KNOWLEDGE PARTNERSHIP PROGRAMME

Knowledge Partnership Programme

Sectoral Assessment report

Under Project

Promoting resource efficiency along the value Chains of key sectors in South Asia

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Promoting resource efficiency along the value chains of key sectors in South Asia

SECTOR ASSESSMENT REPORT

Institute for Industrial Productivity

Sharing best practices for the low carbon future

Chapter 1
Introduction

1. Context

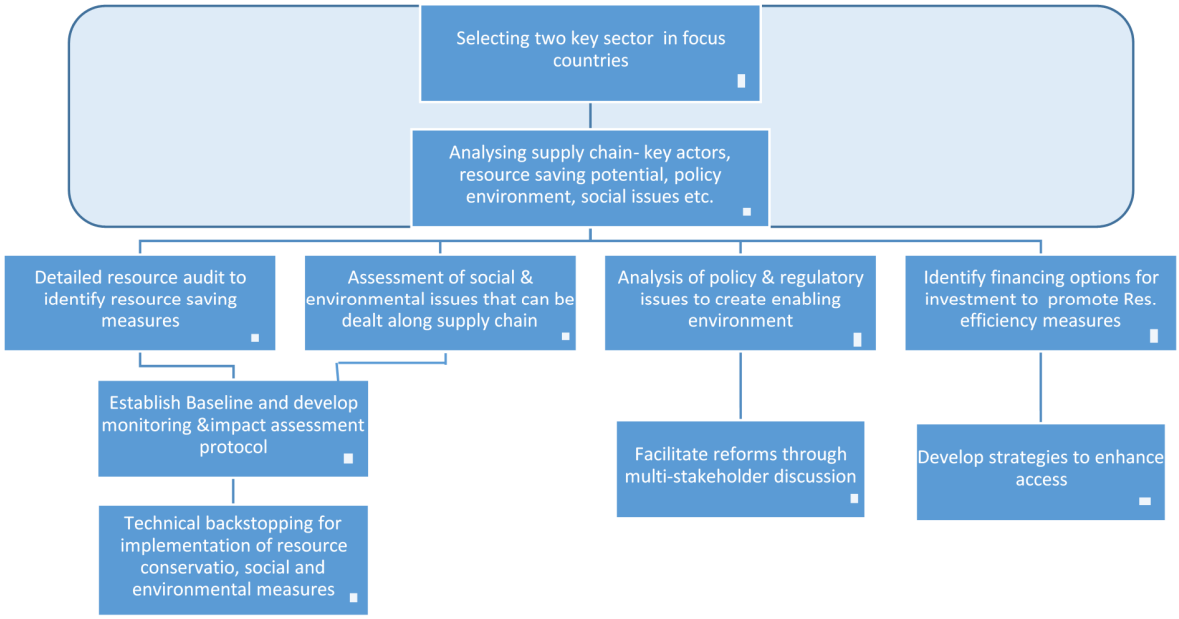
Policy-makers in South Asia as well as other developing economies are increasingly focusing on the development of small &medium enterprises (SME) and agro based value chains as a means of promoting economic growth and poverty reduction. This is because agriculture and SMEs account for a major share of workforce providing employment to millions, both directly as well as indirectly, apart from contributing to Gross Domestic Product (GDP) and export earnings. However, these sectors are also vulnerable due to high dependence on natural resource (land, water, energy, forests) with significant environmental (waste generation, pollution of water, air & land, resource depletion etc.) and social (poor working condition, insecure livelihoods etc.) externalities. Along with this, they also need to cope with the challenges and constraints posed by a continuously changing marketplace. Most noteworthy among these challenges are the intense competition due to the globalization of economies and the liberalization of markets and the growing demand for high-quality, organic, resource efficient and less environmentally damaging products as well as and the emphasis on traceability and social responsibility.

A supply chain based development approach with a focus on effective resource conservation and management that also addresses environmental and social issues can help in dealing with these challenges. If effectively implemented, such an approach can have a positive impact on: (i) ensuring sustainable supply of natural resources/ raw material/ other inputs, (ii) profit margins of the SMEs and primary producers, (ii) sustaining employment in these sectors, (iii) offering access to better market to small and medium entrepreneurs, and (iv) create business linkages with large national and international buyers. Such developments will have a number of co-benefits like better quality of life for workers and their family (better access to education, health and other facilities due to sustained and better earnings), better and safe work place environment etc. It will also help in building a responsible and sustainable relationships among supply chain actors and enhanced resource efficiency, food security, responsible production and trade. In India, a number of similar interventions have been supported through policy changes, technological input, institutional reforms, changes in practices etc. along the value chain of key sectors with positive impact on resource conservation and overall bottom line, particularly for the primary producers and SMEs. The knowledge from these initiatives has high value for replication and scale up in other countries in South Asia region, which have quite similar socio-economic & institutional construct along with similarity in production and manufacturing practices. This knowledge base can also facilitate the development process in these countries by providing access to learning (from both successes and failures), to enable them to make informed decisions.

The project on “promoting resource efficiency along the value chains of key sectors in South Asia”, aims at capitalizing on this potential by promoting Indian best practices/ technologies/ policies in key sectors in the focus countries (Bangladesh and Nepal) of South Asia. The project will also facilitate multi-stakeholder dialogue (policy makers, industry associations, major brands, SMEs, financial institutions etc.) to facilitate cross-sectoral coordination, policy reforms and better access to financing options.

As shown in figure 1, the proposed initiative would focus on two most promising sectors in each country, where resource efficiency measures would be piloted. The identification of these two sectors is an important stage in the project and needs to resonate well with the priority areas of the local stakeholders and should also be viable for substantial improvement in both energy and environment performance (in terms of reduced global as well as local emissions, water savings, waste minimization/ recycling etc.) through focused technical assistance, capacity building, fund facilitation, and hand holding support. An added advantage would be derived if the chosen sectors are agro based and source their inputs from farmers (textile, tea, sugarcane etc.) or other smaller entities as then the benefit of greening the supply chain can be expanded to a wider stakeholder base addressing the issue of poverty alleviation in line with Millennium Development Goals. As the focus of intervention will also be on addressing social issues around workplace safety, livelihood sustenance, working conditions etc., it is important to target sectors where these issues are significant and need urgent attention.

Figure 1: ***Approach proposed under the project (items in box illustrates the scope of this report)***



This report provides details of the two sectors that have been identified in each country, their selection approach and the parameters used to assess their potential for supply chain intervention. Each of these sectors have been further analyzed to understand the supply chain structure and functioning, the relationship between different actors along the chain to help the initiative go beyond single production process, get an overview of the scale of operation, importance for the local economy, policy environment, resource use trend, saving potential and social environment.

2. Identification of sectors and parameters to assess their potential for intervention

The two most promising industry sectors in each country was identified based on a two stage selection process. Firstly, a list of key attributes were used to assess their potential for resource efficiency along with prospect for reaching out to small holder farmers, producers and SMEs along the supply chain.

A total of ten (10) attributes were used for assessment at this stage. These attributes broadly covered four areas of assessment viz. Resource intensity, Economic, Institutional and Social. The information on these parameters was collected through secondary research. A brief description of these attributes is provided in sec. 2.1 to 2.4.

2.1 Resource intensity Attributes

Resource efficiency/savings potential

Resource intensity is the amount of water, energy, raw material, chemicals etc used in production at different stages of the supply chain and the waste/ effluent discharged, and is an important attribute to gauge the potential. This attribute will help in assessing the scale of resource efficiency impact that can be created by enhancing resource productivity, savings, waste minimization and recycling through technological intervention and changes in existing practices.

Resource use nexus and issues

The pattern of use of any particular resource (land, water, energy, forest etc.) is interlinked with other resources within a sector as well as with other sectors and quite often management practices in a particular stage of a supply chain can have a positive or negative impact on the availability or scarcity of a particular resource for one or several sectors. Therefore this is an important parameter to select and assess the potential of its impact through supply chain intervention.

Scale of environmental impact

The use and abuse of resources in a particular sector can have far reaching environmental consequences on its availability (fossil fuel, water, land, forests) and environmental pollution through surface and ground water contamination, land degradation, emission of GHG/ particulate matter/ black carbon etc. having spillover effect on social aspects like health, drinking water, contaminated living and working conditions. The severity of environmental impact along the supply chain of a particular sector is therefore of high significance for assessing the potential for intervention.

2.2 Economic Attributes

GDP share/ Export share of the sector

The high share of contribution by a particular sector to the GDP and export earnings of a country is an important parameter for promoting economic growth as well as poverty eradication in a country. These sectors therefore become important for intervention because sectors which are particularly dependent on export are currently facing intense market competitions from other countries on quality and price and there is also increasing pressure to adhere to environmental and social standards of production/ manufacture. Intervention through supply chain can help these sectors achieve better profitability through resource efficiency measures and also achieve accreditation to international standards/ norms.

Employment potential

A sector providing employment to large workforce means that resource conservation in these sectors will be important for its sustenance and for ensuring sustenance of livelihoods of the people dependent on them. Better profit margins through resource efficiency measures will also help in growth of the sector creating additional livelihoods option.

2.3 Institutional Attributes

Presence of a strong cooperatives/proactive industry association

The presence of a strong industry association/ cooperative in the cluster also plays a positive role. Responsive office bearers of an active industry association/ cooperative can play the role of a catalyst to motivate members adopt resource efficiency measures and help create wider impact. Other aspects considered included, awareness created about the imperative of dealing with resource conservation issues, success or failure of any past intervention in this area and the urgency of dealing with the environmental and social issues and expanding the existing market.

Scale up potential

The sectors chosen for intervention must have high replicability and scale up potential, which is directly linked to the total number of farmers/ primary producers and manufacturing units within a sector, and number of clusters in which the sector is spread. This is important for the spillover effect and in the expansion/sustenance of the proposed activities beyond the period of project intervention.

2.4 Social Attributes

Supply Chain Stakeholder profile

This factor is of particular importance particularly to understand the nature and number of stakeholders that can be targeted through the supply chain intervention in a sector. For agro based sectors like sugar, tea, textile etc. that source their raw material from farmers or are reliant on agricultural produce would provide an opportunity to reach out to small holder farmers. Similarly, sectors where SMEs are involved in processing and manufacture of semi-finished/ finished products will help in targeting small and medium entrepreneurs. Therefore stakeholder profile of a particular sector would provide an assessment of the range and scale of stakeholder group that can be targeted through the intervention.

Occupational Health, Safety, Work place environment

As the primary produces and SMEs operate on very small profit margins and that too on account of low wage rates, the health and safety issues of the workforce is the last priority for investment. The workers in some important sectors work under extremely harsh conditions with no protective gear, in many cases leading to accidents, health problems and respiratory diseases. The intervention in this area would be dependent on enhancing the workplace environment and safety through resource conservation measures.

Social economic issues (gender, children, migrant workers-quality of life)

Many important sectors in focus countries face issues related to child labour, basic amenities for the workers (especially women), access to health and education facilities for the workers and their family members, workplace drudgery etc. Although there are policy provisions for dealing with many of these issues but their enforcement generally remains a challenge. Quite often intervention in these areas require a change in mindset, awareness and not necessarily investment. The potential for impact in these areas would depend on the practicality of addressing these issues through supply chain intervention in a sector.

2.5 Important factor highlighted by Stakeholders for selection of a particular sector

The above parameters helped in identifying the potential of supply chain intervention in achieving intended resource saving and environmental impact in the identified sectors. This assessment was then used for discussion with key stakeholders in the second stage. The stakeholders consulted include policy makers, industry associations, development agencies, Cooperatives etc. The key parameters used for discussion with these stakeholders to finally arrive at two sectors include- relevance to local priorities/ economy, resource saving potential, policy imperatives and sectors where Indian experience, learning and technologies are valued. The manner in which the discussions around these factors helped in identifying the most appropriate sector is as follows:

- ***Sectors where Indian experience, learning and technologies exist:*** The discussions helped in identifying the sectors where Indian experience from implementation of different policy/ regulatory measures, technology and practices were valued and stakeholders expressed interest/ demand for facilitating knowledge exchange.
- ***Policy imperative:*** The discussions helped in identifying the sectors which were high on the priority of the policy makers for dealing with urgent development issue/ environmental challenge/ important social issue, which were negatively impacting the growth of those sectors in the country. It also helped in identifying sectors where there were policy impasse around resource management aspects, adversely impacting the interest of different actors along the supply chain.
- ***Resource saving potential:*** The discussion on this parameter helped in identifying the relative resource saving potential with different actors along the supply chain. The feedback from the stakeholders based on their field experience on the practical viability of the interventions helped in identifying the most relevant sector.
- ***Responsiveness of producers/ entrepreneurs:*** Responsive entrepreneurs and producer along supply chain would be important for adoption of new practices and technologies in a sector. The interaction helped in gauging their initial motivation.
- ***Relevance of the sector to local priorities/ economy:*** The discussion on this aspect helped in identifying the sector which were high on priority of the stakeholder group, particularly for increasing the export share, accelerating growth and ensuring sustainability of resource supply and use.

Based on the attributes and the approach highlighted above, the focus sectors identified in the targeted countries is as follows:

1. Nepal: Tea and Sugar
2. Bangladesh: Textile and Brick

The following section provides factsheet for each of the chosen sector on the above attributes followed by a detailed sector assessment.

Chapter 2
Sector Assessment - Tea (Nepal)

1. Context

Almost two third of Nepal is covered by hills and fragile mountains, which offers ideal climate and geography for tea cultivation. It's warm and humid climate with plenty of rainfall and long duration of sunlight is best suited for effective growth of tea bushes. Accordingly, Nepal's middle and eastern Himalayan corridor and the Terai have developed in to tea producing belt. Tea is grown in more than 16000 hectares, producing both Orthodox and CTC (Cut Tear & Curl) types of tea. Nepal has more than 85 tea estates and about 8000 small tea farmers. There are 13 orthodox and 23 CTC tea processing factories producing more than 13.68 million kg of tea. Land area used for tea cultivation is increasing by approximately 11% per year.[1]

CTC type tea, which has a strong colour, is cultivated mainly in Jhapa District of the Terai region at lower altitudes. About 12.03 million kg CTC tea is produced per year out of which small farmers produce about 35%. Land used for producing CTC type of tea is 8976 hectares. Currently, 50 tea states, 700 small farmers and 23 tea-processing factories are engaged in CTC tea production in Nepal (NTCDB). Tea grown in high altitudes is processed to produce Orthodox type tea. It has lighter colour, better flavour and good aroma. The total land area under orthodox tea plantation is 7036 hectares. This industry consists of more than 35 tea estates, around 7000 small farmers and about 13 tea-processing factories. Currently Nepal is producing more than 1.55 million kg of Orthodox tea of which small farmers' contribution amounts to 68%.[2] More than 90% of orthodox tea is exported to India and overseas countries and the rest is partially used for consumption and partially for blending purpose in black tea to impart good flavour. The major hill districts for orthodox tea production are Ilam, Panchthar, Dhankuta, and Terathum.

Table 1: Status of Tea production in Nepal

S. No.	Particulars	Orthodox		CTC		Total	
		Area (ha.)	Production (kg.)	Area (ha.)	Production (kg.)	Area (ha.)	Production (kg.)
1	Garden	2805	542090	6107	7901817	8912	8443907
2	Small Holder	4231	1113060	2869	4131270	7100	5244330
3	Total	7036	1655150	8976	12033087	16012	13688237

Source: National Tea and Coffee Development Board (NTCBD)

Due to its high potential for export, foreign exchange earnings, employment generation and economic growth, Government of Nepal has accorded high priority to Tea in their Agricultural Perspective Plan (APP) and industrial policy providing support for expansion of area under tea plantation, subsidy for processing and expanding export market. All these efforts have contributed to high growth rate in the sector, which has recorded almost eight fold increase in plantation area and 9 fold increase in tea production over the last two decades. The number of small tea farmers has also increased by more than 15 fold in the same period. However, Nepal's yield per hectare is still lower than the major tea

producing and exporting countries in the region, with similar growing conditions. The agro-climatic conditions of the Nepal hills and North East India (Darjeeling) and Terai region products of Nepal are very similar to the Indian CTC, but the yield of tea in Nepal is much lower than that compared to India.

Table 2: Tea Production and productivity in Nepal & North East India

Indicator	Unit	Nepal		India		
		Hills	Terai	Darjeeling	Terai	Deoars
Production	Tonnes	1200	6300	10100	138800	35400
Yield	kg/ha	287	851	566	1943	1864

Source: Tea Board of India for India; MOAC for tea yield in Nepal

The table 2 shows that yield in India is almost three times higher than in Nepal. Similarly excessive, indiscriminate and incorrect use of chemicals, fertilizer, insecticides and pesticides by the Nepali farmers has led to establishment of their dubious reputation in international market of being producers of tea with higher than accepted pesticide residue levels rejected by most buyers in the EU, North America, Japan, Australia and New Zealand. The quality of the orthodox tea is also not consistent, as there are differences recorded in the same classified grade in leaf and liquor properties making it difficult for orthodox teas to be sold in big parcels. A major reason for this is irregular electricity supply where interruptions, affects quality due to machinery downtime and increases the cost of processing. The Indian Darjeeling tea in similar agro-climatic conditions as Nepalese Eastern Himalayas has at the same time earned a global reputation for its aroma and quality. This has been achieved by taking several measures to address sustainability issues in the tea sector by targeting social, economic, agronomic and environmental aspect, which has helped in improving the competitiveness of Indian tea sector and also facilitates in achieving compliance with national regulations and international sustainability standards. Notable amongst these are the development and implementation of Plant Protection Code and multi stakeholder led 'Trust Tea' initiative, which have been designed to reach out to not just large estates but to small holder farmers.

Ministry of Environment, Nepal has requested the project team to facilitate knowledge exchange around these initiatives and review how learnings from such policy measures could be used to strengthen their existing schemes or whether new policy measures were needed. Ministry has also requested the project team to facilitate the development and implementation of a 'Sustainable Consumption and Production Policy' that would help them achieve sustainability, ensure growth & poverty reduction and longer term commitments of Rio +20.

In view of the above, review of different aspects of tea sector has been done in the following sections to (i) assess the resource saving/ efficiency potential, (ii) assess the institutional, social and economic aspects, and (iii) to understand the areas where there is demand for learnings from India experiences/ practices.

2. Resource Intensity in the tea sector

Resource efficiency/savings potential

Tea industry in Nepal is a highly resource intensive sector and the unsustainable plantation and processing techniques presently along its supply chain makes it extremely vulnerable and threatens the existence of bio-diversity rich ecosystems in which it is produced.

Energy Intensive. Tea processing is highly energy intensive. Different stages of tea processing like withering, rolling, drying, grading and packing of tea requires energy in the range of 4 to 18 kWh per kg of made tea. Different types of feed stocks are used to produce energy that are used in each of these processes, such as firewood, coal, electricity. Roughly 85 percent of the total energy used is thermal energy (fuel wood, coal), while the rest is in the form of electricity for the machines. Nepal's tea processing units are more energy intensive because of the use of inefficient and outdated machinery, requiring both high electrical and thermal energy, with energy costs contributing to 30-40 percent of the total processing cost. Drying, the most energy-intensive phase of tea processing, is mainly carried out using firewood from natural forests. Data from some tea processing units in Nepal indicate that 0.45 kWh of electrical energy, 4 kg of fuel wood and 0.7 kg of coal is required to produce 1 kg of made tea. Experiences of energy conservation from Indian tea sector indicates that savings of up to 20 percent of electrical energy and 20 percent of thermal energy is possible through conservation measures alone. On a conservative estimate, at current production level, this has the potential to translate in to saving of 1.4 million Kwh of electricity, 12.3 million kg of wood and 2 million kg of coal annually.

Forest degradation due to fuel wood required in tea processing. Along with forest conversion for tea planation, logging for fuel wood to meet the demand for tea processing, in particular, has caused extensive deforestation in Nepal. At the present production level of tea in Nepal it can be assumed that about 60 million kg of fuel wood is needed per year for processing. This on a very conservative estimate it would mean logging of more than 600 ha. of forest every year. Even if 20 % thermal efficiency is introduced in the tea sector it would mean conservation of 120 ha of forest land.

High fertilizer and pesticide use. For sustaining high productivity of tea, the soil needs regular supplementation with fertilizers. An average crop of 2000 kg made tea/ha is expected to remove around 100 kg nitrogen, 20 kg phosphate and 40 kg potash per ha per year from soil in addition to nutrients locked up in the plants. The high nutrient removals, low nutrient retention capacity of tea soils and the low fertilizer use efficiency are leading to decline in productivity, water pollution and reduced soil biodiversity. Nepal on an average consumes 142 g/ha of pesticides, however, the application of pesticides in tea plantation is 2100g/ha, which is on a very high side. Farmers on an average spend NR 8500 per year on buying pesticide. Fertilizer, insecticide and pesticides are all imported duty free through official and unofficial channels and are readily available. According to official data only, the import of insecticides and pesticides has increased by 118% in the past five years, but they also come in to Nepal through other illegal channels from India. These are available to the farmers at market prices and since there is no duty, are reasonably priced for farmers. Indiscriminate and high use of pesticides and insecticides and incorrect application cycles mainly in the orthodox areas, where the insect and pest presence is higher due to the dampness of the atmosphere, have caused the final product to contain more than the maximum level of residues permitted. This has caused environmental damage and an imbalance in the insect population.

Use of hazardous and banned chemicals/ pesticides. More than 20 different types of pesticide are used by the farmers in Nepal. The average application frequency of pesticides is five to ten times in one crop cycle of tea. Majority of pesticides belong to pyrethroids group. According to WHO classification of hazard, pesticide which was used mostly in the field fall under the category of

moderately hazardous group (Group II). Use of extremely hazardous pesticide endosulfan was also found in the field. High pesticide use is also impacting the export market as Nepalese tea gets a beating in the international market due to high quantities of pesticide residue level, considered harmful for health. The plant protection code developed by India can be used effectively in Nepal for dealing with these issues.

Damage due to pest attack. Tea is often produced in monoculture and therefore these plantations lack natural protection that is offered by diversity to pests. To combat pest attacks in Nepal a huge quantity of pesticides finds its way to the industry and this has led to indiscriminate use. However, despite high application, crop loss of 10 – 15 percent have been reported in Nepal. Integrated pest management can help in dealing with the issue of pest attack in an economical manner.

Poor management practices. Other reasons relating to sustainability and quality deterioration is related to over plucking. Most of the small growers and tea estate owners pluck more than four to five leaves and a bud to obtain more quantity, which leads to wastages and low price for output. In fact, plucking two leaves and a bud is most appropriate for making good quality tea. Factories are also not serious about good manufacturing practices. Good sanitary condition is required in the tea processing units for producing quality tea.

Conversion of Forests in to tea plantation area. One of the most harmful environmental impact of tea production in Nepal is conversion of forest area in to tea plantation. Most of these plots are being converted by small farmers, to develop it as a source of livelihoods. This is primarily because the forests that are cleared for tea cultivation is often located in more rugged and remote areas, which tend to be those with the highest biodiversity. Converting such forest area leads to species reduction. This issue is particularly important for Nepal because though the country covers only 0.1 percent of total world land area, it has 136 ecosystems and ranks 25th in the world in terms of bio-diversity. Loss of such bio-diverse rich area will not only have local impact but may have long term global impacts. As per the forestry sector outlook study of Nepal almost 70256 ha forest area has been encroached for different purposes of which 75 % is for agricultural purposes.

Soil erosion is another problem associated with forest conversion especially in hilly area. Considerable soil loss takes place before the plantations are fully established to protect the soil. If a forest is replaced with a tea plantation, the same surface area can lose from 20 to 160 tons of soil each year.

Resource use nexus and issues

The resource use nexus in tea sector in Nepal is very strong with tea plantation and processing dependent on forest for land and energy. Productivity enhancement on existing tea plantation area will reduce the pressure on forest conversion and accordingly thermal efficiency in tea processing using large volumes of wood can reduce tree logging for fuel wood. Conversion of bio-diverse rich forests and agricultural land to tea monoculture are degrading the natural ecology. Soil fertility is negatively affected by the same plot being used continuously for a single crop and by erosion, which is magnified because tea is often grown on slopes. Both inorganic and organic fertilisers are applied to compensate for this loss. All this leads to a negative spiral in which increasing amounts of agrochemicals are needed in order to maintain production in inverse proportion to the decreasing soil quality.

Scale of environmental impact

The environmental impacts due to unsustainable resource use in the tea sector is considerable. There is significant biodiversity loss when high biodiversity areas such as forests converted to tea plantations. Along with forest land use change, logging for fuel wood to process tea, in particular, has caused extensive deforestation. Energy consumption for tea processing is also high which is aggravated by often inefficient and outdated machinery. The injudicious and improper application of chemical pesticides have resulted in several problems such as resistance to pesticides, resurgence of pests, toxic residues in soil, water, air, and food stuff, elimination of natural pest enemies, disruption of tea quality and agro bio-systems. In recent years, Nepal is facing problem in exporting tea to Europe, US and even India due to pesticides and quarantine checks. More importantly, last year three country importers have detected pesticide residues in Nepal tea. European Tea Committee and German Tea Council have found the use of pesticides like Ethion, Monocrotophos, Phorate and Quinalphos, which are banned insecticides in Nepalese tea. Since the tea growers in Nepal regularly use these chemicals, the orthodox tea industry has started losing good markets.

Here move towards organic tea production, can help in dealing with negative impacts due to chemical use, maintain eco-friendly environment for better human health and produce high quality tea. However, the cost of organic certification is expensive for tea producers and processors particularly due to the cost of international consultants because of which the farmers are dissuaded from adopting it. Similarly, many international standards are not being widely adopted in Nepal due to high cost of implementation and also because many standards are not compatible/ suitable to local conditions.

3. Economic Attributes

GDP share/ Export share of the sector

At the present, the tea sector in Nepal consists of private producers, both large-scale tea estates and small-holders. It was not always so. Prior to the reforms initiated in 1993, there was a government monopoly in producing, processing and regulating the tea industry. With the introduction of multi-party democracy in 1990, a concerted push was made to liberalize all sectors of Nepal's economy and to invite private participation in sectors previously reserved for the government owned corporations. As a result, the National Tea Development Corporation (NTDC) was dissolved and its assets was privatized. With privatization of the tea business, along with reforms aimed at boosting the sector has increased the size of the sector significantly. As a part of an effort to promote Nepalese tea industry, the government in 2000 formulated the National Tea Policy. The primary goals of the policy were to provide financial incentives for encourage investment, ease the availability of land required to for plantations, develop institutions to foster export, market Nepalese tea and maintain quality. Additionally, the policy aimed to establish training centers to enable small farmers to participate in growing tea.

The liberalization of the tea sector has brought about some noticeable changes. With a view of increasing production, new districts like Kaski, Dolakha, Sindhupalchowk, Solu and Nuwakot have been involved in tea production as a result the tea industry is growing in size. During 1994-95, 3,100 hectors was used for the purpose of growing tea. This area has now increased to more than 16000 hectors. This increase in total land used for tea production shows that tea has become an attractive sector to invest in with prospects of high returns.

Corresponding to the growth in the total area used for growing tea, there has been a remarkable growth in the total tea produced by the tea farms. During 1994-1995, total amount of tea produced in Nepal stood at 1945 Metric Tons. By 2003-2004, the total amount produced rose to 13,688 Metric Tons now. Moreover, the share of the tea estates in total production has been declining. The steady growth of small holders' output gives a strong signal that the benefits of tea trade are not limited to tea estates owned by rich industrialists but are spread to local farmer with little or no access to capital. Until 2003, the volume of tea exported annually from Nepal was around 80-100 tons, after which the tea sector saw an exponential rise in exports of more than a thousand percent, largely as a result of liberalization in Nepal. Over the last 10 years, Nepal has become increasingly self-reliant on tea and import of CTC has decreased substantially. At the same time, there has been a growth in tea exports from Nepal. Although the value of the world's total tea export has had a negative growth rate of -1% per year between 1999 and 2003, Nepalese tea export has grown by 70% per year in value during the same period. Nepal earned Rs 2.04 billion from exporting 10,709 tonnes of tea in 2012-13 compared to Rs 53.9 million from 193 tonnes in 2002-03. More expensive orthodox tea is being exported to Europe and the cheaper CTC tea is being exported India and Pakistan.

Figure 1: Trends of tea plantation and production in Nepal

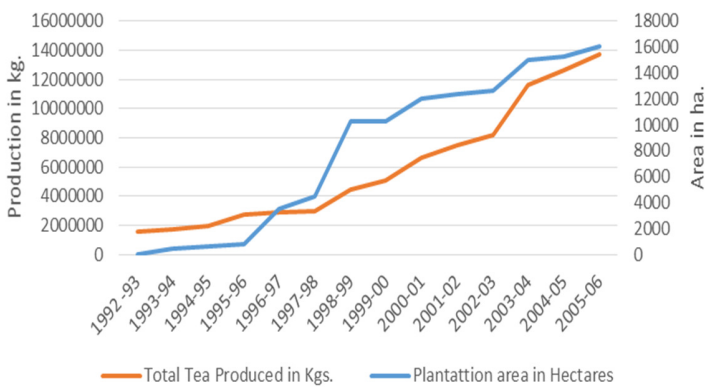
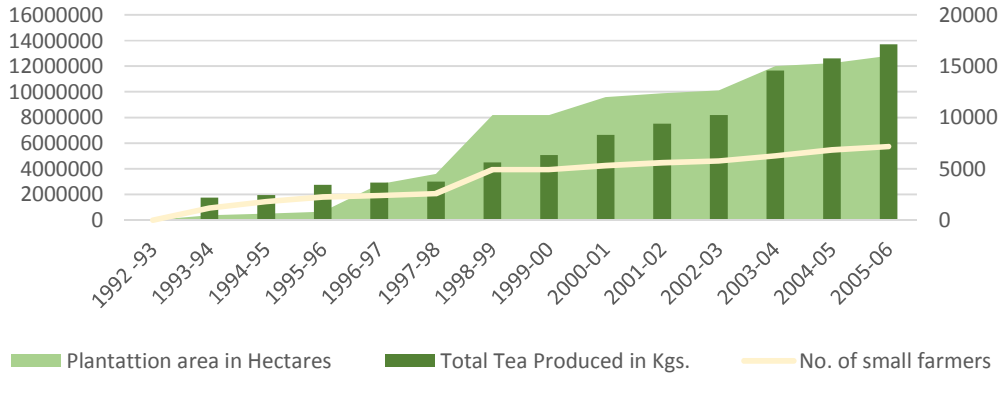


Figure 2: Growth trends in Tea Sector



Source: National Tea and Coffee Development Board

It is estimated that the average size of the land holding is around 0.60 ha per farmer. The contribution of tea estates and small tea farmers in terms of plantation area expansion and the tea production are reflected, respectively in Figure 3 and Figure 4. Throughout a period of a decade, the data shows that the contribution from small farmers, both in terms of increasing plantation area and tea production, was higher than from the private tea gardens in the total production of orthodox tea.

The growth in the output of small holders' provides a strong indication that the benefits of tea trade are not limited to large tea estates owners but are spread to local farmer with little or no access to capital.

Figure 3: Trend of Expansion of Orthodox Tea Plantation Area by Tea Estates and Small Tea Farmers of Nepal (1999-2009)

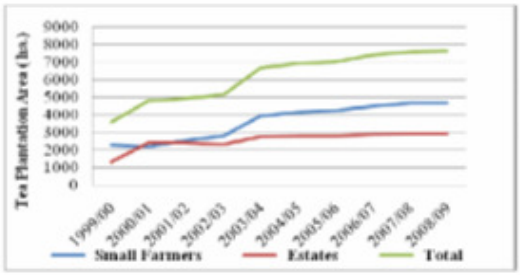
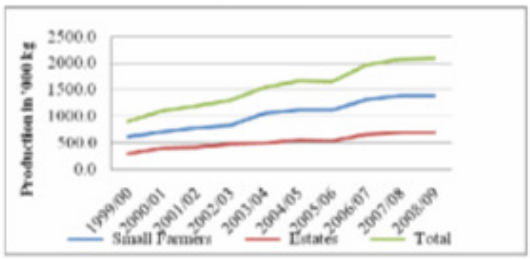


Figure 4: Orthodox Tea Production using Green Tea Leaves from Estates and Small farmers (1999-2009)



Source: Status Paper on Nepalese Orthodox Tea Sub Sector, May 2010, Tea Development Alliance

Employment potential

From a poverty-reduction point of view the tea sector is important because the growth in area used for tea production has been spurred by the participation of small holders. Their share of the total land used has grown from 20% of the total in 1994-95 to 68% now. The amount produced by the tea estates is only marginally greater than the total output from the small holders. A large number of farmers are attracted by this cash crop and given up traditional farming (when they used to grow multiple crops for their own consumption) to specialize in growing tea alone and using the profits to buy the essential food grains. As such, districts like Ilam, where the participation of the small farmers in cash crop is noteworthy, have come to be seen as "trendsetters" to farmers in other similar locations in the country, primarily because specialization in one crop has proven to increase the overall yield and promote commerce in agriculture outputs. The popularity of cash crops has, in turn, helped reduce poverty rates among small farmers in the tea growing regions. In Nepal, almost 27 thousand farmers are involved in producing, refining and selling tea.

The tea industry provides moderately higher farm wage rate for the workers with high participation of women. The estates and the tea factories provided employment to as much as 105000 people. As tea industry is a labour intensive industry, there is a great scope for employment of rural surplus labour and reducing migration from hills to the plains and towns.

4. Institutional Attributes

Presence of a strong cooperatives/proactive industry association

The growth and development of tea sector both Orthodox and CTC tea –production, processing and marketing in Nepal, took place after economic liberalisation process started in 1991 and efforts of private sector together with small holder farmers were crucial in much of the growth seen now in the tea sector. The tea industry began to be more organized and recognized as a potentially significant sector with the government bringing in the National Tea Development Board Act in 1992 and setting up of the National Tea Development Board (NTDC) in 1993. A National Tea Policy was introduced in year 2000 to support the growth of the tea sector as a whole. The Government divested its holdings of NTDC in 1996 so that the private sector could become the engine of growth for the industry envisaging that tea would be one of the major crops for poverty reduction in the rural areas and become a significant export earner. Much later, after 2003, efforts to organise farmers began with formation of farmers' association/cooperatives and district cooperative society.

There are number of farmers' organization, cooperatives, and associations involved in promoting tea in Nepal. Establishment of farmers organisations like producer's cooperatives and district cooperative unions are a new phenomenon and are in a process of development. A brief overview of the activities of some of the relevant development stakeholders like private sector commodity associations, and marketing cooperatives and other support agencies/organisations involved like government agencies, private sector facilitators, service providers etc. is provided below:

A) Commodity Association and Marketing Cooperatives

Himalayan Tea Producers Cooperative Limited (HIMCOOP) is the cooperative formed in 2003 for market promotion and marketing of tea. It is actively promoting the sales of Nepalese tea through various events, through participation at trade fairs around the world and direct contacts with buyers. It is acting as a joint marketing office, strongly committed to promoting Nepal tea in the international tea market. For this, HIMCOOP together with tea producers have developed a network of importers, sending tea samples and providing other necessary assistances (quality control, product information, price reassurance, marketing/trade fair participation, operational supports and advocacy etc.). Working together with HOTPA, the HIMCOOP has launched a Nepal tea brand in the international market as "Nepal Tea: Quality from Himalayas", which would stand for superior quality tea produced in an environmentally friendly ways in Nepal. GTZ/PSP –RUFIN had assisted HIMCOOP in promoting the brand and launching the brand in Germany.

Himalayan Orthodox Tea Producers Associations (HOTPA) was established in 1998 as an association of small tea growers, tea factories and tea estates. It seeks to promote Nepal's Orthodox Tea as a major export commodity and envisions producing the best quality orthodox tea while supporting the growth of a niche industry. This association has currently 23 members comprising of tea enterprises of three categories- tea estates, tea estates and tea factory combined, and bought leaf tea factories.

B). Private sector facilitators

Agro Enterprise Centre (AEC/FNCCI) was established in 1991 by the Federation of Nepal Chambers and Commerce and Industry (FNCCI). Its aim is to accelerate market driven, high value agriculture and forest based products and private sector led agriculture development in Nepal. Key activities undertaken by the institution are policy advocacy, market and demand analysis, trade and business

development, strengthening agro-commodity associations and market information services. It had played a very crucial role in bringing small tea producer farmers, private sector stakeholders like estate owners, processors, and exporters into a single platform. AEC is also a Tea Development Alliance partner and is currently functioning as the Alliance Secretariat.

C) Government Agencies

National Tea and Coffee Development Board (NTCDB): One of the major facilitating government organizations working in the field of tea is NTCDB formed under the chairpersonship of Minister of Agriculture, Government of Nepal. The NTCDB is the commodity board established on 1993 originally under Tea Development Board Act 1992 in Nepal. The objective of this board is to promote and strengths Tea and Coffee sector through policy formulation, Technical and managerial support. In August 2011, the government took a decision to split the National Tea & Coffee Development Board (NTCDB) into two institutions each looking after the tea and coffee sectors only. Currently, major activities of the Tea Development Board include:

- Encouraging tea farmers for tea plantation,
- Conduct observation tours, trainings for tea farmers
- Distribution of subsidised tea cutting (50% subsidy) and other materials
- Technical services related to tea farming through its extension programs stations at different places
- GoN has arranged a capital subsidy of 25% (on equipments/machineries) for establishing six orthodox tea processing factories at cooperative level
- For commercialisation of tea, it is extending financial supports to the tea stakeholders to participate in national and international trade fairs and organising seminars, and interactions
- Nepal Tea brand promotion with Nepal Tea Logo
- International Tea Committee membership (Nepal got Associate membership in the Committee)
- Tea database publication
- National Tea sector Development Strategy (2010-2014) preparation

Scale up potential

Commodity Association & Cooperatives like HIMCOOP & HOTPA and Private sector agencies like AEC/ FNCCI are major actors responsible for much of the past and on-going initiatives for the growth and development in the tea sector, starting from mobilization of small farmer and tea producers to the establishment of tea estates and processing industries and also in the tea market promotion in the international markets.

To bring about rapid scale up of sustainable management and production practices it is strategically important to link up with these institutions and reach out to their member base. HIMCOOP and AEC/ FNCCI have shown keen interest in learning from Indian best practices particularly because their biggest export market is in India and of late many of their consignments have got rejected both in India and other countries due to poor adherence to sustainability and quality standards. They feel that learnings from some of the recent quality control and certification measures from India would help them achieve international standards.

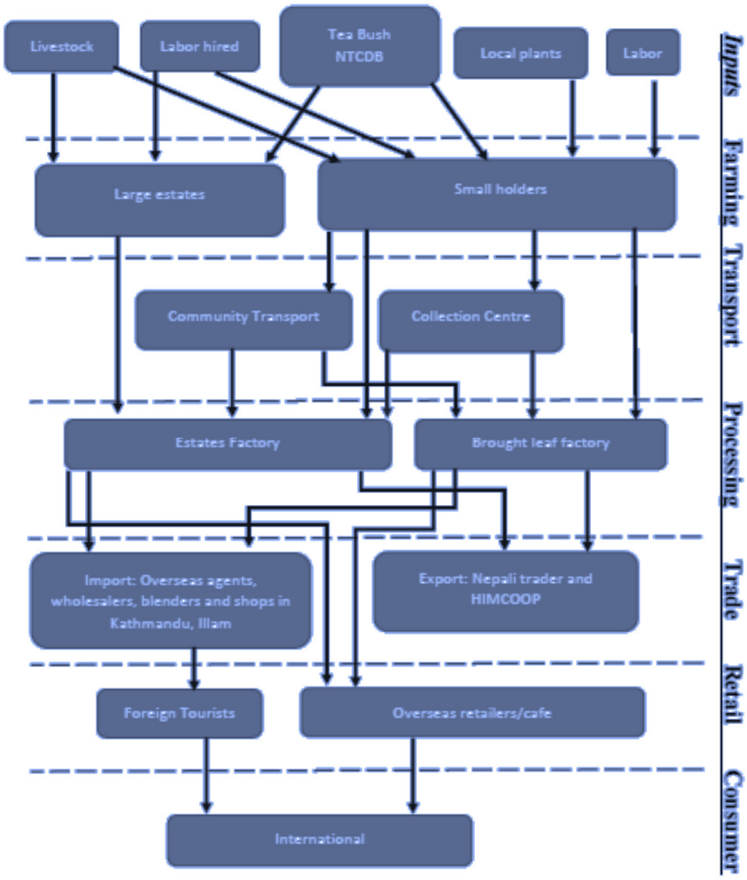
5. Social Attributes

Supply Chain Stakeholder profile

Value chain of the tea sector right from the sourcing of the raw material to final output is depicted in Figure 5. The figure also depicts the stakeholders involved in different stages and the value addition done at their level.

Primarily, tea estates (organised tea gardens), small tea farmers are at the first stage of the supply chain and one making most important contribution in the production of tea leaf which is then processed by tea factories operating at two levels (one factory with its own tea estate and one as bought leaf factory) for production of the made tea, which is marketed by tea traders and exporters, domestically and internationally.

Figure 5: Supply chain of the tea sector



Source: Institutions and livelihoods in Nepal's tea value chain, Sarah Mohan

The involvement of small tea farmers in tea plantation began in late seventies in Ilam. But number of farmers involved were very small until the Tea Extension/ Out growers Program in Ilam was launched by the NTCDB in 1995. The tea plantations have now spread to more than ten districts mostly involving small tea producer farmers. Although, it is officially reported that the number of tea farmers is around 7000 (NTCDB), local operators believe that there may be almost equal number or more of the farmers as tea planters, that have not been reported to the concerned authority.

Although the cooperative concept in tea plantation and processing started in eighties, the concept could not be realised successfully. However, with more and more involvement of farmers in the tea plantation, need for organised operations going beyond the group concept was realised by farmers from 2005. Gradually, a number of tea producers' cooperatives were conceived. As per the figures of 2009, there are already around 48 cooperative. To further coordinate and consolidate support activities required for these cooperatives, efforts are being made for establishing district level cooperative unions/associations. However, there are many more tea producing farmers who are yet to accept the concept of cooperative and form their cooperatives.

Second most important value chain stakeholder in the sector is the tea processors. Presently, there are 85 tea factories operational in Nepal. Besides, there are several bought leaf factories, which are exclusively relying on green tea leaf supplies by small tea farmers. All tea estate-owned tea factories also buy green tea leaves from small tea farmers within the vicinity.

Table 3: Share of different stakeholders in tea production in Nepal

	Plantation area in hectares					Tea production in kgs			
Year	Pvt.	NTDC	No. of small farmers	Plantation area	Total	Private	NTDC	Small Holders	Total
1992 -93						754000	860000		1614000
1993-94			1191	493		687000	982000	75000	1744000
1994-95			1788	644		837000	1009403	100000	1946403
1995-96			2243	828		1500000	1112329	125000	2737329
1996-97	1685	938	2390	879	3502	1800000	925942	180000	2905942
1997-98	2192	938	2591	1385	4515	1946455	603136	468980	3018571
1998-99	6073	938	4915	3239	10250	3577857	496881	418242	4492980
1999-00	6073	938	4915	3239	10250	3577857	496881	1010499	5085237
2000-01	8179		5310	3818	11997	5089579		1548503	6638082
2001-02	8179		5575	4186	12365	5864720		1653855	7518575
2002-03	8321		5760	4314	12635	6478000		1720000	8198000
2003-04	8869		6252	6143	15012	7694669		3956535	11651204
2004-05	8312		6845	6989	15301	7789893		4816188	12606081
2005-06	8912		7154	7100	16012	8443907		5244320	13688237

Source: National Tea and Coffee Development Board

There are more than twenty private sector firms which are involved in the direct trading of orthodox tea. Some of the firms are tea estates operating the whole value chains from garden to export and some are exclusively acting as exporters. Till early 2000, export of tea destined to countries overseas was exclusively through individual exporters, on a personal contact basis. Later on, as more and more efforts were made to promote Nepal Tea in the global market; a group of member took a lead in formation of HIMCOOP, which is now acting both as an exporter and a development stakeholder.

Occupational Health, Safety, Work place environment

Tea plucking, especially in Nepal's hilly terrain is difficult and hazardous work. Workers have to be on their feet for hours, carrying tea collecting baskets on their backs because of which many of them suffer back problems. The uneven terrain and sometimes steep slopes on which tea is plucked raises the risks of accidents and as a result fractures due to falling (from height) are quite common. In addition they are exposed to harsh weather conditions (hot, cold, wet), pesticides, mosquitoes and other insects, and poisonous snakes. Protective clothing, such as masks to protect oneself from inhaling pesticides when applying these chemicals, are often not provided or used. Many workers therefore suffer from respiratory as well as skin problems due to such unprotected application.

Social economic issues (gender, children, migrant workers-quality of life)

Smallholder tea gardens rely solely on casual (and family) labour. One important reason for this is that tea work is often seasonal, in other words the amount of work available may vary from month to month but also from year to year, depending on climatic conditions. Casualization of labour is a major concern, because workers are not guaranteed job security (contracts) and other benefits that permanent workers accrue.

In Nepal, workers in tea gardens are often isolated from mainstream society, which is a major constraints in providing them access to major health, educational and development initiatives and programmes of the government and other organisations.

Many workers, and temporary workers in particular, are paid at a piece rate, with a fixed price per kilogram of green leaf picked. The result is that worker income varies according to factors such as skill, working hours, health, strength and high and low season. Secondary labour provisions such as education, medical care, accommodation and food are sometimes provided or are included in the total wage of estate workers. In India, the wage rates of tea garden workers fall under the plantation

labour act (estates) and are generally fixed through bipartite agreement between the representatives of employers and employees of the tea gardens, which gives them better bargaining power.

On the large tea estates, workers live on the plantation site in houses provided by the plantation company as long as they have work. The living conditions here are also sometimes unsanitary and with poor basic facilities like drinking water, electricity etc.

6. Areas of Interest/ Demand for Knowledge Partnership with India

The Nepal tea sector after going through a spell of high growth in last two decades are faced with the challenge of addressing sustainability issues. These issues threaten their export market including those with India, which may in turn threaten the livelihoods of millions dependent on it. Nepal's agro climatic conditions as well as processing technologies are quite similar to North East Indian tea sector therefore many good practices and technologies introduced in India can find replication/ applicability in Nepal.

Many resource efficiency measures have been promoted by the Bureau of Energy Efficiency, Govt. of India in the Tea sector, which has the potential of enhancing efficiency and reducing at least 20 % energy thermal and electricity savings with a scope for replication in Nepal. This will help in dealing with the issue of forest degradation, reduction in wastages and enhancing the quality of tea.

The Nepal government has requested support in facilitating the development of sustainable consumption and production policy in Nepal based on learnings from similar policy measures in India. This they feel would help them in that would help them in achieving sustainability, ensuring growth & poverty reduction and also in meeting the commitments of Rio +20.

Trust Tea Sustainability Initiative

The trust tea is driving a multifaceted effort for continuous improvement of tea-producing farms and plantations. The founding members of the Trust tea were IDH, Hindustan Unilever and Solidaridad and the strategic partners were ETP, The Rainforest Alliance and UTZ, which helped in ensuring that the Trust tea code resonated well with international standards. For this the new code has largely been modelled on current internationally recognized standards and yet it takes into consideration the realities of Indian markets. The Rainforest Alliance is a strong endorser of the program as The Rainforest Alliance is directly involved in the program as the Technical Partner for IDH, Solidaridad and HUL. The India sustainability verification code will be benchmarked against ETP, The Rainforest Alliance and UTZ and will show the steps to be taken by producers to move from compliance with the India code to other certification codes if they so desire.

Apart from this Trust tea not just covers the tea processing units and estates, but also small framers. The trust tea program incorporates elements of management systems, product traceability, soil conservation, water management, agrochemicals, food safety, occupational health and safety, biodiversity and environmental management, working conditions, labour rights, and waste and pollution management. Plantation companies and smallholder farmer groups are encouraged to achieve verification against the voluntary trust tea code, while the program offers training programs and tools to help farmers & factories achieve verification and become more sustainable. The trust tea also incorporates the Tea Board's Plant Protection Code (PPC), which helps in dealing with the issue of minimum residue level due to indiscriminate use of pesticides.

The Tea Board of India announced that the program will certify capacity of at least 50 million kilograms of tea as sustainably grown by December 2014. The program has already verified approximately 4.3 million kilograms across Assam and South India. In the next three years, the program envisions verifying over 600 factories, covering 500,000 workers and 40,000 small holders, making 300,000 hectares sustainable, placing 1,200 trust tea trainers on the ground, and certifying 500 million kilograms of tea, amounting to 51% of India's tea supply.

There is a particular interest in learning from 'Trust Tea' sustainability initiative of the Tea Board of India. Under this program, the Indian Government has launched a multi stakeholders Initiative to develop a sustainable tea code based on Indian realities and globally accepted sustainability principles. The Tea Board of India later launched a **'trust tea code'** which is designed to evaluate the social, economic, agronomic and environmental performance of tea plantations in India and covers all aspects of tea production and manufacturing.

Learning from trust tea initiative (as well as PPC) holds potential of dealing with many sustainability issues that Nepalese producers and processers are facing (agronomical, ecological, resource use and social issues). Along with this it can also help in addressing the challenges around certification, where international standards are costly to implement in Nepal's low-margin business model, and the top-down one-size-fits-all approach of global certifications does not consider Nepalese conditions.

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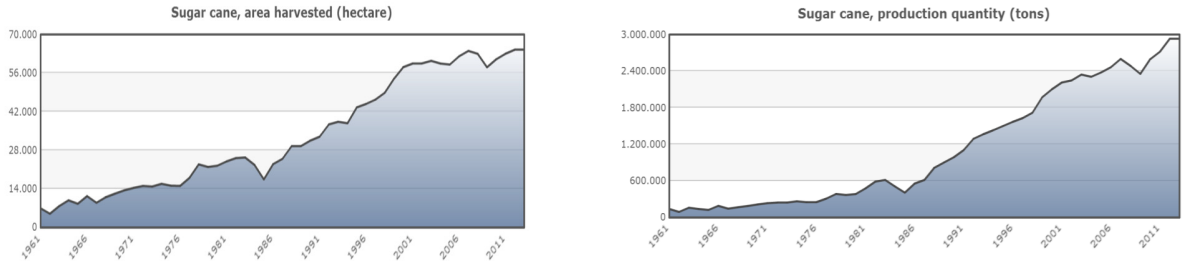
Chapter 3
Sector Assessment - Sugar (Nepal)

1. Context

In an era where there is a need for inclusive growth, the sugar industry is of significant importance to Nepal's national economy. It is also amongst the few industries that have successfully contributed to the rural economy. It has done so by commercially utilizing the rural agricultural resources to meet the large domestic demand for sugar and providing livelihoods to millions along its' supply chain both in production as well as processing of sugarcane. An estimated 0.2 million (200,000) farmers are involved in sugarcane cultivation. In addition workers are directly employed as agricultural labour involved in cultivation and harvesting. The sugar industry also supports diversified ancillary activities and skills that support the local economy. The dependent population creates substantial demand for local goods and services. Apart from this, large number of unskilled workers, mostly from the rural areas are engaged in the sugar processing industry.

Sugarcane is one of the major agricultural commodity in Nepal, which has seen a steady increase in production and area under plantation, over the years. Sugarcane was cultivated in 31,500 ha in 1990 producing 988,300 MT of sugar. The area under sugarcane cultivation has almost doubled now with 64,472 ha under the crop with total production of 2,930,047 MT. Figure 1 show year wise increase in area and production of sugarcane in Nepal.

Figure 1: Status of Tea Sector growth (Area and production) in Nepal



Source: Statistical Yearbook of Nepal 2013, Central Bureau of Statistics

Figure 1 clearly indicates that the increase in sugarcane production in the recent decades has mainly been from the expansion of the planted area. The increase in plantation area has also been because farmers, whose paddy fields were damaged due to flooding by covering them with sand, have shifted to sugar cane cultivation. The improvements in sugarcane yields have however, been only marginal since 1990s. The average yield of sugarcane in Nepal is 45 tonnes per ha. The National Agriculture Research Organisation (NARC), which is the agency involved in the agriculture research in Nepal have released a few varieties of sugar cane in the recent years, claiming they would give higher yield, however, there has not been much impact. India at the same time has come a long way in terms of improving its yield from 30 tonnes per ha in 1930s to around 70 tonnes per ha, now. This is a result of all round improvement in agriculture input, credit supply, varietal improvement, plant protection measures etc. A number of these practices and approaches would be relevant in Nepal, especially

those practiced in neighbouring Indian states like Uttar Pradesh and Bihar, which are also high sugar producing areas.

Not all sugarcane produced in Nepal is used for producing sugar. A part of the production is used for chewing and production of other sweeteners (which is referred as Chaku and Shakar). The actual amount of sugarcane used for production of these sweeteners has not been estimated in Nepal, but figures from neighbouring countries like India and Pakistan show that about 20-30 percent of sugar cane is used for this purpose. Thus only around 70 percent of the total amount of sugarcane is used for sugar manufacture, which is equivalent to about 1.8 million tonnes per year. There are 12 sugar mills in Nepal out of which 2 are government owned and rest are private. The capacity (tonne crushing capacity) of the sugar mills in Nepal is provided in table 1. Out of these the two government run sugar mills and two other private mills have closed down due to recurring losses. There are currently only eight operating sugar mills in Nepal with the total capacity for 19, 500 tonnes per day. This gives a total plant utilization factor of about 71 percent for a period of 150 crushing days per year.

Table 1: Capacity of the Sugar Mills in Nepal

S No.	Sugar Mill	Crushing Capacity per day (TCD)	Annual Crushing Capacity (tonnes)
1	Everest Sugar Mills	3000	450,000
2	Indushankar Sugar Mills	3000	450,000
3	Eastern Sugar Mills	2500	375,000
4	Sri Ram Sugar Mills	3000	450,000
5	Lumbini Sugar Mills	3000	450,000
6	Bagmati Sugar Mills	1250	187,500
7	Mahalaxmi Sugar Mills	2500	375,000
8	Birgunj Sugar Mills	1250	187,500
9	Vasuling Sugar Mills *	2500	375,000
10	Indra Sugar Mills *	1250	187,500
11	Morang Sugar Mills *	1250	187,500
12	Mahendra Sugar Mills *	3000	450,000
	Total	**27500**	**4,125,000**

Note (*)- Closed

Source: Department of Industry & Industry experts

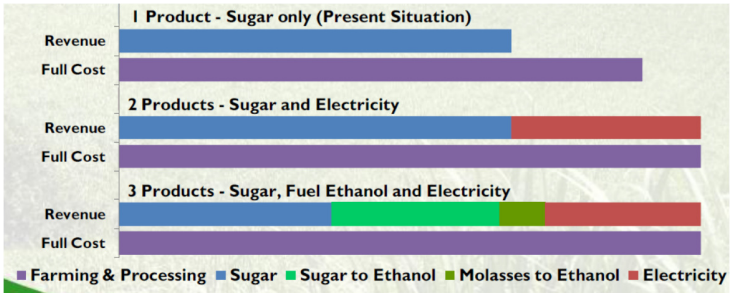
Nepal can produce 171,000 tonnes of sugar per year from the available 1.8 million tonnes of sugar cane assuming sugar extraction rate of 9.5 percent. Previously Nepal was reported as being self-sufficient in sugar production, but the country has recently experienced equivalent to two month (on an annual basis) sugar deficit. This is due to a no. of sugar mills closing down due to losses. As a result, sugar is being imported from India to make up for the gap.

The poor performance of the sugar industry in Nepal can be attributed to the complex web of resource use nexus and inefficiencies that are adversely impacting the sugar processing industry, which are gradually losing out on their financial viability and closing down. Similarly farmers are getting impacted due to price volatility on account of poor profitability of the sugar industry and market

dynamics. The sugar industry is not able to compensate the farmers adequately due to poor profit margins because of which they are either forced to sell at a lower price or let the crop dry in the field. Unlike India, there is no government regulations on sugarcane prices in Nepal, so the farmers' interests are not protected. The sugar mills also show their helplessness to pay higher prices due to poor profit margins that are causing many sugar mills to shut down. The profitability and price dynamics is also impacted due to Indian markets, where the prices of sugar have gone down, due to better productivity, better utilisation of industrial by-products like ethanol, bagasse etc. Sugar and sugarcane are smuggled from India hitting the manufacturers and farmers in Nepal hard. Investments in by-products are at a nascent stage in Nepal, and the sector is struggling to generate return on invested capital in excess of its cost of capital in most years, primarily due to a high cane price and a volatile sugar price. Besides, sugar industry, both in the agricultural and industrial stages, are causing severe damage to the local and global environment due to inefficient and unsustainable use of resources like water, chemicals and lack of productive use of its by-products.

Nepal presently has a 'sugar only industry' and the learning that is clearly emerging from many countries like India is that 'Sugar only industries are revenue un-competitive'. This is because sugar revenue is insufficient to secure sugarcane supply however, if sugar cane is used as a common raw material for both sugar and electricity then it can help in minimising the market risk (volume and price) and input risk (volume and cost of fuel). Sugarcane is a volatile agricultural commodity, where agricultural risks such as weather, drought and pests and exogenous financial parameters can risk its supply, however, this inherent risk to secure supply of sugarcane fibre can be partially covered by sugarcane fibre value. World's two largest sugar cane producers, Brazil and India, have already transformed to co-produce sugar, ethanol and electricity from sugarcane rather than just sugar. Thus there is a need for cogeneration of sugarcane fibre in Nepal and change from low to high energy efficiency.

Figure 2: Economics of sugar industry under different by-product use scenario



Co-generation of sugarcane to produce electricity particularly makes sense for a country like Nepal that is energy insecure. Nepal's energy demand is currently about 11.6 million units. The available energy system in Nepal manages to support demand of only 6.2 million units of energy which account to be 55 per cent of the demand. The traditional source meets the bulk of total energy demand with 85.5 per cent share, followed by commercial and renewable energy sources at 13.54 per cent and 0.61 per cent, respectively. Fuel wood, agriculture residue and animal residue provide 88.68 per cent, 4.85 per cent and 6.47 per cent of the total traditional energy consumption, respectively. The hydropower (renewable) generation potential of Nepal is estimated at 83,000 Mega Watts (MW) out of which 42,000 MW is commercially viable capacity. At present mere 0.75 per cent (i.e., 619 MW) of its total generation capacity is exploited. Nepal Electricity Authority (NEA), has coverage of 41.5 per cent of people with electricity. The annual demand of electricity has been steadily increasing by 9.3 per cent which indicates the new plant of size 60-80 MW is needed to meet the growing need of

domestic market. This demand alone can be met by the surplus power generation potential through cogeneration in existing sugar mills in Nepal.

In India more about 190 sugar mills are generating more than 2,000 MW of surplus power that is being supplied to grid. Apart from meeting the power need, optimum bagasse cogeneration benefits not only the sugar mills but also the sugarcane farmers as the value addition to their cane is enhanced and thus they can realise more money for it. Over the last two decades India has also developed low cost cogeneration technology in house, which has helped in its rapid scale up. All this development has been possible through the participation of all the stakeholders (Mill owners, Cooperatives and small farmers) with Government providing appropriate policy guidelines, regulatory framework and incentives. There is thus potential for replication of this successful experience to Nepal. It is in this context that the Ministry of Industries, Government of Nepal has requested the project team to facilitate knowledge transfer (technology supply, expertise, management practices) from India for promoting co-generation in sugar mills in Nepal and also help in review of existing policies based on Indian experiences to ensure its implementation and rapid uptake.

In view of the above, review of different aspects of sugar sector has been done in the following sections to (i) assess the resource saving/ efficiency potential, (ii) assess the institutional, social and economic aspects, and (iii) to understand the areas where there is demand for learnings from India experiences/ practices.

2. Resource Intensity

Resource efficiency/savings potential

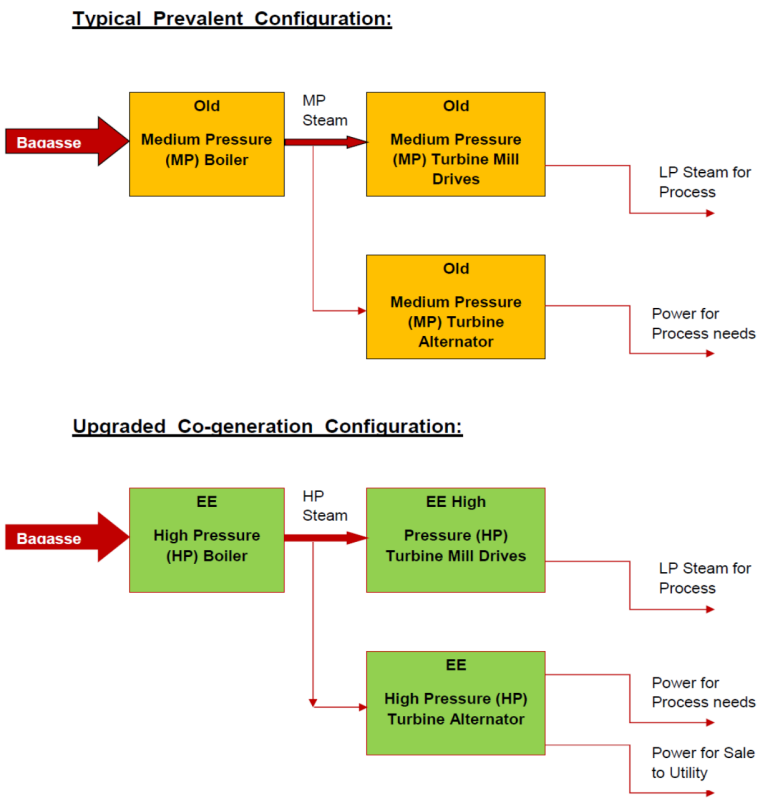
Sugar is a highly resource intensive and polluting sector, with widespread environmental and social impacts. However, this industry can be turned green by encouraging efficiency and productive use of by-product at the mill side; quality and productivity improvement at the farm side; and strengthening the farmer-miller relationship. This can help in ensuring sustainability along the supply chain of sugar sector in Nepal. Efforts are needed to introduce better seed varieties and adoption of improved farm practices for improving farm productivity. Fuel ethanol and surplus power production through cogeneration can provide two key by-products' related opportunities that can help ensure the financial viability of the sector. Some of the resource use impacts and potential for efficiency/ savings in Nepal's sugar industry are discussed in detail as follows:

Cogeneration for production of surplus electricity. The high photosynthetic capacity of sugar cane makes it an important source of energy. A comparison of the energy value of the cane biomass and the energy consumed in its harvest and cultivation shows a ratio of 20:1 (FAO). The sugar industry produces the by-product bagasse, which is not only capable of satisfying the energy demands of the factory but generating surplus electricity, with the consequent ecological and economic benefits. The present sugar mill in Nepal however are highly inefficient from an energy standpoint, since it has been so designed that they do not have any bagasse surpluses. Overall 29,30,047 MT sugarcane is produced in Nepal from which 21,99,282 MT sugar cane used to produce sugar in factories. This results in production 74,7755 MT of bagasse as per 2012 Central Bureau statistics. Twelve plants with TCD capacity varying from 12500-5000, aggregating to 27,500 TCD, produce sugar over a 100-120 day season. These traditional sugar plants were designed to obtain only their season specific captive thermal and electrical needs, for which they use low/medium pressure boilers, cogen turbine etc. of

small capacities. On an average, steam consumption for the process in the sugar mill ranges between 450 and 550 kg of steam per tonne of cane processed. However, consumption of under 300 kg / t is possible to achieve, with equipment well-known and widely used in the sugar industry in neighbouring country, India. Likewise, the furnaces in which the bagasse has traditionally been burned for steam production have energy efficiency rates of approximately 60-65%; whereas it is possible to achieve efficiency rates of nearly 90%, with heat-recovery designs and systems to reduce the final temperature of combustion gases. In this way although they are using the by-product to meet their own energy demand however this is only a fraction of total energy that can be generated from the by-product or in other words wasting a substantial portion of energy that can be generated from it. If however, they invest in technologies that can recover this energy and sell it to the grid they will be able to diversify their revenue source and enhance the profitability of their operations that they can pass on to the farmers.

As per technical estimates, the units with less than 5000 TCD capacity can opt for steam parameters up to 67 Bar at 480°C and those units with and higher than 5000 TCD capacity could opt for steam parameters up to 110 Bar at 535°C for maximizing power generation potential and benefiting through revenues from sale of surplus electricity, after meeting captive needs. With this broad assumption, one sugar mill would require upgradation to 87 Bar steam based co-generation system, five mills will require upgradation to 67 Bar steam based cogeneration system and six units will require upgradation to 45 Bar steam based co-generation system, with the same level of bagasse consumption. The potential gross generation of power will be of the order of 93 MW, of which, after accounting for 28.85 MW towards the power need of sugar mill for various processes and 14.06 MW towards auxiliary consumption there will still be about 50.8 MW of surplus power that can be sold to the grid.

Figure 3: Sugar mills: with and without co-generation



Source: Overview of cogeneration opportunities in Nepalese Sugar industry, NEEC

Production of surplus electricity from sugar cane through cogeneration will help in making productive use of by-product of the sugar processing industry for producing another valuable resource for the country. Improved use of by-products such as bagasse and molasses will also help in diversifying the revenue basket sources and reduce industries and farmer's vulnerability to sugar price shocks.

Sugar recovery. Sugar recovery is the parameter, which indicates the amount of sugar recovered as a percent of cane crushed in the mill. This percentage is in the range of 5-8 percent in sugar mills in Nepal due to obsolete technology and poor efficiency, which means loss of sugar in cane. In India energy efficiency and improved technologies have resulted in sugar recovery to the tune of 12 percent therefore there is a possibility of enhancing the current sugar recovery by 4-5 percent depending on the level technology currently employed and therefore represents a potential saving area.

Reducing habitat loss and impacts on biodiversity. In Nepal, historically, clearing of a forest area for sugarcane cultivation has been a major cause biodiversity loss. This is because sugarcane can be grown in areas cleared from forest and other marginal land, where other crops don't do well. The need for increasing production has been one of the prime reasons for this. Given the projected growth in domestic markets, the sector would need to produce at least by 5000 MT of sugar by 2017, which would put further pressure on habitat. Increase in sugar production can however be achieved through productivity improvements and increment in milling capacity of existing mills. The sector has the potential to improve sugarcane yields by 15 to 20 tonnes per ha. (from current 45 t/ha) and also improve the recovery by 50 points basis by 2017. This would enable the sector to produce additional 0.95 million MT of sugar.

Excessive water consumption in cultivation. Sugarcane is a water intensive crop and its industrial processing also uses large amounts of water. As per scientific estimates globally, about 1,500-3,000 liters of water is used to produce 1 kg of sugar. Over exploitation of water resources, diversion from rivers, and excessive use of groundwater is common in many sugarcane growing areas. Cumulative impacts of water use with expanded production can have negative impacts on water availability/ quality in the long run. Though this problem is equally precarious in India, there are experiences on use of technologies (general improvement from furrow/ alternate furrow irrigation to sprinkler to surface drip) that have helped in increased water use efficiency, which can be shared with Nepal. There are also experiences from schemes in India that provide financial support for ensuring adequate irrigation facility through canals, borewells, lift irrigation systems from rivers and intensification of micro-irrigation system in terms of promotion of drip irrigation programme etc. that can find relevance in Nepal. Similarly burning sugar fields is a common practice along both sides of border in India as well as Nepal. In India many scientific studies have proven that burning reduces organic matter, increases input use and reduces production. This knowledge base can be used to educate farmers.

Agrochemical use. Government of Nepal extends fertilizer subsidy to farmers with a landholding size of up to 0.75 hectares in the hills and mountains and up to 4 hectares in the terai (Himalayan foothills). There is also a provision for meeting the transport cost for 26 remote districts through a special program. Although these provisions are designed to help the small farmers they would impact the productivity and soil quality in the long run. In Nepal, soil acidification has been on the rise and it is reported that 80 per cent of the soil samples analyzed by the Department of Agriculture show acidic

features. Acidification stems from excessive use of nitrogenous fertilizers by poorly informed farmers using low quality fertilizer. To increase the crop productivity, management of insect-pest and diseases is of great significance. IPM measures and use of bio- fertilizer can help in dealing with a no. of these issues, where much research by Indian Agriculture department in similar agro-ecological conditions could be of relevance in Nepal.

Resource use nexus and issues

The resource nexus in the sugar sector is very complex and interlinked with land, energy, forest and water. Nepal relies heavily on biomass fuel as a result of lack of development of other energy alternatives and fossil fuel reserves. Fuel wood meeting 88.68 percent energy needs of Nepal are primarily met from forests and has remained the main source of energy for a long time. The theoretically estimated annual yield of fuel wood in Nepal is 25.8 million tonnes, or an average 2.8 tonnes per ha of forest. Forest resources are therefore under threat for meeting their annual energy needs of the country. In Nepal about 44000 ha of forest area is believed to be degraded and deforested annually, while only 4000 ha is reforested. Surplus electricity generation from the by-product of sugar industry has the potential for meeting a portion of the energy needs of the country and therefore easing out the pressure on forest fuel wood. Besides, enhancing productivity and use of better crop management techniques like IPM, optimum irrigation methods etc. in the existing sugarcane producing area, will also help in reducing land degradation, soil erosion, biodiversity loss and pressure on conversion of forest area.

Scale of environmental impact

Sugar mills at the time of processing produce wastewater, emissions and solid waste that impact the environment. A major portion of industrial waste discharged by sugar mills either reached directly to river or indirectly through run offs. Only Sri Ram Sugar Mills Ltd., has proper treatment plant of spent wash and wastewater. Rest of the sugar mills are operating in conventional way (lagoon system) without effective pollution prevention or control measures. Effective resource management, efficient use of by-products and reduction/ recycling of waste can help in reducing these impacts.

3. Economic Attributes

GDP share/ Export share of the sector

Nepal has primarily been an agriculture based economy, where the sector contributes 33 percent of nation's GDP (2007). Within Agriculture, cash crop sector contributes around 3% of the GDP. Cash crops like sugar is further important for Nepal's economy in two ways, viz. 1. Meeting the domestic demand for sugar, and 2. Sustaining rural economy by providing employment in production and processing industry. Nepal historically has been a net importer of sugar, but in the last decade it has doubled its production, to become nearly self-sufficient. This has been done by primarily by bringing new area under cultivation. Although this has helped in saving countries' precious foreign exchange, but has had a negative impact on natural resources.

The present utilization factor in sugar industry ranges between 30-35%. The growth trends in cultivated area, production and employment for the last decade indicate further growth in the sector.

Employment potential

The sugar industry has tremendous potential for employment generation along its supply chain. Almost 200,000 farmers earn their livelihoods through sugarcane cultivation. In addition, workers directly employed as agricultural labourers for cultivation and harvesting also depend on sugarcane cultivation for their livelihoods. Apart from this, large number of unskilled workers, mostly from the rural areas are engaged in the sugar processing industry.

4. Institutional Attributes

Presence of a strong cooperatives/proactive industry association

Agro Enterprise Centre (AEC/FNCCI): AEC was established in 1991 by the Federation of Nepal Chambers for Commerce and Industry (FNCCI). Its aim is to accelerate market driven, high value agriculture and forest based products and private sector led agriculture development in Nepal. AEC has been working actively in the sugarcane sector. Low yielding sugarcane varieties and a large gap between the domestic demand and production of sugar were the main reasons for AEC's intervention in this commodity, which started with a 30- month long trial production with Indian and Nepalese varieties on commercial plots of two sugar mills in 1995. The trial was conducted by NARC with full financial support from AEC. The AEC's support also included exposure visits for farmers and the staff of sugar mills to India. The progress that resulted from this support has been recorded by AEC, as good and having better multiplier effect.

Nepal Energy Efficiency Center (NEEC): was established under the umbrella of FNCCI as a wing handling all relevant issues on energy and resource efficiency of FNCCI and its partners. The mandate of NEEC is to become the leading national Centre of Excellence in the field of energy efficiency in Nepal, create a platform for exchange and development of energy efficiency knowledge, and act as a think tank for policy advisory services. Promoting co-generation in sugar Industry is high on NEEC's agenda and has carried out some preliminary research to assess the potential of this sector.

Nepal Sugar Mills Association: The active (nine) sugar mills in Nepal have created an association under the aegis of FNCCI. Although there are not much collaborative efforts been done by the association for the growth of the sector but, FNCCI is interested in expanding its role for technology updradation particularly for co-generation.

Scale up potential

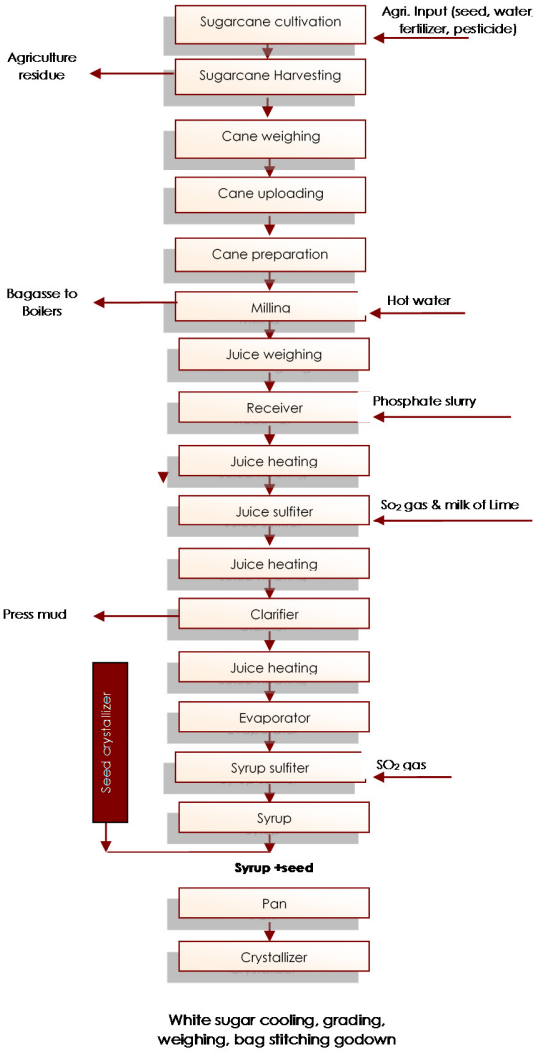
Associations like NEEC and AEC currently have sugar sector on their priority list. AEC in the past has achieved some positive impacts in promoting Indian crop varieties that helped in enhancing productivity on pilot scale. These results were then used by NARC to promote these varieties at the national level. AEC is interested exploring knowledge exchange with India around new high yielding varieties, improved crop management practices etc. They have a collaboration with NARC and Nepal's Ministry of Agriculture and will be able to use its leverage potential to reach out to a large no. of farmers through their extension services. NEEC is also interested in tying up with Indian technology suppliers and technical experts to promote co-generation in their sugar mills. They have the backing of the Nepal's Ministry of Industries and will be able to rapidly scale up their efforts.

5. Social Attributes

Supply Chain Stakeholder profile

The typical supply chain of the sugar industry is depicted in figure 4. Small and marginal farmers are involved in the cultivation of sugarcane. Large contract farming/ estate managed sugarcane farms are not prevalent in Nepal. Some sugar mill owners have their captive sugarcane plantation in Nepal, but the output of these farms only meet a small percentage of their requirement. These farms are maintained by some mill owners more as R&D site for testing out new crop varieties. A number of workers are involved in plantation and harvesting operations. Harvested cane is transported by the farmers to the mill. At the mill site skilled and semi skilled workers are involved in most of the operations. The workers cut the cane into small pieces, and shred them into fine fibers. The fibrized cane is converted into raw juice in the cane milling section, in which sugar in the cane is extracted. Mostly skilled workers are involved in this operation. The juice collected in different sections of the milling tandem, called mixed juice, is fed to the treatment and clarification section. The juice is treated with lime and other chemicals, and heated further. The heated juice receives sulfur dioxide (SO2) treatment in the juice sulphiter and is then sent to a clarifier where solid impurities are removed. The clarified juice is sent to rotary vacuum filter for further purification. The purified juice is boiled in a multiple-effect evaporation system in a boiling house. Here the juice is concentrated to 65% brix when it is called syrup. The syrup from the boiling house is again treated with SO2 in the syrup sulphiter. The sulphited syrup is then sent to vacuum pans installed in series for further concentration and crystallization. Centrifugal machines then separate the sugar. This process is called the double sulphitation process because sugarcane juice is treated with SO2 twice, first at the raw juice sulphiter, and later at the syrup sulphiter. The cooled sugar is then graded and stored in Sugar Bins. From the Bins, the sugar is taken out as per the requirement, weighed and packed in bags.

Figure 4: Supply chain of sugar industry



Occupational Health, Safety, Work place environment

The workers in the mills are exposed to hazardous working conditions. Burning of sulphur in the sulphur furnace for bleaching releases sulphur dioxide gases. This causes irritation to eyes, asthma and respiratory problems during production season of sugar both for the workers as well as for those

living close to mill premises. Besides, the sugar milling operations also releases dust, which again causes respiratory problems. The workers need to be provided with masks over the nose and mouth. Higher grades of protective masks are needed for people working in bagasse station, sulphur furnace and in sections where toxic gasses are released. Modern and improved filter needs to be installed in boiler's chimney, because all sugar mills in Nepal have traditional chimney, which is not efficient to catch fly ash and control air pollution.

Social economic issues (gender, children, migrant workers-quality of life)

The sugarcane growers are generally small farmers cultivating on marginal lands with poor productivity. Besides they are also vulnerable due to high level of variation in cane ex-factory prices. While the price of input remains the same the sale price keeps fluctuating. At many instances the farmers are forced to sell their output at par or below their production cost. There is no pricing policy of the government that safeguards their interest. In the event of loss on sugar cane production, farmers are forced to migrate to pay back the moneylenders (normally take credit to buy agriculture input)/ sustain their livelihoods that is further associated with a host of other issues like poor living condition, safety and security of women and children, out of school children etc.

There is also casualization of (and family) labour in the sector. One important reason for this is that sugarcane harvesting is seasonal, and the amount of work available may vary from month to month and from year to year, depending on climatic conditions. Casualisation of labour is a major concern, because workers are not guaranteed job security (contracts) and other benefits.

6. Areas of Interest/ Demand for Knowledge Partnership with India

Sugarcane sector is important for Nepal, both for meeting domestic demand as well as for generating livelihoods for millions. However, it is plagued with severe inefficiency leading to closure of a number of sugar mills despite increase in area and production volume of sugarcane over the years.

India was faced with similar situation over two decades ago but now it has emerged as one of the leading sector in the country that is growing consistently. India is now world's second biggest producer of sugarcane with 527 working sugar mills that crush around 240 million tonnes of cane per year and generate 80 million tonnes of wet bagasse also used for electricity generation. Electricity production through cogeneration in sugar mills in India is an important avenue for supplying low cost, non-conventional power. Indian efforts for promotion of bagasse cogeneration started with two pilot projects taken up in cooperative sugar mills in Tamil Nadu in 1988-89 for generation of surplus power and feeding it to the grid. Based on their success, government announced a programme on bagasse based cogeneration in India. A capacity of around 1854 MW of surplus power generation has so far been commissioned in 170 sugar mills. More than 200 MW of projects in about 20 private sector sugar mills are under construction. The sugar industry in India is now largely self-sufficient in energy needs and generating surplus exportable energy through cogeneration and contributing to reducing the energy deficit. The sugar industry is also the primary source of raw material for the alcohol industry in India. India achieved this through a combination of technical, policy and regulatory measures.

The Ministry of Industrial Development in Nepal has requested the project team to bring in technical expertise, knowledge and policy learnings from India in sugar sector with a view of encouraging

efficiency at the mill side particularly by introducing co-generation, and quality improvement at the farm side.

Surplus electricity can be produced in the sugar mills from the existing by-products that can increase their profit margins, enable them to pay better prices to the farmers/ hedge market price fluctuation to pay committed price to farmers, and help solve energy concerns of the nation. India is well positioned with matured technology and expertise to meet the demands of Nepal to provide technological support for promoting cogeneration in their sugar mills. Besides technical support, Nepal Government has also requested the project team to review their existing policy and regulatory environment and suggest reforms needed for promoting cogeneration, based on the learnings from policy measures taken in India, where Government took several steps at policy, regulatory and fiscal level to promote bagasse cogeneration.

Some key Policy, Regulatory and Fiscal measures taken by GOI

- The Electricity Act (EA) 2003 is the milestone of electricity reforms in India. The Act gave impetus to speedy diffusion of renewable energy by mandating the states to promote electricity generation from renewable energy. Provisions 86(1) (e) of EA 2003 mandates the states to "*promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licence ".* Amount of power which must be purchased from renewable energy sources by DISCOMs is known as Renewable Purchase Obligation (RPO). Further, Electricity Policy 2006 mandated the premium tariff to be fixed by SERCs and CERC for the renewable energy. Para 6.4 of the Tariff Policy stipulates "*Pursuant to provisions of 86(1) (e) of EA 2003, Appropriate Commission shall fix minimum percentage for purchase of power from RE sources in the region and its impact on retail tariffs*".
- India has implemented National Action Plan on Climate Change (NAPCC) released by Prime Minister of India in 2008. One of the important measures envisaged in the plan to deal with climate change is to enhance proportion of renewable energy into electricity generation. Total renewable energy electricity installed capacity targeted in the plan was 5% in 2010 and 1% increase every year up to 2020. Thus total planned installed capacity would be 15% by 2020.
- Renewable energy resources are not evenly spread across India. Further, few states rich in renewable energy have exhausted their potential. Therefore the Renewable Energy Certificate Mechanism (REC) was adopted in India in 2010 to enable interstate sale and purchase of electricity produced from renewable sources of energy.
- Special Feed-in-tariff is fixed by Central Electricity Regulatory Commission (CERC) for bagasse cogeneration and RPO fixed by the respective State Electricity Regulatory Commission (SERC) for each year in the bagasse cogeneration states.
- The financial assistance is being provided by Ministry of New and Renewable Energy (MNRE) for the bagasse cogeneration as capital subsidy for private, cooperative, public sector sugar mills. The BOOT/BOLT projects are being supported in cooperatives/ public sector sugar mills and for the boiler up gradation in existing cooperative sugar mills.

Similarly, productivity enhancement to the tune of 15 to 20 tonnes per ha. (from current 45 t/ha) is possible in Nepal by using better crop management practices, improved crop varieties and production techniques that are being used in bordering states in India. These regions have similar agro-climatic conditions as terrai regions of Nepal (main sugar cane growing area) and can have replication potential. Enhanced productivity will help in reducing the pressure on existing land resources to meet

the growing demand. Nepal is particularly interested in this as they have had good results from similar experiments carried out by AEC under FNCCI. AEC had carried out trials with two Indian varieties, which resulted in increasing the sugarcane yield significantly from 35 tonne/ha to 60-90 tonne/ha. The area under these varieties has now reached 2300 ha and is expected to increase further in the years to come. Similarly, the number of farmers involved in the production of these varieties in the command areas of the four sugar mills is expected to reach 2,000. Government is keen to provide supportive role for facilitating similar knowledge exchange and scale up such efforts by mobilizing a large number of farmers in the sugarcane growing regions.

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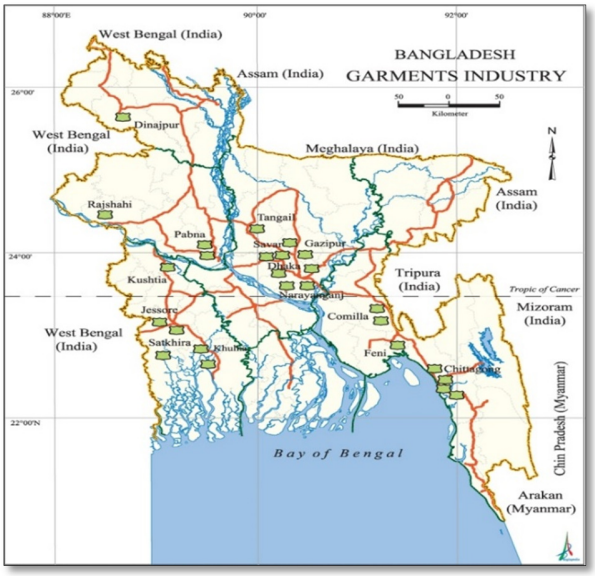
Chapter 4
Sector Assessment - Textile (Bangladesh)

1. Context

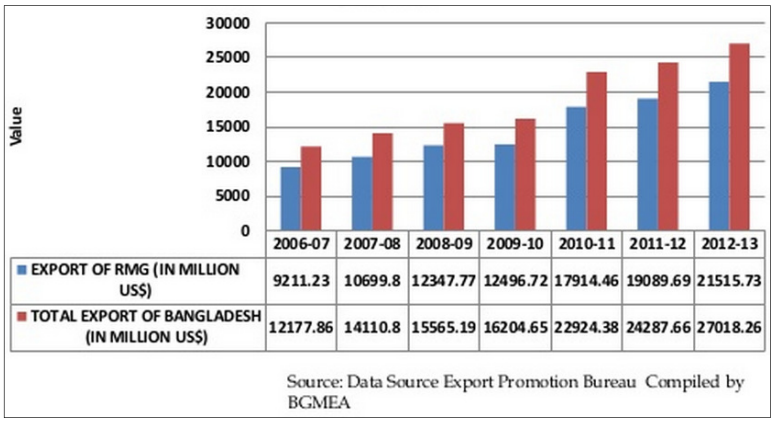
The Textile sector has been an integral part of Bangladesh's economy for a long time. The sector accounts for 15 percent of the total GDP of the country and has therefore assumed significance in the growth of economy, employment generation and poverty reduction. Accordingly the government of Bangladesh has provided various incentives for the growth of the sector for e.g. duty exemption on imports of raw materials, tax holidays and exemptions, reduced import duties on capital machinery and spare parts etc. Besides, the preference and assurance of market access to Bangladesh by some international agreements have further created opportunities for its growth and attracted the investors to the region. Major Engagements such as Multi-Fiber Arrangement (MFA), the Generalized System of Preference (GSP), and the EU‟s "Everything but Arms initiative" (EBA) etc. have been instrumental in bringing investments to Bangladesh.

Figure 1: Geographical Spread of the Garment industries in Bangladesh



The textile sector though caters to a significant proportion of domestic requirement, it is largely export driven. Bangladesh is world's second largest exporter of clothing after China. Country's annual exports is of the scale of $24 billion which accounts for 79% of the total export earnings of the country (Figure 2). The sector has shown sustainable growth over the last two decades and combined with good export performance the sector's development has contributed hugely to the economic and social development of the country.

Figure 2: Export of Redymade Garment (RMG) sector to total export of Bangladesh



	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
EXPORT OF RMG (IN MILLION US$)	9211.23	10699.8	12347.77	12496.72	17914.46	19089.69	21515.73
TOTAL EXPORT OF BANGLADESH (IN MILLION US$)	12177.86	14110.8	15565.19	16204.65	22924.38	24287.66	27018.26

Source: Data Source Export Promotion Bureau Compiled by BGMEA

The sustained increase in number of garment factories and demand for skilled workers have contributed to livelihood generation in the country. From a meagre 384 units with 1, 20, 000 workers during 1984-85 to 5400 hundred units with 4 million workers in the year 2013 (Figure 3 and 4), testifies the growth of the industry and contribution in the employment generation and consequently to the economy. The Textile Sector is currently responsible for 45% of all industrial employment and contributes 5% of the total national income. Besides, the sector has also provided employment opportunities to women and out of the current total work force engaged in the sector, 80 % are women.

Figure 3: Factory Growth in Bangladesh

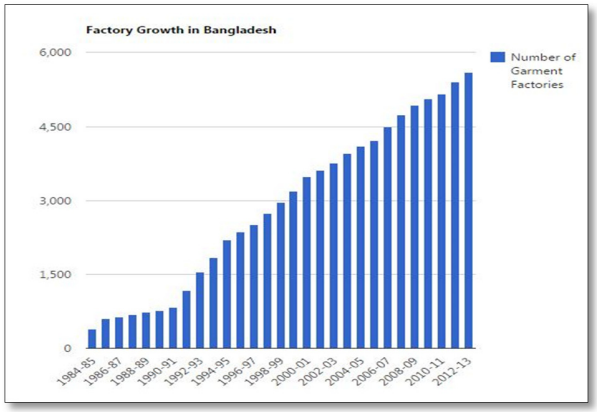
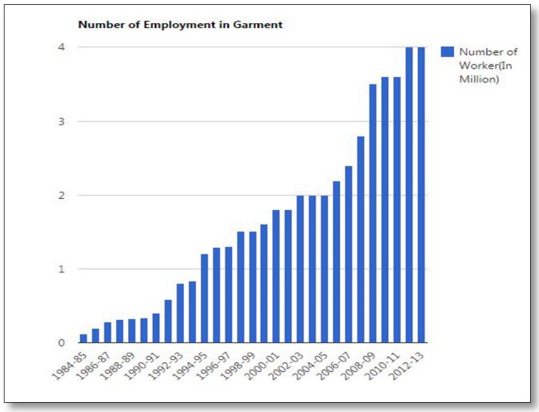
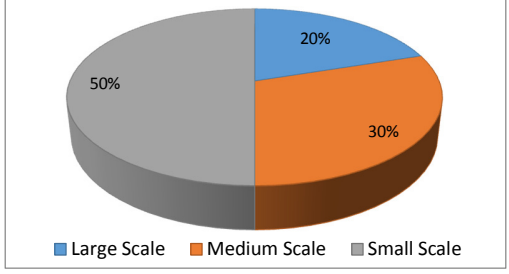


Figure 4: Number of Employment in Garment sector



Cotton is one of the important raw materials used in Bangladesh's textile sector. Thus domestic production only accounts for about 4-5% of the total requirement, the remaining 95-96% is fulfilled through import. This makes the textile supply chain highly vulnerable to price fluctuation/ other fiscal issues (exchange rate fluctuation, taxation regime etc.) of the international market. Price fluctuation impacts the small scale spinners and weavers the most, who are not able to cope with constantly increasing prices and are at constant risk of losing their livelihoods. The processing units of textile are primarily dominated by small scale mills, which account for 50 % of the total. Out of the remaining about 20 percent of existing mills are large-scale and roughly 30 percent are medium-scale mills.

Figure 5: Operating scale of Textile Industry



Although the textile sector is the backbone of Bangladesh's economy, it is faced by numerous challenges due to its' widespread environmental and social impacts emanating from haphazard growth, poor operating practices, complete disregard to sustainable resource use and production practices and bad working conditions. Although cotton farming in Bangladesh is done in a small area but the current practices are highly water, fertilizer and pesticide intensive leading to degradation of soil and water resources and further up in the value chain the processing of raw cotton into fabric uses large quantities of energy, water and chemicals and in effect discharging large amounts of GHG emission, effluent and waste water. Unfortunately, most of the waste water is currently discharged into a nearby water body or river through the drainage system and the solid wastes/ sludge are

disposed in nearby land or surface water body. Besides these, the operation practices and working conditions of the workers are very poor and exploitative. There are also fire and safety issues in the work place. Together these factors are having a negatively bearing on the existence of this sector threating the livelihoods of millions. This is particularly being felt because leading brands, multinationals and international buyers of late have started demanding for products that comply with sustainability norms. However, Bangladesh's textile industries are far behind it and at risk of losing the export market.

Realising the scale of the issue and the urgent need for addressing it, Bangladesh government has recently issued the Zero Liquid Discharge Regulation mandating all textile mills to ensure that no effluent is produced from their factory. However during the interaction of the project team with different stakeholders groups like the Department of Environment, small and medium size textile units, textile association and large brands it turned out that they were currently facing a lot of challenges in implementing it and there were many un resolved issues like: 1. the technical feasibility of implementing it (issue of retrofitting it in existing factory units); 2. Financial feasibility (cost, payback period etc.); 3. Practical implementation issue like lack of space in existing factory units to install effluent treatment plants; 4. Effectiveness in dealing with the environmental problems; 5. Issue of disposing large quantities of solid waste that would be created as a result. The stakeholder group has requested the project team to share learnings from the Tirupur textile cluster in India, where zero discharge regulation has been under implementation since three years and have dealt with similar issues. They have also requested for practical recommendations on what policy changes, financial provisions and institutional arrangements need to be put in place for implementation of 'Zero Discharge' guideline.

Some international Brands operating in Bangladesh are funding another initiative – 'Partnership for Cleaner Textiles Program' (PACT) that is being implemented by IFC. This project aims to reduce water footprint of the textile units in specific geographic clusters. They have also requested for information on the issue of Zero Discharge and requested the project team to dovetail efforts. GIZ is exploring ways in which the sludge produced in the textile sector can be effectively disposed. The project team is in discussion with them to see if it can be used as an alternate fuel in cement industry along with coal. IIP has supported a similar initiative in India, but in order to implement a similar initiative in Bangladesh it would require review of existing policy framework to explore whether it can be carried out within the existing policy and regulatory regime.

In view of the above, review of different aspects of textile sector has been done in the following sections to (i) assess the resource saving/ efficiency potential, (ii) assess the institutional, social and economic aspects, and (iii) to understand the areas where there is demand for learnings from India experiences/ practices.

2. Resource Intensity in the Textile sector

Resource efficiency/savings potential

The existing production & processing practices and technologies in the textile sector in Bangladesh poses a serious threat to the environment as well as to the surrounding ecosystem having widespread environmental, social and health impacts. The following section discusses the scale of problem

associated with different stages of supply chain/ resource use and possibility for introducing efficiency/ conservation measures.

Productivity, yield and duration of cotton Crop

Cotton is one of the important raw materials used in Bangladesh's textile sector. Annual requirement of raw cotton for textile industry of Bangladesh is estimated around 2.5 million bales. Out of this total requirement, local production is only accounts for about 0.1 million bales (BTMA). In Bangladesh the total land area considered suitable for cotton cultivation is estimated to be 2.42 lakh hectares, however, the area harvested in 2013-14 was 42,000 ha, with a production 144,000 bales or 26,182 tonnes. Bangladesh Government is focusing on enhancing the share of domestic cotton production, however, the country does not have a cotton research institute, which severely constraints these efforts. The Bangladesh Cotton Development Board (CDB) is the sole organization responsible for providing extension services to Bangladeshi cotton farmers, and also for conducting trails of imported cotton varieties/hybrids for cultivation. The CDB strategy includes an expansion of the use of new high yielding varieties, introduction of summer cotton, and gradually converting 20,000 hectares from tobacco to cotton cultivation. Notwithstanding these efforts, a lack of short duration, high yielding, and pest tolerant cotton seed severely constrains the expansion of cotton acreage in Bangladesh. Cotton cultivation is very susceptible to excessive rainfall/floods and pest infestations. Modern production technologies are not developed and even in places were knowledge is available, there is lack of effective outreach/ extension services for farmers. Further most of the existing variety are long duration crop that needs 6-7 month for production, which are highly susceptible to pest attack. In Bangladesh, the cropping intensity is quite high, where the farmers want to have maximum return from their land in a given time period. This is the reason why many farmers show reluctance in cotton cultivation. As such, a short duration variety of around 4.5 months combined with moderate yield is very much needed to satisfy the long felt demand of farmers. This type of variety can be accommodated very effectively in the cropping patterns of northern districts particularly where winter comes earlier than the other parts of country. More emphasis needs to be given on intercropping, relay cropping and cotton based sequential cropping. A lot of research has already been carried out for dealing with these issues by the Central Institute for Cotton Research in India, wherein an effective knowledge exchange can benefit the farmers in Bangladesh and also help the country achieve some degree of self-reliance in cotton production.

High agriculture input reducing profitability and impacting local habitat

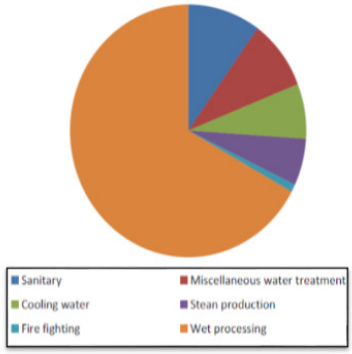
Similar to many countries, cotton in Bangladesh is major polluter crop due to the heavy and indiscriminate pesticide use, especially insecticides for Aphids, Jassids and cotton bollworms. The

number of insecticide sprays exceeds 15-20 per season bringing the cost of insecticides to more than 40% of total input costs and triggering pest resurgence and secondary out breaks. Important insect pests of American cotton in Bangladesh include the chewing insect namely American bollworm, spotted bollworm and pink bollworms and the sucking insects namely the Jassids, aphids and whitefly. Integrated Pest Management (IPM) is an effective way of dealing with this. A lot of experience on this is available in India. For e.g. hand picking of larvae followed by use of insecticides at economic injury level under IPM is found to be very effective and economical in controlling the attack of insect. However, farmers in most parts of Bangladesh are not aware of such approach. The farmers typically spray insecticides, which is not very effective in controlling pests, and also costs the farmers dearly. The cost of production of cotton can also be brought down for farmers by introducing concepts like reduced tillage, foliar application of nutrients, use of selective herbicides , IPM practice etc.

High Water Footprint

Water usage by the textile industry in Bangladesh is estimated to be 1,500 million cubic meters, principally of groundwater (ADSL 2009).The amount of water used in different processes in Bangladesh is depicted in figure 6. The majority of the water consumption (70%) takes place in the wet processing of textiles, which involves washing, dyeing, and finishing of textiles. Large amounts of clean freshwater, ranging from under 100 cubic meters to well over 300 cubic meters of water per tonne of textiles is typically needed for this process, depending on the nature and efficiency levels of the manufacturing processes.

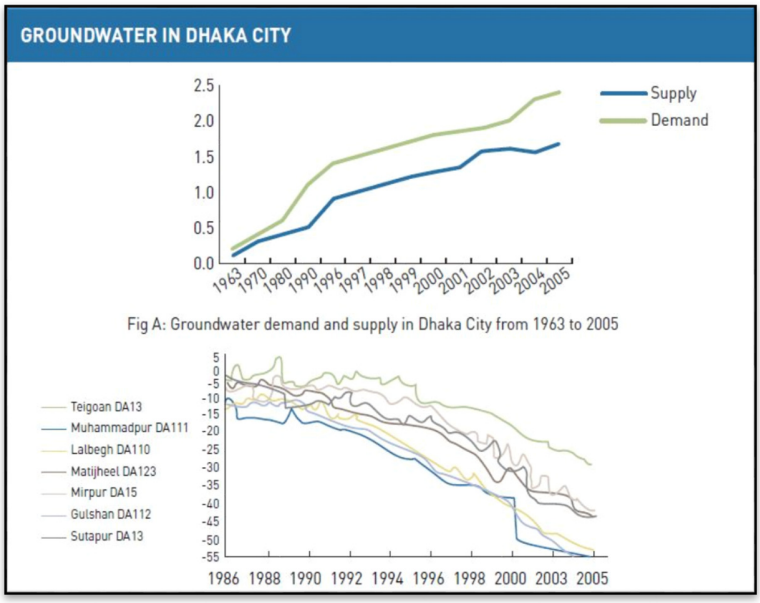
Figure 6: Bangladesh's textile industry water usage pattern



(Source: Research Journal of Management Sciences by Adnan Maroof Khan and Md. Mazedul Islam July

The rapidly expanding textile industry's demand for freshwater supplies is increasing pressures on scarce water resources in the urban areas in Bangladesh. At present, over 80 percent of the city is reliant on groundwater for domestic consumption and industrial uses. However, at the current growth rates, demand for water from textile mills is expected to double within the next seven years if no efficiency improvements are made and threaten the availability.The groundwater situation in Dhaka for example is particularly critical (figure 7). Various studies suggest that the textile mills in and around Dhaka may consume as much groundwater as is supplied to the entire megacity of over 12 million inhabitants. It is estimated that annual groundwater consumption

Figure 7: Groundwater hydrograph of seven observations well of Dhaka city from 1986 to 2005



Source: Akhter, Ahmed and Rasheed 2009

by washing and dyeing units in Dhaka is currently around 880 million cubic meters a year, based on the following assumptions: total annual fabric production of 5 million tonnes, average water efficiency of 250 cubic meters per tonne (conservative estimate), and around 70 percent of washing and dyeing units located in Greater Dhaka area *(ADSL 2009).* In comparison, the Dhaka Water Supply and Sewerage Authority currently obtain around 16,500 million liters per day from groundwater, or 610 million cubic meters a year *(Akther, Ahmed, and Rasheed 2009).* The absence of proper monitoring facilities allows the textile industries to extract excess amount groundwater. Groundwater over-abstraction has dropped the water level to more than 70 meters from the surface in some locations (IWM 2007). Moreover, the productivity of new boreholes have declined by almost a third between 1970 and 2000 (UNEP 2003).

Textile industry in Bangladesh uses 180 (low case) to 300 (high case) tons of water per ton of fabric produced. This is 2-3 times higher than the global benchmark. Considering Annual production of 2,760-4074 tons/ year (dyeing and finishing), the potential for water saving potential in low case and high case production could be 331200 and 488880 tons of water per year, respectively. Best practices from textile sector in India shows that benchmarking of usage patterns through use of flow meters (gas, water), insulating pipelines, replacing faulty steam traps, replacing magnetic ballasts in lighting system, standardizing the storage and disposal of waste, can help in minimizing this wastage.

To reduce the groundwater usage in the textile industry, Government of Bangladesh has decided to impose compulsory installation of zero liquid discharge effluent treatment plant (ZLD-ETP) systems. There are a lot of learnings from India in this regard. In India, this practice was implemented in Tirpur textile cluster of Tamil Nadu, however, initially it was not successful. Now, due to a series of policy measures and fiscal support it has been scaled up in the cluster. These learnings would be of tremendous use to the government and textile industry, who are currently faced with a number of barrier for implementation of Zero Discharge policy.

Untreated Effluent discharge polluting river and soil

Dyes used in the textile industry usually contain various organic compounds including different functional groups. Amine, carboxylic and azo functional groups are common among them. Azo dyes are the most commonly used dyes for textile. Azo dye produces aromatic amines and other degradation products that are highly carcinogenic (Szymczyk et al, 2007). Mostly these dyes are either trapped in bioflocs or adsorbed and not biodegradable under aerobic condition. Thus they pose serious environmental threat and affect the aquatic ecosystem. The average composition of textile waste water is shown in Table 1.

Table 1: Average composition of textile dyeing waste water

Substances	Values
pH	9,8 -11,8
Alkalinity	17-22 mg/l as CaCO3
BOD	760-900 mg/l
COD	1400-1700 mg/l
Total solids	6000-7000 mg/l
Total Chromium	10-13 mg/l

Most of the textile dyeing industries of Bangladesh does not have any ETP or waste water treatment plant. Therefore, the common practice is to discharge untreated effluent in to the nearby area and water body. These drainages are mostly connected to the nearby river or lake, which leads to the contamination of soil and water body. One of the most important rivers in Bangladesh, Buriganga River, is in a sorry state due to excessive discharge of untreated effluents from the textile industry. The textile industry also dumps their solid wastes and sludge at the bank of the river. As a result, the river has become highly polluted and lost the aquatic ecosystem. The Turag river is also important to mention as it is also situated in the vicinity of the industrial area.

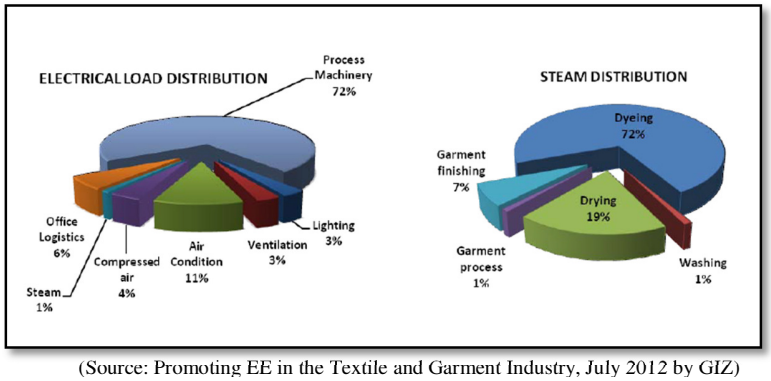
According to the recent regulation of Bangladesh Government all textile dyeing industry have been mandated to install Effluent Treatment Plant (ETP). The installation of ETP however involves high cost. Depending on the size of the unit and ETP plant may need an investment of approximately Takka 7-20 million as well as 1840-2760 m2 land. The operating cost for cleaning 1000 liter waste water also require expenditure of Taka 20-30. Therefore, local small factories are finding it difficult to establish ETP. Like India, most of the textile industries have emerged in clusters, where the practice of establishing a Common Effluent Treatment Plant (CETP) to cater to the needs of number of smaller units is practiced. Similar approach can be adopted in Bangladesh. Several smaller units in small cluster or area can jointly install and operate the ETP and share the capital and operating cost. This will help in achieving economy of scale and encourage the small scale factories to treat their effluents rather than discharging it illegally in natural water bodies.

Textile industry in Bangladesh also use coagulants and chemicals to treat the effluent. As a result large amount of sludge is generates from primary and secondary clarifiers. The sludge collected from clarifiers is dried in sludge drying beds and is sent to landfills. In India, textile sludge is being used in a number of productive ways, for substituting for raw material and energy requirements, in other industries. IIP in India has also been supporting a project to promote the use of wastes as fuel in cement industry. Some Cement Plants in India (UltraTech Cement) have also started using textile sludge in Kilns as alternative fuel. Aditya Birla Cement, Chittorgarh (Rajasthan, India) unit has been co-incinerating ETP sludge of about 1000 tonnes per month from textile mills from Bhilwara Industrial Area in the cement kilns. Textile industry has requested project team to share technology around this practice in Bangladesh.

High Energy intensity

Energy is mostly used to meet the electricity and steam requirement of the textile units. The energy needs for different processes/ operations in Bangladesh textile industry is shown in Figure 8. Textile sector mainly comprises spinning, weaving and composite (spinning, weaving and dyeing) units. Electricity and steam required for spinning units (on the lower side) has been estimated at 900kWh/MT and 1.53 times MT of yarn produced respectively.

Figure 8: Energy usage in Bangladesh's Ready-made Garment



(Source: Promoting EE in the Textile and Garment Industry, July 2012 by GIZ)

Weaving and processing units require higher energy. Composite units require 4,700 kWh/MT of energy comprising electricity and steam for processing each MT of material produced. Steam required for composite units was around 18.6 times (unit with lower steam consumption) the weight of fabric produced. As per an industry specific study carried out by SEFD, the total energy consumption in the spinning sector is estimated at 1,299 GWh per year and that for the composite (weaving and processing) is estimated at 4,426 GWh per year. Both amounts include steam equivalents.

Experiences from India demonstrate that a large cross-section of energy efficiency and conservation measures can be applicable in textile units in Bangladesh. Some of the common measures that can be carried out with low to medium investment would include Waste heat recovery of the exhaust of the gas generators & boilers; Improving efficiency of the boilers, motors and compressors; Heat recovery from stenter and dryer machines; Decrease inlet air temperature to the compressors; Use variable frequency drives (VFD) in compressors; Ensuring proper insulation in boilers, feed water tanks, steam lines; Using efficient steam traps and stop leakage of steam & compressed air; Maintain Power Factor Correction; Maintain Electrical demand side management (DSM) etc. The estimated energy saving potential in textile sector in Bangladesh is shown in Table 2:

Table 2: Estimated energy saving potential

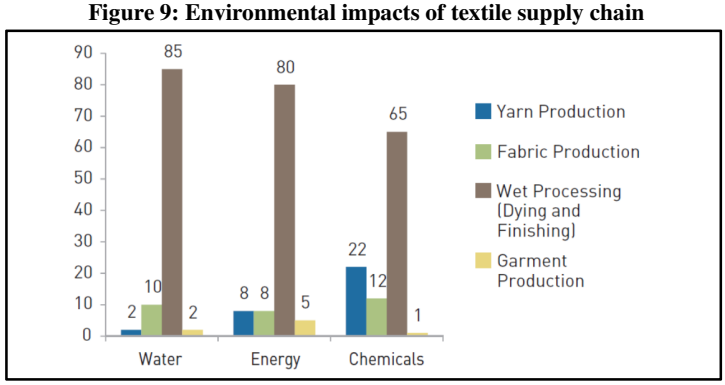
Parameters	Units	Spinning	Weaving& Processing	Total
No of units in Bangladesh	No.	350	4,595	4,945
Total Estimated Energy Consumption per year (GWh)	GWh	1,299	4,426	5,726
Total Estimated annual energy savings (GWh) in all plants	GWh	103	269	372
Savings on GHG(0,57 tons CO2 eqv./MWh)	Tons	19,640	51,089	212,188

Resource use nexus and issues

The complex un-sustainable resource use nexus in textile sector in Bangladesh while impacting land, water, energy resources is also threatening the natural river systems and its associated aquatic bio-diversity. The cultivation practices with high pesticide/ fertilizer use are degrading the soil and water resources. Although the area under cotton cultivation is small so the scale of impact is not wide spread, but the impact is being acutely felt higher up in the value chain due to inefficient resource use practices. Textile processing industry has a high water and energy footprint in comparison to the global average resulting in a consequently high GHG emission. The high usage of ground water resources and declining water table means high energy usage to draw water from greater depth and less and less water availability for drinking purposes. People in cities are increasingly using portable water, which in turn uses high energy producing large quantities of plastic wastes. High effluent discharge from textile units in to the rivers is gradually destroying the aquatic ecosystem, on which livelihoods of a large population is dependent and is also one of the primary source of food for people in Bangladesh.

Scale of environmental impact

Figure 9: Environmental impacts of textile supply chain



Source: Cotton Incorporated 2010

Bangladesh's textile sector has high levels of environmental externalities in different processing stages. The high environmental footprint of the textile units can be attributed to the intensive use of clean freshwater to wash, dye, and finish textiles, the associated generation of large volumes of wastewater and effluent that is discharged in to the natural water bodies and river systems, resulting in high environmental, health and social impact. The effluents with high COD and BOD contaminate the surface and ground water sources, destroying the agricultural field, causing water borne diseases and polluting drinking water sources. The high usage of energy generate GHG and particulate matter emissions, which pollutes the local environment and causes respiratory and health problem for the workers and people living close to the factories. Cotton Incorporated undertook a research to find out the scale of environmental impact of the textile sector in different production processes, which is depicted in figure 9. The figure clearly indicates that the wet processing stage of textile production is most environment damaging and needs urgent attention.

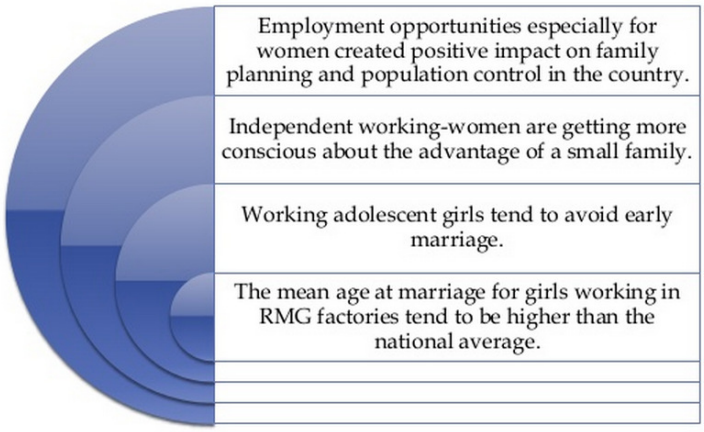
3. Economic Attributes

GDP share/ Export share of the sector

The economy of Bangladesh is largely dependent on agriculture. However the textile sector has emerged as the biggest earner of foreign currency. The textile sector has experienced an exponential growth since the 1980s and has been contributing significantly to the GDP. The contribution of the textile sector to GDP is 15 percent, next only to agriculture at about 19 %. McKinsey, projects Bangladesh as the next hot spot in apparel sourcing and forecasts export-value growth of 7-9% annually with apparel export doubling by 2015 and nearly triple by 2020 provided Bangladesh can successfully overcome challenges of sustainable production, adherence to social standards, development of infrastructure and creation of skilled workforce.

Employment potential

Figure 10: Contribution of women in textile industry towards



The number of garment factories have increased over the years and so has the demand for skilled workers. There are currently 5400 units employing 4 million workers. The textile industry accounts for 45% of all industrial employment in the country and contributes 5% of the total national income. The textile sector has a major contribution to poverty reduction in Bangladesh by providing

employment to millions, majority of whom are women (80%) from low income families. The women employed in the textile industry are mostly from the rural areas, where they previously did not have any opportunity to be part of the formal workforce. This has given women the chance to be financially independent and have a say in the decisions of their family. Figure 10 (BGMEA survey) shows the impact of textile sector on women empowerment in Bangladesh particularly with regard to population control in Bangladesh.

4. Institutional Attributes

Presence of a strong cooperatives/proactive industry association

Bangladesh has a few strong textile industry association that play the role of policy advocacy with the government on behalf of the industry. To ensure growth, in the recent years, they are also playing an active role in promoting sustainability and adherence to social and safety standards in the industry. Some of the active associations are:

Bangladesh Textile Mills Corporation (BTMC)

The role of BTMC within Bangladesh's textile industry has substantially been altered since the denationalization of a large number of public sector textile mills over the last decade and a half. Prior to denationalization, BTMC enjoyed a near-monopoly within the yarn and fabric market in Bangladesh. At present, there are 21 textile companies are under BTMC. They operate 24 spinning facilities with an installed capacity of 490,892 spindles and 1,036 looms.

Bangladesh Garment Manufactures & Exporters Association (BGMEA)

BGMEA plays a very strong role in leading the industry in concurrence with the government. The major activities of BGMEA are as follows:

- Protect and promote the interests of the industry; thus ensuring a sustained growth in the foreign exchange earnings of the country.
- Maintains liaison with foreign buyers, business associations and chambers.
- Bring the opportunities for local manufactures to interact with foreign buyers and form new rapport by arranging different apparel fairs at home and abroad.
- BGMEA has also established its own Institute called "BGMEA Institute of Fashion & Technology (BIFT)" which has been approved by the government to turn into a university.
- Organizes trade missions to explore the new markets and to facilitate trade in existing markets and organizes seminars for recommending on key policies.
- Set up a Crisis Management Committee for emergencies.
- BGMEA undertakes a number of regular activities and projects to ensure workers rights, social and environmental compliance and welfare.
- Ensure environmental sustainability to promote environmental compliance in the RMG industry. Recently we have set up an environment cell in BGMEA to reinforce such activities.
- BGMEA has been running several programs with partners like IFC, SEDF to assist the member factories toward energy efficient and cleaner production.

Bangladesh Knitwear Manufactures & Exporters' Association (BKMEA)

BKMEA was formed in 1996 by the all-out efforts of few knitwear manufacturers. Soon after the formation it undertook activities to look after the interest of the knitwear sector of the country. Today it is an association of 1131 knitwear manufacturers and exporters that represent the largest export

earning sector of the country. BKMEA has been active in increasing productivity of its members, enhancing social compliance status and workers welfare, diversify export market, and better market access of the country's knitwear products to EU, USA, China, and other countries. BKMEA is working with German Technical Cooperation (GTZ), South Asia Enterprise Development Facility (SEDF), European Commission (EC), and other related organizations in this regard.
The major activities of BKMEA include:

- Protect the Interest of the Sector.
- Promotion & Development of the Market.
- Promotion & Development of the Sector.
- Capacity Building of the Sector.
- Social Compliance Status Enhancement.
- Basic Rights Education and Awareness Raising.

Scale up potential

Industry associations have a fairly large membership base, reaching out to both large as well as small scale units. Ensuring sustainability in operations of the textile mills have been on high on their agenda. They have shown keen interest in linking up with the project and supporting the scale up of project approaches with their member base. IFC, GIZ and other development agencies are also working through them so it will be easy to synergise the effort under the project with the on-going initiatives in the textile sector.

5. Social Attributes

Supply Chain Stakeholder profile

The supply chain of textile sector composes of cotton grower at the backend, who are mostly the small and medium scale farmers. The next in line are the small scale spinners and weavers. The wet processing operations are typically carried out by a range of entrepreneurs, which is comprised of small, medium and large scale operators. Most of the operations in wet processing as well as cutting and stitching are carried out by skilled labours. (Figure 11) As mentioned earlier, the majority of this workforce is women.

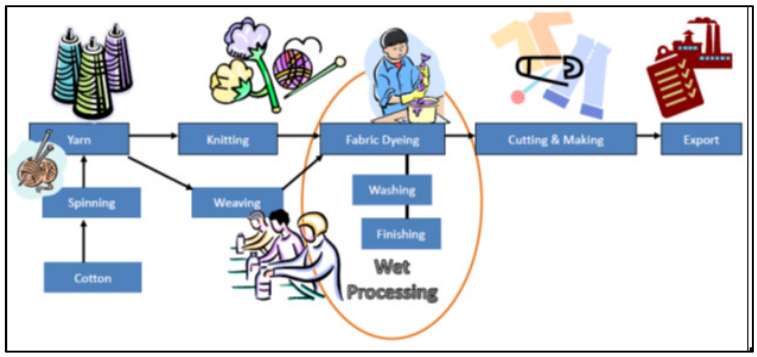


Figure 11: Supply chain of the textile sector

Occupational Health, Safety, Work place environment

The textile sector in Bangladesh fares poorly on the standards of work place safety. The fire accidents in garment industry are very common (Table 3). The latest factory building collapse has added another type of hazard in garment industries. According to Bangladesh Fire Department data, during 2006 to 2009 period, about 414 garment workers died in 213 factory fires. In 2010, about 79 workers died due to factory fires (Source: Clean Clothes Campaign, 2012). Some major factory incidents are mentioned in the table

Table 3: Major Incidents in Bangladesh textile factories

S. No.	Hazard Type	Date & Year	Name	No. of workers died/ injured
1	Fire	8 October, 2013	Palmal Group Factory	10 workers died
2	Fire	9 May 2013	Tung Hai	9 workers died
3	Building collapse	24 April, 2013	Rana Plaza, Savar	1129 workers died, 2515 injured
4	Fire	February, 2013	Smart Garments	9 workers died
5	Fire	24 November 2012	Tazreen factory	122 workers died, 200 injured
6	Fire	3 December, 2011	Eurotex	2 died, 64 injured
7	Fire	14 December, 2010	Hameem Group	29 died, 11 injured
8	Fire	25 February, 2010	Garib and Garib	21 died, 50 injured
9	Fire	6 March, 2006	Sayem Fashions	3 died, 50 injured
10	Building collapse	25 February, 2006	Phoenix Building	22 died, 50 injured
11	Fire	23 February, 2006	KTS Textile, Chittagong	61 died, 100 injured
12	Building collapse	11 April, 2005	Spectrum Factory	64 died, 74 injured

The main reasons for fire incidents is that most of the factory buildings have been established by converting residential building which is not appropriately designed for high electrical circuits needed to run a factory, thus:

- Most of these buildings have faulty electrical circuits, poor electrical wiring, and with uncertain and unstable power supply, unprotected electrical outlets makes it prone to short circuits , which is further aggravated by inflammable materials surrounding electric outlets.
- A lot of factories run all day and all night without shutdown throughout the whole week or even more in order to meet the supply demand which increases pressure on the electrical lines not designed to take such pressure.
- Non-stop operation also generates a lot of heat from heavy electrical heavy equipments that makes it prone to fire.

Building collapse is the second type of major hazard in garment industries in Bangladesh. The main reasons of building collapse are:

- Unauthorized and unplanned structure of the building. For example, Rana plaza of Savar was an eight story building, but it had permit only for four floors (Figure 12). The upper four floors were made without permit and as a result it collapsed in April, 2013 killing 1129 workers.
- No proper soil test and site investigation is done before construction. Many land owners have filled up water body or a local pond and then build up their high rise building on that newly filled up land. In many cases, the surface layer below has clay dominant soil which cannot tolerate heavy load. For example: Savar Spectrum building was made after filling of water body as a result it collapsed in 2005 and killed 64 workers.

Social economic issues (gender, children, migrant workers-quality of life)

Although the garment industry of Bangladesh is expanding dramatically day by day, it already has started to face several social problems. Many workers hail from village area who were used to working in agriculture fields before and have no work experience. Because of the lack of skill and difference in living and working style from village to urban area, these poor people become victims of exploitation. They receive lower salary and provided with very poor living/ working conditions. In most of the cases, workers do not get the salary, bonus and overtime work compensation in time. Due to the lack of education and awareness, the workers are not able to join a quality trade union and thus do not get any chance to influence on policy making. Details of some of the key social issues are as follows:

Poor Wages: The main reason that attracts many foreign buyers to Bangladesh is the low production cost of textile and readymade garments. This is possible in Bangladesh due to low wages of the workers. In general, around 50% of net profit of the industry goes towards workers wage worldwide, but in Bangladesh only 30% of net profit is spent on workers wage (Yunus M. et al 2012). Table 4 shows the average workers wage in Bangladesh compared to other major textile producing countries in the world. The salary of the garment workers has increased three times since 1994. During that time the minimum salary was 930 taka (12.1 USD) per month which was changed after a long time to 1662 taka (21.6 USD) in 2006. But it was not sufficient to maintain their living costs. Therefore the workers continued to protest against low wages. As a result, in 2010 the wage board raised the minimum wage to 3000 taka (38.9 USD) per month. Although the demand of wages of the workers was 5000 taka (64.8 USD) (Kakuli A. et al 2012). The most recent updated (November, 2013) minimum wage was decided 61.8 USD per month.

Table 4: Comparison of Wage rates in Bangladesh compared to other countries (in 2008)

Country	USD/ Hour
Bangladesh	0.22
Cambodia	0.33
Vietnam	0.38
India	0.51
China	0.55-1.08
Turkey	2.44

(Source: Jassin-O-Rourke Group, 2008. Global Competitiveness Report. New York: Selling to Full Package Providers)

Working excessively overtime: Workers often work for longer period to earn extra money to cover high living costs. In many cases, the workers are forced to work overtime to meet the demand of supplier in time. According to Bangladesh Labour Law 2006, eight hours per day comprises a standard workday and six days a week. Therefore 48 hours per week is considered as work week that can be extended to maximum 60 hours including overtime. According to Kakuli A. et al (2012), Bangladesh garment workers however, work an average of 76 hours per week which is far above the standard work week. The Labour Law also states that a worker should be paid within 7 working days of completion. Unfortunately, most of the factories practically do not follow this.

Gender Inequality: The expansion of garment industries of Bangladesh has provided a great opportunity for women workers. Around 80% of garment workers are women, however they face

exploitation and unequal working conditions. Women are often employed in jobs with less or non-technical skill compare to men that is generally as helpers, machinists, finishing helpers and sewing helpers. Female workers also get paid lower than the male workers doing similar job (Table 5).

Table 5: Gender differentials in Wages in RMG Sector

Categories of workers	Male wages (Tk/month)	Female wages (Tk/month)
Operator	2,254	1,536
Cutting Master	3,935	-
Ironer	1,894	1,106
Sewing helper	1,200	762
Cutting helper	1,512	837
Finishing helper	1,209	1,023
Folder	1,528	1,157

(Source: Absar, S.S. (2001). Problems surrounding wages: the readymade garments sector in Bangladesh, LMD, Volume2, No.7, pp-5)

Due to lack of education and skill, most of the women agree to even work at a low salary. The newly migrated women workers from the villages without any skills are offered even lower wage rates. Many studies suggest that majority of the women workers are unmarried and younger. The major factors that drive them to engage at garment industries are poverty, family conflict and divorce (Nidhi K. 2009).

6. Areas of Interest/ Demand for Knowledge Partnership with India

As the textile industry in Bangladesh is primarily export driven it is currently faced with serious challenges related to sustainability of its textile processing, negative environmental impacts due to overuse and abuse of resource use and wide-ranging social issues related to poor working conditions because of which many reputed international buyers are going away from Bangladesh market and many have imposed strict norms for production. This would threaten the livelihoods of millions employed along the supply chain and adversely impact Bangladesh's economy. The Bangladesh Government and industry are therefore concerned with finding a solution to these problems. Some of the intervention carried out by the government in this direction include the Zero Discharge Regulation that mandates all textile units to implement it. However its practical application is fraught with technical, financial and practical issues. Similarly some of the other resource constrain issue that has recently cropped up for textile industry is the rapidly decreasing gas reserves of Bangladesh that used to cater to most of the energy requirement in the processing units. The Bangladesh government had also subsidised the gas prices for the textile units, which may change in the coming times. This would increase the energy bills of the small and medium entrepreneurs. Therefore they are now looking for more energy as well as water efficient technologies and operating practices as well as cheaper sources of alternate energy. India has evidences and learnings on technical and policy level intervention that can provide a more sustainable and longer term solutions to some of these burning

issues. It is in this context that Bangladesh policymakers/ industry associations/ SMEs have requested support from the project team.

In India, Tripur and many other major textile producing clusters have long experience of implementing Zero Liquid Discharge (ZLD) systems and over the years have dealt successfully with many issues. The textile sector has learnings and expertise from technological issues with implementation of ZLD such as the efficiency of the systems particularly the evaporators, practical and financial problems associated with land availability in single textile unit, disposal of huge quantities of solid (hazardous) wastes generated and financial viability of running effluent treatment plant. The learnings from India clearly indicate that ZLD cannot be typically viewed as a panacea to all the problems associated in with waste disposal. Although it helps in minimising liquid effluent discharge, it results in generation of hazardous solid wastes creating disposal challenges. In India, solid incinerable hazardous waste generated from textile units are now being used in cement plants to replace the use of coal. ZLD systems also have high operating cost creating financial impact on the industry and its Regional/ National/Global competitiveness. In India, Government had to step in with subsidy to bail out the industry from this problem as it was adversely impacting the small and medium entrepreneurs.

> In Tirupur, attempts to implement ZLD began in 2010 when existing treatment plants were upgraded and new ones set up. At present, there are 20 common effluent treatment plants (CETPs). To achieve ZLD, secondary treated waste is passed through membrane filters. The filter-reject, or reverse osmosis (RO) reject, is evaporated so that no pollutants are discharged in the open. (*Two textile cities, Tirupur and Ludhiana, explore ways to stop effluent discharge into streams*, Centre for Science and Environment, May, 2011)

The Department of Environmental Control, Textile Associations (BTMA & BGMEA) and entrepreneurs have requested the project team to share technology, technical expertise, and policy learnings that can help them evolve a more practical approach to dealing with the issue of effluent discharge, particularly with regard to the issue of technical feasibility (issue of retrofitting it in existing factory units); Financial feasibility (cost, payback period etc.) and level of support needed from government (subsidy) and financial institutions/ Banks (financing packages); Practical implementation issue (lack of space in existing factory units); experiences of installing common effluent treatment plants covering many textile units; and Issue of disposing large quantities of solid waste that would be created as a result.

Bangladesh Stakeholders have also requested technical support in enhancing resource efficiency in textile mill operation, similar to that done in the IKEA supply chain, so that it can help in reducing the energy consumption, water use, waste minimizing along with enhancing the efficiency of operation. Dealing with proper electrical load management will to a large extent also help in minimizing the fire hazard risk. They are also looking for Indian experience and knowledge in the area of promoting co-generation and use of renewable energy in textile plants, which is very much the need of the hour given the dwindling gas reserves and decreasing subsidies that are bound to increase the energy prices.

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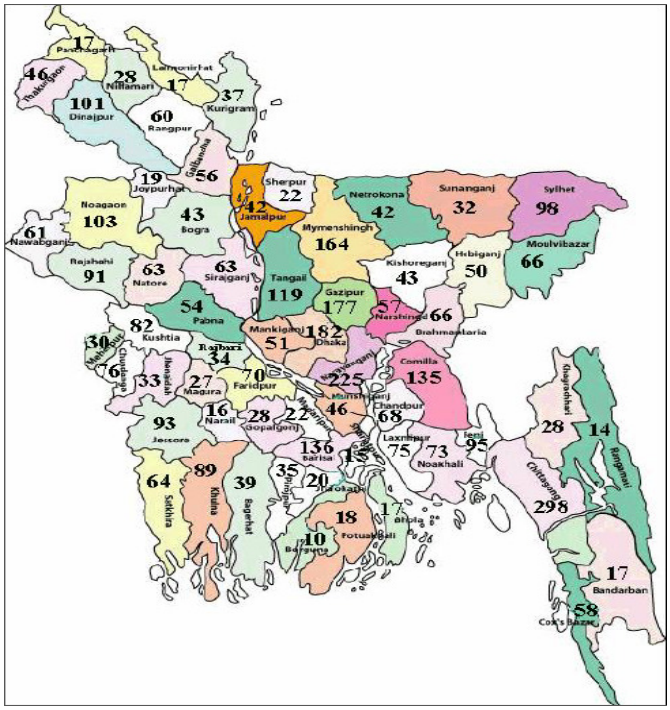
Sector Assessment - Brick (Bangladesh)

1. Context

Brick making though not formally recognized as an industry is a significant economic activity in Bangladesh. There are about 5,000 operating kilns, contributing about 1 percent to the country's gross domestic product (GDP) and generating employment for about 1 million people. Bangladesh produces about 17 billion bricks per year and stands fifth in terms of its contribution to global production. Brick making is prevalent in almost all parts of the country but concentrated more in and around Dhaka. Figure 1 shows the geographical spread of Brick kilns in Bangladesh.

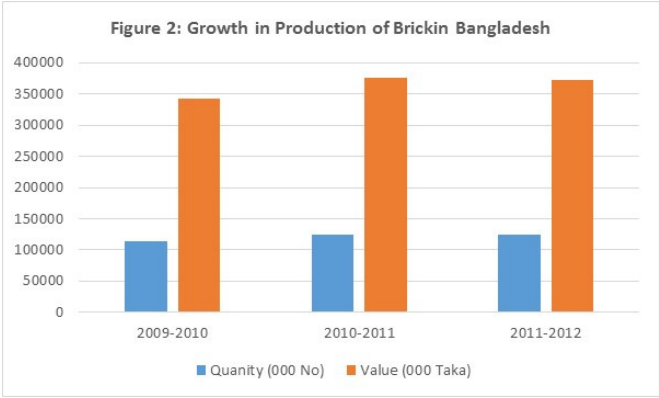
Figure 1: Geographical Spread of Brick Kilns in Bangladesh



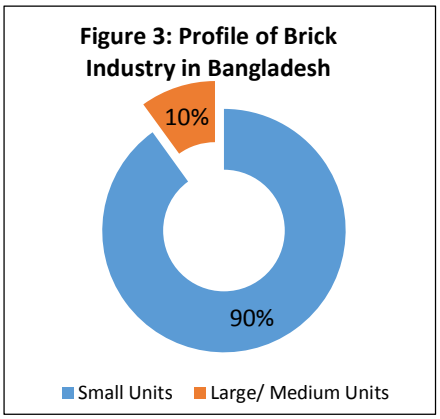
Source: GEF-UNDP Study 2006: The total number of Brick-kilns depicted in Map is 4140, which has now increased up to 10-15% in different regions.

The brick industry has been growing at the rate of 2–3 percent annually with the rising demand for construction material to cater to the infrastructure growth. Country's overwhelming dependence on bricks is due to its lack of availability of stones in any sizable quantity or other alternative building materials at comparable cost. Therefore, brick is the main building material for the construction industry.

The growth in brick industry is also driven by a rapidly rising population, which has shown a high migration trend to urban areas. Bangladesh has a population of about 153 million having a growth rate of 1.34% in 2011. At this rate, Bangladesh will need to construct approximately four million new houses annually to accommodate the growing population. Figure 2 shows the growth pattern in the production of Brick over the years reported in 2012 Statistical Year Book of Bangladesh (Aug 2013). However, this may not be the correct depiction of the production figures as the discussions with stakeholders reveal that the actual number of brick knlins are far more than government figures. This is because Brick kilns in Bangladesh are mostly informal and small-scale



operations. As can be seen in Figure 3, about 90 percent of brick kiln owners are small-scale operators. Most brick kilns are individually owned, with each owner possessing one kiln only. Multiple ownership of kiln and multiple kilns under the same ownership are rare. In rare cases, established business houses own brick kilns that are part of a portfolio of industrial establishments. The kiln owners are organized as the Bangladesh Brick Manufacturers Owners Association (BBMOA).



Due to the dominance of small scale brick entrepreneurs with limited financial capacity, Bangladesh's brick sector is characterized by outdated technologies with low energy efficiency and high emissions, low mechanization rate, and dominance of single raw material (clay) and product (solid clay brick).

Bangladesh Brick sector has seen massive change in the brick kiln technology due to government regulations. Currently, there are about four main types of kiln technologies used in Bangladesh, as presented in table 1.

Table 1: Existing Brick Kiln Technologies in Bangladesh (2009)

Kiln Type	Number	Percent of total Kilns	Brick Production (billion bricks)	Percent of total production
Fixed Chimney Kiln	<4,500	92	15.8	91.4
Zig Zag Kiln	<150	3	0.6	0
Hoffman (gas) Kiln	<20	0.4	0.2	3.5
Hybrid Hoffman Kiln	<10	0.2	0.2	1.4
Others	<200	4	0.5	0.9

(Source: D.O. E. 2010)

Bulls Trench Kilns (BTK) was the predominant technology prior to 2004. But due to poor environmental performance, government imposed a ban on this technology in 2004. After this Fixed Chimney Kilns (FCKs) become most adopted technology. The FCKs constitutes more than 90 percent of kilns, but they are also highly polluting and relatively inefficient. The government therefore issued a notification in September, 2013 imposing a ban on FCK and its gradual phasing out to other technologies. So the FCKs are now gradually converting to coal-based Zig zag kilns and gas-based Hoffman kilns that are marginally cleaner, but represent just a small percent of the total. This is because of high initial cost and requirement of skilled manpower for construction. Adopting gas-based cleaner technologies is hampered by serious shortage of gas projected in near future, wherein brick industry is expected to get a low priority for supply.

Besides air pollution, the current brick technology that uses clay as the primary raw material is using up large parcels of fertile agriculture belt and also causing degradation of soil and surrounding

ecosystem. Although this issue has not received much policy attention, but for a country like Bangladesh with one of the highest population density and limited agriculture land, continuous land use for brick manufacture can have serious implication on food security of the country. The brick industry is also heavily reliant on fuel wood to cater to its energy use as coal availability and price is an issue for small scale brick manufacturers. Many entrepreneurs set up their units close forest area to have easy access to wood, but this is increasingly leading to large scale de-forestation. The government has already established regulations that ban the use of fuel wood, FCKs and has reconsidered the location and height of brick kiln chimneys. However, their enforcement is poor. This is on account of a number of reason that include lack of sound alternative technology that can produce same quality and volumes of brick at comparable cost. Further the available alternative technologies though use relatively less energy, do not completely eliminate its requirement so the brick manufacturers are still faced with the problem of access to continuous and cheap energy supply.

The current status of brick industry in Bangladesh is highly unsustainable and needs to upgrade in order to save valuable natural resources, reduce air pollution, and increase energy efficiency. There are innovative technological options, polices and measures available that can help ensure resource conservation and manage environmental issues in a manner that can solve the issues currently being faced by the Bangladesh brick industry and the policy makers. The FaL-G Brick (Fly ash- Lime- Gypsum) technology that has been invented and patented by two Indians, Kalidas and Bhanumathidas, is a climate-friendly technology that produces bricks without using top soil and coal and completely eliminates carbon emissions. Bangladesh Department of Environment, Infrastructure Development Company Limited (IDCOL), which is the state financial institution and in particular the BBMOA has requested project team to facilitate technical and policy support for adopting this technology in Bangladesh. The stakeholders in Bangladesh feel that this is the right time to have such an intervention as the government has recently banned FCK technology, which have to be completely phased out by next year and at the same time government is commissioning three large coal base super thermal power plants to deal with the shortage of gas reserves. These thermal power plants will produce large quantities of fly ash, which otherwise is a huge environmental and health hazard, but if technologies like FaL-G are promoted, it can be gainfully be used to produce bricks of higher quality than those made from clay, saving forests, agricultural land and preventing environmental pollution and increase sustainable livelihood potential.

In view of the above, review of different aspects of brick sector has been done in the following sections to (i) assess the resource saving/ efficiency potential, (ii) assess the institutional, social and economic aspects, and (iii) to understand the areas where there is demand for learnings from India experiences/ practices.

2. Resource Intensity in the tea sector

Resource efficiency/savings potential

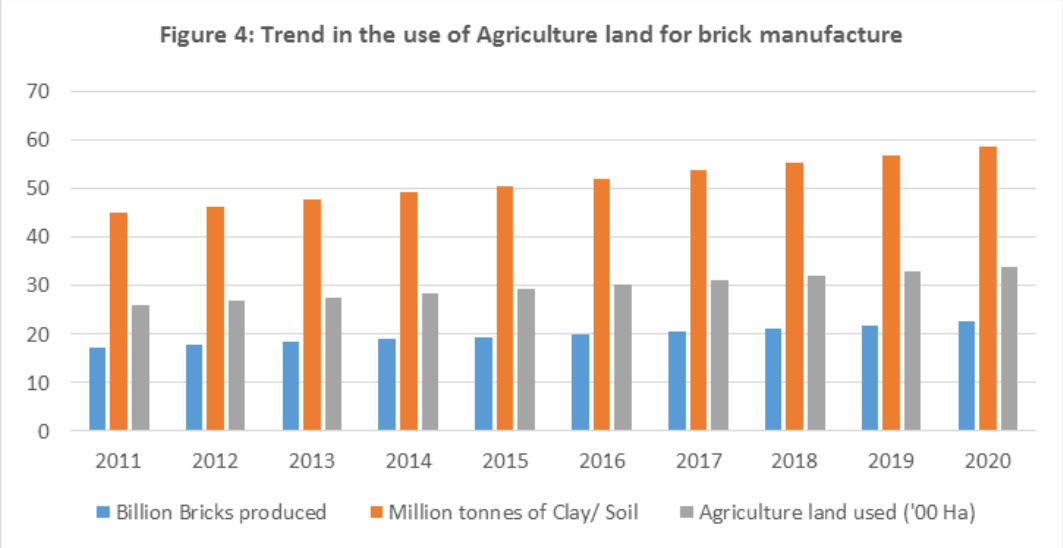
The existing technologies in the brick sector in Bangladesh poses a serious threat to the environment as well as to the surrounding ecosystem having widespread environmental, social and health impacts. The analysis from various reports indicates that GHG emissions from the brick industry are already at a high level. In addition, the brick industry is contributing in various ways to growing carbon emissions from other sources. The impact of brick making on land degradation and deforestation is of a very major concern. In a country where the pressure of population growth on a relatively small land mass

is significant, farmland depletion can have alarming prospects for food security. The following section discusses the scale of problem associated with different stages of supply chain/ resource use and possibility for introducing efficiency/ conservation measures.

Depletion of agriculture land threatening food security

Bangladesh is the most densely populated country in the world. High density of population means that agricultural land is virtually saturated, to meet the existing demand for food production. Demographic trends indicate that the current population will grow to around 220 million by 2050 putting a further pressure on the existing farm land. Currently, the total farmland in Bangladesh is about 14 million hectares and this is depleting by about 80,000 hectares every year, a 0.05% depletion rate.

Bangladesh currently produces around 17 billion bricks per year, consuming around 45 million tonnes of fertile agricultural soil in the process. As the majority of the bricks produced is burnt clay bricks, this volume of production will require about 24 million m3 of agricultural soil. This is equivalent to around 2,600 hectares of fertile agricultural land, with the exploitive depth being 1 m. Figure 4, shows the increasing trend of in the conversion of agriculture land for brick manufacture assuming a conservative estimate of 2-3 % growth rate in the brick industry. Given this trend, the competing use of already declining fertile agriculture land for brick manufacture will push the country towards the brink of severe food shortages in near future.



Soil Degradation and destruction of natural ecology

A research by Hasan (2010) found that Brick burning not only alters the physicochemical properties and habitats of the nearby soils but also contributes to the pollution of environments and ecosystems. The top soil nutrient elements and soil biota are destroyed through brick burning. Land area with high concentration of brick kilns suffer from land degradation as each brick kiln occupies 3–4 ha land, which get converted into wastelands as a result of industrial operation in the life of a brick kiln (8–12 years). These industries have immense disturbance potential to cause ecological alterations with the

potential to adversely affect human health and vegetation, soil and productivity. The brick kiln operation over the years not only covers the neighbouring area of vegetation with layers of brick dust, but also consistently dissipates heat all around. It alters the physicochemical properties and habitats of nearby soils by destroying the top soil nutrient elements and soil biota, which are likely to impact species diversity and biomass structure of the neighbouring plant communities.

Raw material usage causing degradation of forest area

The main raw materials used in brick kilns apart from clay is, firewood and coal. As per the Department of Environment figures, brick kilns burn nearly 3.5 million tons of coal and another 1.9 million tons of wood for production of brick.

Table 4: Consumption of Raw materials by the brick industry in Bangladesh

Parameters	Consumption
Coal Consumption	3.5 Million Tons
Firewood consumption	1.9 Million Tons
Clay	45 Million Tons

Almost all the coal used in brick manufacture is imported from the Indian State of Meghalaya. In case of unavailability of coal brick fields (about 33%) use firewood illegally to dry bricks. Usage of firewood in kilns still account for about 25 percent of the fuel used in Bangladesh's brick making kilns every year. This puts tremendous pressure on the already declining forest cover in the country. There is about 2.2 million ha forest area in Bangladesh on which only 6 percent area has tree cover. A large number of trees like Keora, chaila, sundari, mehguni, bain etc. are being felled indiscriminately from this scarce resource to meet the requirement of the brick industry. Discussions with local stakeholders revealed that many brick manufacturers set up their kilns near forests with the intention to plain the forests illegally. Another discussion revealed that workers of the brick field not only cut trees but also built dikes to stop water from entering its premises during high tide which results in sudden flood in the adjacent areas.

High Energy consumption

Coal is the primary source of fuel in the BTK, FCK and zigzag kilns. Natural gas is used only in Hoffman kilns. The most coal demanding kiln is BTK, which is now banned in Bangladesh, consumes 28 tons coal per 100000 bricks production where as FCK and Zigzag kilns consume 20 tonnes and 18 tons respectively for same number of brick production (BCAS, 2011). The production period for BTK, FCK and Zigzag is November to mid-April. Table 5 illustrates the total energy consumption and CO2 emissions by three types of kilns used in Bangladesh.

Table 5: Amount of Energy consumption & CO2 emissions

Parameter	FCK	Zigzag	Hoffman
Fuel	Coal	Coal	Natural gas
Total Fuel (tons)	20t	18t	16320m3
Total Energy consumption	418 GJ	376 GJ	571 GJ
CO2 Emissions (tons)	39.8t	35.7t	31.86t

Box 1: Bangladesh's Energy Shortage

Bangladesh faces up to 1,800 MW of load shedding. According to the latest data from the Power Division of the Ministry of Power, Energy, and Mineral Resources, the country's generation capacity is about 3,800–4,300 MW, with a peak demand of about 5,500–5,800 MW.

At present, the electricity-access rate is still as low as 47 percent. In 2009, per-capita electricity consumption was only 220 kWh (50 percent of India's, 40 percent of Vietnam's, and 9 percent of China's).

In addition, more than 88 percent of electricity is generated from natural gas–based power plants. The reserve of natural gas is limited and fast depleting, and domestic production is expected to peak soon if new reserves are not found. Power plants and other industrial sectors, such as fertilizer and steel production, compete for the limited natural gas supply. Under these circumstances, the GOB has decided not to provide natural gas to brick kilns, and existing gas-fired ones face closure due to supply shortage. The country expects an enormous increase in electricity demand as economic growth continues (at a rate of 5–6 percent per year). As supply shortages of natural gas are likely to grow in the future, more coal might be demanded for power generation and industrial sectors.
Source: GOB (2010)

High CO2 emissions and poor efficiency

Most brick kilns in Bangladesh are highly polluting as they use crude technology and low-quality coal for fuel. Burning of coal in the kilns releases various pollutants into the atmosphere, including particulate matter, sulfur dioxide (SO2), carbon monoxide (CO), CO2, and NOx. (Table 6)

Table 6: CO2 Emissions by different Kilns

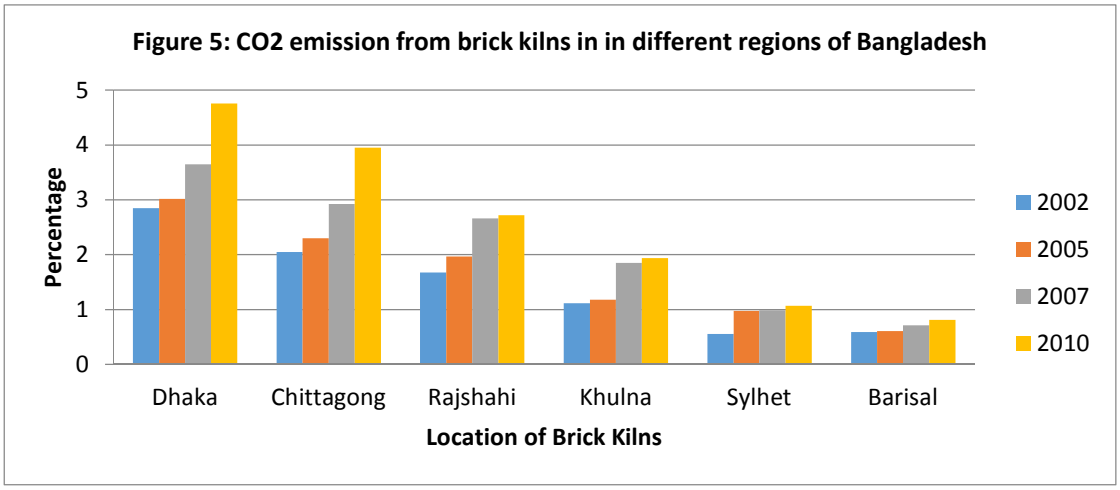
Kiln Type	Coal per 100,000 bricks (t)	Particulates (mg/m3)	CO2 emitted per 100,000 bricks (t)
FCK	20-22	1,000 +	50
Zigzag	16-20	500-1000+	40-45
Hoffmann (Natural gas)	16,000 m3	<100	30

(Source: BUET 2007)

Among the three kiln types, the FCK releases the highest level of PM and SO2, primarily because of the high ash and sulfur content of the coal. Evidence is inconclusive on particulate matter emissions of the Zigzag kiln. In terms of pollutants, the Hoffmann kiln, fired by natural gas, is considerably superior but, due to natural-gas supply constraints, the expansion of this technology stopped and existing kilns are facing closure.

World Bank (2006) reported that Brick industries are important sources of greenhouse gases as they use wood fuel coal and fuel oil for high temperature brick burning. In Bangladesh for the burning of 1800000 tons of coal, 3492681 tons of CO2; 376.76 tons of methane, 52.74 tons of N2O, was estimated. On the other hand for the burning 1260000 tons of wood fuels, 4006246.86 tons of CO2; 567 tons of CH4; 1890 tons of NOx; 37800 tons of CO2, 5040 tons of SO2 are produce each year. Of the other pollutants particular matter and the fluoride are mainly emitted from brick kiln. (World Bank).

The current levels of fuel use and consequent CO2 emissions have increased over the years due to growth in the number of brick kilns. Figure 5 shows the increase in CO2 emissions over the years in different regions of Bangladesh (Source: Carbon dioxide emission from brick fields around Bangladesh by MD. Al- Imran, June 2013)



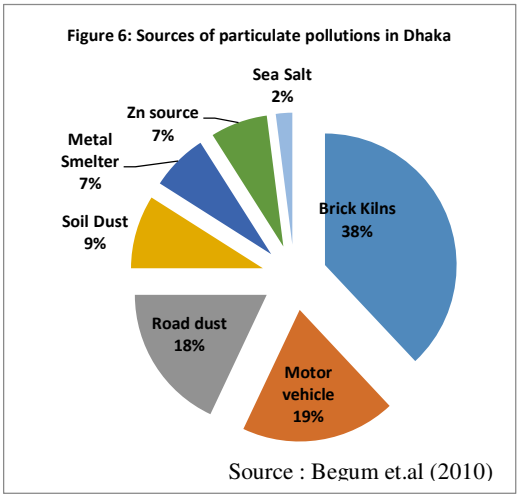
Resource use nexus and issues

The primary raw material used in brick manufacture for almost all types of brick making technology presents a complex unsustainable resource use nexus that is putting tremendous pressure on the existing natural resources on which the food security and livelihoods of millions are dependent. If the existing clay brick technology is continued than it will use up a major share of agriculture land and also destroy the soil ecology of the nearby area. This will have an impact on not just decreasing the crop land but also the productivity of adjoining land area. Similarly inefficient technologies increase demand for fuel wood which in turn are impacting the forest area and alteration in nearby area is causing flooding of agricultural area. The increased use of coal is causing emission of particulate matter and CO2.

Scale of environmental impact

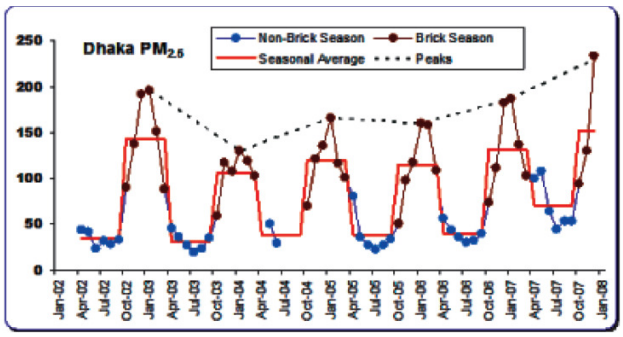
Most of the Brick kilns in Bangladesh are outdated and highly energy-intensive that causes severe pollution. Those located in the North Dhaka cluster are the city's main source of fine particulate pollution, accounting for 40 percent of it during the 5-month operating period. This causes harmful impacts on health (from particulate matter) and agricultural yields (from nitrogen oxides) and contributes to global warming (from carbon dioxide).

The figure 6 shows that almost 38 percent of the particulate matter pollution is caused due brick klins in and around Dhaka, which shows the scale of impact that the industry is having on local pollution.



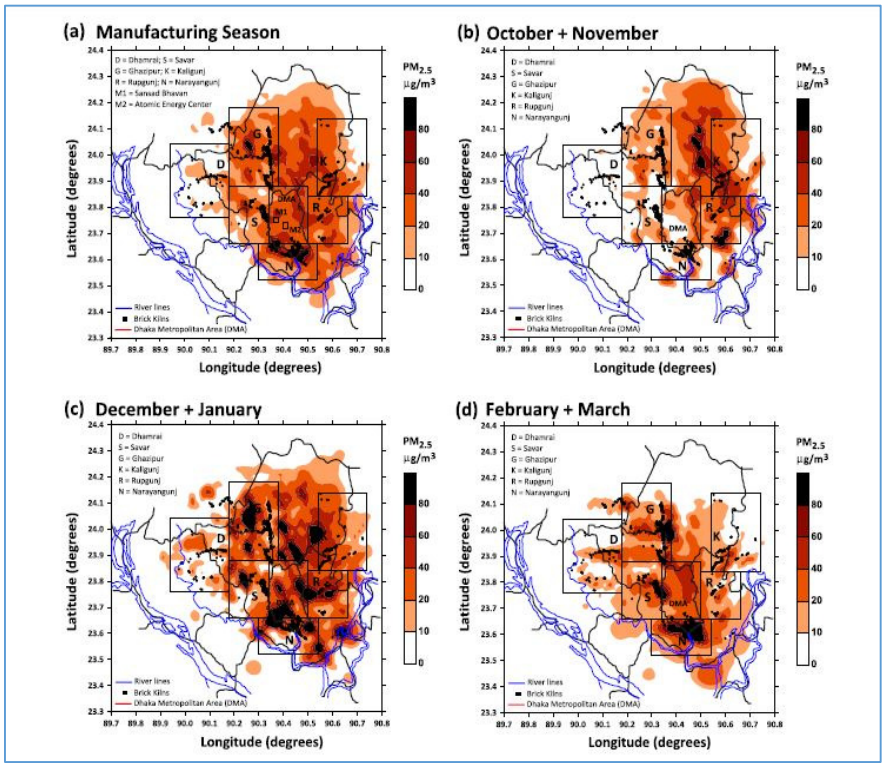
In manufacturing seasons of brick, October to March, pollution goes to peak in Dhaka and around the city depending on the monsoonal rains. The Figure 7 & 8 shows air pollution of Dhaka throughout the year because of brick manufacturing. Most brick fields have set up 25-feet tin chimneys in place of 120-feet ones, defying government rules. In the brick kilns smokes are wafting out of the chimneys polluting the environment of the area. According to the Brick Kiln Control (amended) Act (2001), there must be no establishment of brick kilns within a three-kilometer radius of human inhabitation as well as fruit garden. But lack of proper monitoring, brickfields have sprung up like mushrooms and the situation has created a serious threat to environment and biodiversity while the people in the neighboring areas face health hazards and fertility of farms is going down (The Daily Star, 2011). The brick kilns emit toxic fumes containing suspended particulate matters rich in carbon particles and high concentration of carbon monoxides and oxides of sulphur (SOx) that are harmful to eye, lungs and throat. (Source: Securing the Environment: Potentiality of Green Brick in Bangladesh by Maksuda Hossain & Abu Md. Abdullah)

Figure 7: Air pollution of Dhaka caused by brick manufacture



Source: Impact analysis of brick kilns on the air quality in Dhaka, Bangladesh; Dr. Guttikunda; 2009, May

Figure 8: Modeled PM2.5 (micrograms per cubic meter) concentrations averaged over a manufacturing season over the Greater Dhaka region



(Source: Particulate pollution from brick kiln clusters in the Greater Dhaka region, Bangladesh by Sarath K. Guttikunda & Bilkis A. Begum & Zia Wadud)

Pollutants from brick kilns (particularly PM and SO_2) contribute to health problems of the exposed population. These include: (i) adult mortality from cardiopulmonary diseases and lung cancer caused by long-term $PM_{2.5}$ exposure; (ii) infant and child mortality from respiratory diseases caused by short-term PM_{10} exposure; and (iii) all-age morbidity resulting from PM_{10} exposure . Among existing technologies in Bangladesh, the FCK is likely to cause the worst health problems due to the highest level of particulate emissions. (Source: Introducing Energy Efficient clean Technologies in the Brick sector of Bangladesh by ETMAP)

Box 2: Premature Deaths in Bangladesh due to poor air quality

BCAS (2011) prepared a report on the basis of the Bangladesh Country Environmental Analysis reports that poor air quality in Dhaka city (due to all polluting sources, including brick kilns, transport, road dust, metal smelters, and other causes) contributes to an estimated 3,500 premature deaths per year (World Bank, 2006). While the 1,200 brick kilns north of Dhaka are an important contributor to air pollution, their overall health impact has not been quantified. This analysis is limited to estimating the health impacts of the North Dhaka cluster (530 kilns) in terms of PM10 and PM2.5 pollution only. Despite these limitations, the analysis shows that PM10 and PM2.5 pollution from these 530 kilns currently leads to 750 premature deaths per year, accounting for 20 percent of total premature deaths due to poor air quality.

3. Economic Attributes

GDP share/ Export share of the sector

With the total estimated brick kilns of 5000 and annual brick production of 17 billion bricks per year, the value of the total output of the sector stands at TK 83 billion (~US$1.2 billion). The total contribution of the brick sector to Bangladesh's economy is around 1 per of its GDP. This contribution is expected to increase with growing urbanization and population growth increasing the demand for housing and infrastructure growth. It is projected that the construction sector in Bangladesh would grow at the rate of 6 percent with estimated future growth rate of the sector over the next ten years at around 3 percent as per conservative estimates, however many industry players place this growth figure to around 5 percent.

Employment potential

The brick sector provides seasonal employment to a large volumes of rural workforce. It is estimated that the brick industry provides employment to nearly 1 million people as per official figures. There is a large number of brick kilns that are not registered and if one considers the workforce employed in these kilns then this figure is expected to be even higher. The Brick industry provides both direct as well as indirect employment. People are employed in supply of raw material such as clay, coal and fuel wood as well as transport of bricks apart from those employed in the actual brick manufacturing process.

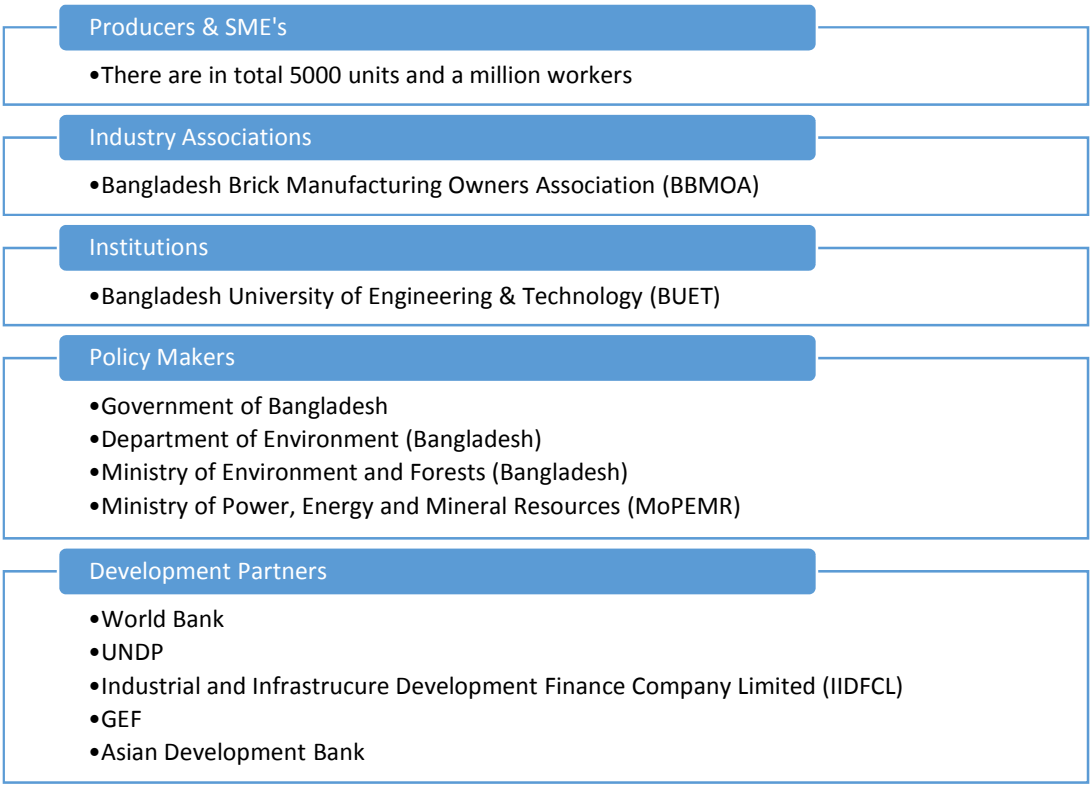
4. Institutional Attributes

Presence of a strong cooperatives/proactive industry association

Bangladesh has a strong industry association in the brick sector, the Bangladesh Brick Manufacturers Owners Association (BBMOA), plays the role of policy advocacy with the government on behalf of the industry. To ensure growth, in the recent years, they are also playing an active role in promoting energy efficient technologies like zigzag, HHK etc. to ensure sustainability and adherence to

environmental standards in the industry. The other key government and private institutions governing the sector is depicted in figure 9.

Figure 9: Key institutions active in the Brick Sector in Bangladesh



Scale up potential

The BBMOA membership base covers almost the entire brick industry in Bangladesh, reaching out to both large as well as small scale units. Ensuring energy efficiency and adherence to environmental standards is high on their agenda particularly in light of the recent regulation of the government imposing a ban on FCK technology. The Industry association is in the look out of a new technology that would give them a longer term visibility in terms of addressing resource use sustainability issues. After the ban of BTK technology in 2004 the industry switched over to FCK and with the new ban on FCKs the industry wants to weigh out all options before they get locked in a new technology. They have shown keen interest in FaL-G technology, given the government's decision to commission three new super thermal power plants from where they can have assured supply of cheap raw material in the form of fly ash. Working with them will provide an opportunity for rapid scale up of efforts.

5. Social Attributes

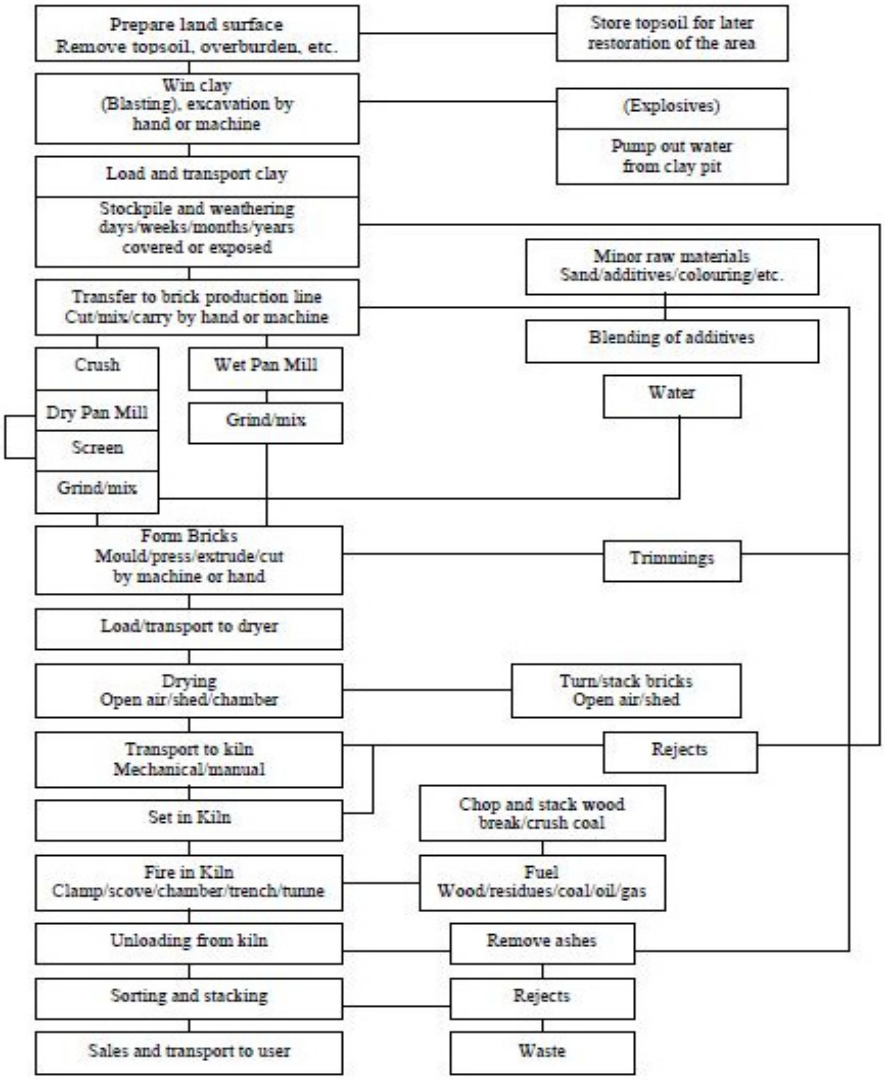
Supply Chain Stakeholder profile

Brick manufacturing Kilns in Bangladesh are often termed as "footloose". Brick manufacturing kilns usually operate 5–6 months of the year, from November to April, because most of them are located in low-lying areas, which experience flooding during the rainy season. Unskilled workers are involved in preparation of clay like un-soiling the top loose earth, then digging, cleaning, weathering and

blending of the earth. This is followed by Pugging or tempering of clay which involves breaking up the prepared clay by watering and kneading till the earth become a homogeneous mass. Nowadays in Bangladesh pug mill is widely used for manufacturing of bricks, where skilled workers are employed in operating these machines.

Moulding of bricks is a labour intensive activity, where hand moulding is used. In Bangladesh most of the brick manufacturing company uses the hand moulding as it is economical due to low labour costs. In some modern brick manufacturing factories, extrusions are used to mould the bricks. Drying and burning of bricks are again carried out by workers but a slightly higher skill set is used in this process.

Figure 10: Value Chain of the Brick sector



Occupational Health, Safety, Work place environment

The brick industry has extremely hard and hazardous working conditions. Except for firemen, who are skilled and better paid, the other workforce involved in various operations usually perform unskilled, low-wage work, requiring hard physical labour for long hours (e.g., mud-pugging by foot, brick-molding by hand, and carrying head-loads of bricks), which can cause severe muscular and skeletal stress. In many cases, workers temporarily migrate with families and take up residence near kilns. These residences are usually self-made, ramshackle structures made of bamboo, wood, cardboard, and corrugated iron sheet. The sanitary conditions in such residences are not good. Moreover, the high level of air pollution in the kiln area is a health hazard for workers and their family members.

These hard and unsafe working and living conditions leads to both short- and long-term health problems for workers.

Social economic issues (gender, children, migrant workers-quality of life)

Seasonal Employment. The average brickfield employs about 150-200 skilled and unskilled workers. Apart from 6 to 10 permanent employees, most are employed for only six months during the production season. Migrants from northwestern Bangladesh comprise most of the kiln workforce due to the seasonality of kiln operations, their clustering, and lack of local workers. The workers are not organized and lack trade unions to promote their interests. Thus, the existing kilns have many social issues related to migrant workers, gender and child, and health and sanitation.

Wages. People working in brick kilns even after being subjected to harsh and difficult working conditions are poorly paid. On an average the workers receive 80 taka every day for over 12 hours of extremely hard or hazardous work (Akter, 2010).

Child labour and gender issues. While each kiln employs about 150-200 workers, migrant families usually bring some 30–50 children to live nearby. Although banned from working by law, older children often join in work to improve their family's income. Families, including children, often collect partially-burned coal to use for household cooking. Younger children play in unsafe conditions (e.g., mud, dirt and coal), and young girls sometimes perform domestic chores. Women are usually paid less than men, although they do equally arduous jobs; and children are paid even less. While children in villages can attend government primary school for free, kiln workers' children are deprived of this opportunity during the working season, as there are often no schools close to kiln sites.

6. Areas of Interest/ Demand for Knowledge Partnership with India

Although the use of fly ash in brick making is not new, two Indians, Dr N Bhanumathidas and N Kalidas, have invented a new climate-friendly technology that produces bricks without using coal. The new method, known as FaL-G or Fly ash-Lime-Gypsum has the potential to completely eliminate carbon emissions from brick-making. Another significant benefit of this technology is that unlike clay bricks that use valuable top soil as raw material, the new method uses fly ash, an unwanted residue from coal-fired power plants. Putting fly ash to productive use can reduce water, air, and soil pollution and respiratory problems of the populations living near thermal power plants. A further advantage is that fly ash bricks can be produced in a variety of strengths and sizes. This means that apart from their conventional use in building walls etc. fly ash bricks can also be used for the construction of a variety of infrastructure projects such as roads and pavements, dams and bridges. Plus it is a technology that can be used to produce bricks throughout the year thus eliminating the problem of seasonality of employment for the workers engaged with the industry. Recognizing the importance of restricting the excavation of top soil for manufacture of bricks and promoting the use of fly ash in brick making, the Government of India has taken several measures to enable the same.

Success of FaL G Technology in India

To encourage the widespread adoption of this environment-friendly technology, the inventors of FaL-G are providing their technology without invoking the patent. They also provide microenterprises that opt for this technology with technical assistance on production techniques, skills training for workers, and advice on the marketing of bricks. The inventors' decision not to invoke the patent to facilitate the diffusion of FaL-G technology has paid off:

- Over 16,000 FaL-G brick plants were in operation by March 2012 throughout the country, up from just 100 enterprises in 2000. It has created creating employment for over 200,000 workers, producing bricks and blocks eq. to over 48 billion standard bricks, generating a turnover of over Rs.12000 crore annually (at a conservative average of Rs.3 per brick) and resulting in the abatement of over 11,520,000 tons
- Fly ash bricks account for about one sixth of India's annual brick production.
- Fly ash brick plants use over 20 million tons of fly ash which would otherwise have been dumped into hazardous ash mounds and ponds.
- The timely flow of carbon revenues through the World Bank project has helped in increasing the participation of microenterprises.
- FaL-G technology is providing workers a stable year-round income nearer their homes and allowing their children to attend regular school, giving them reason not to migrate to a city.
- Until March 31, 2012, Rs. 1.6 crores had been spent for the benefit of workers' communities from the carbon credits earned.

Interestingly, a sizeable number of women entrepreneurs are setting up FaL-G brick manufacturing plants

Given that Bangladesh government is commissioning three new large coal based thermal power plants to deal with its energy crisis, it is estimated that 1.3 million cubic feet of fly ash will be produced per annum from dumping of thermal power plants alone, and is estimated to reach an alarming level of 9.5 million cubic feet by 2018. At the same time Bangladesh brick industry is grappling with the issue of high resource intensity (Soil, Coal, fuelwood use) and environmental externality of their operation and also faced with the challenge of finding an alternate to the banned FCK brick Kiln technology.

Bangladesh Department of Environment, Infrastructure Development Company Limited (IDCOL), and BBMOA has therefore requested project team to facilitate knowledge transfer around FaL-G technology, wherein they are willing to put in their own investment for pilot demonstration of the technology. The government is also keen to learn from the policy support provided by Indian government for fly ash brick technology and has requested support to review the possibility of having similar policy reform in Bangladesh.

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