Collaborative action on soil fertility in South Asia

Experiences from Bangladesh and Nepal

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Soil degradation – largely caused by unsustainable farming practices – is threatening food production in many parts of the world. To break the vicious cycle of over-reliance on agro-chemical inputs and inadequate additions of organic matter, farmers and policymakers need to focus on maintaining soil fertility through greater attention to soil organic matter, agroecological farming practices and the value chains that can supply organic fertiliser in large enough quantities. This paper represents a first step, describing recent initiatives in Bangladesh and Nepal to bring together government, NGOs, farmers and the private sector. Awareness of the problem is on the increase and small-scale solutions – from urban waste recycling to vermi-compost production – are proving that the potential exists. Policy support is now needed to scale these up.

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List of acronyms and abbreviations

AIC	Agriculture Input Corporation
AICL	Agriculture Inputs Company Limited
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BDT	Bangladeshi taka
CO_2	carbon dioxide
DADO	District Agriculture Development Offices
DAE	Department of Agricultural Extension
DLS	Department of Livestock Services
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
Ha	hectare
IPNS	integrated plant nutrient system
IYS	International Year of Soils
K	potassium
MoAD	Ministry of Agricultural Development
MT	metric tonne
N	nitrogen
NARC	National Agriculture Research Council
NFP	National Fertiliser Policy
NGO	Non-governmental organisation
NPK	nitrogen, phosphorous and potassium
NPR	Nepalese rupee
P	phosphorous
SDC	Society Development Committee
SRDI	Soil Resource Development Institute
SUP	Society for the Urban Poor
USD	United States dollars
WORD	NGO and organic fertiliser production plant based in Faridpur

Executive Summary

Soil degradation is threatening agriculture and its ability to adapt to climate change in many parts of the world. High population growth and increasing demands on agriculture for food security and livelihoods are exacerbating this threat in South Asia, where soils have also been affected by intensive agriculture and a heavy reliance on agro-chemical inputs. Traditional practices that sustain soil fertility – such as fallowing and crop rotations – are increasingly neglected due to the need to keep land in continuous cultivation. At the same time, sources of organic matter in rural areas are in short supply. The result is a decline in soil organic matter that is not replaced by farmyard manure, organic fertilisers or agronomic practices. While the organic matter content of soil should ideally be between 4–5 per cent to sustain productivity over time, in Bangladesh and Nepal it is now less than 2 per cent in many areas, and in some areas less than 1 per cent.

While scientists recognise the need for larger amounts of organic matter to maintain the fertility of soils in Bangladesh and Nepal, the organic fertiliser sub-sector in both countries is still at a very early stage of development, with limited levels of production from a small number of firms. Policymakers are beginning to pay more attention to the problem of soil fertility and measures to address it, but it is still not as important a priority for them as chemical fertilisers, which have been used to drive productivity for decades. Partly as a result of this, there is a dearth of reliable data on the size and value of the formal organic fertiliser industry, as well as its informal counterpart of small-scale production by households both for sale and household use.

This paper describes recent initiatives in Bangladesh and Nepal by the NGO Practical Action and its partners to reverse declining soil fertility and promote sustainable agricultural practices by increasing the use of organic fertilisers – from both commercial and household sources. This has involved:

- Bringing together a range of actors interested in increasing the use of organic fertilisers and composts. Through regular multi-stakeholder meetings, organic fertiliser manufacturers, government agencies, district extension staff, farmers' groups and others have explored the issues, and developed and implemented action plans to build organic fertiliser value chains.
- Researching the main obstacles to well-functioning value chains for organic fertilisers in both countries. These include contradictory policy signals; poor awareness of soil fertility problems; burdensome licensing procedures and unrealistic standards; weak capacity among companies and retailers; landholding patterns which discourage investment in land stewardship; and low demand among farmers sceptical that organic fertilisers will deliver good and timely benefits.
- Identifying and piloting workable solutions. There is a steady increase in the number of commercial organic fertiliser and vermi-compost enterprises supplying the horticulture sector in the Kathmandu valley in Nepal. Similarly, there are kitchen waste-to-compost enterprises in both countries. While small, such schemes demonstrate the commercial viability of the sub-sector. The challenge for policymakers now is to encourage greater investment and scale.

To break the vicious cycle whereby intensive agriculture in both countries depletes soil organic matter and increases vulnerability to drought, an integrated approach is required which balances applications of organic and chemical fertilisers and promotes agronomic practices that enhance soil fertility. Research is needed to develop cost-effective agronomic and market-based strategies adapted to the countries' wide range of circumstances and kinds of farmers. Ensuring large enough quantities of organic matter will require policies that raise awareness of soil fertility problems, encourage and support organic matter value chains, simplify licensing procedures and unrealistic standards, build capacity among companies, secure sufficient quantities of raw materials from multiple sources, and stimulate demand.

One of the key lessons of this case study is that such value chains for commodities such as organic fertiliser do not simply materialise by themselves. They need to be nurtured over time, and require action by multiple stakeholders. This includes the private sector, NGOs, government agencies and farmers. Knowledgeable and well-respected civil society organisations have a crucial role to play in facilitating collaborative mechanisms and building momentum.

1

Responding to the soil fertility crisis in South Asia

Soil degradation is threatening food production in many parts of the world. This paper describes recent initiatives in Bangladesh and Nepal to address declining soil fertility and promote sustainable agricultural practices by upscaling the use of organic matter, particularly by fostering collaboration between government, NGOs, farmers and the private sector.

Soils are the foundation of all terrestrial life on the planet and are essential for agricultural production. Yet soils are becoming degraded in many parts of the world, while demand for food is increasing. According to the Food and Agriculture Organization of the United Nations (FAO), one third of the world's soils are moderately to severely degraded (FAO 2015a). One study found that as a result of degradation, 12 per cent of all land experienced declines in productivity in the period between 1981 and 2003 (Millstone and Lang 2008). In recognition of the problems facing soils, the 68th UN General Assembly designated 2015 as the International Year of Soils (IYS).[1] The objectives of the IYS were to educate the public, raise awareness among governments and civil society and promote sound policies and action that contribute to the sustainable management of soils. The IYS highlighted the fact that increasing attention is being paid to soils and their degradation in the context of climate change and rising demand for food, industrial crops and biofuels.

What is contributing to this soil degradation? In intensive agricultural systems which are dependent on external inputs (hereafter referred to as conventional agricultural systems), soil degradation can be a result of the removal of crop residues from the soil, excessive use of chemical fertilisers and pesticides, and compaction by heavy machinery. Such agricultural systems can undermine soil health by causing pollution and soil erosion, depleting nutrients from the soil, changing soil structure, decreasing water holding capacity and reducing soil biodiversity. Monocultures (the practice of planting a single crop in a field) and the removal of fallow periods can deplete soil nutrients in intensive

[1] See www.fao.org/soils-2015/about/en.

agricultural systems if nutrients are not replaced through other means (FAO 2015b).

In smallholder agricultural systems, nutrient mining is another serious source of soil degradation. Farmers in many parts of the world have traditionally cleared land to grow crops, then left those plots fallow for a time to restore fertility. But due to population pressures and land scarcity, farmers are increasingly forced to use land continuously, "mining" or draining the soil of nutrients without restoring its fertility either through fallowing or adequate additions of fertilisers. This problem is particularly severe in Africa, but it is also a major problem in South Asia (Henao and Baanante 2006; Karim 2007; Quamruzzaman 2005; Sommer et al. 2013).

This paper presents case studies of Bangladesh and Nepal to illustrate how the health and fertility of soils are urgent issues (as elsewhere in South Asia). These two countries were selected to build upon ongoing work by Practical Action, which has offices in these countries and a longstanding programme of work in the agricultural sector, as well as established relationships with government and other actors. Nepal and Bangladesh also provide contrasting cases for research and action. Following a brief overview of the key issues and the methodology underpinning the study (this chapter), the situation in each country is described in some depth, including the work that has been done to date (Chapters 2 and 3). A comparative analysis is then made for the two countries (Chapter 4) and some conclusions drawn based on existing evidence (Chapter 5).

The soil fertility crisis in context

Organic matter – a vital resource

Only a small proportion of soil mass is made up of organic matter, typically between 1 to 6 per cent. Most of the mass of a soil is composed of inorganic particles such as sand, silt and clay. However, organic matter has a far greater influence on soil properties and on plant growth than this small ratio would suggest. It acts as a glue, binding mineral particles together to form the loose, friable soil structure that characterises productive soils. Furthermore, it is the main source and store of nitrogen, as well as a major source of phosphorus and sulphur – all vital for plant growth. As soil organic matter decomposes, these nutrient elements are released in a form that can be taken up by plant roots. Organic matter forms the principal food for soil organisms. In its absence, biochemical processes that are indispensable for the normal functioning of ecosystems would virtually grind to a halt. Soil organic matter is also an extremely important part of a soil's water retention capacity (Bot and Benites 2005; Brady and Weil 1996).

Soil organic matter is composed of a number of different organic materials, including living organisms, the organic remnants of plant and animal matter (such as decomposing crop residues), manure and other organic fertilisers, as well as organic compounds generated by past and present metabolism in the soil. The remnants of plants, animals and microorganisms are constantly decomposing in the soil, even as new materials are created by microorganisms. In the process of microbial respiration, organic matter is continuously lost from the soil as carbon dioxide (CO_2). It is also lost through soil erosion. As a result of erosion, decomposition and the removal of biomass through crop offtake, plant and/or animal residues need to be repeatedly added to the soil in order to maintain soil organic matter (Brady and Weil 1996). However, this need is often neglected in conventional agricultural systems, which focus on the application of agrochemicals such as chemical fertilisers, as well as in many smallholder systems that are non-regenerative.

A larger issue is that soils have a crucial part to play in curtailing and adapting to climate change through their role in the carbon cycle. Soils form the greatest storehouse of terrestrial carbon. With sustainable management, soils can sequester carbon and reduce greenhouse gases in the atmosphere. However, improper management of soils can accelerate climate change by releasing more soil carbon into the atmosphere as CO_2 (FAO 2015c). Reducing greenhouse gas emissions from agriculture, including through sustainable soil management, is a key component of the Paris Agreement which came into force on 4 November 2016 (UN 2015).[2]

The predominance of chemical fertilisers in agricultural policy and practice

In agricultural systems, water and nutrients are the main factors limiting the growth of plants. Conventional agriculture relies on the application of chemical fertilisers to supply nutrients to crops, particularly the macronutrients nitrogen, phosphorus and potassium. Global fertiliser applications have increased some

[2] Agricultural expansion is also a major cause of deforestation, and of the greenhouse gases emitted from land conversion. Improving soil fertility and thereby preventing the degradation of land is one factor that can help reduce the pressure on farmers to move into forested areas.

700 per cent over the past 40 years (Foley et al. 2005). Global fertiliser consumption was over 183 million metric tonnes (MT) in 2013, and world demand for fertiliser is growing at around 1.8 per cent per year (FAO 2015b). Most conventional agricultural systems around the world are increasingly reliant on chemical fertilisers for several reasons. High-yielding crop varieties have been bred to respond to high levels of nutrients, which are easier to provide from chemical fertilisers because they are more concentrated and less bulky than organic fertilisers. Meanwhile, the agrochemical companies which create them and which sell to farmers the full package required for this model – from seeds, to chemical pesticides and fertilisers – have significant economic and political power. These fertilisers tend to be heavily subsidised, which both reflects and perpetuates the power of these companies. Other reasons for the reliance on chemical fertilisers include the shift from mixed farming to monocropping, the ease of transportation and application of chemical fertilisers, the decline in availability of farm labour and a mind-set among academics, researchers, policymakers and investors that favours the heavy use of agro-chemicals.

While agricultural production in many parts of the world is heavily reliant on chemical fertilisers,[3] they have a number of downsides. One is that nutrients derived from these fertilisers leach through the soil more rapidly than nutrients that originate from composts, manures and other organic sources. A portion of these synthetic nutrients is thereby lost and does not remain available to plants (Rodale Institute 2015). On average only 30–50 per cent of the nitrogen fertiliser and about 45 per cent of the phosphorus fertiliser that is applied to fields is actually used by crops (Tilman et al. 2002). The rest remains in the soil or is lost either through gases released into the atmosphere (see below) or as nitrates leached from the soil, causing surface and ground water pollution. Phosphorus runoff from fertilisers is another major source of water pollution (Matson et al. 1997). Nitrogen fertiliser also contributes to acid rain and ground-level ozone pollution, as well as damaging the stratospheric ozone layer (Millstone and Lang 2008).

Issues of fertilisers and soil health take on added importance in the face of climate change. The global food system contributes between 19 and 29 per cent of all anthropogenic greenhouse gas emissions (Vermeulen et al. 2012), and the manufacturing of chemical fertilisers alone produces 575 megatonnes of greenhouse gases per year (Gilbert 2012). Nitrogen fertilisers are produced through an energy-intensive industrial process reliant on fossil fuels that converts atmospheric nitrogen into forms which are accessible to plants. The mining, processing and transportation of phosphate (for phosphorus fertilisers) and potash (for potassium fertilisers) are also energy intensive and dependent on fossil fuels.

Additionally, emissions produced during the application of chemical fertilisers to fields made up 14 per cent of total agricultural emissions in 2012, and are the fastest growing source of emissions in the agricultural sector, rising 45 per cent since 2001 (FAO 2015c). Nitrogen in the form of volatile compounds such as ammonia (NH_3) and nitrogen oxides (NO and NO_2) is lost in the process of applying nitrogenous fertilisers (Smil 2001). Nitrous oxide is 300 times more potent as a greenhouse gas than carbon dioxide (EPA 2016).

The role of diversified agroecological systems

Given the energy intensity of fertiliser production and its atmospheric losses during application, greenhouse gas emissions from agriculture could be reduced if a portion of chemical fertilisers were replaced by organic sources. In addition, chemical fertilisers can only supply nutrients – they cannot supply organic matter to the soil. For that reason, composts, manures, crop residues and other organic materials are needed in combination with the use of chemical fertilisers.

In order to curtail greenhouse gas emissions, pollution and soil degradation while promoting sustainable practices, a fundamentally different model of agriculture is required, one which the recent report from the International Panel of Experts on Sustainable Food Systems terms "diversified agroecological systems" (IPES-Food 2016).[4] Such systems are based upon "diversifying farms and farming landscapes, replacing chemical inputs, optimizing biodiversity and stimulating interactions between different species, as part of holistic strategies to build long-term fertility, healthy agro-ecosystems and secure livelihoods" (IPES-Food 2016: 3). There is a growing body of evidence demonstrating that these systems can sequester carbon in the soil, conserve biodiversity, enhance soil fertility and generate high yields, while securing the livelihoods of farmers (Box 1.1).

[3] This is not the case in sub-Saharan Africa, where chemical fertiliser applications are very low – 8–12 kg/ha/yr on average (Charles 2013; Sommer et al 2013).
[4] Agroecology has been defined by Altieri (1995) as "the application of ecological concepts and principles to the design and management of sustainable agro-ecosystems." See also Silici (2014).

BOX 1.1 THE POTENTIAL OF AGROECOLOGICAL FARMING: SOME EXAMPLES

A 30-year study of a corn and soybean rotation in the US found that organic and conventional systems had equivalent yields, and that organic yields outperformed conventional ones in drought years (Rodale Institute, 2015). The study also found that organic plots sequestered more carbon and enhanced soil health better than conventional plots. Another study, using a global data set of 293 comparisons of organic and conventional production, found that organic yields were 8 per cent lower on average than conventional yields in developed countries, but were up to 80 per cent higher in developing countries (Badgley et al. 2007). The study also argues that "data from temperate and tropical agroecosystems suggest that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertiliser currently in use" (Badgley et al. 2007: 86)

Towards agroecological approaches to maintaining soil fertility in South Asia

High population growth, loss of arable land, climate change, as well as widespread soil impoverishment all present challenges to food production across South Asia. The agriculture sector in lowland South Asia has been transformed by the Green Revolution – a package of high-yielding varieties, irrigation (where possible), fertiliser and pesticides. The sector is increasingly mechanised and continues to be a heavy user of external inputs. The use of Green Revolution approaches led to major increases in productivity, which lowered food prices and enabled food production in South Asian countries and elsewhere to keep pace with rapid population growth.[5] While this is a major achievement and has been vital to ensuring food security, there have been many adverse consequences of high external input farming practices in the region.[6]

Soils in many intensively farmed areas of Bangladesh and Nepal are suffering from the loss of organic matter. The organic matter content of soils is now less than 2 per cent in many areas – and in some areas below 1 per cent (SRDI 2016; MoAD 2014), whereas it should ideally be between 4–5 per cent. This is due to continuous removal of crop biomass, the overall reduction of crop residues in improved cereal varieties, changes in cropping practices, and continuous applications of chemical fertilisers without commensurate additions of compost and other organic fertilisers. Lack of soil organic matter affects water retention and microbial activity, with knock-on effects for the ability to withstand drought and climate change and the ability of soil to provide nutrients to plants.

One solution to this problem is to improve soil fertility through greater applications of compost, manure and other organic fertilisers. However, organic matter in rural areas is in increasingly short supply. Mechanisation has replaced draught animals with tractors, and crop residues are often diverted for use as fuel and fodder. Moreover, powerful commercial interests promoting agrochemicals, and a prevailing mindset geared towards maximising yields through the use of external inputs, tend to drive government policy, technological innovation and agricultural investment in the region. As a result of all these trends, not enough organic matter is making it back to the fields to sustain healthy soils.

This study therefore aims to contribute to the promotion and upscaling of agroecological practices through improving the availability and use of organic matter in rural areas in South Asia. Rather than advocate for a wholesale transition to organic farming, this study proposes a more feasible strategy involving augmenting the availability of organic fertilisers, which farmers can use in combination with chemical fertilisers as needed. Ensuring greater availability of organic fertilisers and promoting the incorporation of agroecological farming practices – such as nitrogen fixing crops and crop rotations which increase soil fertility – should help to reduce dependency on chemical fertilisers where there is overuse, as well as reverse declining soil quality where there is mining of nutrients and organic matter.

[5] Between 1950 and 1990, grain harvests around the world increased by an average of 2.1 per cent per year, nearly tripling grain yields during that period. This was largely due to the introduction of hybrid wheat and rice, combined with chemical fertiliser applications (Mann 1997). In Asia alone, grain production doubled between 1970 and 1975, even as the total amount of land devoted to growing grain rose by only 4 per cent (IFPRI 2002). However, gains in productivity varied significantly between crops and regions. In real terms, food prices fell 40 per cent between 1965 and 2000, largely due to increased productivity from the Green Revolution. In its absence, crop prices would have been 35 to 66 per cent higher than they actually were (Evenson and Gollin 2003).

[6] The Green Revolution had serious unintended consequences, including for diets and crop diversity in the developing world. The shift away from traditional mixed cropping systems towards cereal monocultures has had the effect of limiting food-crop diversity and appears to be contributing to micronutrient deficiencies (Welch and Graham 1999; Welch and Graham, 2013). The Green Revolution has also led to widespread environmental degradation, including pollution of soil, vegetation and water bodies. Heavy applications of chemical fertilisers and pesticides have killed beneficial insect populations and other wildlife, poisoned agricultural workers, polluted surface and ground water and contributed to declining soil organic matter levels. Irrigation practices have led to salinisation of croplands (IFPRI 2002; Singh 2000). For a detailed account of the negative impacts of the Green Revolution, see Shiva (1989).

Even if it were agronomically possible to significantly reduce the use of chemical fertilisers in South Asian countries while maintaining current yield levels, it is unlikely to be politically feasible at the present time. Governments in the region are highly sensitive to any moves which could threaten food security and thereby undermine political stability. In addition, the political power of the chemical fertiliser lobbies means that governments are advised by agricultural technologists and policymakers whose conventional agriculture mindset has locked them into 'Green Revolution' style strategies to ensure high yields. Similarly, investors and fertiliser manufacturers are committed to the production and delivery of chemical fertilisers, an industry upon which many agribusinesses and jobs depend.

There are several options available to farmers to increase their applications of organic matter to the soil. The first involves self-reliance, whereby farmers use organic materials available on the farm – such as manure – or incorporate agroecological farming practices which augment soil fertility – such as planting nitrogen fixing legumes, conservation agriculture, crop rotations, cover crops, green manures and fallowing. In fact, many farmers are already using some of these practices – but there is considerable scope for improvement, e.g. more efficient and nutrient-preserving methods of composting, better crop rotations, etc. Self-reliance decreases farmers' dependence on expensive external inputs, which in turn can reduce their reliance on local vendors and moneylenders (De Schutter 2011). In addition, farmers often collect organic matter (dry leaves, dung) from common property land: this is happening both in Asia and Africa. There are also arrangements whereby farmers agree with herders to leave their livestock in the fields overnight to graze on residues and thereby leave droppings on the land.

The second option is for farmers to purchase organic fertilisers from formal and informal markets.

While this is not a substitute for practices like crop rotations, which are cheaper and are vital for maintaining soil fertility over time, given current shortages of organic matter in rural areas, farmers may need to purchase some organic fertilisers for use in their fields, for instance from other villagers who are producing vermi-compost (see Box 2.1 in Chapter 2) or as bags of commercially produced organic fertiliser. However, these two options are not mutually exclusive, and farmers can pursue both simultaneously. In fact, both are necessary. While this paper covers both options, it places particular emphasis on the second through its focus on organic matter value chains.

Collaboration and action research to improve soil fertility

This paper describes recent initiatives in Bangladesh and Nepal to halt declining soil fertility and promote sustainable agricultural practices by upscaling the use of organic matter. The initiatives focus on promoting organic matter value chains (Box 1.2), and use action research to engage with policy and the private sector. This approach offers the potential to scale up more inclusive and sustainable agriculture in a context in which more radical approaches – such as a wholesale transition to organic agriculture – are not acceptable to governments concerned about food security and maintaining the stability of national food production.

Collaboration can address issues in the organic fertiliser sub-sector and achieve actions beyond the reach of individual actors or interventions. Greater use of organic fertiliser and/or other methods of improving soil fertility require coordinated action at many levels, such as:

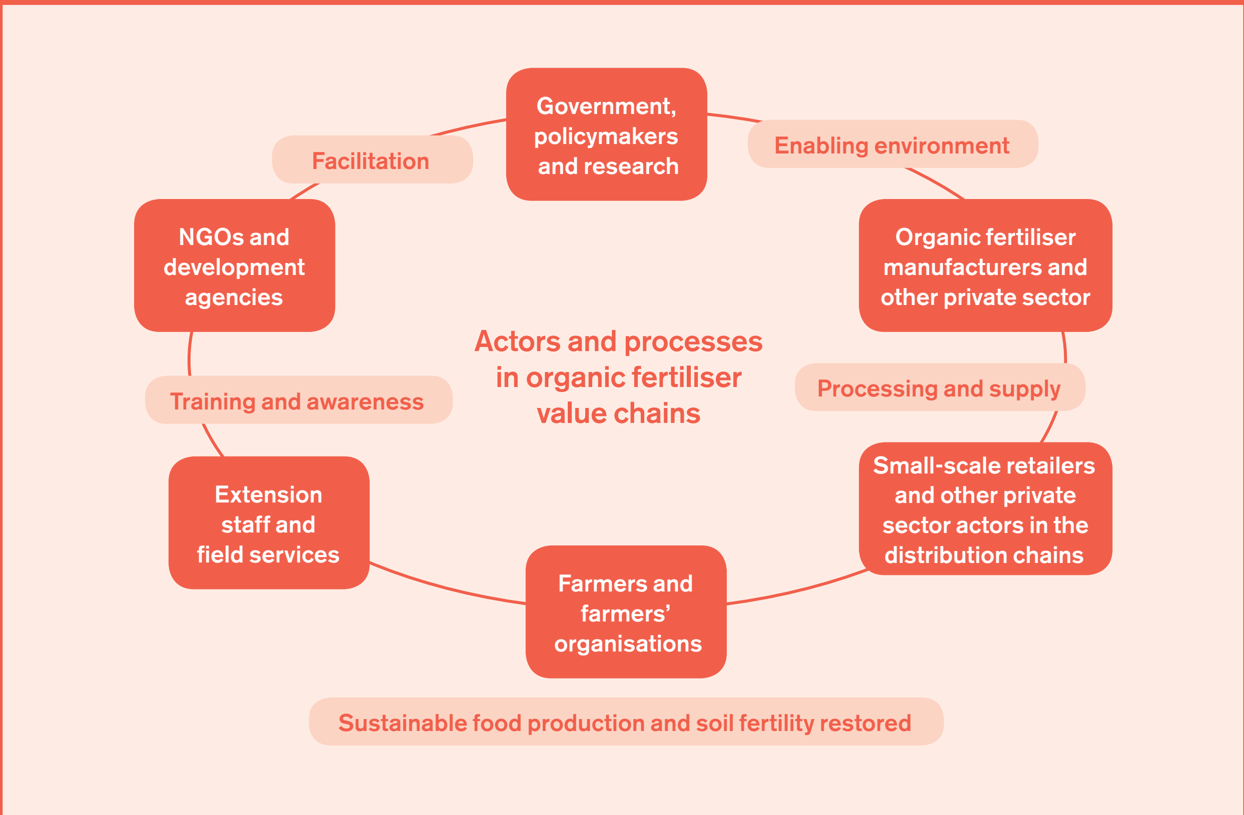
- with farmers and their communities to understand their constraints and build capacity to produce their own compost
- with policymakers to ensure an enabling environment for investors, manufacturers, traders and farmers
- with investors and manufacturers to develop the supply side of the sub-sector, including agro-dealers and providers of knowledge and advice.

With this need in mind, the action research helped to establish collaborative mechanisms to drive innovation and coordinated action in both countries. These collaborative mechanisms involved a series of multi-stakeholder platforms combined with action planning and implementation of a common agenda. These were far more than just a discussion platform, instead requiring sustained engagement by key partners and stakeholders (listed in Appendix 1 and 2).

BOX 1.2 WHAT IS AN 'ORGANIC FERTILISER VALUE CHAIN'?

An organic fertiliser value chain is the full range of activities involved in converting waste (kitchen waste, municipal waste), farm yard manure, crop residues, and other organic materials from their raw state to a form of fertiliser that can be safely used in food production, and adding value to it in the process. It includes collection, processing, sale, transport, use and awareness raising by the multiple actors involved in each 'link of the chain' (Figure 1.1).

Figure 1.1 The role of different actors and processes in organic fertiliser value chains



Practical Action's work on collaborative mechanisms pertaining to soil fertility and organic fertiliser in Bangladesh began in 2014 and built upon a longer history of engagement with government and the private sector on these issues. Previous work included stakeholder mapping, the production of several consultancy reports (e.g. Hasan et al. 2016; Islam 2014; Practical Action 2015a; Practical Action 2015b), focus group discussions with farmers and other stakeholders, key informant interviews and market surveys. This work reviewed government policies on this sector, documented the status of the organic fertiliser market and types of fertilisers being produced, analysed companies' business models in the organic fertiliser sub-sector to shed light on what is working well and what is not, and examined current management systems for organic waste in urban areas (Box 1.3). Its aims were to: 1) understand organic fertiliser value chains; 2) to engage with the key actors involved in these value chains to learn about their views and constraints; 3) to educate policymakers, farmers and other key stakeholders in the importance of organic matter for soil health; and 4) to lobby these stakeholders to take action to address the problem of declining soil fertility. Practical Action Bangladesh has also been instrumental in establishing several waste-to-compost plants in different parts of the country (described in Chapter 2).

BOX 1.3 URBAN WASTE – A RICH RESOURCE

One key question underlying this study is where the organic matter to produce fertiliser will come from. In light of the shortages in rural areas, making use of urban organic waste is an attractive option, as it can address several problems at once. The production of urban organic waste in South Asian countries has grown significantly in tandem with urbanisation and economic development. In fact, the management of municipal solid wastes remains one of the most neglected areas of urban development in many developing countries. In Bangladesh, municipalities generate approximately 13,000 tons of waste a day and spend about 10–15 per cent of their budget on solid waste management (Practical Action 2015a). Despite such heavy expenditures, waste continues to pose a threat to public health and environmental quality in general.

Some 60–70 per cent of waste produced in urban areas in Bangladesh is organic, while the rest is inorganic.[7] While markets (mostly informal) exist for inorganic waste, this is not the case for organic waste. Considering the large amounts of organic waste that are generated, there is clear potential to use these materials for productive purposes, such as energy generation or for reuse and recycling. Organic waste can be composted and turned into fertilisers for agricultural production, and can help to compensate for shortages of organic materials in rural areas. The conversion of urban organic waste into fertiliser is one of the strategies described in this report that is being used to address problems of soil fertility in rural areas of Bangladesh and Nepal.

Practical Action's work in Nepal on soil fertility and organic fertiliser has been more recent, and has benefitted from regular exchange with the Bangladesh office of Practical Action. Engaging with the Department of Agriculture, Practical Action Nepal conducted a market system analysis of organic fertiliser, which included a detailed policy review (Practical Action 2016). Key actors in organic fertiliser value chains were mapped and their roles and functions analysed. Furthermore, a household survey was conducted in two districts – Chitwan and Kathmandu – which revealed that farmers have more confidence in the quality of available chemical fertilisers than organic fertilisers. A cost-benefit analysis of chemical and organic fertiliser showed that using a combination of the two kinds of fertilisers is profitable for farmers. Meanwhile, the private sector is increasingly engaged in the organic fertiliser sub-sector in Nepal. The issue of soil fertility has received attention by policymakers and has been reflected in national plans and policies.

More recent research and action undertaken with the support of IIED involved gathering existing information on soil conditions and trends in each country, holding a series of multi-stakeholder meetings at regional and national level, developing and executing action plans along with stakeholders, and producing several videos. This work is described in more detail in the chapters on Bangladesh and Nepal that follow.

[7] Interview, Uttam Kumar Saha, Head, Energy and Urban Services Programme, Practical Action Bangladesh, 6 June 2016.

2

Bangladesh: strengthening the links in the soil fertility value chain[8]

Soils in many parts of Bangladesh are suffering from low levels of organic matter, and a legacy of intensive agriculture without adequate additions of organic fertiliser and other practices which return organic matter to the soil. At the same time, the policy environment is not favourable to the production of organic fertilisers. Recent collaborative efforts have raised awareness of the problem and are piloting solutions, albeit on a small scale.

Bangladesh is a largely agrarian nation of approximately 160 million people. It has one of the highest population densities in the world – with 1,287 people per square kilometre[9] – which presents major challenges. About 47 per cent of the population are employed in agriculture and 76 per cent live in rural areas. Agriculture accounts for 19 per cent of country's GDP (Bangladesh Finance Bureau 2014). The country has 8.75 million ha of arable land, nearly all of which has been brought under intensive cultivation (SRDI 2016).

Bangladesh has a tropical climate which receives an average of 2,320 mm of rainfall annually, varying from 1,110 mm in the northwest to 5,690 in the northeast. Most of the precipitation occurs during the monsoon, and natural disasters such as floods, droughts and cyclones are common. On the whole though, natural conditions are favourable for crop production. Some 33 per cent of arable land is single cropped, 45 per cent is double cropped and 11.5 per cent is triple cropped.[10] The main crops are rice and jute, although wheat is

[8] As there is very little published material on the topics covered in this chapter, most of the material in this chapter was drawn from consultants' reports and project documents produced by or commissioned for Practical Action Bangladesh (e.g. Hasan et al. 2016; Islam 2014; Practical Action 2015a; Practical Action 2015b; SRDI 2016) and interviews conducted in June 2016 with farmers, NGO workers, officials from the Soil Resource Development Institute and the Department of Agricultural Extension of the Ministry of Agriculture, as well as staff of Practical Action Bangladesh.
[9] http://data.worldbank.org/indicator/EN.POP.DNST
[10] Information from FAO AQUASTAT: www.fao.org/nr/water/aquastat/countries_regions/bgd/index.stm

growing in importance. Tea is grown in the northeast part of the country. Other important crops include potatoes, sweet potatoes, oilseeds, vegetables, sugarcane, and fruits such as mango, banana, jackfruit and pineapple.[11]

Prior to the 1950s, agriculture in Bangladesh was entirely organic. Farmers applied organic manures such as cow dung, bone meal, mustard oil cake and fishmeal to their rice fields and vegetable crops to maintain soil fertility. In 1965, the government embarked upon a 'Grow More Food' campaign designed to alleviate the country's food shortages. Chemical fertilisers and low lift pumps were provided to farmers at highly subsidised rates, along with pesticides. With the introduction of high-yielding rice varieties, use of chemical fertilisers began to increase rapidly. By the 2013–14 fiscal year, total use of chemical fertiliser amounted to 3.9 million tonnes, 72 per cent higher than in the 1992–93 fiscal year. Although conventional agricultural production prevails for most of the country's field crops like rice and jute, vegetables and other crops grown adjacent to people's homes are often organic (Musa et al. 2015).

Soil fertility status

The fertility status of soils in Bangladesh is extremely variable, reflecting the country's diversity of natural environments: there are 30 different agro-ecological zones with distinct soil and hydrological characteristics. However, loss of soil fertility is a problem in many parts of the country. A recent study by the Soil Resource Development Institute found that nearly all soils in Bangladesh are deficient in nitrogen and deficiencies of phosphorus, potassium, sulphur, calcium, magnesium, zinc and boron have been observed in many areas as well (SRDI 2016).

In terms of soil organic matter, the picture is varied but not healthy on the whole. In general, soils at lower elevations contain more organic matter than soils at higher elevations. Low-lying soils remain under water for a considerable period of time during the year and receive silt deposition. These conditions do not favour the decomposition of organic matter and as a consequence organic matter accumulates. Moreover, the growth of aquatic plants adds organic matter to these soils.

Overall though the organic matter content of soils in Bangladesh is poor. Soil organic matter content is less than 1.7 per cent on about 3.64 million ha or 42 per cent of the total cropland area, whereas it should be 3 per cent or higher to maintain soil health and agricultural productivity (Figure 2.1). In some areas it is less than 1 per cent (BARC 2012; SRDI 2016).

The low reserves of organic matter and plant nutrients in Bangladesh's soils can be explained by increasing cropping intensity, the high rates of organic matter decomposition that prevail in hot and humid climates, declining applications of animal manure and little or no use of green manures. Soil disturbance by tillage in intensive cropping systems also leads to accelerated loss of organic matter (SRDI 2016).

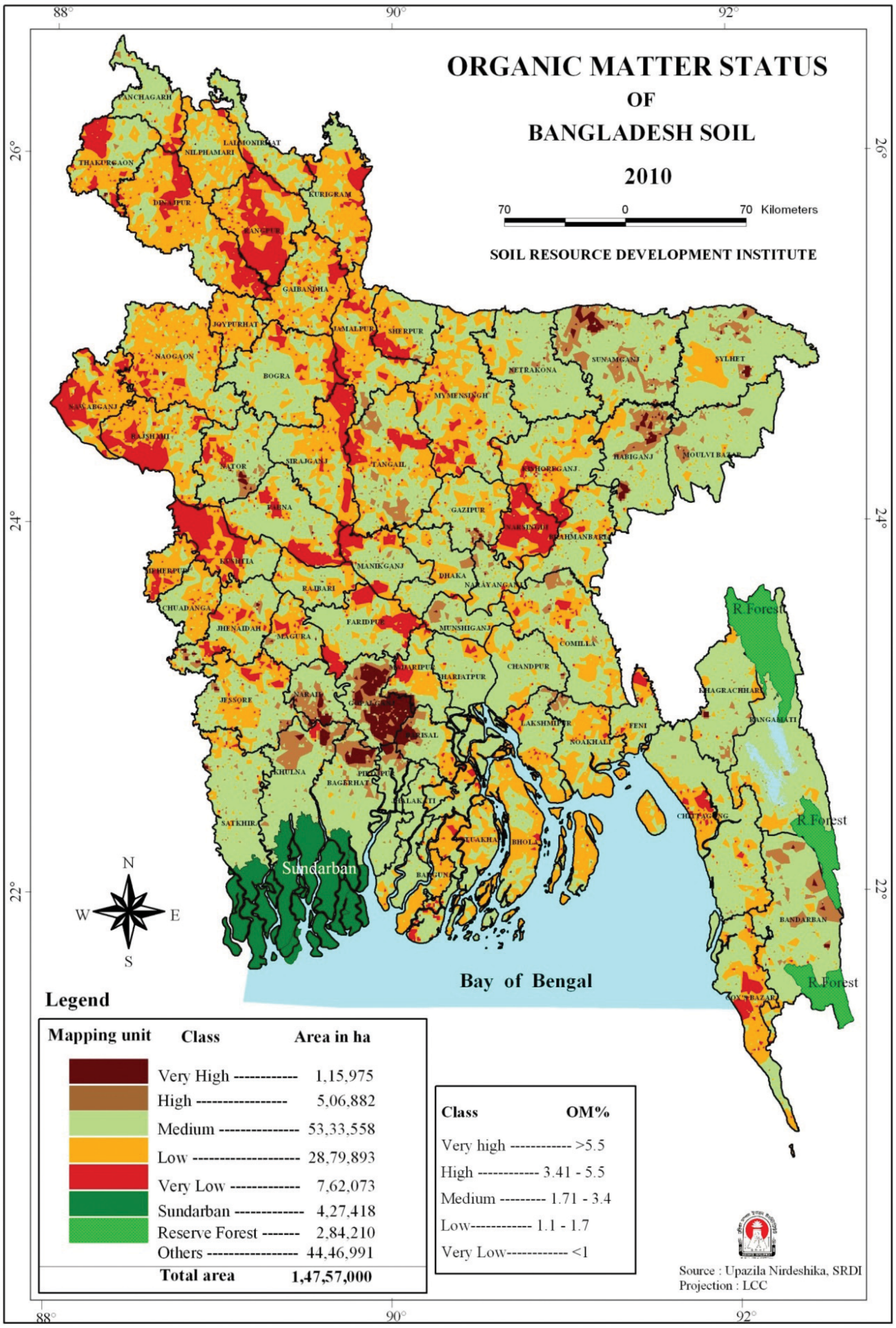
With the increasing prevalence of chemical fertilisers and pesticides, additions of organic matter to soils have declined significantly, and farmers (especially commercial farmers) in Bangladesh do not normally combine chemical fertilisers with organic fertilisers. This has had deleterious impacts on the health and fertility of the country's soils. While reliable data on this are lacking, declining levels of soil organic matter may already be affecting agricultural productivity. According to Mondal (2010), a Ministry of Agriculture task force found that crop productivity over the past several decades had either stagnated or declined, in spite of the fact that chemical fertiliser use increased nearly three-fold in that period.

Part of the issue is that organic fertilisers are often not being considered as an option in field crop farming systems. Another aspect to the problem is the shortage of biomass in rural areas. Biomass is in high demand in all its forms – cow dung, rice straw, palm fronds, jute sticks, timber, etc. – with most of it used for fuel and fodder. Virtually nothing is wasted, unlike in urban areas. The problem is that not enough biomass is making it back to the fields to replenish their fertility.

The availability of biomass in rural areas has declined over time for several reasons.[12] First, high-yielding varieties of rice and wheat produce less crop residues than traditional varieties. Second, farmers contend that there are fewer animals in rural areas now.[13] In the past, cattle were used for ploughing. Today cows are only used for milk and meat while tractors are used for farm work. Farmers do leave some rice straw and other crop residues in the fields, but not as much as in the past. As the intensity of agriculture has increased, three crops are being produced in the same field every year, compared to only two in the past. This means that the stubble does not have time to decompose and be absorbed into the soil. Moreover, farmers depend on crop residues as their primary source of fodder and fuel (for which demand has increased due to population

[11] Information from Wikipedia: https://en.wikipedia.org/wiki/Agriculture_in_Bangladesh
[12] Research is needed to quantify the scarcity of biomass in rural areas, as data are currently lacking.
[13] In our visits to rural areas as well as in farmer group meetings organised by Practical Action, farmers pointed out that there are fewer animals being raised at the household level than in the past. At the same time, the dairy and poultry industries have grown rapidly, so it is unclear whether absolute numbers of animals in rural areas have declined, or simply become more concentrated.

Figure 2.1 Organic matter status of soils in Bangladesh



Source: Soil Resource Development Institute.

growth), so they are not in a position to return many residues to the fields. Rice straw is the main fodder for cattle; it is mixed with rice husks, water and other materials. In the northeast, farmers tend to leave more rice stubble in the fields, so organic matter is less of a problem.

The scarcity of cow dung and crop residues has forced farmers to look elsewhere for fertilisers. In subsistence production, farmers tend to use their own compost and organic fertiliser. In commercial horticulture production, farmers already tend to buy more organic fertiliser than in rice farming and other types of production.

How to get greater amounts of organic matter into field crop production is a key question. Backyard production may be less problematic, because farmers appear to be applying more organic matter to those plots near their houses where they grow high value crops like vegetables and betel leaf. But there is less application of organic fertiliser to crops like rice and jute.

Urban waste: a rich potential source of organic matter

While organic matter in rural areas is fully used and recycled, the opposite is true in urban areas. Urban waste is a huge and growing problem in Bangladesh and the government is only beginning to come to terms with it. According to Practical Action Bangladesh, some 20,000 metric tonnes of urban waste are produced each day nationwide. Approximately 60–70 per cent of waste produced in urban areas is organic, while the rest is inorganic.[14]

Product markets exist for recycled paper (different types), scrap metal, batteries, plastics (different types – cans, bottles, thin, thick), cottons, leather, human hair, animal bones and fish bones. Waste pickers and street vendors sell to retailers, who in turn add value by collecting, compacting and transporting to wholesalers. Then wholesalers sell to different industries like paper, plastics, metals, etc.

Waste is generally not separated by type in Bangladesh and most organic waste ends up in landfills. Kitchen waste separation efforts have not worked well to date, although there are some small-scale collection efforts and kitchen waste could potentially provide a rich source of raw material for compost production (see Box 2.1). Vegetable markets provide another good potential source of organic matter, as do cotton seed and sugar cane waste. However, these latter two types of waste are seasonal. Other potential sources of organic waste include water hyacinth, poultry litter and slaughterhouse residues. Sewage in Bangladesh is mostly dumped into waterways. Only 25–30 per cent of the population in Dhaka have access to sewage treatment plants. The rest of the country depends entirely on site-based sewage disposal systems.[15]

Practical Action operates four kitchen waste composting plants in Bangladesh, with three more in the pipeline. They also run two sewage treatment plants, one in Satkhira and another in Faridpur. Organic fertiliser is produced from the faecal sludge. Cultural stigmas surrounding contact with human waste and concerns about food safety are an obstacle to the marketing of fertiliser produced from faecal sludge, however. The Dutch agency Ruaf is working with Practical Action to support the use of treated sludge in agriculture. Whether based on kitchen waste or faecal sludge, these plants are run as examples and demonstrations that will eventually be spun off to the municipalities or other entities.[16]

Organic fertiliser

According to the government of Bangladesh, "organic fertiliser means the fertiliser which is collected from decomposed, processed or transformed organic materials."[17] There are a number of different types of organic fertilisers in use in Bangladesh, which can be categorised into four main types:

1) **Bulky organic fertilisers:** are composed of bulky materials which tend to have low concentrations of nutrients. These fertilisers are made from raw materials such cow dung, poultry litter, kitchen waste, vegetable waste from markets, crop residues, industrial wastes like cotton seed and sugar cane, bioslurry and faecal sludge. Vermi-compost (Box 2.1) is an example of bulky organic fertiliser.
2) **Green manure:** this is the practice of ploughing under or burying green plant material in the soil in order to improve its physical, chemical and biological characteristics. It has been used by farmers for millennia. The most common green manure crops in Bangladesh are Sesbania, sun hemp and cowpea.
3) **Concentrated organic fertilisers:** are produced from raw materials of plant and animal origin such as oil cakes (mustard oil cakes, sesame oil cakes, groundnut oil cakes, linseed oil cakes), fish meal, blood meal, bone meal, as well as horn and hoof meal. These fertilisers have higher concentrations of essential plant nutrients such as nitrogen, phosphorus and potassium than bulky organic fertilisers.
4) **Nutrient-enriched/organo-chemical fertilisers:** are organic fertilisers which have been enriched with macronutrients such as nitrogen, phosphorus, potassium and sulphur and in some cases micronutrients. Different grades of nutrient-enriched organic fertilisers are produced by companies in Bangladesh such as Northern Agro Ltd. and Faruq Fertilisers Ltd.

This chapter focuses on bulky organic fertiliser, as it is by far the most common type available in Bangladesh.

[14] Interview, Uttam Kumar Saha, Head, Energy and Urban Services Programme, Practical Action Bangladesh, 6 June 2016.
[15] Interview, Uttam Kumar Saha, Head, Energy and Urban Services Programme, Practical Action Bangladesh, 6 June 2016.
[16] See the example later in this chapter of the WORD plant in Faridpur, which was originally established by Practical Action and later handed over to other stakeholders to operate.
[17] Ordinance No 07, 2008. Revision of The Fertiliser Management Act, 2006 (Regulation No 6 of 2006).

BOX 2.1 VERMI-COMPOST IN BANGLADESH

Vermi-compost is a common form of organic fertiliser in rural areas of Bangladesh – promoted by NGOs and government agencies – which is produced from the excreta of earthworms. Cow dung is the principal raw material for vermi-compost; other materials such as banana leaves, neem leaves and kitchen waste are also used. In Bangladesh it is most commonly made in cement rings, earthen pots or other containers of varying sizes (40–150 kg). It can also be made in covered heaps or long beds (ridges).

There are no reliable data on the number of farmers who are producing vermi-compost in Bangladesh. Preliminary fieldwork in Faridpur indicates that most vermi-compost producers make it on a small scale using 1 or 2 pots or cement rings which are 90 cm in diameter and 30 cm in height.

There are some larger scale village businesses producing vermi-compost to sell to other farmers, but these are relatively small in number. Most farmers who produce vermi-compost see the benefits in their fields and become vocal advocates of the technology (at least in the villages we visited).

Farmers tend to prioritise the use of vermi-compost on their own land – rather than leased land – and particularly on the land adjacent to their courtyards. They also prioritise its use for horticulture and high-value products, such as betel leaves and vegetables. This implies that farmers value vermi-compost, and have seen and understood its benefits.

One farmer we visited is producing vermi-compost on a large scale, using at least 20 cement rings. It normally takes 30–45 days for vermi-compost to mature. He claimed that through his experience, he is able to produce good compost after only 30 days. He uses it on all his fields, including rice and jute, rather than just on courtyard vegetables. His example shows that vermi-compost can be produced on a somewhat larger scale. However, availability of cow dung is often the key limitation to the amount of vermi-compost farmers can produce, as cow dung is also sought after for fuel, and farmers have fewer cows than in the past.

The policy environment for organic fertilisers

Policymakers in Bangladesh generally understand the necessity of using organic fertilisers and compost to improve soil health, but they have not yet put in place the policies needed to promote this on a large scale. Chemical fertilisers are sold at highly subsidised rates in order to increase food production, ensure affordable prices for rice and maintain national food security and social stability. Over the last five or six years government expenditure on chemical fertiliser (urea and non-urea) has been significant – in 2014–15 it consumed nearly USD 910 million, which was equivalent to 70 per cent of the agricultural budget (over 1.5 per cent of the national budget). In 2012–13 the expenditure exceeded USD 1.5 billion (Appendix 3).

Organic fertilisers have to compete in the market with these highly subsidised chemical fertilisers with a well-developed supply chain. Thus there is an uneven playing field favouring chemical fertilisers, which reflects the political-economic power of the chemical fertiliser lobby, as well as the Green Revolution orientation of policymakers, academics and agricultural extension workers.

Another key reason for the favoured treatment of chemical fertilisers is the government's overriding concern to ensure food security. As a Scientific Officer for the Soil Resource Development Institute put it, "our policy people understand the importance of organic matter. The question is how to augment it. In our country, food security is key. About 70 per cent of the land receives seasonal inundation. Farmers can only grow rice on this land, or perhaps jute. Government will not take much risk, because grain is food security, grain is politics."[18]

The 7th Five-Year Plan (2015–2020) places an emphasis on sustainable agricultural growth, highlighting the need for increases in the productivity and incomes of farmers. At the same time, the government is interested in meeting the global Sustainable Development Goal targets, including sustainable food production systems and resilient agricultural practices that can improve land and soil quality. There is ongoing discussion concerning the draft Organic Agriculture Policy at ministerial level (Ministry of Agriculture). This draft policy broadly covers organic agriculture, including organic fertiliser.

[18] Interview, Scientific Officer, Soil Resource Development Institute, Dhaka, 7 June 2016.

Fertiliser in general has been regulated in Bangladesh since The Fertiliser (Control) Order, 1995, which has been revised twice, and which became The Fertiliser (Management) Act in 2006. There was no specific policy or regulation for organic fertiliser in Bangladesh until 2nd April 2008, when the government published a gazette notification as per Section 7 of The Fertiliser (Management) Act, 2006. In this notification the government specified the physical and chemical standards for organic fertilisers. These rules specify that organic fertilisers should be produced from organic materials, and should not contain plastic, toxic materials, medical waste, etc. They also state that the source materials used in the production process should be clearly stated in the application form; and they prohibit imports of organic fertiliser from abroad.

The Department of Agricultural Extension is responsible for the registration of fertilisers in Bangladesh, according to procedures specified in The Fertiliser Management Act of 2006. Producers and retailers have to list the registration number and nutrient content on the bags of the fertilisers they sell. The registration and licensing process for organic fertilisers is complicated and expensive. Companies seeking a licence to produce organic fertiliser are required to own a lab facility costing at least BDT 10 million (USD 123,000), which is clearly prohibitive for most enterprises. The licensing process also requires three field trials, which means that the process takes at least two years and longer in some cases,[19] causing companies to lose interest in their production. By contrast, obtaining a full or temporary licence to manufacture and sell organic fertiliser takes only 40 days in the Philippines, 45 days in India, and 60 days in Thailand. In fact, licensing is the single biggest constraint to the development of the organic fertiliser industry in Bangladesh.

Adulteration is another common problem in Bangladesh for both organic and chemical fertilisers.[20] The fact that farmers are often distrustful of the efficacy of organic fertilisers is partly a result of bad experiences with adulterated fertilisers. Contamination by pollutants like heavy metals is another issue. As mentioned above, there are government standards for the quality of organic fertiliser, but these have not been able to prevent problems of adulteration and contamination, which in turn indicates the need for greater efforts in quality control.

Value chains for organic fertiliser

Organic fertiliser is a neglected and underdeveloped sub-sector in Bangladesh. There is a lack of reliable data on the total production and value of the organic fertiliser sub-sector, as the government does not keep track of this information, unlike for chemical fertiliser. There is also a lack of data on applications of organic fertilisers and compost by farmers.

There are two types of marketing systems for organic fertiliser in Bangladesh: formal and informal. The formal system involves the sale of registered organic fertilisers, whereas the informal system centres upon home-made unregistered organic fertilisers, including vermi-compost produced for sale and household use by farmers (Box 2.1). Relatively little is known about the informal system, but it is assumed to be larger than the formal one.

The actors involved in formal organic fertiliser value chains are producers of organic fertiliser, dealers/sub-dealers, retailers, farmers and consumers (Practical Action 2015a):

- **Producers:** There are approximately 50 companies in Bangladesh that have obtained a licence to produce organic fertiliser; however, Practical Action estimates that only 10–15 of these companies are actively producing it.[21]
- **Dealers/sub-dealers**: There are 45,000 fertiliser dealers and sub-dealers in Bangladesh, who mainly sell chemical fertiliser, whereas there are less than 100 dealers and sub-dealers selling organic fertiliser. Dealers sell bulk quantities of fertiliser to sub-dealers or retailers. Sub-dealers sell to retailers and farmers. The commission for dealers is different for different brands of organic fertiliser and ranges between 20 to 30 per cent. The purchase price of dealers is in the range of BDT 10 to 12/kg and selling price between BDT 12 to 15/kg.
- **Farmers and consumers**: Farmers and consumers buy organic fertiliser from retailers or sub-dealers at a retail price of BDT 18 to 20/kg. Currently the main buyers of organic fertiliser are vegetable farmers, flower farmers, betel leaf farmers, nurseries and potato farmers.

[19] In the case of Mati Organics (see Table 2.1), the company applied for a licence to produce their organic fertiliser Biozem in April 2011 and got approval in December 2013 – a total of two years and eight months.
[20] According to The Fertiliser (Management) Act, 2006 subsection 17(2) a fertiliser is considered to be adulterated if:
i) it does not adhere to standard specifications
ii) laboratory tests reveal that there are toxic materials present in the fertiliser in amounts that are harmful to plants, animals and the environment if used according to the instructions in the label
iii) precautionary measures about the harmful effects of the fertilisers are not mentioned on the label
iv) the fertiliser is produced using substandard materials or otherwise produced in a different way, and
v) the fertiliser contains nonessential, environmentally polluting or toxic materials.
[21] Many of the companies that have obtained a licence from the Department of Agricultural Extension to produce organic fertiliser use the licence to apply for loans. If granted, the loan money is then used for other purposes.

The organic fertiliser manufacturing sector in Bangladesh is currently quite small. Some of the best-known companies involved in producing organic fertilisers (three of which are profiled in Table 2.1) are Annapurna Agro Services, Waste Concern, Majumder Agro Services Ltd, RUSTIC, WORD, Aprokashi Khamar, M/S Ria fertiliser, Mohammadi Fertiliser, MATI Organics Limited and ESDO. Several of these companies, such as WORD and RUSTIC, are actually NGOs. A few, such as ESDO and WORD, also produce biogas.

The market for organic fertilisers remains underdeveloped due to lack of government support, low levels of demand, low and inefficient production, weak supply chains and insufficient private sector investment. The lack of a subsidy for organic fertiliser companies acts as a disincentive for manufacturers, who have to compete with highly subsidised chemical fertilisers with a very well developed supply chain. Higher prices for organic fertilisers in the absence of subsidies are also a disincentive for farmers to buy them. Partly as a result of this, the organic fertiliser sector suffers from lack of scale, which translates into higher per unit costs, making it less attractive for investment. It also leads to neglect by government officials and dealers. At the same time, stringent licensing procedures pose a significant obstacle for new/small entrepreneurs, who often lose interest in producing organic fertilisers given the long delays in obtaining a licence.

Table 2.1 Three organic fertiliser companies compared

ITEM	MAJUMDER AGRO SERVICES	MATI ORGANICS	RUSTIC
Area of operation	Comilla and its outlying regions	Gazipur, Mymensingh, Dhaka and northern districts	Khulna, Dhaka, Dinajpur
Core business	Cold storage	Fertiliser	Fertiliser
Business model	Company	Company	NGO
Full time staff	25	16	17 at production facility + 14 waste collectors
Part time/seasonal staff	150–175	–	14 in waste collection
Total annual production (MT)	500–600	3,000	500–550
Annual production capacity (MT)	10,000	10,000	1,200
Raw materials for organic fertiliser	Cow dung, poultry litter, poultry litter bio-slurry (from biogas plants), municipal household organic waste, sawdust, bone meal	Cow dung, poultry litter, bio-slurry, municipal organic wastes, kitchen wastes, water hyacinth, as well as other agricultural wastes & residues	Local municipal organic waste
Main customers for organic fertiliser	Nurseries and potato farmers	Dealers, sub-dealers, farmers (paan, potato and rice farmers)	Dealers, sub-dealers, farmers (paan, rice, and vegetable growers) households and nurseries
Obstacles	Lack of raw material separation; no household waste collection system; lack network with dealers and sub-dealers	Lack of raw material separation; availability of raw materials	Lack of raw material separation; NGO structure may hinder expansion
Assets	Good reputation of the director; potato farmers who use the company's cold storage facilities also buy their fertiliser	Good dealer distribution network; located close to Dhaka; diversified products	Demand exceeds supply for its products; good dealer network; strong connectivity with farmers; specialised product line

Source: Practical Action 2015b

Farmers lack confidence in the private companies selling organic fertiliser – often due to their experience with sub-standard or adulterated products – and tend to rely instead on the composts and fertilisers they produce themselves. However, most farmers are not producing them in sufficient quantities to cover all their land. Shortages of organic matter in rural areas further compound the problem. While urban organic waste is a potentially rich source of raw materials to produce fertilisers, viable business models linking urban waste recycling with the organic fertiliser market have yet to develop on a large scale, although there are small-scale examples such as the WORD facility discussed below. Transport costs are an important factor in this linkage, as economic viability declines with distance from purchase site to farms.

The case of WORD: an NGO and small-scale enterprise producing organic fertiliser from household waste

The case of WORD illustrates the potential for an organic fertiliser value chain in Bangladesh, albeit at a small scale. WORD (Welfare Organization for the Rural Disabled) is an NGO in Faridpur that operates a facility which produces 1.5 MT of organic fertiliser per month. The facility was established by Practical Action Bangladesh in 2007 as part of the Integrated Urban Development Project supported by the European Commission's Asia Pro Eco programme. The project was implemented in partnership with Faridpur municipality and a Faridpur-based coalition of 13 local NGOs called Society for the Urban Poor (SUP). Practical Action constructed the plant and provided technical assistance on operation and management, branding, promotion and business planning to SUP for the operation of the plant and establishment of the business. In 2009, Practical Action transferred responsibility for the plant to SUP; WORD – a SUP member organisation – agreed to operate the plant on behalf of SUP and Faridpur municipality.

The facility collects organic kitchen waste from 5,500 households in Faridpur (out of a total of 27,000 households in the city),[22] for which each household pays a fee of BDT 60 per month. WORD has 17 collectors who visit each household to collect waste six days a week. Householders were initially asked to separate their waste, but it was found that they were not used to doing this. The absence of waste separation makes the process of producing compost more cumbersome and expensive.

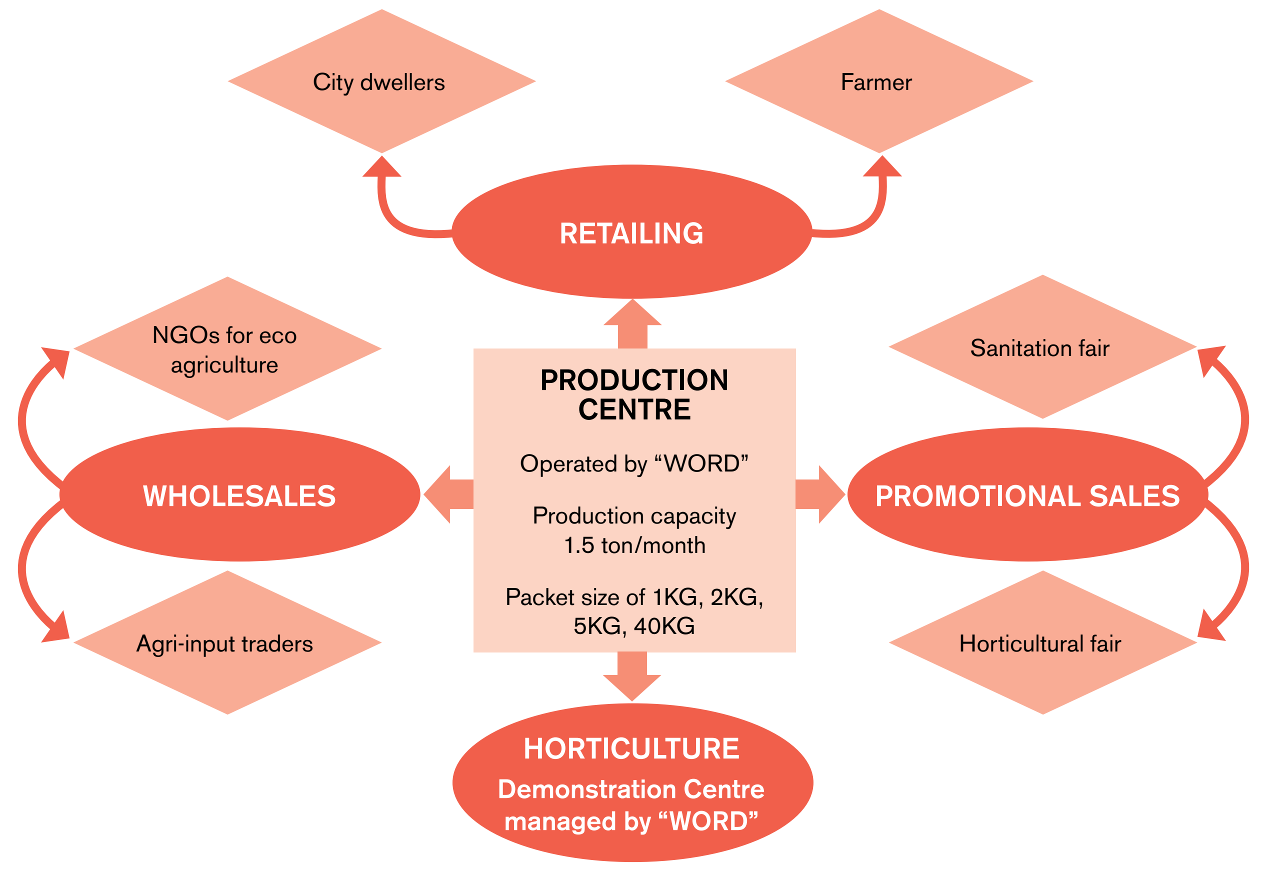
The waste is transported to the plant, where it is first sorted to remove the inorganic portions. The organic portion is used for composting and biogas, the valuable inorganic portion is collected for sale, while the small portion which cannot be used is discarded in a corner of the property. How to treat that waste which cannot be sold or composted is a problem that has yet to be resolved, as it is contaminating a nearby pond. The organic waste is composted for 45 days in one area before being sieved and transferred to another area – where it is turned and mixed – and left to sit for an additional 15 days. Trichoderma is added during the composting process to facilitate decomposition. After that, the waste is dried, mixed with sawdust and packaged for sale.

A 5kg bag of fertiliser is sold at their facility for BDT 75; dealers sell it for BDT 100. Gas from the 6.8 cubic metre biogas plant is supplied to four families who live near the facility – for which each family pays BDT 700 per month. While WORD would like to expand its plant, this has not been possible so far as the facility cannot get access to additional land. Another obstacle is that WORD does not have a licence so the fertiliser can only be sold locally. They are currently applying for a licence, but they have been advised that the approval process could take an additional 1.5 years.

WORD has identified four main avenues to promote the sale and use of its organic fertiliser: wholesale, retail, promotional sales and a horticultural demonstration centre (Figure 2.2). For wholesale marketing, it has established relationships with local agri-input dealers, nursery owners and with other NGOs who have ecological agriculture programmes. WORD sells its fertiliser at a retail price to local city dwellers and farmers who come to the plant. WORD also takes part in various promotional events such as horticulture and sanitation fairs, where it markets its fertiliser. Lastly, WORD has a horticulture demonstration centre where a variety of flowers, fruits and medicinal plants are grown using its organic fertiliser. Local people come to this centre to buy plants and fertiliser. WORD is able to run the fertiliser plant profitably through its diversified services (e.g., waste collection from households, marketing fertiliser and plants through multiple channels and sales of biogas). Although WORD's processing facility is currently small, it has a viable business model and hence provides evidence that it is possible and profitable to turn kitchen waste into organic fertiliser.

[22] Although WORD's monthly production of 1.5 tons of fertiliser may seem very small, the facility processes the organic waste of one-fifth of all households in Faridpur municipality, which is nonetheless significant.

Figure 2.2 Marketing channels used by WORD



The role of collaborative mechanisms in increasing organic fertiliser use

It was largely in response to the problems facing the organic fertiliser industry that Practical Action got involved in the sub-sector in Bangladesh. It was clear that joint action by multiple stakeholders would be necessary to remove the obstacles currently facing the sub-sector. Hence the focus of Practical Action's recent work has been on the development of collaborative mechanisms that could drive the innovation and multi-stakeholder dialogue required. This work has centred on two rural districts: Faridpur and Rajbari. In both districts, Practical Action Bangladesh initiated multi-stakeholder forums involving stakeholders representing government agencies, farmers' organisations, civil society groups, producer organisations, research bodies and private companies (Appendix 1). In both Faridpur and Rajbari, multi-stakeholder meetings have been held every two months.

The work of the multi-stakeholder forums has focused on fostering greater knowledge and awareness of organic fertiliser and compost, promoting soil testing services to correct nutrient and other imbalances in the soil (Box 2.2), removing obstacles to the smooth functioning of organic fertiliser value chains and providing an enabling environment for implementing joint action plans.

Action plans were developed in each district, with stakeholders committing to undertake specific activities. These have included: demonstration plots for organic fertiliser in farmers' fields, handouts for farmers on the recommended doses of organic fertiliser for different crops, providing soil testing services, supporting vermi-compost production by farmers, trying to ensure that organic fertilisers are made available by agro-retailers, and manufacturing compost from urban waste (see Table 2.2 for more detail).

In Faridpur, the multi-stakeholder forum has carried out work in four locations: Faridpur Sadar, Madhukhali, Sadarpur and Boalmari. In Rajbari, work has been done in three locations: Rajbari Sadar, Balikandi Upazila and Khalukhali Upazila.

As similar work was conducted in the two districts, Table 2.2 describes the work undertaken by the various stakeholders in Faridpur district as an example.

BOX 2.2 THE VALUE OF SOIL TESTING

One of the keys to encourage farmers to apply more organic matter to their soils is to raise their awareness of its importance through soil testing. Soil testing also allows farmers to apply the right types of fertiliser and compost exactly where they are needed. There are two main avenues for soil testing in Bangladesh: one is through the government-run Soil Resource Development Institute (SRDI); the other is through private companies, which are currently testing hand-held (on-farm) soil testing kits. The latter may offer a viable large-scale alternative, if their accuracy can be improved. SRDI has 16 laboratories in different districts of the country, but many of these suffer from serious shortages of manpower and thus soil testing capacity is limited. In addition it takes between two weeks and one month for SRDI to provide the report, which has an impact on farmers' cultivation plans. SRDI can only provide regular soil testing services to around 40,000 farmers annually; for a country with 15 million farm households this is quite limited (SRDI 2016). Thus there is tremendous scope to increase soil testing services for farmers. Workshops with farmers facilitated by Practical Action have found that many farmers would like to test their soils before planting but do not know how to access this service.

Table 2.2 Action by the various stakeholders in Faridpur District

STAKEHOLDER	ACTIONS TAKEN
Department of Agricultural Extension (DAE)	• Selected farmers for demonstration plots and provided technical support for agricultural production techniques, the application of organic fertiliser and the design of demonstration plots • Budget preparation for the demonstration plots along with entrepreneurs, farmers, Society Development Committee etc. • Provided licence to one entrepreneur to sell organic pesticides • Conducted four meetings (with 25 to 30 farmers each time) to create awareness of the benefits of organic fertiliser • The Deputy Commissioner of Faridpur was inspired by this initiative to set up demonstration plots to show the benefits of vermi-compost on the premises of his office
Bangladesh Agricultural Development Corporation (BADC)	• Connected two entrepreneurs with their regular seed supplier so that the entrepreneurs can keep and sell quality seeds
Soil Resource Development Institute (SRDI)	• Provided handouts to farmers on the recommended doses of organic fertiliser for different vegetable and cereal crops • A representative of SRDI joined in a DAE sponsored meeting with farmers and created awareness on the importance of soil testing • Tested soils in eight demonstration plots and compared their results with those of soil testing entrepreneurs
Bangladesh Agricultural Research Institute (BARI)	• Provided seeds for four demonstration plots
WORD (NGO and fertiliser producer)	• Making their organic fertiliser available in the entrepreneurs' outlets, so that besides providing soil testing services these entrepreneurs can also sell organic fertilisers, thereby ensuring that farmers have access to them

continues

STAKEHOLDER	ACTIONS TAKEN
Department of Livestock Services (DLS)	• Provided training on cow dung management in order to produce good quality compost
Metal Seed Company (seed supplier)	• Provided seed for two of DAE's demonstration plots free of charge • Conducted bi-weekly follow-up to monitor the progress of crops in demonstration plots • Participated in two DAE-sponsored meetings with farmers to create awareness on the importance of quality seeds
Ispahani Company (seed supplier)	• Participated in two DAE-sponsored meetings with farmers to create awareness of the importance of quality seed and organic fertiliser
Society Development Committee (SDC- MFI)	• Provided credit support of Taka 90,000 to seven entrepreneurs to purchase soil testing service kits • Also supported entrepreneurs by taking them to visit the farmers' groups to promote soil services and build their clientele
Entrepreneurs (soil testing service)	• Communicated with 40 farmers, provided soil testing service to 15 farmers and sold 300 kg of organic fertiliser to farmers • 11 entrepreneurs have developed a database of 1100 farmers, out of which 50 per cent of the farmers have expressed interest in getting soil testing services
Dutta Seed and Nursery	• Provided seeds for two demonstration plots free of charge • Conducted bi-weekly follow-up to monitor the progress of crops in demonstration plots
Faridpur business association (inputs dealer)	• This organisation provided a certificate to one entrepreneur, and participated in DAE-sponsored meetings with farmers to promote the use of organic fertiliser
Farmers	Provided land for one demonstration plot Assisted in organising other farmers for meetings Advocacy to other farmers about using organic fertiliser
Practical Action Bangladesh	Practical Action is serving as a facilitator of the collaborative mechanisms. One full time staff member is engaged.

At the national level, the collaborative mechanisms have been able to raise awareness among policymakers to the extent that almost all the relevant government departments are now talking about soil health and the importance of organic fertiliser. In the past, they were reluctant to do so, as the sole focus was on meeting the country's food security needs through agro-chemical inputs. Now the government is also starting to talk about the need to liberalise the licensing policy and to be flexible about the requirement for organic fertiliser producers to have their own laboratory.

At the local level, work in the two districts is still at an early stage and has encountered significant obstacles. For example, heavy rainfall and flash floods from June to October 2016 meant that most of the land in Faridpur and Rajbari was waterlogged. It has also been difficult to convince farmers to reduce dependency on chemical fertiliser and use organic fertiliser in the short term. Nevertheless, there are now entrepreneurs who are able to provide soil testing services as well as awareness-raising and demand generation activities. Government agencies are also supporting entrepreneurs to do soil testing and to inform farmers about the need for soil testing and use of organic fertiliser. SRDI, DAE and BARI have provided technical support to farmers through demonstration plots, and on seed selection, use and availability of organic fertiliser, and vermi-compost production, none of which was previously available.

Conclusions and recommendations

Practical Action's work in Faridpur and Rajbari districts has brought government agencies, NGOs, farmers and the private sector together to foster joint action on the problem of soil health and low soil organic matter. Work at the national level has raised awareness of the problem and the need for policy change. Nonetheless, there is still little national-level government support for organic fertilisers in Bangladesh, nor are there reliable data available on the value or annual production of the organic fertiliser industry.

Organic fertilisers are currently used more in horticultural production than in major crops like rice and jute, both because there are insufficient quantities available to cover all crops and because farmers are not yet convinced of the need to apply them in these fields. So the question is how to get more organic matter into large-scale crops like rice and jute. This is complicated by the fact that many small farmers in Bangladesh lease all or part of their land. As they may not be farming the same plot of land in the next season, there is no incentive for them to apply organic fertilisers or consider soil health. Instead, these farmers tend to over-use chemical fertilisers in order to maximise production in a given season.

The shortage of biomass in rural areas is another issue that must be addressed if soil fertility problems in Bangladesh are to be alleviated. Urban organic waste could partially address this shortage, but urban households are not currently separating their waste. The lack of waste separation makes composting more expensive, time consuming and increases the risk of contamination. Hence it is important that local governments start to require waste separation at the household level. Faecal sludge – which is currently polluting waterways – could be another raw material for organic fertiliser. However, cultural acceptance and public health concerns are major barriers to the use of faecal sludge as fertiliser. Strict measures are also needed to ensure that the pathogens present in faecal sludge are eliminated in the composting process.

Specific recommendations are as follows:

Government:

- Simplify the licensing procedures for organic fertiliser to shorten the required processing time, following the examples of neighbouring countries such as India and Thailand.
- Give incentives for commercial production of organic fertiliser by the private sector along with incentives and training for household-level production.
- Give incentives to producers of vermi-compost to encourage them to scale up production.
- Encourage decentralised production and distribution of organic fertilisers in order to reduce transport costs.
- Ensure regular monitoring by the Department for Agricultural Extension of the quality of organic fertiliser.
- Promote soil testing as a means of ensuring that farmers understand the condition of their soils and apply fertilisers according to their specific nutrient requirements.

Government, NGOs, farmers' organisations:

- Continue to conduct motivational and awareness-raising activities for farmers on the importance of soil organic matter and the need for balanced applications of chemical and organic fertilisers.
- Promote organic fertiliser use through the media (print, online and social media).
- Provide capacity building to existing producers of organic fertiliser and licence holders and support them to develop value chains for their products.

Private sector:

- Assess the demand for organic fertiliser in specific areas in order to get an accurate sense of the size of the market.

3

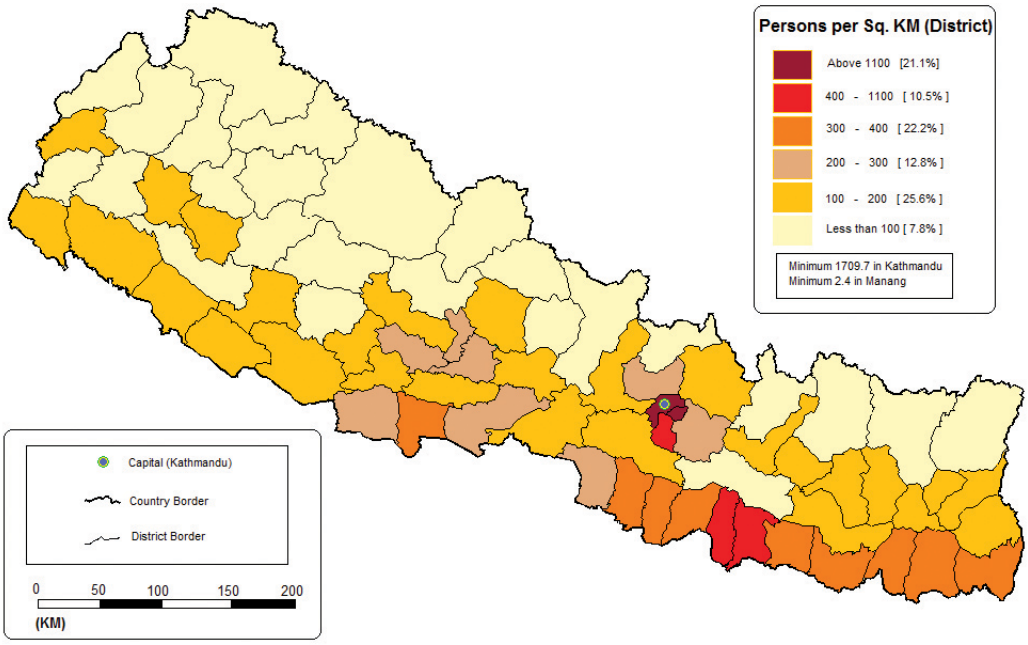
Nepal: taking an integrated approach to soil fertility

While Nepal's soils are currently low in organic matter, there is now a supportive policy environment for organic fertilisers, embodied in the vision of the 2015–2035 Agriculture Development Strategy to increase soil organic matter to 4 per cent. This chapter provides a brief review of current fertiliser policy, the licensing system for organic fertiliser, and existing value chains for organic fertiliser in Nepal. The potential for action through collaboration is discussed before concluding with suggested actions for government, NGOs, private sector actors and farmers' organisations.

Nepal is a land-locked country of approximately 26 million people, most of whom depend on agriculture for their livelihood. The population is growing at a rate of 1.42 per cent annually and is predicted to reach 31 million people by 2021, nearly 7 million of whom will live in urban areas (22.6 per cent of the total; CBS 2012). Agriculture is the mainstay of the economy (around one-third of GDP), despite the fact that only about 25 per cent of the land is cultivated. Another 33 per cent is forested and the rest is mostly mountainous. Nepal is a net importer of food. In 2010 the annual growth in agriculture was measured at 3 per cent. The government's target over the next 10 years is to increase annual agricultural growth to 5 per cent (MoAD 2014).

Nepal has the lowest agricultural productivity of all South Asian countries (ANGOC 2012). This is partly because of its vast rural hilly and mountainous areas, characterised by traditional subsistence production and low levels of commercialisation. The continuous subdivision of farms in the lowlands means that the majority of households (45 per cent) own less than 0.5 hectares (ha). Consequently, even in the most productive areas of the *terai* (the lowland region bordering India), subsistence family farms are the majority (64 per cent), and only a small proportion of these are commercial operations. Many men migrate to urban areas or abroad in search of jobs, leaving women to take care of the household and farming. Male out-migration has further affected agriculture productivity (Tamang et al. 2014).

Figure 3.1 Population density in different regions of Nepal



Source: Regmi (1991), Population density map of Nepal, https://en.wikipedia.org/wiki/File:Population_density_map_of_nepal.png

Nepal has an overall population density of 199 people per square kilometre,[23] although this varies significantly by region. Figure 3.1 shows the gradation in population density from very low in the mountains to very high in the eastern *terai* (Regmi 1991).

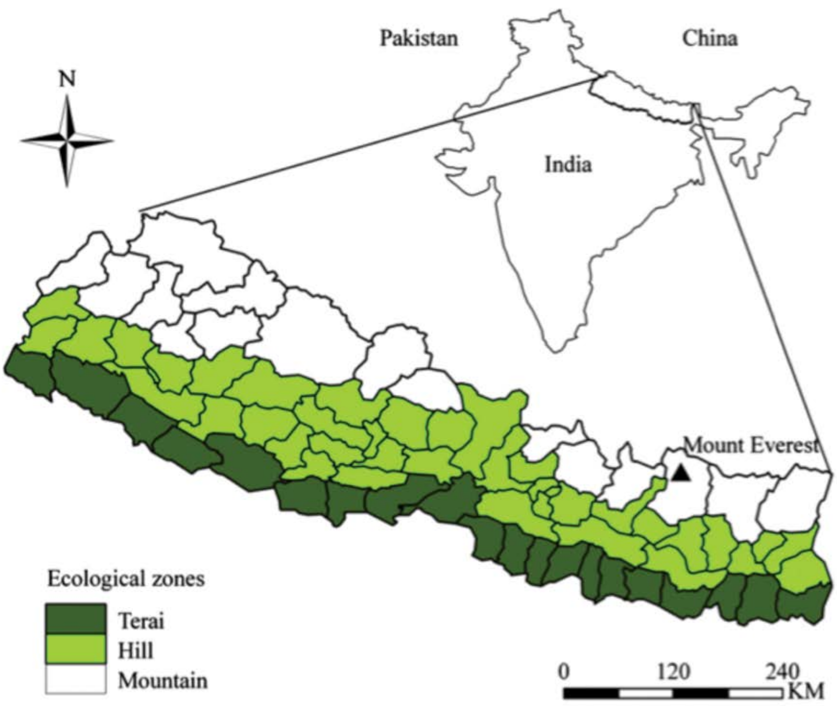
The change in altitude creates three main ecological zones in Nepal (Figure 3.2). It also affects the climate, which is mainly tropical in the *terai* (less than 1,200m), but changes from sub-tropical to sub-temperate in the low hills and high hills (1,300–5,000m) and temperate in the mountains (5,000–8,848m). Rainfall is unevenly distributed and has strong seasonal variations: pre-monsoon, summer-monsoon, post-monsoon and winter-monsoon. The average annual rainfall is 600–1,300mm in the *terai*, 1,000–2,800mm in the hills, and 140–900 mm in the mountains. These varying micro-climatic conditions result in a diverse range of crops and livestock (Library of Congress Country Studies 1991).

Cereal crops occupy more than 70 per cent of the cropped area – mainly paddy (rice), followed by wheat in the lowlands. About two-thirds of farmers use fertiliser on paddy and one-half of farmers use fertiliser on wheat, but not always an appropriate type or amount. In rainfed upland areas the main crop is maize, followed by mustard or winter vegetables. Legumes and vegetables are important throughout, especially for household consumption. Other commercial crops include sugarcane, lentil, oilseed, coffee and tobacco. Only about one-third (31 per cent) of the agricultural land is irrigated, and only 18 per cent has year-round irrigation.

One reason why the hill and mountain areas are less intensively farmed is the difficulty in accessing markets. This affects the relevance of market approaches to improving soil fertility and agriculture in general. In contrast, the *terai* and areas near towns – such as the Kathmandu valley – are heavily influenced by commercial agriculture and markets.

[23] http://data.worldbank.org/indicator/EN.POP.DNST

Figure 3.2 The location of Nepal in South Asia and its ecological zones



Source: Chhetri et al. (2012)

The *terai* is similar to much of Bangladesh in terms of climate and agricultural practices (Chapter 2). Many changes that have taken place in Bangladesh have also taken place, and continue to take place, in Nepal. These trends include:

- farmers becoming conditioned to use chemical fertilisers (Raut and Sitaula 2012), driven by a Green Revolution mindset among policymakers and within the technical community (scientists, extensionists and the private sector)
- a shortage of biomass, especially in the intensively farmed lowlands, caused by several factors including a switch to short straw grain varieties, tractors replacing draught animals and an increasing demand for cooking fuel driven by population growth
- a growing contrast between 'conventionally farmed field crops' and more organically grown vegetables in and around the villages
- commercial horticulture being the main users and source of demand for organic fertiliser
- the growing potential of urban waste as a source of organic matter for agriculture: both composts and fertilisers.

Soil fertility status

Soil fertility and organic matter are low in Nepal. In 2010 the average organic matter content of agricultural soils was found to be less than 1 per cent. The 20 year long-term vision of the 2015–2035 Agriculture Development Strategy of Nepal is to increase soil organic matter to 4 per cent (MoAD 2014).

Historically, soil fertility has been maintained through integrated farming systems which recycle organic matter and other nutrients through the use of farmyard manure. Over the past three to four decades, cropping has dramatically intensified in the lowlands (both yields and the number of crops per year) and the use of livestock has declined, especially in recent years. Imported chemical fertilisers have played a key role in achieving and maintaining this intensification.[24] In 2011/2012, 422,547 metric tonnes (MT) of NPK fertilisers (nitrogen, phosphorus and potassium) were imported and sold at a subsidised rate through agricultural cooperatives (Box 3.1). It is estimated that this is only 25 per cent of the total quantity used and the remaining 75 per cent were imported informally (ADB 2013) – i.e. smuggled in from India across the long and porous border. It is also estimated that the demand for chemical fertilisers in the country is increasing by 15 per cent per annum

[24] To date no chemical fertilisers are manufactured in Nepal because the energy and raw material requirements make it unviable (Thapa 2006).

BOX 3.1 FERTILISER POLICY IN NEPAL

Inorganic fertiliser was introduced in Nepal in the 1950s. The Agriculture Input Corporation (AIC) – a publicly owned company – was the sole authority for the import and distribution of inorganic fertilisers in Nepal. Initially these came mainly from India, but also from other countries in later years. In 1973–74, the government introduced a price subsidy and transport subsidy in selected mid and high hills districts of Nepal. The transport subsidy applied to costs incurred while transporting fertiliser from the *terai* region to the hills.

With the rise in demand for inorganic fertilisers in the country and prices on the international market in the mid-1990s, the subsidy became a huge financial burden for the government. As a result, in 1997 the government decided to deregulate the fertiliser trade, removing the subsidy on fertiliser and allowing the private sector to import and distribute it. The Fertiliser Control Order, 1999 institutionalised the deregulation policy.

The AIC was then dissolved and two private companies were formed: the Agriculture Inputs Company Limited (AICL), responsible for the fertiliser business, and the National Seed Company Limited, responsible for the crop seed business. Thus, deregulation removed the AIC's monopoly on the fertiliser trade and provided opportunities for the private sector to participate.

After the deregulation policy, the National Fertiliser Policy (NFP), 2002 was formulated. The NFP 2002 emphasised the provision of infrastructure management for enhancing fertiliser consumption and promotion of integrated plant nutrient management systems (IPNS) for the efficient and balanced use of fertilisers.

As prices of chemical fertiliser increased on the global market, the fertiliser policy was reviewed in 2008. After this review, government reintroduced the subsidy for chemical fertilisers in March 2009 and also provided AICL with sole authority to distribute and manage chemical fertiliser. Salient features of this policy are:

- Provision to fix sales prices to 20–25 per cent above those of India for five import points – Biratnagar, Birgunj, Bhairahawa, Nepalgunj and Dhangadi.
- AICL is the sole agency to import fertiliser distributed at a subsidised rate and receives the difference between the actual cost price of importing fertilisers and the sales price at import points.
- The retail price for farmers equals the sales price at the import points plus transportation costs up to the delivery point.
- Subsidised fertilisers are provided for three crops: rice, wheat and maize.
- Subsidised fertilisers are sold through the offices of AICL, as well as cooperative organisations and cooperative shops.
- The Fertiliser Supply and Distribution Management Committee headed by the Chief District Officer of the respective district is responsible for distribution of subsidised fertilisers at district level.

Annually, 100,000 MT of fertilisers are imported under this scheme. The demand for chemical fertilisers has increased by an average of 15 per cent every year over the last ten years, while the supply has been in deficit by 46 per cent over the same period (AICL 2013). Government's failure to meet the demand for inorganic fertilisers can be explained by limited budgetary allocations, fluctuation in international market prices and illegal trading of sub-standard fertilisers across the Indian border.

Sources: AICL. 2013. Fertilizer import and distribution. Agriculture Input Company Limited. www.aicl.org.np; Shrestha, R.K. 2010. Fertilizer policy development in Nepal. The Journal of Agriculture and Environment, 11: 126–137.

(AICL 2013). The increase in use of chemical fertiliser is not being matched by an increase in the use of organic matter (manures, fertilisers, composts, or other soil improvers). This imbalance in the use of chemical and organic fertilisers is causing deterioration in the soil health of commercial farms in Nepal (Khadka et al. 2008).

Soils and agriculture in many upland areas have been less affected by intensification and mechanisation as farmers continue to use traditional production and methods of soil fertility management, notably livestock manure and crop rotations (MoAD 2014). Upland areas have, however, been affected by deforestation and climate change.

Farmyard manure and compost are still valued and used by farmers, but volumes are not enough for crop production or to replenish organic matter in the soil. The decline in smallholder livestock numbers and competing uses for manure (notably for fuel for cooking) have also reduced the availability of manure and compost for agriculture. Whilst organic fertiliser production has increased within Nepal, its volume and use are still too low. In contrast to chemical fertiliser, very little (<1 per cent) organic fertiliser is imported.

Recently, productivity in the intensively farmed lowland has stagnated, and the low use of chemical fertiliser is often blamed for this (Shrestha et al. 2013). However, this stagnation is partly also due to the unbalanced use of chemical fertilisers. The most commonly used fertilisers are nitrogen (mainly urea) and, to a lesser extent, phosphorous (diamonium phosphate). Some potassium (muriate of potash) is also used. However, applying nitrogen when the limiting nutrient is potassium or phosphate, or a micronutrient like iron, magnesium or boron, is a likely cause of the stagnation in productivity.

The policy environment for organic fertilisers

Nepal's national plan and policies have prioritised fertiliser as an engine of agricultural growth. However, supplying adequate quantities of inorganic and organic fertiliser to farmers across the country has always been challenging for the government. Fertiliser policies have been changed many times in order to enable an adequate and smooth supply of fertilisers, driven by the need to ensure national food security. The government has introduced, lifted and then re-introduced subsidies on inorganic fertilisers, and recently introduced a subsidy on organic fertilisers (Box 3.1).

The 2002 National Fertiliser Policy aims to address stagnating yields and the imbalance in the use of chemical fertilisers by promoting an integrated plant nutrient system (IPNS). IPNS involves the appropriate 'balanced' use of inorganic nutrients (NPK and micro nutrients) and the combined use of organic and inorganic fertiliser (Government of Nepal 2002). But although the policy talks about organic fertiliser and organic matter, in reality the focus tends to be on other inorganic nutrients and micronutrients because they are easier to analyse, distribute and sell.

The context described above, combined with the emergence of new kinds of organic fertilisers, new market actors, and the dangerously low levels of soil organic matter, motivated the government to introduce incentives in 2011/12 for the manufacture and use of organic fertiliser. These include:

- an NPR 10/kg (USD 0.09/kg) subsidy on organic fertiliser for farmers (up to 1,500 kg) through a voucher scheme based on legal documents submitted to the District Agriculture Development Office which prove land ownership
- NPR 25,000 (USD 230) cash support for households which produce vermi-compost (Box 3.3)
- NPR 5,000 (USD 46) cash support for households to improve their cow sheds to collect urine and cow dung
- up to 50 per cent subsidy on equipment for the commercial production of organic fertiliser
- provision of temporary licences for the production of organic fertiliser based on product samples and an application, and permanent licences based on only two field trials (see Box 3.2).

Despite these provisions, the use of organic fertiliser in Nepal is still woefully inadequate given the low organic matter status of the soils and the need to increase agricultural productivity.

An important element in improving soil fertility is to enable farmers to regularly test their soils for organic matter and fertility. Soil testing by the government now includes soil organic matter as well as NPK, whereas historically soil testing was used to ensure optimal levels of N, P, K and soil pH. There are plans to increase the service from the current 10 to 35 districts (out of 75 districts in Nepal). The government is also piloting a mobile laboratory for on-farm testing to improve access; however, coverage is still low. There are a few private sector soil testing services but they are expensive. The District Agriculture Development Offices (DADO) have increased the information they provide to farmers about their various soil testing services. However, it is up to farmers to request the service and to interpret and use the results.

The government has also introduced recommendations and quality standards for the nutrient content of organic fertiliser, as well as a two-stage procedure to license manufacturers and their products. Quality control however remains difficult as the procedure is new and monitoring systems are weak (Box 3.2).

BOX 3.2. THE LICENSING SYSTEM FOR ORGANIC FERTILISER IN NEPAL

Nepal has a two-stage licensing system for organic fertiliser. Companies must first apply for a 'temporary licence' that is valid for up to 1.5 years. The cost of a temporary licence is currently around 6,000 Nepalese rupees (approximately USD 55) per product. To receive this licence companies must have their product tested by a government-authorised private laboratory (around five such labs exist) to prove it meets the required standard. Parameters include, amongst others, minimum levels of N, P, K and organic matter and maximum levels of moisture and heavy metals. Companies then apply to the Ministry of Agricultural Development (MoAD) and confirm they will meet the packaging and branding guidelines. Once approved for a temporary licence they are registered in MoAD and can produce and sell organic fertiliser.

If companies want to be allowed to sell their organic fertiliser through government channels (eg the District Agriculture Development Offices) and have their product stamped with the government stamp of quality assurance, they need to obtain a permanent licence and meet the requirements of the government monitoring system. To get a permanent licence the National Agriculture Research Council (NARC) must test the product in the field over two separate seasons. This costs NPR 400,000 (approximately USD 3,680) in total (NPR 200,000 per field trial; approximately USD 1,840). Currently it is anticipated that the process will take two years; however it is proposed that this could be reduced to as little as eight months if back-to-back trials were done (i.e. on subsequent crops).

The system is still in its infancy and so far no companies have a permanent licence. At present, companies can still sell through their own dealers or agro-vets, for which there is no government controlled monitoring system.

Source: Department of Agriculture (2011), Guidelines from the website, http://doasoil.gov.np/karyabidhi-organic-fertilizer-regulation (in Nepalese).

Value chains for organic fertiliser in Nepal

Cow dung and poultry manure have been used by farmers to improve soil fertility for generations. Thanks to this traditional practice, there is good awareness and knowledge among farmers about the value of manure and compost. However, an increasing demand for energy is now competing for this organic matter. Dried cow dung is a very common source of cooking fuel in rural areas and both poultry manure and cow dung are also used to generate biogas. Some large farms use biogas to generate electricity.

It is estimated that around 15,000 MT of commercial organic fertiliser are produced annually in Nepal by 24 companies, mainly in 'granular' or 'dust' form, or as vermi-compost (Box 3.3). Commercial organic fertiliser is still a very small part of the national fertiliser market (less than 1 per cent). However, it is estimated that these companies have the capacity to produce up to 100,000 MT annually.[25] Most of the current production (80 per cent) is supplied to farmers through cooperatives at minimal profit. The remainder is supplied through agro-vets (local small-scale input suppliers) or the District Agro-Input Corporation (DAIC). Very little chemical fertiliser is supplied through the cooperatives (around 5 per cent) (Practical Action 2016).

In Nepal, household waste is recognised as a resource; the country has well-developed systems for the separation and use of urban waste. For example, decomposed waste from pit latrines has historically been used as fertiliser in Nepal. In some urban areas, municipalities have joined local communities, private enterprises and community-based organisations to introduce schemes for more cost effective and efficient household waste management. These include door-to-door collection systems, separation of degradable and non-degradable waste, composting at household and community level, and recycling of plastic. However, there is still a huge amount of solid waste that is yet to be properly managed. There is an opportunity for city level processing plants that can convert urban waste into compost, and this could be achieved through innovative private-public-partnerships. There is also growing demand for compost linked to a 'green home concept' and the increasing practice of roof-top gardening driven by concerns among many urban residents about pesticide residues in vegetables. Already there are a growing number of NGO-led initiatives to produce compost from organic urban waste. Given that the use of faecal sludge to make fertiliser is, in theory at least, socially and culturally acceptable, there could also be

[25] Interview with Chief Soil Scientist (Mr Durga Dawadi) of Soil Management Directorate, Department of Agriculture.

BOX 3.3. VERMI-COMPOST IN NEPAL

Vermi-compost is becoming increasingly popular, especially among smallholder farmers living in hilly areas. Reasons for its growing popularity include a better understanding of the technology, its simplicity, its visible positive effects on production, and the fact that it can be made from a range of waste materials – mainly animal manure and kitchen waste, supplemented by cellulose materials like banana stem, straw and leaves. Smallholder farmers mostly use vermi-compost for vegetable production in or near their homesteads. In this context its high moisture content and voluminous nature are advantageous. Some vermi-compost is used in commercial cereal production as an alternative to commercial fertiliser. This vermi-compost mainly comes from commercial producers.

The government is actively promoting the production of vermi-compost though training and grants (NPR 25,000 per farming household) and a 50 per cent subsidy on equipment for commercial manufacturers. There is a steady increase in the number of commercial vermi-compost enterprises in Nepal – the Practical Action team are aware of seven medium and large-scale vermi-compost factories in Nepal, of which at least three have been established in the last three to four years. One example is a small vermi-compost factory established on the outskirts of Kathmandu in 2012 by four biotechnology graduates. It has the capacity to produce 600 tonnes per year. In 2016 it produced around 400–500 tonnes. The factory packages its product in two sizes: around 30 per cent are packaged in 2kg bags, mainly for urban households (for roof-top vegetables and gardens); and the remainder is packaged in 25kg sacks, for commercial horticulture or other farming. Most is produced to order. The company estimates their products reach 10 districts. Within the Kathmandu valley they are bought mainly by agro-vets and nurseries – mostly the 2kg bags. Many of the orders for use outside Kathmandu valley are facilitated by DADO. This illustrates the important networking role of government – not only in improving farmer awareness, understanding and skills, but also in improving the awareness and capacity of private sector service fertiliser providers and in facilitating linkages where possible.

opportunities for research and innovation to convert it to organic fertiliser (as in Bangladesh, see Chapter 2).

Most problems associated with urban waste management in Nepal come from the centralisation of services as the urban areas have expanded and volumes dramatically changed. Rapid urbanisation means the total volumes of urban waste and faecal sludge will continue to increase, along with political and economic pressure for more efficient and cost-effective ways of managing this organic matter. Using it to improve soil fertility and thereby agriculture is clearly a 'win-win'.

The role of collaborative mechanisms in increasing organic fertiliser use

Strong policy support for increasing the use of organic fertiliser in Nepal and a desire by many actors (public and private) to speed up the development of the organic fertiliser sub-sector have seen 'collaborative mechanisms' develop at the national level in the last year as part of this study. These have been inspired by Practical Action's work in Bangladesh, though in that country collaborative mechanisms evolved over the long term out of district based project work (see Chapter 2). Several rounds of individual interviews and workshops were held to explore the interest and mindset of actors in implementing collaborative mechanisms. These allowed the team to choose interested and cooperative participants, who to date have included key people from the Department of Agriculture, the National Agriculture Research Council (NARC), three District Agriculture Development Officers (DADO), and representatives of farmer cooperatives, agro-vets and organic fertiliser companies (Appendix 2).

The Soil Management Directorate of the Department of Agriculture has committed to lead the process; the role of Practical Action is to facilitate it and follow up. Practical Action Nepal also has a formal agreement with the Department of Agriculture for support in promoting new technologies and approaches developed by Practical Action.[26] The sustainability of this collaborative mechanism depends on long-term facilitation and collaboration between Practical Action and the

[26] This agreement is not only for organic fertiliser but also for other innovative technologies promoted by Practical Action.

Department of Agriculture. It also requires funds and programmes to implement it.

Learning from Bangladesh, and recognising the need for grounded action, Practical Action also organised a series of district-level focus group discussions (typically comprising 15–20 farmers) to explore the potential for collaboration in three districts. This dialogue helped to identify key actors and farmers, agro-vet and agri-business representatives in meetings of the collaborative mechanism in Kathmandu. Specific topics raised in the district focus group discussions included awareness and knowledge of organic fertilisers, the various sources of organic fertiliser, the possibility of on-farm trials or demonstrations, and the role of the various actors, namely the DADO, cooperatives, agro-vets and others. A number of issues emerged from the district level consultation, which also informed the national dialogue:

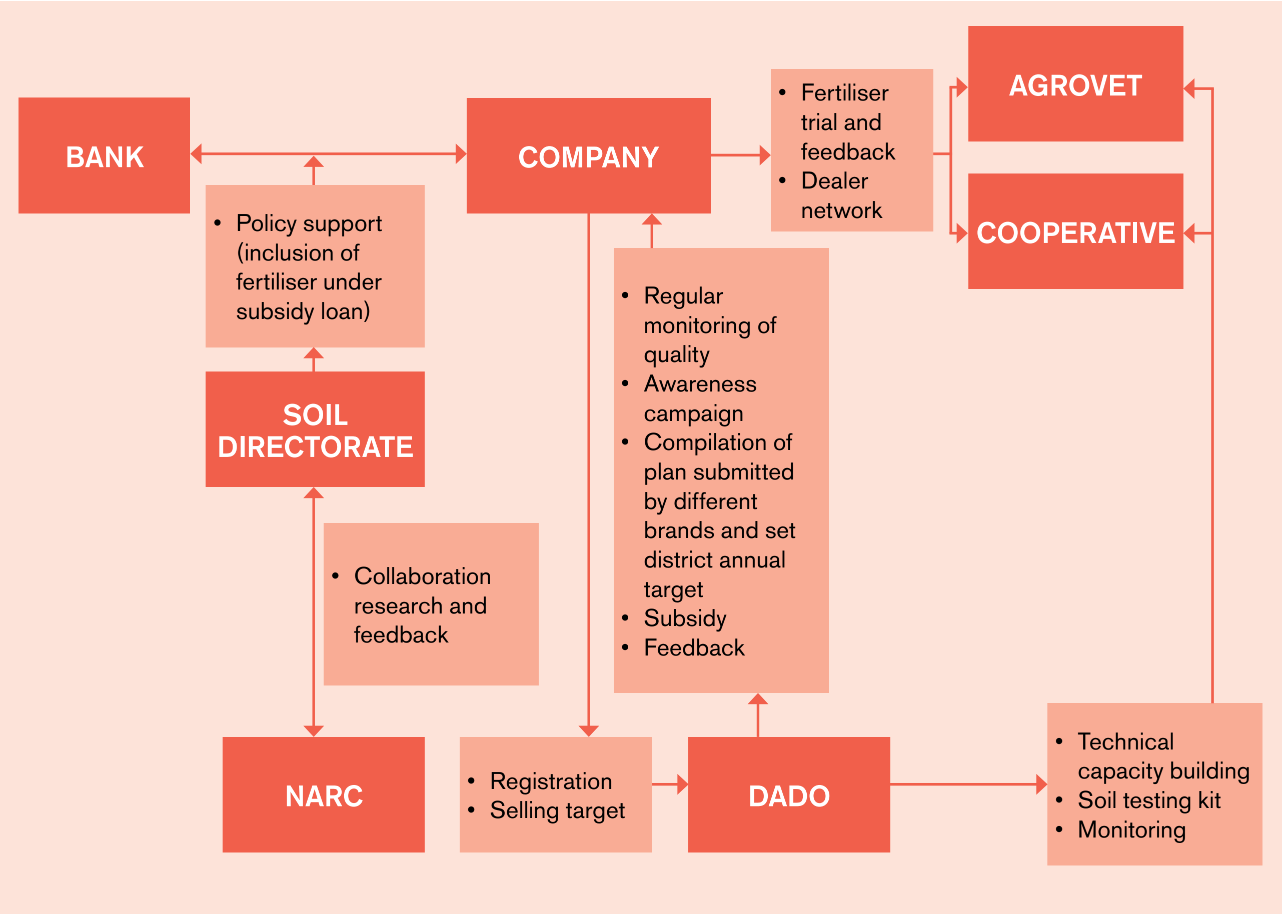
- Many farmers are reluctant to use commercial organic fertiliser because of previous negative experiences: some companies provided samples of organic fertiliser, but never came back; some farmers received poor quality fertiliser which farmers felt had little effect.
- Organic fertiliser companies need to have more dynamic, systematic and convincing marketing strategies. Some companies advertise on FM radio, but they miss other opportunities such as branding, demonstrations (farmer-farmer recommendation), and certification.
- The sub-sector suffers from a poor reputation in terms of quality and reliability.
- There is a general lack of awareness about the importance of organic matter in the soil. Soil testing continues to fail to deliver the changes that government (and scientists) would like. This is commonly attributed to a lack of access, insufficient sampling or delays in providing the results. Practical Action's experience is that a lack of capacity by farmers to interpret and use the information is the biggest constraint, and one which cannot be rectified by agricultural extension staff alone.
- There is a lack of combined information and inputs on organic and chemical fertiliser: agro-vets do not sell or have information on organic fertilisers – they only have information of chemical fertilisers and other inputs like pesticides and animal medicines, hence they provide a very skewed (one-sided) service. Whilst some cooperatives do sell and have information on organic fertiliser, the service they provide is limited and not connected to soil testing or other complementary services.
- There is scope for municipalities to partner with private organisations to commercialise the recycling of organic urban waste. This is based on ongoing experience of NGOs and private enterprises – namely, WEPCO (Women Environment Preservation Committee), NEPSEMAC (Nepal Pollution Control and Environment Management Centre) and NEPCO Nepal (National Environmental Pollution Control).

The following actions are being implemented through the collaborative mechanism (at both district and national level):

- Helping cooperatives and agro-vets to provide more comprehensive services, for example: soil testing; supplying both organic and chemical fertilisers; and giving feedback to suppliers regarding quality and demand.
- Further expanding and improving soil testing; raising awareness and education; increasing access to soil-testing services through both centralised and mobile (on-farm) testing; improving the provision and use of soil organic matter information – i.e. less emphasis on chemical fertiliser recommendations.
- Reviewing the national policy on organic fertilisers and subsidies: notably, increasing the subsidy for organic fertilisers to farmers from NPR 10 to NPR 15 per kg, and including organic fertiliser in government loan schemes.
- Developing new business models (public-private partnerships) for producing organic fertiliser from urban waste.

These actions are being implemented by various stakeholder groups, illustrated (in rose) in Figure 3.3.

Figure 3.3. Stakeholder map showing areas of action within the collaborative mechanism in Nepal



Conclusions and recommendations

This research indicates that farmers are willing to buy and pay for organic fertiliser *if* they are reliably available and *if* the quality is good. Facilitating new markets for organic fertiliser, or changing the system to include new products, requires action from multiple actors and at many levels. For example, the role of government is to raise awareness, provide services and create incentives; commercial manufacturers can reliably supply significant volumes of organic fertiliser which meet an approved standard; cooperatives and agro-vets can provide technical information as well as a choice of products. The 'collaborative mechanism' is proving to be an effective way of initiating and coordinating this action at many levels.

An integrated approach is needed to ensure sufficient quantities of organic matter are available at affordable prices, and/or that more is made on farm. This means agriculture policy that encourages production and use of a broad range of organic fertilisers or composts: e.g. farmyard manure, compost made from kitchen waste, compost from faecal sludge management and urban waste, vermi-compost and other organic fertilisers. It also means using a range of agronomic and farm management practices such as crop rotations with legumes, green manures, low tillage, intercropping, mulching and deliberately increasing crop residues. Different technical solutions will be applicable or affordable to different types of farmers. Such an 'integrated approach' fits well with the existing mixed crop-livestock farming systems in Nepal.

Climate change projections for Nepal indicate there is likely to be increased frequency of climate-induced natural disasters – floods, landslides and droughts – and rural communities will face increased risk of crop failure. Research has shown that soil organic matter greatly improves the water retention capacity of soil (Bot and Benites 2005). Adapting agriculture to cope with climate change is therefore a further, and urgent, reason for the government of Nepal to step up its actions to raise soil organic matter content and ensure long-term soil health.

Specific recommendations are as follows:

Government:

- Within the government's recommendations and implementation of an integrated plant nutrient system, increase the importance or emphasis on organic fertilisers and other practices that improve soil organic matter.

Government and NGOs:

- Provide technical assistance to organic fertiliser manufacturers to improve product quality and licensing, packaging and marketing. Support companies to conduct demonstration trials in farmers' fields.
- Encourage agro-vets and cooperatives to supply and provide technical advice on both chemical and organic fertilisers, including information, services or products for soil testing; as well as information on other ways of improving soil organic matter such as rotations or intercropping.
- Support cooperatives to work with government and the private sector to provide soil testing services and technical advice on soil organic matter for their members.

Government and the private sector:

- Support research into the efficacy and cost-effective ways of using organic fertilisers.
- Intensify research on the use of urban waste and faecal sludge to make safe organic fertilisers; provide incentives to innovative public-private partnerships to convert the organic waste problem into an agricultural market opportunity.

Private sector:

- Support research by organic fertiliser manufacturers and farmers on using organic fertilisers to improve the ability of crops to cope with drought – i.e. the ability of soils to retain moisture in the post-monsoon period.

The overall result should be a level playing field whereby information, incentives and support all mean that farmers can use organic fertilisers that they trust and when they need them.

4

Comparison of organic fertiliser in Nepal and Bangladesh

Nepal has a more favourable policy environment for organic fertiliser than Bangladesh, but this is a relatively recent development and its soils have lower levels of organic matter. In both countries, the organic fertiliser industry is at an early stage of development and suffers from a lack of reliable data and greater government support for chemical fertiliser.

While the need for larger amounts of organic matter to maintain the fertility of soils in Bangladesh and Nepal is great, the organic fertiliser sector in both countries is still at a very early stage of development, with limited levels of production from a small number of firms. Policymakers are beginning to pay more attention to the problem of soil fertility and measures to address it, but chemical fertiliser remains their main priority. Partly as a result of this, there is a dearth of reliable data on the size and value of the formal organic fertiliser industry, as well as on informal, small-scale production by households – whether for sale or household use.

On the whole, Nepal has a more favourable context than Bangladesh for the promotion of organic fertiliser, at least in the last five years (Table 4.1). Nepal also has better systems in place for managing urban waste than Bangladesh, but there is still a huge amount of solid waste that is yet to be properly managed. Factors contributing to Nepal's favourable context include:

- a continued prevalence of integrated crop-livestock farming (though this is declining)
- a culture of using all waste – including composted human waste
- household willingness to separate different types of waste
- greater awareness of the economic cost of chemical fertiliser (all of which needs to be imported) compared to organic fertilisers and compost, which are made locally
- a relatively quick and affordable licensing system for organic fertiliser
- clear policy objectives and incentives to address low soil organic matter (the Agriculture Development Strategy target to increase soil organic matter to 4 per cent; MoAD 2014)
- availability of subsidies for organic fertiliser manufacture and use.

In contrast, in Bangladesh there is a clear prioritisation of chemical fertiliser in policy and practice. Chemical fertilisers are subsidised whereas organic fertilisers are not. Although policymakers in Bangladesh generally understand the necessity of using organic fertilisers and compost to improve soil health, they have not yet put in place the policies needed to promote this on a large scale. As a result, organic fertilisers have to compete on an uneven playing field which favours chemical fertilisers in production, marketing, distribution and use.

Average annual rates of chemical fertiliser use are much higher in Bangladesh than in Nepal – 180.2 kg/ha compared to 20.1 kg/ha (Mujeri et al. 2012). One reason that Bangladesh is more reliant than Nepal on chemical fertiliser is that the stakes are higher. The population of Bangladesh is over six times that of Nepal, and its population density is one of the highest in the world, at 1,287 people per square kilometre compared to 199 people per square kilometre in Nepal.[27] Maintaining high levels of agricultural productivity is essential for food security and hence policymakers are less inclined to experiment with alternatives to the current agro-chemical regime. Moreover, the preference for chemical fertilisers over organic fertilisers is equally ubiquitous among marketers and farmers. Only a small fraction of the 45,000 fertiliser dealers and sub-dealers in Bangladesh stock organic fertiliser. Many farmers in the country – particularly the younger generation – are only familiar with the use of chemical fertilisers and do not realise the importance of balanced applications of organic and chemical fertilisers.

Ironically, in spite of these factors, the average soil organic matter content in Nepal is lower than in Bangladesh –averaging around 1 per cent; whereas in Bangladesh, about 42 per cent of soils have organic matter levels below 1.7 per cent, with the rest being higher than this level. There are two main reasons for this: (1) a significant portion of the cropped area in Bangladesh is regularly inundated with silt-laden water, which adds organic matter and slows the decomposition of organic matter under anaerobic conditions (SRDI 2016); and (2) much of the agricultural land in Nepal is hilly and prone to erosion and leaching (also drier and more exposed to aerobic decomposition of organic matter) (MoAD 2014; Tripathi and Jones 2010).

The use of faecal sludge as compost is less culturally acceptable in Bangladesh than in Nepal, which is an obstacle to the expansion of the pilot faecal sludge composting plants run by Practical Action in two municipalities in Bangladesh. An even bigger obstacle is the system and standards for licensing organic fertiliser, which is currently impeding the sub-sector's development in Bangladesh more than any other factor, and reinforcing the market dominance of chemical fertiliser.

One barrier to expanding the organic fertiliser sector in both countries is the lack of technical information on organic fertilisers and options provided by agro-vets, cooperatives and other agriculture input suppliers. Most farmers have direct interaction with such businesses and organisations. It is therefore necessary that policies and strategies to scale up the use of organic fertilisers address the capacity (knowledge and services) of such businesses, as well as ensuring that they sell organic fertilisers alongside chemical fertilisers.

This research indicates that farmers are willing to buy organic fertiliser if they are available and of good quality. Currently though, farmers in both countries have negative perceptions of organic fertiliser performance in terms of quality and reliability. For this reason, the monitoring and certification of organic fertiliser needs to be improved – it should be quicker, simpler, less costly and therefore more responsive to the needs of companies.

[27] http://data.worldbank.org/indicator/EN.POP.DNST

Table 4.1 Organic fertiliser in Bangladesh and Nepal compared

ITEM	BANGLADESH	NEPAL
Overview of the agriculture sector	Both countries have undergone agricultural intensification in recent decades using Green Revolution technologies and external inputs. In both countries there is good awareness and knowledge (historic experience) of the value of manure and compost	
Source of chemical fertiliser (NPK)	Mostly imported with some domestic production, mostly of urea (nitrogen)	100% imported: heavily influenced by Indian markets and policies
Policy environment (organic fertiliser)	Government policy and financial support for chemical fertiliser, not for organic fertiliser	Favourable government support for organic fertiliser manufacture and use
Quantity of organic fertiliser produced	No available data	Approximately 15,000 MT produced annually
Number of firms producing organic fertiliser	About 50 companies have a licence to produce organic fertiliser, but only 10–15 are actively doing so	24 companies
Quality	Standards or recommendations exist for the composition of organic fertiliser Adulteration and quality control are big issues Monitoring systems for organic fertiliser quality are weak	
Licensing	Lengthy licensing procedure that requires 3 field trials	Provisions for: (1) a rapid, affordable, fixed term temporary license based on analysis of the product and agreement to comply with the guidelines; and (2) a permanent licence based on 2 field trials
Subsidy	No subsidy available for organic fertiliser, but the government does provide subsidies for chemical fertiliser	Government has provided subsidies for production (50% subsidy on equipment for commercial producers and direct subsidies to farmers for on-farm compost production)
Supply chain of organic fertiliser	Not at all developed Market for organic fertilisers remains underdeveloped due to low and inefficient production, weak supply chains and insufficient private sector engagement	Somewhat developed Cooperatives are the main distributors of domestically produced organic fertiliser.
Use of urban waste for the production of organic fertiliser and compost	Segregation and compost production from organic waste in a pilot and testing phase. Some (limited) testing and commercial development of faecal sludge-based compost (still some concerns about this due to cultural stigmas about human waste)	Well-developed systems for separation and use of urban household waste to produce organic fertiliser. Traditional use of human waste in agriculture (decomposed soil from pit latrines)

5

Conclusions

Summary: To break the vicious cycle of over-reliance on agro-chemical inputs and inadequate additions of organic matter, farmers and policymakers need to focus on maintaining soil fertility, which in turn requires greater attention to soil organic matter, good farming practices and the value chains that can supply it in large enough quantities. Research is needed to develop both agronomic and market based strategies that are cost effective for the wide range of circumstances and kinds of farmers in the region.

The research described here has identified the main obstacles to well-functioning value chains for organic fertilisers in both Bangladesh and Nepal. These include contradictory policy signals, such as subsidies for chemical fertilisers; poor awareness of soil fertility problems; burdensome licensing procedures and unrealistic standards; weak capacity among companies; the complexities involved in securing sufficient quantities of raw materials from multiple sources; landholding patterns which discourage investment in land stewardship; and low demand.

The paper has also described the potential – embodied in existing businesses such as WORD in Bangladesh – for commercially viable solutions, such as kitchen waste composting operations, the production of vermi-compost, and the production of organic fertiliser from faecal sludge. These efforts are still at an early stage and much remains to be done. If sufficient quantities of organic matter are to be returned to the soil, organic fertilisers and compost need to be produced from all available source materials and on a much wider scale. Furthermore, concerns over heavy metal contamination in fertiliser produced from household waste, and pathogens in fertiliser from faecal sludge need to be dealt with. In Bangladesh, cultural sensitivity about the use of faecal sludge and perceptions regarding health and safety are also obstacles. Greater incentives or municipal requirements are needed for consumers to separate their waste, particularly in Bangladesh, in order to lower costs and reduce the potential for contamination.

Large information gaps remain, such as the value and production of the organic fertiliser sub-sector, the level of demand for organic fertiliser, organic fertiliser and compost usage rates by farmers, the degree of shortages of organic matter in rural areas, etc. For example, given that dairy and poultry operations have expanded in recent years, it is not clear whether organic matter is in absolute shortage or instead is being concentrated in feedlot operations. Research is needed into all of these issues, as well as to gauge the impacts of farming practices on soil fertility.

While there is considerable potential to scale up the commercial production of organic fertiliser in both countries, other means of retaining or returning organic matter to the soil are also needed if levels of soil organic matter are to be raised to healthy levels (i.e. 3–5 per cent). There are three means by which farmers in South Asia can increase soil organic matter:

1) use agroecological practices which maintain and increase soil fertility, such as crop rotations, inter-cropping, cultivation of legumes, green manures, mulching and low tillage systems
2) produce organic fertilisers and composts on-farm, such as vermi-compost
3) purchase organic fertiliser from formal or informal markets.

Adopting agroecological practices will go a long way towards addressing soil fertility problems and producing their own compost will save farmers money on inputs. Nonetheless, given the current shortages of biomass in rural areas, in many cases it will still be necessary for farmers to purchase some organic fertiliser from dealers or local markets, at least in the short term. This paper's focus on organic fertiliser value chains therefore highlights the third approach. However, all three strategies deserve attention – it is important to promote private markets for organic fertiliser as one part of an overall strategy to build soil fertility. Research is needed to examine which of these three strategies is most cost-effective and farmer-friendly, under what circumstances and for which kinds of farmers.

Unless workable solutions can be found, the vicious cycle of over-reliance on agro-chemical inputs and inadequate additions of organic matter will continue to deplete soils, increase vulnerability to drought and variable weather, undermine food security and contribute to polluting and environmentally degrading farming. To break this vicious cycle, farmers and policymakers need to focus on maintaining soil fertility, which in turn requires greater attention to soil organic matter, good farming practices and the value chains that can supply organic fertiliser in large enough quantities. This will include building awareness of soil fertility problems, simplifying licensing procedures and unrealistic standards, building capacity among companies, securing sufficient quantities of raw materials from multiple sources, and stimulating demand.

One of the key lessons of this case study is that such value chains do not simply materialise by themselves. They need to be nurtured over time, and require action by multiple stakeholders. Civil society organisations such as Practical Action have a crucial role to play in initiating and growing poorly developed value chains. In Bangladesh and Nepal, Practical Action has helped bring together through regular multi-stakeholder meetings – at both district and national level – a range of relevant actors, from organic fertiliser and compost manufacturers to government agencies, district extension staff, farmers' groups and others. The issues have been explored and action plans developed and implemented with the goal of building national organic fertiliser value chains. Government cannot do this alone, as it is often too sectorally partitioned to bring all the different actors together. Likewise, the private sector is too fragmented to link different stakeholders. Farmers' interests also need to be borne in mind. Therefore, collaborative mechanisms ideally need to be spearheaded by a civil society entity that is knowledgeable and well respected by all the parties involved, at least until the value chain is sufficiently well developed to become self-sustaining.

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Appendix 1

Stakeholders involved in the district collaborative mechanisms in Bangladesh

FARIDPUR DISTRICT	RAJBARI DISTRICT
DAE (Department of Agricultural Extension)	DAE (Department of Agricultural Extension)
BADC (Bangladesh Agricultural Development Corporation)	BADC (Bangladesh Agricultural Development Corporation)
SRDI (Soil Resource Development Institute)	Rajbari Sadar Upzilla Department of Agricultural Extension
BARI (Bangladesh Agricultural Research Institute)	Balikandi Upzilla Department of Agricultural Extension
WORD – NGO and organic fertiliser producer	Agricultural Marketing Department
DLS (Department of Livestock Services)	Metal Seed Company
Metal Seed Company	VPKA Foundation
Ispahani Company	M/S Arafat Krishi Vandar (Dealer)
SDC (Society Development Committee)	RSSC
Entrepreneurs	Entrepreneurs
Farmers	Farmers
Dutta Seed and Nursery	Vermi-compost supplier
Faridpur business association (inputs dealer)	Practical Action Bangladesh
Practical Action Bangladesh	

Appendix 2

Stakeholders involved in the national collaborative mechanism in Nepal

Soil Management Directorate, Department of Agriculture
National Agriculture Research Council (NARC)
District Agriculture Development Office (DADO)
Agriculture Service Centers (ASC)
National Biotech Private Limited
Prarambha Biotech Private Limited
Uchit Jabik Mal Udhyog
Agro-vets
Farmers groups/cooperative
Practical Action Nepal

Appendix 3

Chemical fertiliser in Bangladesh

Production, imports, sales and stock of urea and non-urea fertiliser (FY 14/15)

SL NO	FERTILIZER TYPE	PRODUCTION (METRIC TONNE)	IMPORT (METRIC TONNE)	SALES (METRIC TONNE)	STOCK (METRIC TONNE)
1	Urea	878,000	1,876,000	2,638,000	895,000
2	TSP	88,000	678,000	722,000	120,000
3	DAP	60,000	574,000	597,000	105,000
4	MOP	0	608,000	640,000	128,000

Source: http://www.moa.gov.bd/

Subsidy provided on urea and non-urea fertiliser (2008–2009 to 2014–2015) – millions of BDT

YEAR	UREA	NON-UREA	REBATE ON ELECTRICITY	TOTAL SUBSIDY PAID BY GOB
2008–2009	42371.3	8078.2	947.4	51396.9
2009–2010	19287.8	20806.5	810.4	40901.6
2010–2011	25972.5	30398.0	551.1	56921.6
2011–2012	23281.4	46242.4	403.1	69926.9
2012–2013	48244.4	71458.9	231.4	119934.7
2013–2014	34015.1	52412.2	3192.2	89619.5
2014–2015	27073.4	42287.7	1589.1	70950.2

BDT = Bangladesh Taka
Source: http://www.moa.gov.bd/

Subsidy provided on urea and non-urea fertiliser (USD) (2008–2009 to 2014–2015) – millions of USD

YEAR	UREA	NON-UREA	REBATE ON ELECTRICITY	TOTAL SUBSIDY PAID BY GOB
2008–2009	543.2	103.5	12.1	658.9
2009–2010	247.2	266.7	10.3	524.2
2010–2011	332.9	389.7	7.0	729.6
2011–2012	298.4	592.8	5.1	896.3
2012–2013	618.5	916.1	2.9	1537.5
2013–2014	436.0	671.9	40.9	1148.8
2014–2015	347.0	542.1	20.3	909.6

1 USD = 78 BDT

Soil degradation – largely caused by unsustainable farming practices – is threatening food production in many parts of the world. To break the vicious cycle of over-reliance on agro-chemical inputs and inadequate additions of organic matter, farmers and policymakers need to focus on maintaining soil fertility through greater attention to soil organic matter, agroecological farming practices and the value chains that can supply organic fertiliser in large enough quantities. This paper represents a first step, describing recent initiatives in Bangladesh and Nepal to bring together government, NGOs, farmers and the private sector. Awareness of the problem is on the increase and small-scale solutions – from urban waste recycling to vermi-compost production – are proving that the potential exists. Policy support is now needed to scale these up.

IIED is a policy and action research organisation. We promote sustainable development to improve livelihoods and protect the environments on which these livelihoods are built. We specialise in linking local priorities to global challenges. IIED is based in London and works in Africa, Asia, Latin America, the Middle East and the Pacific, with some of the world's most vulnerable people. We work with them to strengthen their voice in the decision-making arenas that affect them – from village councils to international conventions.

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