From urban waste to sustainable value chains:
Linking sanitation and agriculture through innovative partnerships

Political Economy Analysis of Organic Waste Value Chains in Sri Lanka

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This report presents the findings for Activity 3 (Political Economy Analysis) within the project *From urban waste to sustainable value chains: Linking sanitation and agriculture through innovative partnerships*.

This applied research project in Sri Lanka connects the waste management, sanitation and agriculture sectors through the circular economy, to improve food security and environmental health. This project is a partnership between the Institute for Sustainable Futures at the University of Technology Sydney (UTS-ISF), the International Water Management Institute (IWMI), Janathakshan (GTE) Ltd, Sabaragamuwa University of Sri Lanka (SUSL) and the Sri Lankan Department of Agriculture (DoA).

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Glossary

CEA	Central Environmental Authority
DFAT	Department of Foreign Affairs and Trade, Australia
DFS	Dried Fecal Sludge
FSTP	Fecal Sludge Treatment Plants
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
KMC	Kaduwela Municipal Council
MC	Municipal Council
MOH	Medical Officer of Health
MSW	Municipal Solid Waste
NWSDB	National Water Supply and Drainage Board
O&M	Operation and Maintenance
OSS	Onsite Sanitation Systems
PHI	Public Health Inspector
SW	Solid Waste
SWM	Solid Waste Management
UNDP	United Nations Development Programme
WMA	Waste Management Authority

1. Introduction

The project "From Urban Waste to Sustainable Value Chains: Linking Sanitation and Agriculture Through Innovative Partnerships" is funded under the **Knowledge and Linkages for an Inclusive Economy** (KLIE) Grants Program of the Australian Department of Foreign Affairs and Trade (DFAT). This project seeks to answer the question: "**What are the enablers and barriers for public and private institutions in Sri Lanka to advance the implementation of sustainable and innovative value chains to improve sanitation, health and food security?**"

Through a partnership model, the project aims to establish the knowledge, linkages and policy foundations for enabling local entrepreneurs and policy-makers to implement innovative value chains that determine how organic urban waste and sanitation systems can be transformed to deliver to smallholder farmers more sustainable agricultural inputs. The policy impact of the project lies in identified synergies between agriculture, health and sanitation sectors to drive organic waste value chains. Through partnerships with the government, research institutes, the private sector and NGOs, as well as an innovative stakeholder engagement strategy, the project aims to establish an evidence base for driving policy dialogue, reducing policy fragmentation and promoting coordinated action.

Circular Economy and political economy of innovative waste and agriculture value chains

This study presents an analysis of how the current institutional and political environment can trigger new circular economy business models for innovative value chains. The report uses a political economy framework to present a synthesis of policies, interviews, and past research into agriculture and waste systems in Sri Lanka. A political economy of food and waste systems is one where the interplay of social systems, politics, economic contexts and power relations interact to change the state of a system (Baker et al., 2021).

The study has been designed with a circular economy framing to look at the potential for productive linkages between sectors traditionally governed separately. Box 1 defines what a circular economy is. In agricultural systems, circular economy technologies and business models can help producers, businesses and governments create more sustainable models of managing agricultural value chains. Furthermore, a circular economy can help recycle nutrients, materials, and reduce long-term costs if adequate technologies and business models are established.

What is a circular economy?

A circular economy is a production and consumption model, which involves sharing, renting, re-using, repairing, renovating and recycling existing materials and products for as long as possible and reducing waste to the minimum (European Parliament, 2015).

The **circular economy** promotes a more appropriate and environmentally sound use of resources aimed at the implementation of a greener economy, characterized by a new business model and innovative employment opportunities **(Ghisellini et al., 2016)**.

Box 1: What is a circular economy?

Sri Lanka has strong political momentum behind organic agricultural production (Cordell et al., 2021b). Numerous projects in Sri Lanka have documented the challenges and opportunities in agriculture and waste management, which are two sectors than can form part of a circular economy. Most recently, there have been studies exploring the opportunities for organic waste and composting (Hettiarachchi et al., 2020), food waste (Government of Sri Lanka, 2021b; Roy et al., 2021) and sanitation systems (Brechanov, 2018). Extensive work has been done on analysing the sanitation (Fernando et al., 2014) and agricultural (Senaratne, 2003) policies of Sri Lanka. Yet, as of early 2022, there are limited integrative analysis of how sanitation and agriculture are part of a circular economy in Sri Lanka.

This study was undertaken as a partnership between Janathakshan (GTE) Ltd, Sabaragamuwa University of Sri Lanka (SUSL), the International Water Management Institute (IWMI) and the Institute for Sustainable Futures at the University of Technology Sydney (UTS-ISF). Between July 2019 and January 2021, the team undertook two major activities focused on the technical and social marketing dimensions of organic value chains. The first was an Organic Waste System Assessment of Kaduwela Municipal Council where we undertook a stocktake of waste collection and municipal solid waste (MSW) composition. The second was a social market assessment, where focus groups and surveys with different types of farmers were undertaken to understand their agri-input use and preferences.

Building on the social market and organic waste systems assessment from this project, this report contributes to the institutional and policy environment for organic value chains. This study was conducted in the first half of 2021, using a combination of desktop analysis and online interviews. As the research process progressed, the project team had to work with the changing policy context of organic systems in Sri Lanka, which changed rapidly throughout 2021. This report presents results from the synthesis of the institutional dimensions of organic value chains in Sri Lanka, coupled with the changing context of the sector as presented by key informants and emerging news items relating to organic agriculture in Sri Lanka.

Approach for the political economy analysis

Political economy as a discipline considers how political institutions, the political environment and the economic system influence each other (Davis, 2011). It has an interest in processes in a society, how power influences practice, and how different current and historical contexts influence a system (Collinson, 2003). To complement the waste-systems assessment and the market research, we undertook a political economy analysis guided by a 3-part framework (Figure 1). To organise our analysis, we drew from established political economy guidance notes for international development (Davis, 2011; DFID, 2009). In our framework, each of the three categories focuses on the following:

1. Defining the system and the framing of the problem. This relates to the existing context that influences the topic of interest. Research participants help identify the core issues relevant to the research focus.

2. Structures and levels of influence in a system. Here, a PEA focuses on the rules in the system and who wins and loses from the system. This structural analysis helps identify the possible levers and agents that can create some change in the system.

3. The future of the problem and possible interventions. In this study, this concerned identifying possible business models or interventions that can work within the existing boundaries set by the structures in the system.

We spoke to 9 stakeholders from national public agencies or the private sector working in agriculture, sanitation, or waste management. We did not speak to provincial level institutions, and some meetings were cancelled last minute. All data collection was through an online meeting platform due to Sri Lanka's COVID lockdown and safety restrictions at the time of data collection. This was a very challenging modality for in-depth discussion. Participants were frequently overloaded with clashing meeting demands, had varying levels of connectivity when working from home, and had challenges allocating time to long interviews due to overloaded work commitments. To overcome these barriers, the interview guide was adapted to ask the most salient questions to the expertise of the participant. While the questions focused on circular economy, policy and politics, they varied in 'technicality'. That is, we adapted the interviews to agriculture, waste management, or sanitation depending on who the participant was. The participants we spoke to provided a range of national level perspectives on the topic. They also provided us with links to reports and policies, which we use throughout this analysis. Much political economy work is historical and conceptual in nature. Our study draws from this historical and text based evidence, but also from the perspectives of stakeholders, insights from the partners working in this sector in Sri Lanka, and the dynamic policy context of organic fertilizers in the country.

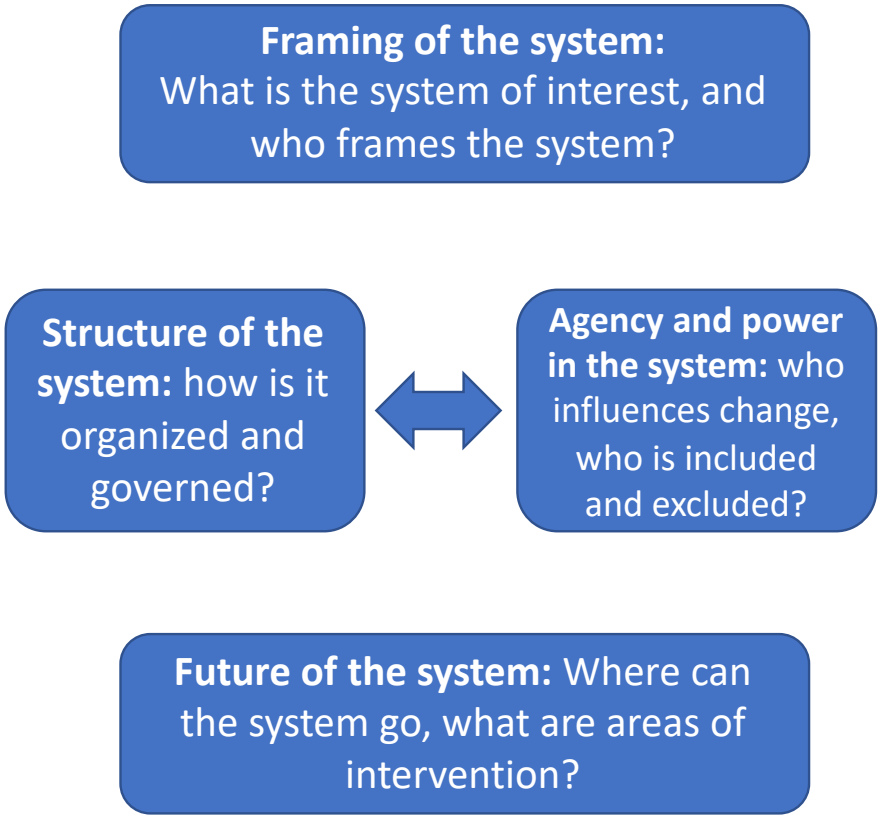

Figure 1: Political economy analytical framework for organic value chains in Sri Lanka

2. System of interest: The waste and agriculture circular economy

A central component of any political economy analysis is critically examining the socio-economic system of interest. In this project, our system of interest is made up of three sectors: agriculture, sanitation, and solid waste. Stakeholders spoke about their specific technical areas of expertise, and provided some guidance of the policy and political context of the three sectors as of 2021. A summarised version of this system of interest, drawing from existing literature, is presented here.

Sri Lanka's national economy is changing, with the historical contributions of agriculture to GDP declining, replaced by the services industry – mirroring many growing economies globally (ADB, 2017). The share of agriculture has declined from 8.5 per cent in 2010 to 7.0 per cent in 2018. Despite this decline, agriculture continues to be a major sector of the national economy. As of 2015 the sector employed 28.7 per cent of the labour force (ADB, 2017), and contributes to 21.7 per cent of national exports. For comparison, 'industry' employs 25.8 per cent of people, and services 45.6 per cent . Agriculture remains the main source of livelihood in rural areas, where the majority of the population lives. Rice, coconut, and tea dominate the land-use pattern in Sri Lanka. Despite the low productivity of rice land in some geographical areas, farmers have not diversified significantly into other crops. Part of this lies in the socio-cultural importance of rice beyond a commodity – rice is core to food cultures and identities, which means it is prioritised while other commodities are not incentivised (ADB, 2017). The growing population and the non-diversified agricultural sector mean the country is a net-food importer, requiring imports to meet the nation's basic food requirements. The country's economy has grown and gone through periods of liberalization, protectionism, and globalisation of trade over recent years (Weerahewa et al., 2018). With these changes, the country has also seen increasing concerns over the sustainability of its agricultural system, and has adapted to focus on sustainable farming practices. A number of farming practices have been tested in Sri Lanka over the last four decades, from avenue cropping, integrated pest management, and inter-cropping systems – yet they have had mixed successes in adoption with farmers (Senaratne, 2003).

Sri Lanka has a high dependence on imported fertilisers and low use of organic or renewable fertilisers. Smallholders, who make up the majority of farms, have limited fertiliser market access and have naturally low-quality soils, which coupled with intensive farming practices, can cause low crop yields (Kumaragamage and Indraratne, 2011b). There is evidence that farmers regularly misuse or overuse fertilisers, and the presence of a government fertilizer subsidy and cash transfer has amplified this (Bandarage, 2013). The Presidential vision for a toxin-free nation and green agriculture, coupled with the recent fertilizer ban, create an enabling environment to explore opportunities for developing organic fertilizer inputs for the country. Other studies have recently documented the potential to reduce food waste, which makes up approximately 50-60 per cent of all MSW in the country (Government of Sri Lanka, 2021b). Reducing organic waste faces large social barriers at the household level, which will be slow to change. An opportunity exists to capture some of this waste and establish new businesses and waste-derived products which, if in accordance with standards and regulations, could contribute to Sri Lanka's sustainable agriculture.

The concept of circular economy for Sri Lanka has been discussed in previous research. For example, a vision for Sri Lanka is discussed by Bekchanov and Mirzabaev (2018) in the context of composting. Their study focused on modelling potential ways in which composting could be done in the country, and outlined the need for clearer links between policies, regulations and technical work. Samarasinghe et al. (2021) discuss the material flows context of plastic waste, and the interventions needed to maximise circularity. For this project, we developed a visual summary of a circular economy model that links source materials, value chains, and end-users (Figure 2).

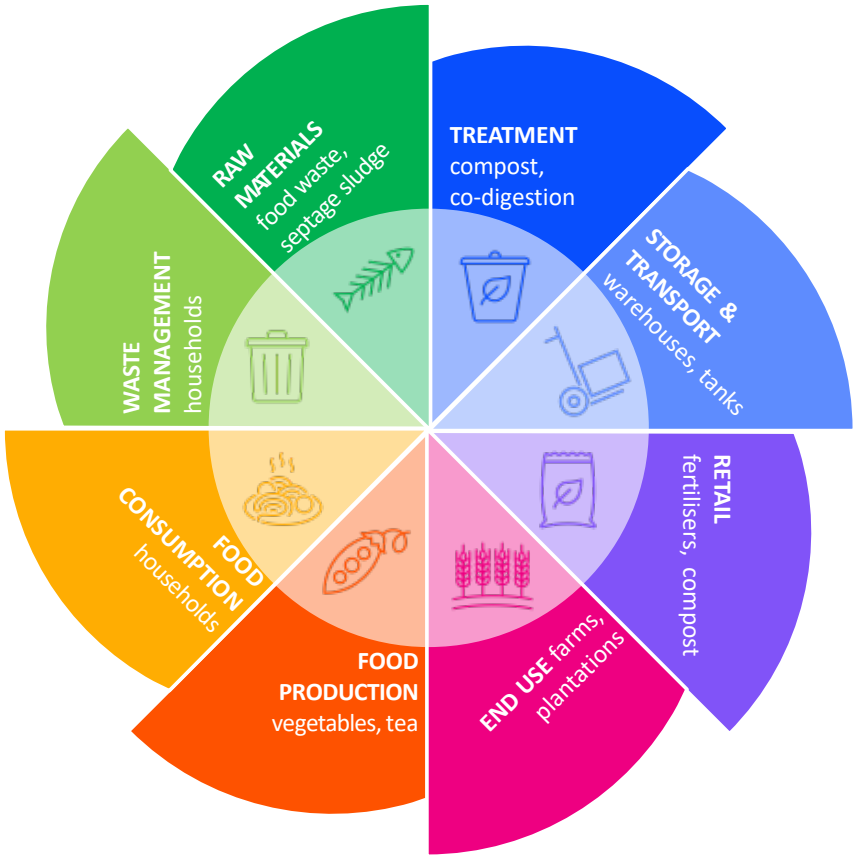

Figure 2: Circular economy for organic value chains in Sri Lanka

2.1 The challenge of agro-chemical use in Sri Lanka

Agriculture continues to be one of the key sectors contributing to the national economy, with one quarter of the labour force employed in agricultural sectors (Central Bank of Sri Lanka, 2021). The agriculture sector in Sri Lanka is characterized as dualistic, comprised largely of plantation and non-plantation agriculture. The plantation agriculture sector is export oriented and mainly involves in the production of tea, rubber, coconut and spices, while non-plantation agriculture is concerned with production of food crops such as paddy, pulses, condiments, vegetables and fruits, mainly for domestic consumption. The agriculture sector contributes to 21 per cent of foreign exchange earnings of which 11 per cent is accounted for by tea exports. About 30 per cent of agricultural land is allocated for paddy cultivation while the major plantation crops tea, rubber and coconut occupy 7 per cent, 5.5 per cent and 6 per cent of agricultural land respectively.

One sub-component of both the plantation and non-plantation sector is organic agriculture, which developed as global certification systems for organic production emerged in the country. According to FIBL and IFOAM (2021), organic smallholder producers mainly work in three value chain types (vegetables, fruits and spices). Organic farming in the country has grown by 200% and currently covers 70,436 hectares in Sri Lanka (FIBL and IFOAM, 2021). As a share of total agricultural land in Sri Lanka, approximately 6 per cent of it is certified organic. As of 2021, national organic regulations are still in draft form (FIBL and IFOAM, 2021). Tea and coconut are mainly grown on large farms. Coconut is frequently intercropped with fruits and spices. Vegetables are mainly grown for fresh consumption, while fruits are mainly for processing and value added for exports to international consumers. Spices are mainly for exports while some products are available in the local market as well.

While the area of certified organic land is limited, organic agricultural inputs are used in both certified and non-certified organic systems. Sri Lankan farmers in both plantation and non-plantation production systems use organic inputs as sources of nutrients. Rice, the staple crop in the country, has historically seen farmers using rice straw, cow dung and green manure to augment nutrients in rice paddies. The introduction of new high-yielding rice varieties has meant that chemical fertilizers have increased in use to meet the nutrient needs of new varieties (Sirisena et al., 2016). This has created a concerning fertilization trend in the country, which has

recently been challenged by President-driven narratives to minimise the use of chemical inputs (Cordell et al., 2017). This has created an environment conducive to the use of composts as an alternative source of nutrients.

In Sri Lanka there are major companies contracted by producer groups to supply compost. The companies sell the compost to their contract farmers, and rice farmers have the advantage of receiving subsidised agricultural inputs (ECORYS and Palladium, 2020). This creates a system where non-rice commodities are largely excluded from subsidy systems, creating a feedback process where high-yield varieties continue to be produced and thus creating demand for chemical inputs.

Use of agro-chemicals in farming systems is a challenge in Sri Lanka. Smallholder farmers have limited fertilizer market access and have naturally phosphorus-deficient soils leading to low crop yield (Kumaragamage and Indraratne, 2011a). Farmers regularly misuse or overuse fertilizers, and this has been attributed to the fertiliser subsidy (Cordell et al., 2021b). Sri Lankan farmers use an average of 138 kg/hectare of fertilizer below the South Asian average of 170 kg/ha (World Bank, 2021). The country does not produce these fertilizers, but has a long history of importing them (Table 1). Aiding the use of fertilizers has been a multi-decade subsidy for chemical fertilizers. The subsidy was initiated in 1962 as the global Green Revolution was accelerating. The subsidy's main objective has been to support farmers in switching from traditional farming systems towards high-yielding rice varieties that responded to chemical fertilizers. The subsidy has been in place for over four decades, but has faced increasing politics and scrutiny with a 'a paradigm shift' aligned with low-chemical and organic agriculture practices.

In 2016, the subsidy became a cash grant program of LKR 25,000/hectare per year for a maximum of 2 hectares for purchasing, which were market regulated at LKR 2,500 per 50kg bag (ADB, 2017). The intention of this cash grant scheme was to allow farmers greater flexibility in selecting their inputs, including supporting them to choose organic fertilizers to reduce the overuse of chemical inputs. While organic fertilizers are available, they exist in limited quantities, and without strong incentives to promote organic cultivation or regulatory standards and information sharing on productivity gains of organic fertilizers, there is a risk of farmers not adopting these inputs. The cash transfer was replaced in 2018 again with direct fertilizer materials, and overall adoption of composting and organic fertilizers has not taken place. As of 2021, when chemical fertilizer imports were largely banned in the country, the cash subsidy is now being used directly for farmers to produce compost, but not necessarily to purchase organic fertilizers. One participant we spoke to said that the fertilizer policy "is creating a barrier [for organic adoption], because the farmers are expecting to have a big yield, so understanding the practices of composting is important. [Farmers] rely on traditional subsidised fertilizers. However, due to the demand from the consumers, there is growing organic farming". It is important to differentiate the different purposes subsidies have existed for – some have been targeted at purchasing chemical fertilizers and now moved towards the production of organic inputs. Both serve very different purposes, and as a participant noted, there are major technical and knowledge barriers for farmers to produce sufficient organic nutrients from available biomass or organic waste to substitute chemical fertilizers.

Table 1: Fertilizer production, exports and imports (1000 tons) in Sri Lanka (Bekchanov and Mirzabaev, 2018)

Year	Production	Exports	Imports
Nitrogen fertilizers			
2005	0.0	0.0	159.6
2010	0.0	0.0	166.1
2014	0.0	0.0	227.4
Phosphate fertilizers			
2005	11.0	0.0	22.6
2010	10.0	0.0	40.7
2014	1.0	0.0	45.4

2.1.1 The 2021 agro-chemical ban as a catalyst for circular economies

Sri Lanka has a complex history of periodically banning agro-chemicals. Glyphosate, a widely used herbicide in annual and perennial crops, was introduced to Sri Lanka in 1977. Its use has expanded since 2008 with the phase-out and ban of paraquat in 2014. In December 2014, glyphosate use in Sri Lanka was regionally restricted (Marambe and Herath, 2020). Since 2001, an additional 36 agro-chemical inputs were banned in the

country. The sudden halt of agro-chemical use, when combined with other external factors, can lead to negative impacts on the immediate production of agricultural commodities. For example, in 2016 and 2017 a combination of drought in the dry zone and the lack of fertilizers led to a decline of production in tea. Increased crop production costs due to the absence of effective and economically viable weed control techniques, low crop yields, loss of foreign exchange, and enhanced use of smuggled glyphosate products were immediate consequences of the glyphosate ban (Marambe and Herath, 2020). In 2018, the Government lifted the ban on glyphosate for all crops throughout the country due to pressure from the farming community, especially the plantation sector. A further sudden disruption took place in April 2021, when the Government of Sri Lanka banned the import of chemical (industrial) fertilisers and other agrochemicals (including insecticides and herbicides). The policy shift was justified based on concerns about non-communicable diseases (NCD) arising due to the use of agrochemicals e.g., chronic kidney disease (although the reasons remain inconclusive). While the direct links between chronic kidney disease and agro-chemical use continue to be debated (Bandarage, 2013; Horbulyk et al., 2021), there are studies that show the direct links of arsenic, present in different phosphate fertilizers and some pesticides, and the growth of chronic kidney disease in Sri Lanka (Jayasumana et al., 2015).

The 2021 agro-chemical ban has been critiqued for failing to consider a 'transition period' in Sri Lanka, whereby key crops planted in the 2021/2022 season will be affected, and accelerate pressures will be placed on the limited organic agri-input producers including compost producers. Agricultural economists assert that this immediate change will result in significant declines in crop yields with implications for national food security. The sudden import ban implemented in April 2021 for the 2021/22 Maha season has created a policy environment for augmenting local production of good quality manures and other effective biofertilizers, yet there remains a gap to increase the technical capabilities and in financial support for entrepreneurs and businesses that can aid this transition, coupled with the limited volumes of organic residues in rural areas that can be used for composting (Dharmakeerthi, 2021). To assist farmers impacted by the sudden ban, some changes have been made to redirect the fertilizer subsidy funds. A subsidy is available for organic paddy farmers to produce organic fertilizer at LKR. 12,500/ha up to a maximum of LKR 25,000 i.e., for 2 ha. The government has also approved the importation of natural organic fertilizer and chelated minerals to bridge the gap in local fertilizer demand for the 2021/2022 Maha season (Government of Sri Lanka, 2021a). An important flow on impact from the chemical input ban is the pressure it may create on the 27 domestic organic fertilizer licenced businesses by the National Fertilizer Secretariat. Given the scale of farming in Sri Lanka, these 27 manufacturers are unlikely to be able to meet any future demand for organic fertilizers.

One response to meet the fertilizer gap has been using manure in place of chemical fertilizer inputs, given the sudden limited availability of imported produce. There is a potentially unintended outcome of farmers increasing their debt to maintain livestock for manure production, if compost fertilizers remain unattainable for them. In March 2021, new standards for organic and compost based fertilizers were established by the Sri Lanka Standards Institute (SLSI). These standards should be streamlined to ensure non-importation of substandard organic fertilizer and other plant nutrients to the country and domestic organic fertilizer compliance with specified quality standards. For example, there was a recent ban on compost imports from China due to microbial contamination – showing the value of adhering to and monitoring existing standards to protect Sri Lanka producers and consumers. These reflect that transformation from conventional to organic agriculture requires careful planning backed by scientific rationale to avoid far-reaching implications for food security and farmer livelihoods (Cordell et al., 2021a).

2.2 Complementing the agro-chemical gap: Food waste, and septage and sanitation derived waste

The political economy overview of the state of the agro-chemical system above indicates a need for farmers to continue using fertilizers and pesticides. A parallel, complementary system that helps amplify existing and future infrastructure for organic soil inputs like compost or animal manure can help meet some (but not all) of the gap created by banning chemical fertilizers. Results from two previous activities in this study have found that there are existing market demands and other nutrient systems available to contribute to the agri-input needs of agriculture.

In a survey of farmers conducted for this project, we found a wide mix of uses for soil amendment products and compost, as well as varying perceptions on the willingness to use compost from organic waste sources.

We found that 50% of farmers surveyed use compost, but this is largely restricted to home gardens and not the commercial crops (like coconut and pineapples). There are generally positive perceptions of compost, and farmers draw direct links to human health and yield benefits from it. The pricing, purchasing options and general information on the yield and income benefits of using compost and alternate inputs was raised as an issue by farmers. This summary or results from Activity 2 in this project point towards an opportunity where agro-chemicals can be complemented or partially substituted if there are adequate structures and systems in place to support farmers as the end users of these products.

Given the complicated history of imported fertilizer dependence in Sri Lanka's agricultural system, there are opportunities to leverage the existing resources available already within the waste system in Sri Lanka. In Activity 1 for this project, we undertook a feasibility study into possible organic waste streams that could act as feedstock for future agricultural inputs. In that analysis, we found that in one municipality (Kaduwela), 60% of the collected daily solid waste is biodegradable. Kaduwela Municipal council collects 71 tonnes of waste, but the compost plant only processes 10 tonnes per day plus 7 tonnes in an additional part for biogas. This is an example of the resources available in different waste streams in Sri Lanka provide a valuable platform for exploring opportunities for filling the 'fertilizer gap' created by the 2021 ban. Studies and initiatives in the country have identified the multiple opportunities offered by MSW, notably food waste, and septage and sanitation systems. In this section we briefly outline the municipal solid waste and septage context of the project, complementing Activity 1, to discuss their relevance for governance and business models of alternate agro-input systems in Sri Lanka.

2.2.1 Municipal solid waste and food waste

MSW in Sri Lanka is characterized by a combination of high organic matter, moderate plastic and paper content, and low metal and glass content. Given the high organic matter, it is high in moisture, in the range of 60 to 80% moisture. Approximately 85% of total MSW is disposed of in open dumps (Menikpura et al., 2012). The management of solid waste is largely the priority of local governments. This means that any national standards for collection procedures and compost qualities end up being the responsibility of a local governments. Local government authorities often do not have sufficient financial resources to develop fully equipped composting centres as income-generating entities (Sinnathamby et al. 2016). Policies and regulations are not in place to encourage private companies to engage in solid waste management (Menikpura et al., 2012). Sri Lanka generates about 7,000 – 10, 768 MT/day of MSW out of which about 1961-3458 MT/day are collected by the local authorities. MSW collected constitutes high biodegradable content offering favourable conditions to process MSW as compost, but the high moisture content continues to create challenges for this conversion. Table 2 summarises the current context of MSW management in Sri Lanka. The nutrients available in the biodegradable content of MSW create an opportunity to enable circular systems where they can be recycled back to agricultural systems (Samarasinha et al., 2015).

Table 2: MSW Management in Sri Lanka

	Value	Reference
Waste generation	7,000 – 10, 768 mt/day	Basnayake et al. (2019); JICA (2016)
Collection efficiency	27.2- 32%	Basnayake et al. (2019); JICA (2016)
Waste collection	1961-3458 mt/day	Basnayake et al. (2019); Hikkaduwa et al. (2015); JICA (2016)
Biodegradable content	50- 66%	Bandara (2008); Hikkaduwa et al. (2015)
Compost % (as a % of the total MSW collected)	10- 25%	JICA (2016)

There have been large-scale investments into developing composting systems to convert MSW into usable inputs for agriculture. The large-scale *Pilisaru* project is one the largest and most well-known ones in Sri Lanka, which was launched in 2008 by the Central Environmental Authority (CEA). The overall aim of the programme was to recycle biodegradable waste at domestic and municipal scales. Through this programme, nearly 18,000 compost bins were distributed freely among people in urban and peri-urban settings mainly, aiming to reduce

the loading of waste to local authorities (Dandeniya and Caucci, 2020). The programme enabled US$40 million of public funds to be used for municipal composting infrastructure – all for public agencies. By August 2016, 113 compost plants were operating in the 131 facilities established under the Pilisaru scheme (Sinnathamby et al., 2016). Although the Pilisaru project promoted the establishment of small- to medium-scale compost production centres in association with solid waste collecting units of local areas, the marketing structure for the produce was not clearly defined. Issues with waste sorting increased labour requirements and reduced the quality of compost, and poor social perceptions of compost management and ineffective use of compost were challenges of the programme. The composting of MSW was focused solely on establishing composting facilities and missed the marketing and social opportunities, and has failed to become an income-generating activity (Samarasinha et al. 2015).

Currently only 10-25% of collected MSW is composted in Sri Lanka. For example, our Activity 1 study found that only 24% of the MSW collected by Kaduwela MC was composted (Jayathilake et al., 2021). In addition to the marketing challenges, MSW as an input material for composting is not free of technical challenges, including: (a) high carbon but low nutrient content (especially nitrogen content, at a ratio of 22:1 (Roy et al., 2021)) of the input material, (b) impurities and contaminants, and (c) less segregated nature (highly mixed nature) (Otoo and Drechsel, 2018). The lower percentages of MSW processed as compost could be attributed to marketing and technical challenges of the compost plants. On the other hand, inadequate capacities of the compost plants to absorb the collected MSW can also be another reason for the reported lower percentages. Assuming a 100% collection efficiency and adequate capacity of the compost plants in the country to process all the biodegradable waste collected, there is a potential for producing 1400-2150 MT/day of compost. This compost, however, will need nutrient enhancement to ensure it meets the required needs of different crops. However, this could only partially meet the required food production needs of crops, as is likely nutrient poor compost that requires complementary nutrients from other sources.

While challenges persist, there are cases in Sri Lanka of successful business entities such as Balangoda compost plant (Otoo and Drechsel, 2018). This plant has adopted value addition processes such as co-composting of MSW with dried faecal sludge, valorised with 15% chemical phosphate (and therefore not fully organic)(Carrard et al., 2021). The co-compost branded as super compost with high nutrient content has created high value in their immediate compost market. Complementing this, the results our KLIE project reflected similar insights indicating that over 50% of farmers preferred to use co-compost made from MSW and septage recognizing the high value created through co-composting provided that the compost standards are met (Dominish et al., 2020).

A potential additional component of MSW is food waste. The literature indicates that about 56% of the MSW collected in Sri Lanka consists of food waste (Government of Sri Lanka, 2021b) implying high content of readily available biodegradable waste available for composting. One of the strategies identified under the food waste prevention and reduction road map developed by Ministry of Environment in collaboration with FAO and IWMI is to provide guidance on compost production and marketing in line with the existing initiatives in the country. This reflects the opportunities for further expansion of compost production and marketing in the country.

2.2.2 Septage systems

Septage systems can also provide valuable nutrients for generating organic-derived agricultural inputs. The current sanitation scenario in Sri Lanka indicates that only 2.7 per cent of people are connected to main sewage systems and 86 per cent of people use septic tanks and pit latrines serve as the country's most prevalent sanitation system (Carrard et al., 2021). These onsite sanitation systems need frequent emptying and the collected septage needs treatment before discharging to the environment. Although the collection of septage is established to some extent in the country through public (LAs) or private sector, currently only few treatment plants exist that can treat the septage collected. Septage is also co-treated along with sewage in municipal sewage treatment plants (MSTP) such as Ratmalana/Moratuwa WWTP (capacity- 17,000 m^3/day) although it is not yet a common practice across the country. In the absence of a treatment plant, septage is mostly disposed into forest, waterways, sewer network and trenches or excavated pits, creating large health and environmental risks (ADB, 2017)For example in Kaduwela MC, collected septage is diverted to one of the pumping stations in the Colombo sewer network with no treatment (Jayathilake et al., 2021). This lack of infrastructure leads to a loss of nutrient resources which could be co-composted with MSW to meet the fertilizer

demand in the country. The national policy on sanitation in Sri Lanka also states the importance of improving septage management, including through treatment for reuse (Government of Sri Lanka, 2017).

Co-composting offers integration of septage as an input material which would provide a solution for much needed treatment of septage from onsite sanitation systems while creating new opportunities to increase resource recovery rates (Sinnathamby et al., 2016). Some of these faecal sludge treatment plants such as Balangoda and Kuliyapitiya plant are equipped with drying beds that allows sludge drying through which septage can be prepared as an input for co-composting with MSW. This, however, can be technically challenging in high-rainfall and humid environments. It is also important to ensure that the compost standards are met for the safe reuse of the products. National standards exist in Sri Lanka for MSW derived compost, but standards for co-composting are currently non-existent. With composting infrastructures already in place across the country under the Pillisaru project, Sri Lanka is in a unique place to advocate for investment in co-composting to implement the faecal-sludge treatment plant (FSTP) component of the co-composting system (Carrard et al., 2021). Establishing co-composting can be risky, as the investment returns might be slow, creating a barrier for businesses willingness to invest. Stakeholders mentioned this cost uncertainty coupled with lack of end-user (farmer) awareness and willingness to buy the product as barriers. Businesses that could develop co-composting products are unwilling to take the financial risk of establishing co-composting if there is no guarantee of an ongoing market for their product. As illustrated in the political and policy context in section 2.1, there is also a lot of policy uncertainty that makes it hard for businesses to commit to a specific system for creating organic inputs or compost.

3. Structure and agency for organic value chains

The previous section provided an overview of the system of interest for a circular economy of organic-derived fertilizer products for Sri Lanka. The country has a buoyant political context to develop organic fertilizer products, yet there are challenges associated with quality, productivity, cost of production, and up-scaling of systems that need to be managed. As organic fertilizers become increasingly relevant in Sri Lanka, the intersection of national policies and institutions, which set frameworks and standards, with the operational and consumer side of the value chains will need to be addressed. In this section, we summarise literature and stakeholder perspectives on the major structures that influence the establishment of organic value chains. We discuss issues of coordination, standards, and the trade-offs of benefits in the system as three items raised by participants. These issues align with other documented analysis of up-scaling composting and organic fertilizer systems in Sri Lanka (Bekchanov and Mirzabaev, 2018; Dandeniya and Caucci, 2020).

3.1 Coordination

Agricultural activities in Sri Lanka operate within national policies that tend to focus on specific sub-sectors, such as agriculture and sanitation. National Government policies are guided by a vision of transforming Sri Lanka into a knowledge-based, export-oriented competitive economy at the centre of the Indian Ocean (ADB, 2017). There are several sectoral and sub-sectoral policy documents covering agricultural activities. Similarly, the waste and sanitation systems also have a range of policies and strategies associated with them. The discussions with stakeholders led to the following list of policy frameworks, which were discussed as policies requiring greater coordination to support circular economies:

- National Land Use Policy (2007),
- National Plantation Industry Policy Framework (2006),
- National Livestock Policy (2006),
- Sri Lanka Rubber Industry Master Plan 2017-2026 (2017),
- National Policy and Strategy on Cleaner Production for the Agriculture Sector (2012),
- National Agricultural Research Policy and Strategy 2018-2027 (2018).
- National Policy on Waste Management (2019)
- Rural Water Supply and Sanitation Policy
- National Policy on Sanitation in Sri Lanka (2019)
- The National policy on Waste Management (2019)
- RoadMap on urban food waste prevention and reduction for households, food services, retailers and wholesalers (2021)
- National Agriculture Policy 2021 (Policy Action 2.11 Enforce a regulatory framework for organic/bio fertilizer production)

The policies and roadmaps are situated within a number of national organisations that oversee the governance of the waste, sanitation and agriculture sectors in the country. These organisations provide a number of systems to regulate and monitor the development of their specific sectors. A summary of the main institutions influencing the value chain are presented in Table 3.

Table 3: Summary of national institutions overseeing agriculture, waste, and sanitation in Sri Lanka

Agency	Roles and responsibilities
Department of Agriculture	The objectives of the DoA are focused on maintaining and increasing productivity and production of the food crop sector to enhance the income and living condition of the farmer and make food available at affordable prices to the consumer. Functions include research, extension, training on food production, seed and planting material production, regulatory services on plant quarantine, soil conservation, and regulation of pesticides. For more details: https://www.doa.gov.lk/index.php/en/
Fertilizer Secretariat	The Fertilizer Secretariat sits within the Department of Agriculture. It is the primary agency responsible for administering fertilizer subsidies and cash programs targeted at agricultural productivity.
Department of Agrarian Development	The Department of Agrarian Development (earlier Department of Agrarian Services) was established to coordinate all agricultural support services at the grass-root level. Key responsibilities related to food production are the distribution of fertilizer, formulating agricultural law, water resource management (village irrigation), and agricultural land management. For more details: http://agrariandept.gov.lk:8008/agrarian/home.jsp
National Solid Waste Management Support Center (NSWMSC)	Responsible for a range of technical support services for solid waste management, including barrel provisioning, technical advice, awareness raising, and providing vehicles and instruments for solid waste management.
Central Environmental Authority (CEA)	The CEA under the Ministry of Environment is one of the main implementing arms of the National Environmental Act (NEA) and is responsible to make provision for the protection, management and enhancement of the environment, regulation, maintenance and control of the quality of the environment and prevention, abatement and control of pollution. The Waste Management Unit (WMU) in the CEA is in charge of the Scheduled Waste Management and provides necessary awareness and educational assistance for the general public. CEA has been appointed as the implementing agency of the NPSWM and also responsible for giving Environment Protection License (EPL) and other necessary approvals for RRR businesses.
National Water Supply and Drainage Board	The Board is largely responsible for the construction and management of pipe-borne water supply and sanitation projects, often at a large scale. The Board also supports local and provincial agencies and communities when they face challenges in implementing their local water supply and sanitation projects.
Ministry of Environment	Main functions are the preservation of the environment for the present and future generations, and formulation and implementation of programs to combat pollution of the environment. This ministry oversees the implementation of multiple environmental protection acts.
Ministry of Provincial Councils and Local Government Affairs	This Ministry is important for the circular economy given that local councils play a crucial rolle in collecting and managing MSW, as well as extending knowledge and supporting farmers. The Ministry provides financing, equipment, and technical support to local councils and governments.

Previous studies have found that value chain and stakeholder fragmentation are an ongoing challenge for Sri Lanka's agricultural sector (ADB, 2017). For example, in the coconut value chain there are multiple producers, such as raw oil, coconut milk, and desiccated coconut. Producers tend to be disconnected from the market, which means they are unable to coordinate and negotiate higher prices or access value-adding opportunities. In a lot of the raw commodity value chains (rice, coconut, spices, tea), middlemen and produce collectors travel to farms to buy the produce and sell to wholesalers.

The multiple policies and strategies that exist in the country provide a normative vision of where the sanitation, waste, and agriculture systems can go towards the future. Yet coordination of these visions and the agencies is often a challenge, given different mandates and diverging disciplinary technical expertise of a particular issue. Issues of coordination are not new, with reports of it being challenging enough within the subsectors.

For example, a report on waste systems indicated that cooperation is needed to improve various aspects of service delivery, especially water resources management, public health, environment and pollution, and municipal solid waste management (ADB, 2017).

A possible area of coordination is the use of standards (discussed in next section) as an area of overlap between the sectors. The Sri Lanka Standards Institution (SLSI) is responsible for the development of national standards and for products and services used in the industrial trade sector. The SLSI has a monitoring committee, which assists in monitoring the quality of compost products generated from MSW and in liquid form. Participants in both public and private sectors spoke of the importance of regulation and standards, as they provide an overall structure for development and marketing to different consumers. Despite the many institutions in the organic circular economy in Sri Lanka, standards can provide a 'coordination bridge' to address fragmentation.

MSW can be rich in resources suitable for composting – for example UNESCAP estimate that between 50-85 per cent of MSW composition is organic matter (Weerasundra, 2020). Our study into Kaduwela found that 60 per cent of the MSW in that council is biodegradable. The Kaduwela composting plant processes 10 tonnes per day, and the biogas plant 7 tonnes. This is from a total collection of 71 tonnes per day. More than 50 per cent of the biodegradable material is moved by private operators for compost production or landfill. Compost sales and waste collection fees cover only 20 per cent of the ongoing waste management costs.

Composting and MSW management in Sri Lanka are largely council-based activities. This is the same case for sanitation systems. Stakeholders discussed issues of technical expertise and infrastructure as barriers preventing the adequate collection, sorting and identification of possible compostable resources at the council level. This has been reported elsewhere as a challenge for improving MSW, as well as sanitation systems. General challenges include a combination of a lack of institutional technical expertise, funding and resource gaps, overlap of administrative functions between national, regional and local levels, lack of monitoring, and general public apathy towards waste.

3.2 Standards and technical capacity as structures for future organic value chains

Participants pointed us towards major standards that have an impact on the development of fertilizers. One was Standard 1702:2021 Specification for Liquid Organic Fertilizers, the other was Standard 1634:2019 Specifications for Compost made from MSW standards. For example, a number of physical and chemical conditions are needed to create the right product, and the produce needs to be biodegradable and made from the correct materials. One participant also said that, along with agricultural input standards, there are also "specific standards for domestic and industrial waste waters - those regulations govern their sanitation policies." A challenge remains in developing the adequate mechanisms, as QR codes such as proposed by a participant, to confirm if and 'final product' on the shelf meets the standards. There is also an opportunity to determine whether the waste standards can meet the criteria for organic fertilizer and compost standards, to help align the existing legal boundaries that exist in this system. Participants generally discussed how these standards provide a framework for developing the product, but adhering to them and scaling-up the production of fertilisers to meet them remains a challenge.

The technologies to support processing of MSW, septage, and food waste into agro-inputs that meet the standards remain fragmented and require both costly upfront investment and often involvement of the private sector. In discussing GreenForce Agriculture, one of the largest organic fertilizer manufacturer in Sri Lanka, stakeholders explained how the business model allows them to "take the sludge, make compost, and distribute it outside Sri Lanka…. [it is] a good example of a public private partnership". Green Force Agriculture also deals with MSW, and we heard that they have "produced organic fertilizers with [high] standards, without any heavy metals from municipal solid waste". Yet in discussing the business model for Green Force, the quality of the waste input influences their ability to produce fertilizers of adequate quality. Green Force is able to follow the existing standards, yet is challenged by the poor social practices in waste sorting and lack of up-scalable infrastructure to work with waste in different parts of the country. The wider system of waste sorting at households influences the end-quality of waster-derived agro-inputs, as do any sorting systems that municipalities have in place (if any). This points towards the broader social dimension of the waste challenge in Sri Lanka requiring targeted consumer and household level information campaigns and incentives.

One opportunity for future standards development to use waste is the development of standards for biogas systems. One participant spoke of the large opportunity for biogas generation in Sri Lanka, requiring business investment. Past studies have indicated the relatively limited uptake of biogas in Sri Lanka, indicating another opportunity for leveraging existing waste systems (De Alwis, 2002). This is an alternate use which may create tensions for the generation of organic fertilizers, as it is a different use for waste. It does not seem to have the up-take and social normalisation as organic fertilizer from waste seem to have. Bio-gas production can also provide high-nutrient liquid bi-products. However, there has been little interest and incentives to generate energy from waste products in the country (De Alwis, 2002), and there is high upfront costs associated with establishing waste to energy systems. These initial barriers, if overcome with investment and adequate structure, can create another opportunity for waste products to be used.

3.3 Agency in the system: Benefits to farmers and consumers from this system

Agency relates to issues of equity, sovereignty, and ability to influence decisions. In major sustainable development challenges, such as livelihoods and food security, agency is concerned with the capacity of individuals and groups to exercise control over their systems and resources, to ultimately influence governance processes (Clapp et al., 2021). In this study, we were limited by talking to institutions and organisations that have greater levels of 'power' in the system. Smallholder farmers or rural communities – often poor, marginalised and distant from formal decision making processes, have less levels of power and influence. We were unable to reach out to these groups, and gathering their perspectives in influencing the system remains an area of future research. In the context of our analysis focused on government policy, agency lies across different groups in the value chain: governments at different scales, individual farmers and their farming systems, the entrepreneurs and businesses managing waste, and the end-consumers accessing the products from organic fertilizers. Our interviews focused on government agency, and the implications of the national-provincial-local council multi-scale interactions in Sri Lanka. Overall, policies and institutions that set the national frameworks provide guidance, but ultimately local/municipal governments are the ones that face the **responsibility** for creating this system. As one business stakeholder pointed out in discussing the challenges for councils:

"There is a fundamental flaw in the [Waste Management] Act itself that leaves the ownership of the waste to local authorities - there are over 300 of them of different sizes. Some of them have very small budgets and are responsible for collection and disposal. The Act itself makes it hard to enable a comprehensive [approach]".

Community-led approaches to awareness and certification were presented as an example of improving agency for communities in the waste management system. Participants spoke about fragmented certification, often with lack of clarity in regards to who is 'doing' the certifying, and what systems they are adhering to. One participant said that there are "community based certification systems", where farmer groups are able communicate the quality of the certified product to others in their network. Given these community systems are informal, there is opaqueness on whether they align with the formal certification guidelines and monitoring systems.

Consumers do not hold 'power' in the system in terms of directing the availability of food-products produced under different organic-input production system. Consumer decision-making power lies in 1) the certification available for organic produce and 2) their awareness and understanding of the different types of agro-inputs used, including combination of organic and chemical inputs. Growing consumer demand for organic produce, coupled with national political narratives of organic agriculture, may trigger greater consumer understanding of organic systems. Stakeholders discussed how the CEA, with a strong environmental focus, aims to develop community awareness of organic products and the benefits to farmers and consumers. The CEA is also in the process of developing a mechanism to register and monitor septage emptying business, to address the challenge of illegal dumping. Waste separation is also a major issue, as noted in the 2021 Food Waste Roadmap (Government of Sri Lanka, 2021b). The CEA is also creating awareness campaigns to encourage consumers to separate their organic waste products at the household level to enable greater segregation of waste for potential future use in the value chain. This is a slow process – it puts the onus of sorting waste at the household level with minimal wider value chain incentives and structures (for example, organic only collection bins). Awareness is an important part of organic value chains and can be leveraged in combination with other incentives and structures to support better waste management.

4. Future organic value chains – considering dynamic political economies

Sri Lanka faces a changing agricultural context, a growing population and increasing pressures to manage waste and septage throughout the country (ADB, 2017; Bekchanov and Mirzabaev, 2018; Fernando et al., 2014; Weerasundra, 2020). The complicated history of agro-chemical imports and complex multi-institutional governance mechanisms in waste systems and agriculture make integrated values chains across sectors highly political, contested, and multi-scalar.

Recent analysis of solid and liquid waste management in Sri Lanka also points towards challenges in the separation of waste, and recent studies have found most MSW in the country has very high organic and high moisture content. Local authorities are tasked with managing waste water and septage, which can be high in nutrients, but they lack funding and technical infrastructure and capacities to re-use the resource (Jayathilake et al., 2020). Previous studies have also pointed towards localised capacities to leverage alternate agro-inputs, such as compost, and adequately market them and extend them to relevant consumers (Dominish et al., 2020; Roy et al., 2021). Our report complements these findings by providing a synthesis of the institutional and political environments of agro-chemicals, waste and septage socio-political systems and current trending policy changes in the period of April-August 2021.

This summary and future looking chapter draws from our literature review and interviews, presented in the previous chapters. We provide some major areas of possibility to work within the constantly moving context of agricultural development, and waste and sanitation management in Sri Lanka. We use the plural 'economies' to illustrate the fact that the complex institutional environment of Sri Lanka might require multiple types of interventions depending on what the ultimate objective of the organic value chain system is at a particular scale. For example, one objective may be to improve on-farm productivity and reduce farm expenditure on agro-chemicals. Alternatively, a different (but related) objective might be to improve waste segregation and quality of organic matter in MSW to enable conversion into compost. These systems have different agencies and stakeholders involved, so the political economic context will vary. We provide some general recommendations based on our desktop analysis, partnership engagement over 2021 and the Zoom interviews with stakeholders.

Technical capability for Local Authorities

There is still a technical capacity gap at municipal levels and the Local Authorities, who are responsible for the management of waste systems and extending agricultural services and knowledge to farmers. Our analysis indicates that while there are a range of policy windows for supporting alternative agro-inputs to complement existing systems, and other studies point to availability of nutrients in waste-streams, technical and staff capacity remains a challenge. Local Authorities are often responsible for collecting, sorting and disposing of MSW and septage. Local Authorities are also at the interface of agricultural extension and farmers, yet the authorities remain disconnected from the Department of Agrarian Development and Provincial Department of Agriculture. Establishing greater linkages between scales of governance in Sri Lanka can support the ultimate beneficiaries – farmers – in acquiring the adequate knowledge on organic fertilizer use. Funding for Local Authorities is often limited within these systems, preventing investment on new technical staff or building capacity of existing staff. Our study points towards a need for capacities to be spread out across aspects of the value chain: sorting waste, monitoring and ensuring alignment with national standards, and understanding the yield benefits of complementary agro-inputs. The future of establishing these value chains thus depends heavily on Local Authorities and the relevant businesses in place to have adequate resources to collect, processes and produce alternative agro-inputs. Complementing this is the crucial capacity of agriculture extension officers to adequately showcase the costs and benefits of complementing chemical inputs with organic inputs in different farming systems.

Cross-sectorial standards and monitoring capacity

As discussed in this report, standards exist to determine the quality of compost and organic fertilizers in Sri Lanka. These standards offer an existing legal and scientific foundation for developing different products targeted at farmers. Standards can be used as a leverage tool to support both business and farmers in being part of innovative value chains that aim to maximise waste products and reduce chemical input reliance. Standards, if monitored and enforced, can be used by businesses to develop products and work with current

or new certification systems to showcase the quality of the product. This can allow businesses to have a competitive edge over imported organic fertilizer and compost, which may not have clear standards attached to them. By developing Sri Lankan based compost or organic agro-inputs, businesses can make the most of existing standards to show the quality of their products. Farmers may need support in understanding the relevance of the standards to their specific food production system, and also the benefits certified products under these standards bring to them in the long-term.

Cost-benefit and impact of non-chemical agro-inputs

The true costs and externalities associated with the production of alternate agro-inputs needs to be adequately calculated. The political economy context presented throughout this chapter ultimately points towards the various policy structures in place to support the economic development of Sri Lanka. Part of working within these policy environments is determining the economic realities of a circular economy, and the impact on yields for farmers. Previous studies have explored farm-level benefits from using a combination of organic and chemical based inputs. For example, over an 11 year period Sirisena et al. (2016) found that there was higher organic matter and nitrogen context in fields with organic manure, and overall obtained higher yields. Contrastingly, in a study conducted in rice systems in the Dry Zone, Wickramasinghe et al. (2021) found that organic only systems were not higher than mixed and conventional systems. While understanding cost and benefits is a complex task for a country-wide system, developing such economic models at the Municipality level may provide the business case for undertaking the integrative activities discussed in this report. The Pilisaru project offers a comprehensive starting point of multiple studies and analysis of the successes and failures of establishing large-scale composting projects. Large projects like Pilisaru give some baselines to work with in establishing place-based scalable infrastructure to develop alternative agro-inputs. There is a need to understand the costs to municipalities, farmers, and food consumers from complementing chemical-based agriculture systems with locally developed alternate inputs. Scenarios of costs and benefits in the future are needed to have dialogues with investors and businesses who may take risks in establishing these systems. For long-term sustainability, there also needs to be an assessment of the externalities associated with these activities. Detailed life-cycle assessments of a specific system, such as Kaduwela MSW, organic waste separation, and septage management and conversion to a co-composted or alternative input, can help capture these externalities.

The actual infrastructure required for composting and/or septage and waste management requires careful planning and mapping of social, environmental, and economic costs. A study by Roy et al. (2021) found that lack of adequate resourcing of composting infrastructure can have long-term impacts on quality, environmental protection and public perceptions. These hard infrastructure costs may require investments from the national governments. Coordination between the agriculture and waste management agencies could help broker the adequate finance flows to set up this infrastructure.

Scalable piloting of interventions

Sri Lanka has a lot of historical and institutional knowledge on the politics and technological dimensions of waste management and food production. Innovating towards integrative approaches between sectors requires risk taking from different partners willing to navigate the compromises needed to achieve the overall outcomes of reducing waste and supporting the food security of the population. Multiple existing innovations exist and continuous research in the country has evidenced both the challenges and opportunities existing in the waste and alternative agro-inputs sector.

The existing knowledge provides a platform to develop the right partnerships at scale to pilot interventions. The interventions may exist in different parts of the value chain – for example in both the production of quality co-composted products or in consumer education. Yet it is important to have parallel pilots in different parts of the value chains operating simultaneously. Pilots need to be system-wide – a household waste segregation campaign to improve quality of organics needs to complement the processing and production of organic-waste derived agro-inputs. Complementing this, a trial site with farmers and different food production systems (home gardens and commercial crops, for example) would create a household-infrastructure-farmer connection.

As with the technical capacity, the scale of intervention is most likely to deliver a ‘functional’ pilot value chain at a municipal scale. Given the over-abundance of examples and entrepreneurial activity in Colombo, it may be worth exploring other regions of Sri Lanka and identifying municipalities where this piloting could be tested across the value chain, working towards a full systems experiment from household waste to farm.

Coordinated cross-sectorial business models for innovative and sustainable value chains

Business models for waste derived value chains and a circular economy have been explored in previous studies (European Parliament, 2015; Ghisellini et al., 2016; Otoo and Drechsel, 2018). In the context of Sri Lanka, Bekchanov and Mirzabaev (2018) propose that composting systems can make contributions to a circular economy in Sri Lanka. In their analysis, they find that subsidising chemical agro-inputs, maintaining quality and standards, building social acceptance, and understanding the planning and structure of waste systems can enable better compost-related economies. Our study aligns with these and other studies pointing towards a large opportunity to use MSW, septage, and food waste as options for agricultural inputs. Our study complements previous work by looking at the agricultural dimensions of the value chain as the end-user of the products.

Our study has indicated the multiple agencies and stakeholder across scales who influence the possible organic waste value chains. Drawing from the work of Evans et al. (2017), who discuss the coupled nature of technological innovations with social relations in the context of sustainable business models, we propose the following actions for business models that can help guide the piloting of organic value chains in Sri Lanka:

- Determining the quantifiable and qualitative environmental, economic, and social benefits of balancing chemical and organic inputs in selected agricultural inputs, at specific scales. Focusing on major production systems that contribute to exports and food security – such as rice and home-gardens – can provide a more systemic picture of this benefits and costs

- Planning and designing for co-benefits between sectors across different domains, such as financial performance and capacity developments. End users (farmers) or an organic agri-input will have some benefits, while the municipal staff or infrastructure may have other benefits from engaging in the same value chain.

- Explicitly address agency and responsibility mapping of the different sectors and institutions in the value chain. Benefits and costs vary, so mapping this transparently can improve the governance and multi-stakeholder buy-in of the business model.

The three categories of actions above can be transferred to the cross-sectorial issues that a particular set of stakeholders might be interested in. For example, in MSW and co-composting, a number of consumer, Local Authorities and collecting and processing businesses would require an opportunity to co-design and built the innovative models required for a circular economy. Within these models, explicit attention needs to be placed on issues of equity and agency, noting the challenges of including marginalised or powerless groups in circular economies. Taking an explicit design approach that focuses on co-benefits in different sectors and the inclusion of marginalised groups can offer opportunities for Sri Lanka to demonstrate novel ways of developing localised circular economy models in the waste-sanitation-agriculture nexus.

4.1 Conclusion and future directions

Sri Lanka's National Government has built a narrative of a 'toxin free nation' for over a decade, with various political statements over the years promoting conversion to organic agriculture. Despite these calls, Sri Lanka continues to use extensive chemical agro-inputs in a range of agricultural commodities. The 2021 attempted ban on chemical agro-inputs proved to be politically challenging, with the immediate cropping season and food security risks not considered. At the end of 2021, the ban has been reverted, showcasing that the conversion to a chemical free food production system is a long way from being achieved in Sri Lanka.

The political economy analysis presented in this report has presented a current contextual analysis of opportunities to link waste systems (municipal solid waste and sanitation) with the agricultural development context of Sri Lanka. This study contributes to the institutional dimensions that can either inhibit or enable integration between these two important sectors for sustainable development in Sri Lanka. From interviews with selected senior officials and experts in agriculture, sanitation, and waste management, we identified three general structural aspects of the political economy of the agriculture-waste nexus that offer opportunities for the future. First, enabling value chains that connect the sectors will require coordination between the existing

standards and legislations behind composting, co-composting, waste collection and management, and organic agro-inputs. Second, the scale in which waste materials are captured, processed, and distributed to farmers remains a challenge. The most logical intervention point for piloting value chains are Local Authorities, given they are responsible for waste management, and are connected to the farmers. Third, developing opportunities for Local Authorities to link with the Department of Agriculture and the Department of Agrarian Development can catalyse ways of extending knowledge to farmers. Future investments need to undertake a combination of cost-benefit analysis, crop-specific studies on use of organic inputs and co-composting options, and improved processes for including smallholders into decision making processes. Consumers also play an important role in generating demand, and targeting households to improve waste separation and awareness of food produced with local alternative agro-inputs is needed. While there are ongoing national debates around incentivising and promoting organic agriculture, the localised approaches that engage with Local Authorities are the ones that are most likely to catalyse changes towards integrative innovative value chains.

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