmers, including women, to introduce vermicompost technology[35]. These include Rural Development academy in Bogra and Serpur districts, Unnyaon Dhara in Dhaka region, Christian Commission for Development in Bangladesh CCDB in Manikgonj, Centre for Mass Education in Science (CMES) and Annapurna Agro Service in Nilphamari district and Hungers Banglasdesh nationally.[36]

CCDB under its project Comprehensive Poverty Reduction Programme (CPRP) has implemented a women's vermicompost program at Koyer Chala, Bakta, Enayetpur, Rangamatia, Kanchichura and Nischintapur villages in Phulbaria, Mymensingh. Around 200 women are involved in vermi compost production in Phulbaria. The vermicompost improves soil fertility, increases crop yields and improves disease resistance.

Women entrepreneurs in several villages of Jhenaida have established successful micro-enterprises breeding and selling worms[37]. Most of these women are from impoverished backgrounds. Both the worms and castings are sold.

(Further details on vermiculture techniques used in Bangladesh are included in Dr Md Mofakhrul Islam Shah's in-country report. Additional information and case studies are provided at http://vermicompostbd.com.)

Biogas Slurry

With the advent of renewable energy technologies, there has been a strong growth in the number of biogas plants across the country[38]. Both large-scale commercial biogas plants and home-based small-scale biogas plants are increasingly being installed across the country. Poultry and cow manures are typical feedstocks into the biogas units. The bioslurry by-product generated from the biogas plant is an excellent compost source. This bioslurry can be purchased from large biogas plants owned by large scale poultry or dairy farms or it can be used by small scale plant owners for their own agricultural crops. A key benefit of biogas technologies is that farmers are able to use manures for both power generation and soil improvement, rather than having to choose between the two.

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[30] Vermiculture refers to the intentional farming of compost worms and production of worm castings / manures and worm farm "teas".
[31] http://thebangladeshtoday.com/2015/06/vermi-compost-protects-soil-nutrients-and-raise-crops-production/
[32] (Shah, 2015, p. 9)
[33] (Shah, 2015, pp. 8-9)
[34] (Shah, 2015)
[35] (Shah, 2015)
[36] (Shah, 2015)
[37] http://www.dhakatribune.com/bangladesh/2013/sep/29/women-turning-earthworms-self-reliance
[38] (Shah, 2015, p. 20)

For example, Kazi and Kazi Tea Estate Ltd[39], a 2500 acres (1012 ha) certified organic farm located at Tetulia Upazila of the Northwestern district of Panchagarh makes extensive used of bio-slurry. The farm includes 800 acre of tea, 500 acres of medicinal plants (254 plant saplings), and pasture for 2000 dairy cows with the remainder used for rice, wheat and vegetables. Kazi has installed 40 biogas plants which are fed cow dung from the dairy. Slurry produced from the biogas units is used as an agricultural input[40].

Pit Culture

Practical Action[41] (Pumpkins against Poverty) has introduced **pit culture** of sweet gourd in unfertile sandy river basin and sand bar areas in the Gaibandha district where other field crops are almost impossible to cultivate. The project uses a simple and unique technology for communities displaced by flooding. After flood waters recede and the river basin dries up in the mid October – November, farmers make pits of 1 m3 size along the sand bars. Jute bags containing 10-15 kg compost/cowdung are mixed with the pit soil and placed in the holes. In some areas compost is made with the residues of last year's crops. Four to six pumpkin seeds are planted in each pit and the pit is soaked with water. The pits are mulched with straw to conserve moisture. Farmers soak the pits two to three times a week with water carried in pitchers or buckets. The project appears to be making a significant impact on the livelihoods of participating communities in relation to food security and income generation.

Trichoderma

Trichoderma enhanced composting (TEC) is being promoted by a number of NGOs and organisations including GETCO Agrovision, Rural Development Academy, Innovision and the Rural Development Academy. TEC refers to the culturing and application of Trichoderma, a soil borne, natural fungus, as an activator in the decomposition process. TEC reduces composting time and fosters a bio-pesticide function in the final product. Demonstrations and field days on the benefits of using Tricho-compost have generated positive response from farmers. To date, 160 farmers in Rangpur, Dinajpur and Meherpur districts have received training on the TEC technology. TEC is being supported and promoted by Rural Development Academy (RDA), Katalyst and the Integrated Pest Management (IPM) unit of Bangladesh Agriculture University (BAU).

Presently our poor farmers and /or women are not beneficiaries of the technology due to the requirement to purchase the microbial input.

Other inoculant based methodologies

Apart from Tricoderma composting, there is little evidence of microbial inoculants (EM, Bokashi, Lacto-Bacillus, urine) being used or promoted in Bangladesh to facilitate decomposition, manage odour, improve quality of finished product.

Organic Vegetable Production

PROSHIKA is promoting organic vegetable cultivation through an established farmers group [42]. The program provides sustainable agro-technology and training to the growers and marketing services for their products. PROSHIKA has selected 775 farmers from 25 villages in 10 upazilas (administrative districts) around Dhaka city and provided training on organic vegetable cultivation. The program uses compost for cultivation and Integrated Pest Management (IPM) techniques including sex pheromone and detergents, for insect control. In 2014 farmers in the program produced 3000 tonnes of organic vegetables from 600 acres of land. In addition PROSHIKA produced 38 t on 11.52 acres in their own farm in Manikganj. PROSHIKA arranged to sell these vegetables in supermarket such as Agora

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[39] http://www.kazitea.com/
[40] (Yousuf, 2015) more informaiton
[41] http://practicalaction.org/
[42] (Yousuf, 2015)

and Nandan. The program is expanding to include market chain development and customer awareness campaigns.

Additional programs promoting composting in Bangladesh can be found on pages 13 – 17 of the in-country report produced by Md. Mofakhrul Islam Shah, available in the addendum to this report.

A number of innovative projects are seeking to directly benefit poor farmers through recycling of human waste.

Eco-toilet and Organic Composting

Eco-toilet and Organic Composting is being trialled as part of the Capacity Strengthening on CMDRR & Climate Change Adaption project[43]. The project highlights the significant difference access to low cost appropriately treated organic waste can make to the livelihood of farming families and communities affected by climate change, droughts and disasters.

Value at the end of the Sanitation Value Chain project

The Value at the end of the Sanitation Value-Chain (VESV)[44] project aims to reduce reliance on imported inorganic fertilizers and provide potential business opportunities for waste transporters and compost producers in places where challenges for managing sanitation waste remain. The project involves engaging collectors to empty waste from village toilets and transport it to a central composting facility. The project is tackling issues of collection, composting, quality assurance and application which are potentially transferable to the collection and processing of organic waste.

6.3 Innovative practices in Bangladesh

Urban organic waste composting projects in Bangladesh are demonstrating significant capacity to engage urban poor in collection and processing of organic waste. Models that engage the informal sector in door-to-door collections of source separated waste appear to have great potential for livelihood improvement and income generation. The added opportunity to provide employment for unskilled workers makes labor intensive technologies such as source separation and composting attractive for South Asian cities[45].

Almost all of the organic waste composting projects identified in Bangladesh are providing opportunities for livelihood improvement and income generation through engagement in the organics recycling process. Waste Concern and the slum based projects are particularly championing models that engage the poor with particular attention to women.

6.4 Bangladeshi farmers use of compost

In 2005, Bangladesh revised its fertilizer application guidelines to include compost application for different crops in conjunction with the use of chemical fertilizer[46]. Since then, the Department of Agriculture Extension program has actively promoted compost to farmers. The Department of Agriculture extension program is providing training and support to farmers to produce their own compost fertilizers[47].

Commercially available compost is produced by a range of players including private companies like Annapurna Agro Services, social enterprises such as Waste Concern, autonomous organisations like RDA, NGOs such as Grameen Shakti (GS) and Grameen

[43] https://youtu.be/9QHjKUI7ySg
[44] http://www.theguardian.com/global-development/gallery/2015/feb/27/bangladesh-toilet-waste-high-value-compost-in-pictures
[45] (Asian Development Bank, 2011, p. 28)
[46] (Asian Development Bank, 2011, p. 54)
[47] http://thebangladeshtoday.com/2015/02/compost-fertilizers-gaining-popularity-manikganj/

Krishok Shohayak Sangstha (GKSS) and research/academic institutes such as Bangladesh Agricultural University (BAU) and Bangladesh Agricultural Research Institute (BARI)[48].

Compost marketing and supply channels are facilitated by entrepreneurs (eg. Achme Laboratories, Rash Agro Enterprise, Farmers), service providers (eg. RDA, GS, Paragon Agro, Rangpur-Dinajpur Rural Service), donor agencies such as Katalyst, Innovision Consulting Pvt. Ltd.), and research and extension institutes (eg. BAU, BARI, BSMRAU, RDA) and fertilizer companies such as ACI[49].

Composted urban organic waste however is not readily available to farmers in either quantity or quality in Bangladesh. There is no evidence that farmers are using urban or peri urban organic waste for their on-farm composting/vermicompost practices[50]. The organic waste sector and the agricultural sector appear to operate completely independently with little or no links.

The arrangement between Waste Concern, Bangladesh's largest urban organic waste compost producer, and Advanced Chemical Industries (ACI) is the notable exception. Waste Concern has been working with ACI since 2000. Since that time ACI has marketed and distributed compost from one of Waste Concerns plants throughout Bangladesh. ACI purchases bagged compost from Waste Concern's plant. The compost is further refined and blended with chemical fertilizers[51] and then transported and distributed through established networks. Waste Concern produces >15,000 tonnes of compost per year. The purchase price is 6,000 taka/ton (US$88/tonne). The retail price to farmers is 9,000 taka/tonne (US$130/tonne), which includes transport, storage, and promotional costs[52].

While unlinked to UOW compost, the Agri-business for Trade Competitiveness Project (ATC-P), trading as Katalyst[53] is working to coordinate and market compost to farmers. Katalyst is supporting Xplore Buinsess Limited and Annapurna Agro Service to increase farmer's access to quality compost products through the coordination of small compost producers and establishment of distribution networks for compost fertilizers in the northern parts of Bangladesh. This sort of market distribution network could potentially benefit small scale processors of urban organic waste.

[48] *(Shah, 2015)*
[49] *(Shah, 2015)*
[50] *(Shah, 2015)*
[51] *(Yousuf, 2015)*
[52] *Waste Concern, cited in (Asian Development Bank, 2011, p. 46)*
[53] *http://katalyst.com.bd/*

7 The Organic Waste Policy Context of India

7.1 The policy and regulatory context in India

The following table (Table 3) lists the policy and regulatory context for organic waste in India. It demonstrates a positive policy environment in India.

Table 3 India Policy and Regulatory Context

LEGISLATION	COMMENTS
Municipal Solid Waste (Management and Handling) Rules 2000	Formed under Environment Protection Act 1986 Municipal authorities are responsible for collection, segregation, storage, transportation, processing and disposal of MSW. The rules require municipal authorities to adopt suitable technology or combinations of such technologies to minimize environmental impact. Under the rules, State Pollution Control Boards (SPCBs) are responsible for authorising & monitoring waste disposal facilitates and ensuring compliance criteria are met. Mandatory actions: • Prohibit littering of waste on the streets • Source segregation • Daily, door to door collection services • Daily street sweeping • Abolishment of all open waste storage bins/sites • Abolishment of uncovered/open transport of waste • Establishment of organics processing plants eg compost, waste to energy, bio-methanization for biodegradable waste • Establishment of engineered landfills • No organics or recyclables to landfill.
Fertiliser Control Order	Sets standards/specifications for composts and bio fertilisers.
Environment Protection Act, 1986	Municipal Solid Waste and Handling Rules 2000 fall under this Act.
REPORTS & GUIDELINES	**COMMENTS**
Solid Waste Management Manual Ministry of Urban Development (MOUD), Government of India	Covers MSW Collection, technology specifications, waste handling techniques, law and government policy
Municipal Solid Waste Management on a Regional Basis (MOUD, GOI)	Specification and feasibility of regional landfills Case studies.
Report: Recycling Livelihoods: Integration of the Informal Recycling Sector in Solid Waste Management in India. Chintan and GIZ. SNDT Women's University.	Role of informal recycling sector in SWM in India. Issues and methods of integrating information recycling sector into the overall waste management system of a city.

South Asian Association for Regional Cooperation (SAARC) Dhaka Recommendation on Waste Management 2004	SAARC Countries agreed to promote community based source separation of waste with separate organics collection and resource recovery systems over incineration and other unproved technologies.
PROJECTS & PROGRAMS	**COMMENTS**
Swachh Bharat Abhiyan (Clean India Mission) 2014 – 2019	National program. Aim to have a "Clean India" by 2019. Support to local authorities to design, build and operate waste management facilities. US$9.4 Billion over 5 years.
National Project on Organic Farming >2004 (Ministry of Agriculture)	Capital incentive subsidy scheme for development and promotion of organic inputs. Objectives: • To promote organic farming in the country by making available the organic inputs such as bio-fertilizers, vermicompost and fruit & vegetable waste compost and thereby better return for the produce • To increase agricultural productivity while maintaining the soil health and environmental safety • To reduce total dependence on chemical fertilizers by increasing **the quantum of quality bio-fertilizers / compost availability in the country** • To set up hatcheries for vermiculture so that the demand for earthworms for on farm production of vermicompost can be met to convert organic waste to plant nutrient resources • To prevent pollution and environment degradation by proper conversion and utilization of organic waste
Jawaharlal Nehru National Urban Renewal Mission (JNNURM) 2005-2012	US$22 billion over 7 years in 65 priority cities. Involves objective to improve SWM as a basic service. Project includes improving primary collection, waste transportation and waste disposal. Expansion of PPP in all areas of SWM. 34 cities to start door to door collection. Includes establishment of some composting facilities.
Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT)	Capital support for establishment of MSW handling facilities.
Inter-Ministerial Task Force on Integrated Plant Nutrient Management from Urban Compost - Ministry of Agriculture	Establishment of organic input production units. Three main types of inputs: Vermi-hatcheries bio-fertilizer units and fruit and vegetable waste compost units. Recommends co-marketing of compost from city garbage with chemical fertilizers.

Sources: (Charyulu & Biswas, 2010) (Rao, 2013) (Annepu, 2012) (Asian Development Bank, 2011) (Singh & Venkataramaiah, 2015)

7.2 The opportunities or drivers within the policy context in India

The policy/legislative context for Solid Waste Management (SWM) developed during the last 15 years in India actively supports organic waste to agriculture. Organic waste is identified as an important input for conventional and organic agriculture in major policies and programs. Systems that will deliver clean source separated organics to processors are incorporated in the Municipal Solid Waste (Management and Handling) Rules 2000. A standard for composts made from recycled organics has been developed and is outlined in the Fertiliser Control Order. An Inter-ministerial Task Force on Integrated Plant Nutrient Management Using City Compost (2005) identified that returning organic carbon and nutrients from urban solid waste to the soil is essential for sustaining the production of subsistence crops required to feed the country's growing population[54] . Promotion of Integrated Plant Nutrient Management as a means to improving and protecting India's agricultural soils allows for the co-marketing of compost in conjunction with chemical fertilizers and enables recycled organics to piggy back on existing fertiliser distribution, sales and marketing channels. National programs such as the National Project of Organic Farming exist to support the development of composting facilitates and increase quantity and quality of recycled organic wastes as inputs into organic and conventional farming systems.

[54] *(Asian Development Bank, 2011, p. 10)*

8 State of Knowledge of the Urban Organic Waste Situation in India

Significant work has been done in the area of MSW and UOW in India to fully scope and analyse the urban organic waste situation. The state of knowledge about urban organic waste is reflected in the well-developed policy, legislative and strategic planning frameworks. There are a number of in country and internationally funded reports and resources which provide a current and comprehensive overview of the situation regionally and locally. Enough time has passed since the establishment of organic waste diversion policy goals to enable review and reflection on progress to date.

Key published resources include:

Municipal Solid Waste Management in Asia and the Pacific Islands – Challenges and Strategic Solutions, edited by Agamuthu Pariatamby and Masaru Tanaka. This book was published by Springer in September 2013. The resource provides an up to date regional overview of urban waste situation, including organic waste, and specific chapters on Bangladesh and India.

Toward Sustainable Municipal Organic Waste Management in South Asia: A Guidebook for Policy Makers and Practitioners . Published by the Asian Development Bank (ADB) in 2011. Funded by the Australia Government. Current, up to date, practical and solution oriented.

Additional resources in India include:

Annepu, R. K., 2012. Sustainable Solid Waste Management in India, (thesis) New York: Columbia University.

8.1 Urban organic waste in India

Currently India produces 68.8 million tonnes of mixed solid waste each year or 188,500 tonnes per day. Municipal urban waste in India is around 51% organics and the moisture content of MSW is 47%[55]. The composition of MSW in the North, East, South and Western regions of the country varies between 50-57% organics[56]. This equates to 35.08 million tonnes of organic waste each year or 96,135 tonnes of organic waste per day.

On average, 6% of MSW is currently collected and composted in mechanical biological treatment (MBT) across India[57].

In 2011[58] India landfilled:

- 6.7 million TPY of recyclable material which could have been used as secondary raw materials in manufacturing industries, due to the absence of source separation;
- 9.6 million tons of compost which could have been used as a fertilizer supplement, due to the absence of source separation and enough composting facilities; and
- 58 million barrels of oil energy equivalent in residues of composting operations that could have been used to generate electricity and displace fossil fuels in Refuse Derives Fuel (RDF) co-combustion plants or Waste to Energy (WTE) power plants.

[55] *(Annepu, 2012, p. 4)*
[56] *(Annepu, 2012, p. 4)*
[57] *(Annepu, 2012, p. 50)*
[58] *(Annepu, 2012, pp. 6, 54 and appendix 15)*

8.2 The drivers for change in India

Similar to Bangladesh, there are a number of drivers for change that support the diversion of organic waste into agriculture in India. These include “push” drivers associated with an increasing need to divert organics away from the waste stream and send it somewhere else, and “pull” drivers associated with a need to put organic matter back into agricultural soils.

In a business-as-usual scenario, India will not be able to cope with its waste issue in the near future[59]. The public health and environmental issues associated with ever increasing quantities of MSW will continue to impart pressure for improved solid waste management systems. Eventually the cost of establishing systems for diversion of organic waste from the waste stream will be less than the costs associated with managing the existing waste management system.

Similarly, the shift from open dumping to engineered landfills provides upward pressure on the direct and indirect costs of sending waste to landfill. As the cost of building and managing landfills rises, gated fees will increase to the point that the cost of collecting and composting organic waste can be increasingly subsidised through gate fee savings.

As in Bangladesh there is strong regional and national policy support for composted urban organic waste to be used in agriculture to improve soil health, agricultural productivity and food security[60]. Livelihood improvement, food production and declining soil fertility are becoming crushing issues in India. The need to increase soil organic matter to secure long term food production has the potential to create a pull market for composted organic waste as an important agricultural input.

[59] *(Annepu, 2012, p. 3)*
[60] *(Asian Development Bank, 2011, p. 8)*

9 Current Practices in Organic Waste Recycling and Composting in Rural and Urban Areas of India

9.1 Current organic waste recycling in India

In 2014 there were more than 80 composting plants processing UOW. Of the 57 cities that generate more than 200 tonnes per day, 38 cities have composting plants, which treat more than 4,361 tonnes per day of MSW[61].

MSW composting facilities in India have a high attrition rate[62]. Many composting facilities have opened and then closed[63]. The first 10 plants opened in India are no longer operational[64].

There are a number of economic and logistical reasons for this. A key factor is that almost all UOW composting facilities in India handle mixed waste rather than source separated organics. More than 60% of mixed waste entering composting facilities is screened out and either dumped or sent to landfill. The conversion rate of mixed waste to compost can be as low as 6-7% of total input[65] which creates a significant burden on processing plants for management and disposal of the rejected material.

Compost made from mixed waste is generally low quality and is at risk of contamination by chemicals and heavy metals[66]. Overall, the literature is clear that composting mixed waste increases processing costs and produces a lower quality end product[67].

Despite the challenges there are examples of MSW derived compost being successfully made and sold. Five of these are outlined below. Compost from each of these facilities is being purchased by fertiliser companies or by farmers directly.

Bruhat Bengaluru Mahanagara Palike

The government owned Karnataka Compost Development Corporation (KCDC) has established and operated a composting plant at Bangalore city since 1975[68]. The KCDC plant receives 200 tonnes per day of MSW and produces around 30 tonnes per day of finished compost through open windrowing and vermicomposting. The MSW to compost conversion rate is 15%. Compost produced by the KCDC plant is approved for sale by the Department of Agriculture.

Mysore City Corporation

Since 2008, Mysore City Corporation with support from Infrastructure Leasing and Financial Services Ltd (IL&FS) has operated composting facilitates on a land lease and royalty basis[69]. The plant receives 150 tonnes per day of MSW and produces 18 tonnes per day of compost using an open window system. The MSW to compost conversion rate is 12 – 13%. Finished compost is sold to fertilizer companies including Coromandel, Zuari, SPIC and Krishak Barati Cooperative (KRIBCO).

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[61] *(Annepu, 2012, p. 50)*
[62] *(Nema, 2013, p. 1)*
[63] *(Nema, 2006)*
[64] *(Annepu, 2012, p. 50)*
[65] *(Annepu, 2012, p. 6)*
[66] *(Annepu, 2012, p. 5 and 45)*
[67] *(Asian Development Bank, 2011) (Nema, 2013)*
[68] *(Singh & Venkataramaiah, 2015)*
[69] *(Singh & Venkataramaiah, 2015)*

Mangalore City Corporation

In 2013, Mangalore City Corporation entered into an agreement with Unique Waste Management Pty Ltd to operate and manage composing facility on a gate fee basis[70]. The plant receives 290 tonnes per day of MSW and produces 30 tpd of compost through windrow composting and vermicomposting methods. The conversion rate is 12 –12 %. The company supplies compost to IL&FS and Kozhikode (Kerala) in bags and in bulk.

Belagavi City Corporation

The Belagavi City Municipal Corporation entered into an agreement with Ramky Enviro Engineers Ltd. Hyderabad in 2007 for establishment of MSW was processing facility[71]. At present, the plant receives an average of 150 tonnes per day of MSW. The MSW is composted by turned windrowing. Approximately 15 tonnes per day of compost is generated. Compost is sold to local farmers and fertiliser companies. The company has contracts with Godavary Gold Fertilizers, Krishak Barati Cooperative (KRIBCO) Ltd, Balaji Agro Agencies, Coromandel International Ltd, Vardhaman Agro agencies and local dealers for supply of finished compost.

Shimoga City Corporation

Shimoga City Municipal Corporation entered into a contract with Ramky Enviro Engineers Ltd., Hyderabad in 2008[72], for the establishment of WSW processing facilities. At present, the plant receives on average, 90 – 100 tonnes per day of Municipal Solid Waste. Approximately 9 – 10 tonnes of compost are produced per day. The MSW is composted by windrow aerobic method. The conversion rate is 10% to 12%. Ramky Enviro Engineers Ltd. sells the city compost to farmers under their own brand, Ramky Shakthi. They also supply to agricultural and fertilizer agencies including Kribhco, Coromandel International Limited, and Balaji Agro Agencies.

Composting facilities processing source separated organic waste

Very little source separation of urban organics appears to takes place in India. This is the primary constraint to effective organic recycling in the region[73]. Identifying and developing effective models of source separation is paramount to increasing diversion of organic waste and creation of quality agricultural inputs. References can be found to 8 composting facilities currently processing source separated organic waste.

Suryapet

In 2004 Suryapet implemented a door to door source separated waste collection system and became India's first "dustbin-free and dump yard free" city[74]. Suryapet was the first (and only?) city to become totally compliant with India's Municipal Solid Waste Management and Handling Rules 2000[75]. After a pre-composting phase, organic waste is put into a vermiculture process.

Warangal

In 2012 the city of Warangal (population 648,000) implemented a universal door to door pick up of waste separated into dry waste going to recyclers and wet waste managed within the city in vermiculture beds or decentralised compost units or the biogas unit[76]. A fraction of the source separated organic waste is processed through a vermiculture plant and a biogas plant. The majority is processed at a composting facility. A full description of

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[70] *(Singh & Venkataramaiah, 2015)*
[71] *(Singh & Venkataramaiah, 2015)*
[72] *(Singh & Venkataramaiah, 2015)*
[73] *(Asian Development Bank, 2011, p. ix)*
[74] *See http://suryapetmunicipality.blogspot.com.au/2011/08/solid-waste-management.html*
[75] *(Patel, 2013, p. 13)*
[76] *(Patel, 2013, p. 13)*

the model for community engagement and the results of the program are contained in Patel's conference paper from the 2013 IIMA International Conference on Waste Health and Health - Resource Book[77].

Nagpur

In Nagpur, the municipality government has partnered with an NGO to implement a door to door collection of waste which has led to savings for the municipality's solid waste services, and provided employment for 1600 people[78].

Lucknow

In Lucknow, an NGO (Muskan Kyoti Samiti) was contracted to collect waste from 30,000 households. Householders are charged for the collection service. The project employs 900 rag pickers. The municipal administration provided cycle vans for collection and land for the establishment of compost pits and vermiculture[79]. The service recycles around 25 to 40 tonnes per day. The project appears to be self sustaining through the provision of land and capital resources by the municipal authority and revenue from compost sales and collection fees[80].

Ahmedabad

Ahmedabad is a large scale composting service provided by a private company[81]. The company entered into a 15 year agreement with the Ahmedabad City Corporation. The City provided land for the project. The company initially agreed to take 5000 tonnes per day of organic waste at no charge to the administration. Problems were initially encountered as the waste was mixed rather than source separated. This directly impacted on processing costs and quality of the finished product. The company was not able to accept the initial quantities agreed to due to the time and space required to manage the mixed waste. Over time, the city implemented source separated collections which have led to overall improvement in quality and higher prices for finished compost, and supported the viability of the operation.

Other references to towns or cities implementing source separation include:

- Chennai – ExNoRa [82]
- Mumbai – Advanced Locality Management (ALM)[83]
- Vijayawada[84] - Referenced as one of only two cities producing compost with acceptable heavy metal levels, however status unclear.

UOW technologies in India

Composting methodologies currently in use to process UOW at scale are *open windrowing* and a *combination of pre composting / pit based worm farming*. Composting is generally done in open windrows which are turned periodically. This technique can work well in smaller operations; however in large windrows material in the centre of the piles can become anaerobic which can cause odour issues during turning. Open windrowing involves variable levels of turning. References can be found of smaller operations using

[77] http://www.ourwmc.com/
[78] *(Asian Development Bank, 2011, p. 43)*
[79] *(Asian Development Bank, 2011, p. 43)*
[80] *(Srivastava, et al., 2005)*
[81] *(Asian Development Bank, 2011, p. 25)*
[82] *(Asian Development Bank, 2011, p. 24)*
[83] *(Asian Development Bank, 2011)*
[84] (Annepu, 2012, p. 50) see also http://www.thehindu.com/news/cities/Vijayawada/no-place-to-dump-garbage-in-vijayawada/article4221202.ece

microbial inoculants (from numerous suppliers plus homemade cultures) to manage odour and facilitate fermentation rather than purification in the piles[85].

Box composting similar to the system developed by Waste Concern in Bangladesh and NADEP, with or without perforated pipe inserts, and with or without vented containers, is being successfully being used in urban community or campus scale composting sites[86]. (Additional information can be found in Appendix 3 of this report).

Rapid Composting techniques promoted by ICAR[87] would also fall in the category of box composting, with the addition of microbial inoculants to facilitate fermentation, manage odour and control the breakdown process.

In the absence of government run organics collection systems, programs and markets for home and community composting systems are emerging as households and neighbourhoods take organic waste management and compost production into their own hands. This has been facilitated to some extent by the requirement of new apartment buildings to manage their own waste[88]. Methodologies include variations on bokashi composting, composting using other fermentative inoculants and many variations of container/drum composting.

Examples of community based composting systems are included in Singh & Venkataramaiah's in country report for India, which is includes in the addendum for this report.

See also:

http://www.dailydump.org/

http://savitahiremath.com/category/community-composting/

http://myecobin.in/

http://www.green-ensys.org/

http://www.swmrt.com/

Biogas

In southern India where the temperature is warmer, small scale anaerobic digesters enable households and institutions to recover energy from source separated food waste. The process generates biogas suitable for cooking and lighting and bioslurry which can be applied to soil. Total number of units in operation is unknown as many private companies offer them to urban and rural customers. Kerala based company BioTech has installed over 20,000 units in Thiruvananthapuram and Kochi, which divert around 40 tonnes of waste from landfills each year, which is 7% of the organic waste generated in that area[89].

9.2 Current compost and composting technologies

Compost is identified as an important agricultural input in both organic and conventional farming systems[90], however use of compost and composting technologies are not widely practiced on Indian farms. Awareness of compost making and application of compost is not common knowledge[91] however the situation is changing and there is increasing interest in both old and new composting methodologies. A number of approaches to

[85] *(Patel, 2010)*

[86] (Singh & Venkataramaiah, 2015) and http://savitahiremath.com/2015/08/07/community-composting-method-9-run-by-saahas-these-tanks-handle-large-quantities-of-food-waste/

[87] *(ICAR Indian Institute of Soil Science, 2015) (ICAR Indian Institute of Soil Science, 2014)*

[88] *(Singh & Venkataramaiah, 2015)*

[89] *(Annepu, 2012, pp. 89-90)*

[90] *(Charyulu & Biswas, 2010) (Asian Development Bank, 2011)*

[91] *(Charyulu & Biswas, 2010, p. 67)*

composting and application of organic wastes exist in India. On the one hand, organic wastes such as crop residues are commonly burned to prevent disease transmission[92]. Concurrently, application of aged farmyard manures and bedding straw has a long history in India[93]. Finally, sophisticated composting methodologies such as Panchagavya[94] have been developed and practiced since Vedic times and are experiencing renewed interested and revival.

The Indian Council for Agricultural Research (ICAR)indicates that India is still short of organic manure to practice IPNM[95] on a large scale, and that the supplies could be augmented to a great extent, especially in peri-urban areas, by recycling and composting organic city waste[96]. The ICAR has developed comprehensive resources and programs to support composting of urban organic waste as an important agricultural input through vermiculture and rapid composting techniques[97]. As evidenced above, supply chains are developing for composted UOW, usually as a blended compost/fertilizer style input and a number of MSW composting facilities are selling directly to fertilizer companies.

In 2010 the CMA produced a report *on Organic Input Production and Marketing in India – Efficiency, Issues and Policies*[98]. The report provides an overview of organic farming and explores the status of organic input production, including composts, in India.

The Inter-ministerial Task Force on Integrated Plant Nutrient Management Using City Compost (2005) identified that returning organic carbon and nutrients from urban solid waste to the soil is essential for sustaining the production of subsistence crops required to feed the country's growing population[99]. The Task Force also notes that unless compost meets the quality requirements of farmers and is affordable, it will not be bought and used in agriculture.

While there is considerable scope for recycled organics in agriculture, a number of challenges would need to be overcome[100]:

- Compost produced by waste processors is generally low quality
- Quality standards are not generally enforced
- Supply chain issues would need to be resolved (volume, transport, storage).

Market development challenges include:

- Use of compost amongst farmers is not common knowledge or practice
- What is available is generally low quality.

A number of agricultural based initiatives, such as the National Project on Organic Farming (NPOF) have been established to start to address these issues.

National Project on Organic Farming

Since 2004 the National Project on Organic Farming (NPOF)[101] has been implementing a capital investment subsidy scheme for commercial production units for organic inputs. The objectives of the scheme are to:

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[92] (Singh & Venkataramaiah, 2015)
[93] (Singh & Venkataramaiah, 2015)
[94] (Singh & Venkataramaiah, 2015)
[95] Integrated plant nutrient management is an approach that incorporates both organic and inorganic fertilizers to attain higher crop productivity and prevent and/or repair soil degradation.
[96] (Asian Development Bank, 2011, p. 9)
[97] (ICAR Indian Institute of Soil Science, 2015) (ICAR Indian Institute of Soil Science, 2014)
[98] (Charyulu & Biswas, 2010)
[99] (Asian Development Bank, 2011, p. 10)

[100] (Annepu, 2012)

[101] (Charyulu & Biswas, 2010, p. 80)

- promote organic farming in the country by making available the organic inputs such as bio-fertilizers, vermicompost and fruit and vegetable waste compost and thereby better return for the produce;
- increase the agricultural productivity while maintaining the soil health and environmental safety;
- reduce the total dependence on chemical fertilizers by increasing the quantum of quality bio-fertilizers / compost availability in the country;
- set up hatcheries for verminculture so that the demand of enough earthworm population for on farm production of vermicompost can be met with;
- convert the organic waste in to plant nutrient resources; and
- prevent pollution and environment degradation by proper conversion and utilization of organic waste.

So far under the program[102]:

- More than 400 Government and Non-Government agencies are working under the project
- More than 300 farmers groups, each comprising of about 1500 farmers have started functioning to bring about 200,000 ha. land under organic certification
- Organic production units supported under the program are able to produce about 5000 tonnes of vegetable market waste compost, 3000 tonnes of bio-fertilizers and 78,000 tonnes of earthworm culture.
- 1848 training programs have been implemented, benefiting more than 37,000 trainers, extension professionals and farmers.
- More than 4100 demonstrations have been conducted
- 232 model organic farms have been established throughout the country.

Building on the impact of the NPOF, Charyulu and Biswas suggest training in how to produce and manage organic inputs should be started at the village level[103]. They also highlight a need to establish organic input channels for better marketing and timely availability[104].

9.3 Innovative practices in India

Models that engage the informal sector in door-to-door collections of source separated waste appear to have great potential for livelihood improvement and income generation. Providing a clean feedstock for low tech composting methodologies such as open windrowing requires a significant labour component. A large labour force is required to undertake door to door collections of source separated waste, removal of physical contamination from feedstock prior to and during composting, and for managing the composting process.

Towns that have introduced door-to-door collections for source separated waste appear to have generated significant employment for people previously involved in the informal waste picking sector. For example, Lucknow employs 1600 people for door-to-door collections and Nagpur employs 900.

The labour costs involved in engaging workers in door-to-door collections or organics processing is potentially offset by the increased value of the finished compost. Compost made from source separated rather than mixed waste is more likely to meet regulatory standards and farmer requirements for clean, high quality organic inputs.

[102] *NPOF, Ghaziabad, cited in (Charyulu & Biswas, 2010, pp. 80-81)*
[103] *(Charyulu & Biswas, 2010, p. 67)*
[104] *(Charyulu & Biswas, 2010, p. 67)*

9.4 Indian farmers use of compost

From an organic farming perspective, systems that are in place, or in which there is interest, are small scale vermiculture, biodynamic compost and food waste compost[105].

Other composting methodologies used on Indian farms include the Indian Bangalore method, passive composting of manure piles, the Indore method, Chinese Rural Composting, passively aerated windrows, NADEP composting, various types of bin composting and vermicomposting[106]. Inoculant bases methodologies including bokashi, Jeevamruthan, Panchagavya and EM™ are commonly used to control and facilitate the composting processed[107]. Farm and prei-urban based methodologies commonly use manures and manure slurries as inoculants to promote fermentation and decomposition[108].

NADEP

NADEP[109] composting has been practiced in western India for the past twenty years. Brick boxes are built with regular spacings along each wall to facilitate aeration. Farmyard waste is mixed or layered with cattle dung or biogas slurry and sieved soil mixed with cow urine. Water is added and moisture levels monitored. Composting is done in batches and each batch takes 3 to 4 months.

Shreesh Krishi Organics, Kunigal[110]

Shreesh Kristi Organics operates a composting facility processing farm generated wastes that would otherwise have been incinerated. Farms provide feedstock into the composting operation in exchange for finished compost. Compost is sold directly to local farmers. The composting methodology includes application of Panchagavya, a traditional bio-fertilizer and pesticide which has been brewed since Vedic times. `

(Additional information about each of these and other on farm composting methodologies can be found in Singh & Venkataramaiah's in country report which is included in the addendum of this report).

[105] *(Charyulu & Biswas, 2010)*
[106] *(Singh & Venkataramaiah, 2015)*
[107] *(Singh & Venkataramaiah, 2015)*
[108] *(Singh & Venkataramaiah, 2015)*
[109] *(Singh & Venkataramaiah, 2015, pp. 16-17)*
[110] *(Singh & Venkataramaiah, 2015, pp. 14 - 18)*

10 Conclusion and recommendations

10.1 Conclusion

This project set out to assess opportunities to utilise urban organic waste for the livelihood improvement of rural and urban communities in Bangladesh and India.

The objectives of the project were to:

1. Analyse the organic waste policy contexts of Bangladesh and India
2. Document the state of knowledge of the urban organic waste situation of Bangladesh and India
3. Explore current practices in organic waste recycling and composting in rural and urban areas of Bangladesh and India
4. Identify innovative practices in organic waste recycling and composting in Bangladesh, India and other developing countries

In exploring these objectives, it is clear that:

- A supportive policy and regulatory framework exists in both countries
- The issues of urban organic waste management are well understood
- The scale of municipal solid waste issues in large metropolitan areas creates a number of logistical barriers for organic waste recycling projects
- There are examples of urban organic waste being successfully composted and returned to agriculture in both countries
- Use of composting and other organics recycling techniques are gaining popularity in both conventional and organic farming practices.

Overall, unrecovered organic waste represents a vast river of resources that could be tapped into by farmers. This potential is clearly reflected in the public policy and regulatory frameworks in both countries.

Despite the potential, only 2% (Bangladesh) and 6% (India) of urban organic waste is currently being diverted and composted. The rest is ending up in dumps and rivers. Using composted urban organic waste in agriculture on any large or systematic scale remains aspirational as the systems for collection, processing, transport and application are yet to be fully realised. Successful working models do exist in each country and these are worth exploring further for scalability and replicability.

Bangladesh

Specifically, the enablers for for urban organic waste recycling in Bangladesh include:

- Supportive policy and regulatory contexts
- National compost standard and process for certification of compost
- Mandatory requirement for municipalities to establish source separation of organic waste
- Tax ‘holidays’ and VAT exemptions for urban organic waste composting facilities
- Promotion of Public Private Partnerships and partnerships with NGOs and CBOs to support reconfiguration of waste management system
- Rising cost of landfills and landfilling
- Multiple small scale community engagement and composting projects provide opportunities for learning and knowledge transfer about what works
- Large informal sector from which to draw workforce.

Enablers for use of recycled urban organic waste by farmers in Bangladesh include:

- Supportive agricultural and regulatory contexts
- National compost standard and process for certification of compost
- Active promotion of Integrated Plant Nutrient Management and co-marketing of compost with fertilizers
- Department of Agriculture extension programs promoting on farm composting and use of compost in agriculture
- Increasing uptake of vermicompost, organic fertilisers and use of compost in both organic farming and in conjunction with chemical fertilizers.
- Declining soil fertility and soil carbon levels.
- Recognition by farmers of need to increase soil organic matter levels in soil
- Opportunity to reduce fertilizer costs through fertility gains from using composts.

The barriers for urban organic waste recycling in Bangladesh include:

- Lack of source separation and collection of source separated organic waste
- Low cost of landfill and no-cost dumping making it cheaper to dump rather than separate and compost organic waste
- High processing costs and long processing times
- Compost accreditation process is expensive and takes around 2 years
- Compost made from mixed waste has higher physical, chemical and heavy metal contamination, and it unlikely to pass certification process
- Undeveloped markets
- Distance from agricultural markets.

Barriers for use of recycled urban organic waste by farmers in Bangladesh include:

- Limited, if any, examples of farmers using urban organic waste as an agricultural input
- Not many examples of composted urban organic waste being used in agriculture
- Composted urban organic waste not readily available
- Almost all composted urban organic waste is made from mixed waste resulting in quality issues including odour, physical, chemical and heavy metal contamination
- Difficult to develop demand for a product that does not exist yet.

India

The enablers for urban organic waste recycling in India include:

- The sheer scale of the waste issue in urban India will provide increasing pressure and incentive to find ways and means to divert organic waste from waste stream and into agriculture
- A supportive policy and regulatory framework exists to support establishment of urban organic recycling facilities
- There are a small but increasing number of successful models that demonstrate positive economic, social and environmental benefits for municipalities from reorientation of the waste system to include source separation and processing of organic waste
- A small but growing number of composting facilities are successfully selling product to fertilizer companies and in some cases, directly to farmers.
- Compost made from urban organic waste is identified as an important input for both conventional and organic farming. There is strong regional and national policy support for compost urban organic waste to be used in agriculture to improve soil health, agricultural productivity and food security.

The enablers for use of recycled urban organic waste by farmers in India:

- National policies and agricultural extension programs support and promote Integrated Plant Nutrient Management approaches to address declining soil fertility and productivity
- Adoption of Integrated Plant Nutrient Systems requires large volumes of compost and enables compost to be markets through existing fertiliser channels in conjunction rather than in competition with chemical fertilisers[111]
- National Project for Organic Farming actively promoting and supporting on farm composting / vermicomposting and use of compost or vermicast in agriculture.
- Growing number of farmers adopting on farm composting technologies

Barriers that impede urban organic waste recycling in India include:

- Lack of source separation and collection of source separated organic waste
- Low cost of landfill and no-cost dumping makes it cheaper to dump rather than compost organic waste
- Economic viability. Many composting facilities have failed. Contributing factors are lack of source separation, lack of gate fees, processing issues, processing costs, disposal of rejected material, poor quality of finished product
- High production costs that cannot be recovered through sale price alone
- Low quality and contamination, most compost produced in India is made from mixed waste. This increases the risk of contamination with glass, plastics, metals, chemical and heavy metal contaminants.
- Other issues identified in the Asian Development Bank[112] report include:
    - Municipalities poor financial capacity to invest in organic recycling
    - Low municipal capacity to operate and maintain organics recycling facilities or to engage private sector partners
    - Low community awareness
    - Scarcity of government land to provide for organic waste management
    - Weak regulatory and enforcement systems, couples with poor monitoring capabilities to ensure high standards of compost.

Barriers for use of recycled urban organic waste by farmers in India include:

- No validated examples of composted urban organic waste being used in agriculture in any systematic way.
- Composted urban organic waste not readily available.
- Almost all composted urban organic waste is made from mixed waste resulting in quality issues including odour, physical, chemical and heavy metal contamination.
- Difficult to develop demand for a product that does not exist yet.
- Weak regulatory and enforcement systems cannot guarantee quality.

[111] *(Asian Development Bank, 2011, p. 47) and (Charyulu & Biswas, 2010)*
[112] *(Asian Development Bank, 2011, pp. ix-x)*

10.2 Recommendations

The key finding from this report is that use of urban organic waste for livelihood improvement of rural and urban poor is worthy of further investigation and investment.

Three specific areas for further investigation are outlined below.

Recommendation 1 - Agricultural Industry

While the potential benefits of composted urban organic waste in agriculture are clearly articulated, there are few examples and little information or research available regarding the actual use of composted urban organic waste in agriculture. Use of composted urban organic waste in food production remains largely theoretical. A project that worked directly with agricultural enterprises to produce, test and explore the use of composted urban organic waste would help to:

- Generate knowledge about the use and effect of composted urban organic waste on soil health and food production
- Develop models for best use
- Drive demand for clean source separated product
- Support increased use of composted urban organic waste in conventional and organic sectors.

Potential Partners in India include IPAA Indian Council for Agricultural Research (ICAR).

Potential Partners in Bangladesh include Bangladesh Agriculture University, Bangladesh Agricultural Research Institute (BARI).

Recommendation 2 - Scalability/Replicability

While overall diversion rates are low, there is clear expertise and knowledge in both countries in regard to community engagement in source segregation/collection and urban organic waste processing methodologies. There is no doubt that the required knowledge and expertise exists in each country. However successful models are generally small scale and localised. There would be value in evaluating existing approaches to source separation and processing to:

- Identify and highlight the leaders in community engagement, source separation and processing in each country.
- Identify components of successful community engagement, source separation and processing methods.
- Test the transferability and scalability of successful models
- Identify the critical success factors
- Promote and disseminate what works

Recommendation 3 - Livelihood improvement for urban and rural poor

Innovative programs in both countries are demonstrating the transformative impact that composts, vermicasts and other locally made organic inputs can have on the lives of rural and urban poor. These programs generally access on-farm or human waste, which require minimal if any upfront costs apart from labour and time. At this stage the urban organic waste stream is not being systematically accessed as an input into localised subsistence or food production projects. Yet food and other urban organic waste constitute a valuable and almost endless source of feedstock for composting and vermicast projects. This is an area worthy of further exploration, particularly in villages or urban fringe areas where enough organic waste is produced to be a problem and distances to gardens and food growing areas are minimal.

Participatory Action Research in this area could:

- assist communities and families to identify and access potential sources of organic waste
- develop processing methodologies to safely transform urban organic waste into suitable and valuable gardening and farming inputs
- demonstrate, test and evaluate the impact of urban organic waste derived inputs in food production, soil health and livelihood improvement.

Potential Partners in Bangladesh include Practical Action, Christian Commission for Development in Bangladesh CCDB and CARE Bangladesh.

Potential Partners in India include the Nation Project on Organic Farming and Indian Council for Agricultural Research (ICAR).

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11.1 Additional reports produced by project

The following in country report were commissioned as part of this project. The three reports are included in the addendum to this report.

Shah, M. I., 2015. *Composting in Bangladesh,* Canberra.

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