WORKING PAPER

Towards an environment-and-worker-friendly brick kiln sector in Punjab, Pakistan

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Executive summary

Approximately 100,000 brick kilns are scattered across South Asia. Together, they contribute significant emissions of greenhouse gases (GHG) and black carbon (BC) into the atmosphere. Black carbon is the second largest contributor to global warming after carbon dioxide (CO_2), and has direct effects on health, visibility, and the melting of Himalayan snow and ice. Therefore, GHG and BC are of local, regional and international concern. Majority of brick kilns in Pakistan are Fixed Chimney Bull Trench Kilns (FCBTK) and Moving Chimney Bull Trench Kilns (MCBTK). Both FCBTK and MCBTK employ straight line firing configuration for baking green bricks, which is highly inefficient in terms of energy combustion and consumption and hence highly polluting. Besides, they are often poorly constructed and suffer from excessive air leakage, resulting in heat loss, inefficient fuel usage, and high air pollutant emissions. Punjab province alone hosts 52% of around 20,000 brick kilns in Pakistan; only 7% are using environment-friendly technology. Of the brick kilns found in Punjab province, 89% are FCBTK and a little over 9% are MCBTK. On an average one brick kiln in Punjab province consumes 328.2 tonnes of coal for baking bricks in one year. This suggests that the 10,394 brick kilns in Punjab province alone consume an average of 3.41 megatones of coal in a year.

A feasible option for converting FCBTKs into more environment-friendly brick kilns is to modify green brick stacking practices from straight line to zig-zag patterns in a manner that increases energy efficiency and improves combustion while retaining the FCBTK structure. Stacking green bricks in a zig-zag pattern increases the heat/air flow path length, resulting in better combustion and a higher heat transfer rate. Every brick that is produced in a zig-zag FCBTK (zig-zag kilns) emits approximately 90% less black carbon compared to straight line firing. If all FCBTKs in South Asia are converted into zig-zag kilns, it is estimated that black carbon emissions from the brick kiln sector would reduce by 60%. Besides, zig-zag kilns reduce coal consumption by 20%, providing a 'win-win' situation for brick kiln entrepreneurs and the environment.

It is imperative that Pakistan's brick sector adopts environment-friendly technology and evidence-based best practices as the brick sector drives many other sectors in the country. Pakistan's brick sector not only provides fundamental inputs to the formal and informal construction sector, it is also a major source of employment, particularly for the rural poor. At the same time, strengthening housing and construction in Pakistan is a priority of the Government of Pakistan (GoP). Pakistan is facing a housing backlog of 10 million housing units with demand growing at a rate of 0.7 million new housing units per year. Vowing to help the country's poorest stratum move from 'kachi abadies' (informal settlements) into newly built formal settlements, the GoP has announced construction of 5 million housing units over five years through the 'Naya Pakistan' housing scheme. Bricks are one of the most widely used walling materials in Pakistan. It is estimated that the construction industry will grow at an annual rate of 8.9% over the next five years, which will inevitably increase demand for bricks. It is high time Pakistan's brick kiln sector is converted into an efficient, environment-and-worker friendly sector.

The International Centre for Integrated Mountain Development (ICIMOD) is coordinating the Climate and Clean Air Coalition-Brick Production Initiative (CCAC-BPI) activities in South Asia. Following successful piloting of zig-zag kilns in Nepal, ICIMOD has started providing technical support to brick kiln entrepreneurs in Pakistan, starting with Punjab province. In this regard ICIMOD is closely collaborating with Brick Kiln Owners Association of Pakistan (BKOAP), Ministry of Climate Change, and Environmental Protection Agency, GoP. The overall purpose of this collaboration is to transform the brick kiln sector in Pakistan into an efficient, environment-and-worker friendly sector. For this, it is imperative to better understand the brick kiln sector in Punjab. A comprehensive baseline study was conducted to understand the overall political economy of the sector, existing brick making practices, and the socioeconomic conditions of workers in the brick kiln sector of Punjab, Pakistan. This report provides important insights into the overall situation of the brick kiln sector in Punjab province of Pakistan. It presents key findings of the baseline study and makes important recommendations for the development of an environment-and-worker friendly brick kiln sector in Punjab in particular and Pakistan in general.

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Abbreviations and acronyms

ADB	Asian Development Bank
BC	Black carbon
BKOAP	Brick Kiln Owners' Association of Pakistan
BPI	Brick Production Initiative
CO_2	Carbon dioxide
CCAC-BPI	Climate and Clean Air Coalition-Brick Production Initiative
CoEP	Community of Evaluators Pakistan
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
FCBTK	Fixed Chimney Bull Trench Kilns
GDP	Gross Domestic Product
GEF	Green Environment Facility
GPS	Global Positioning System
GoP	Government of Pakistan
GHG	Greenhouse gases
ICIMOD	International Centre for Integrated Mountain Development
LPG	Liquefied petroleum gas
MoCC	Ministry of Climate Change
MCBTK	Moving Chimney Bull Trench Kilns
PDMA	The Provincial Disaster Management Authority
PKR	Pakistani rupee
SoPs	Standard operating procedures
TIC	Technology Incubation Centre
UN	United Nations
USD	United States dollar
TEVTA	Technical Education and Vocational Training Authority
VSBK	Vertical Shaft Brick Kilns
WHO	World Health Organization

Contents

SECTION I

Introduction

The estimated population of Pakistan in 2020 was 220,892,340 (Pakistan Bureau of Statistics; the World Bank, 2020; Macrotrends LLC, 2020; Nielsen, 2010), of whom 60 million constituted the labour force. The country's population has increased at an average rate of 2.5% over the last 71 years, and in 2020 it was 6.2 times higher than its estimated population in 1950 (i.e., 37,542,376), a 17% increase from 1950 (Figure 1). Pakistan has become the world's 5th most populous country (BOI, 2020; Wikipedia, 2020; Internet World Statistics, 2020).

New urban centres are emerging, particularly in the peripheries of major cities across Pakistan, and at the same time population in the existing urban centres continues to rise (Figure 2). According to the 2017 census of Pakistan (Table 1), the urban population across 10 major cities had more than doubled since

FIGURE 1 **A HISTORICAL PREVIEW OF POPULATION IN PAKISTAN**

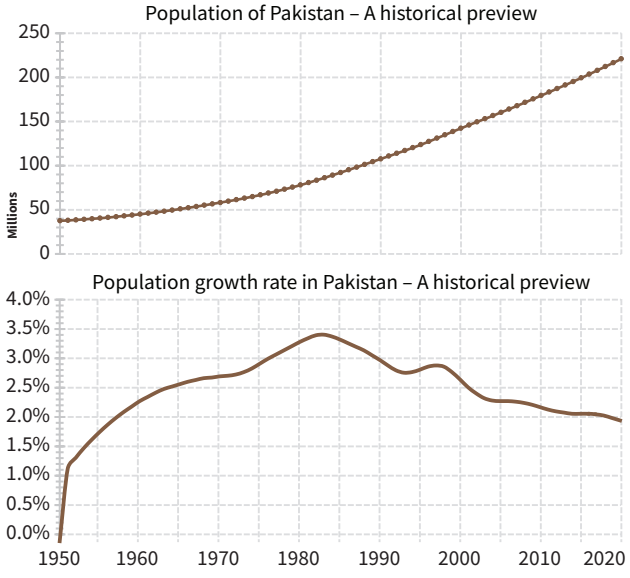
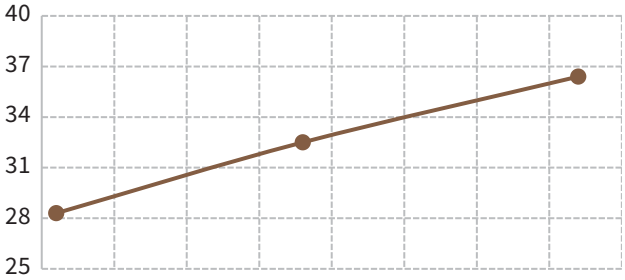


FIGURE 2 **URBAN SHARE OF POPULATION (%) VIS-À-VIS TOTAL POPULATION DURING THE YEARS 1981, 1998, AND 2017**



1998, suggesting an ever increasing trend in the urban share of the population counted during census 2017 vis-à-vis total share of population compared to the population count during census years 1981, and 1998 (Macrotrends LLC, 2020).

Because of rapid population growth and resulting urbanisation, Pakistan requires about 700,000 housing units per year. About 50% of its annual housing demand is currently being met; yet the housing deficit in Pakistan is 10 million units, and this deficit is growing each year (BOI, 2020), suggesting that Pakistan is facing a shortage of housing.

In Pakistan, historically, the construction industry has not received due consideration (Rizwan U. Farooqui and Syed M. Ahmed, 2008). To address this, the current government of Pakistan led by PM Imran Khan has initiated extensive reforms through its far-reaching housing and infrastructure development and extension programmes. These reforms and associated programmes have huge potential not only for developing the construction industry on a strong footing, but also for boosting the country's economy (Moazzam, A. et al., 2020; Naeem, E. et al., 2013; Tahir N. et al., 2013; Nida A. et al., 2008; Tauha H. et al., 2007). Towards this end, the brick kiln sector of Pakistan can

TABLE 1 URBAN POPULATION COUNT ACROSS 10 MAJOR CITIES FROM 1998 TO 2017

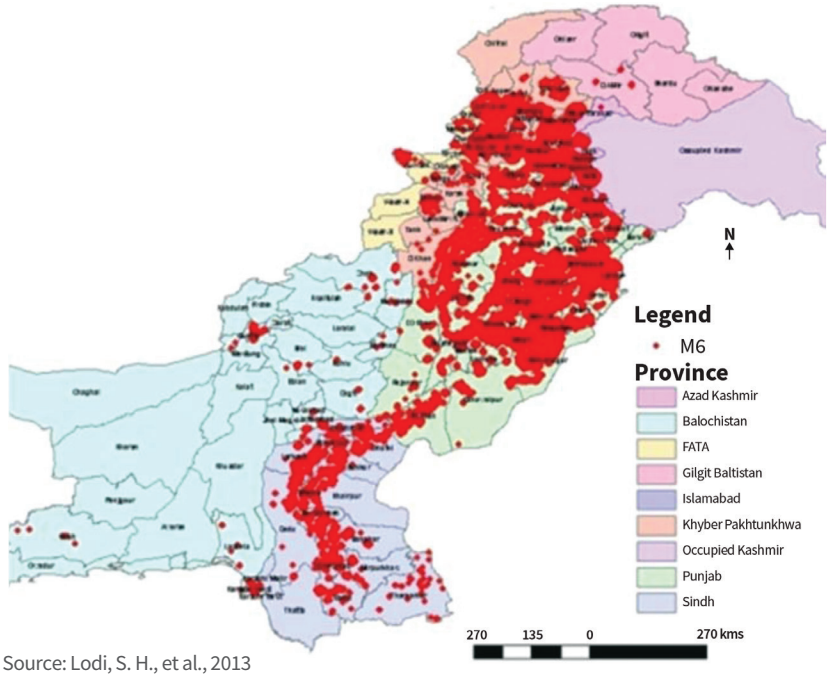
Major cities	Urban population count		Increase in urban population (%)
	Census 1998	Census 2017	
Karachi	9,339,023	14,910,352	62.6
Lahore	5,143,495	11,126,285	46.2
Faisalabad	2,008,861	3,203,846	62.7
Rawalpindi	1,409,768	2,098,231	67.2
Gujranwala	1,132,509	2,027,001	55.9
Peshawar	982,816	1,970,042	49.9
Multan	1,197,384	1,871,843	64.0
Hyderabad	1,166,894	1,732,693	67.3
Islamabad	529,180	1,014,825	52.1
Quetta	565,137	1,001,205	56.4

Source: Pakistan Bureau of Statistics, 2020

play a major role by ensuring uninterrupted supply of bricks and smooth functioning of the construction sector. In Pakistan 62.38% of infrastructure is built using masonry bricks (Tariq, R.T., et al., 2014; Lodi, S.H., et al 2012, Attiq). Brick masonry construction ranges from one-storey rural houses, to 4–5 storey residential and commercial buildings, to taller buildings with more than 5 storeys in urban areas and cities (Lodi, S.H., et al., 2013). Masonry bricks produced in brick kilns are also used in other built infrastructure, such as concrete structures, roads and pavements, mainly in rural areas (Figure 3).

To address the housing shortage in Pakistan, the government of Pakistan has started Naya Pakistan Housing Programme (NPHP). Under this programme, the government intends to construct about 5 million housing units across Pakistan (Nasir, 2019). In countries across the globe, particularly in developing economies, the construction sector accounts for a substantial proportion of the Gross Domestic Product (GDP) (S.M Zafar, 2020). The construction industry is considered a mother industry capable of generating and stimulating economic activity. It creates a snowball effect in the economy, setting off a chain of activities in many other related industries and associated businesses. The construction industry is known to trigger economic activity in more than 40 related sectors (M. Ejaz, 2020; FBR, 2020). In Pakistan, construction and agriculture are industries that employ the highest numbers of people in the country. The construction sector pulls the weight of other industries as it makes them function, thus acting as an economic catalyst (S.M. Wajih Zafar, 2020). To further strengthen economic activity in Pakistan, the government has introduced revolutionary reforms for the construction sector (MoF, 2020; FBR, 2020). To uplift industries and sectors linked to the construction sector, the government has given the construction sector the

FIGURE 3 SPATIAL DISTRIBUTION OF BRICK MASONRY BUILDINGS IN PAKISTAN



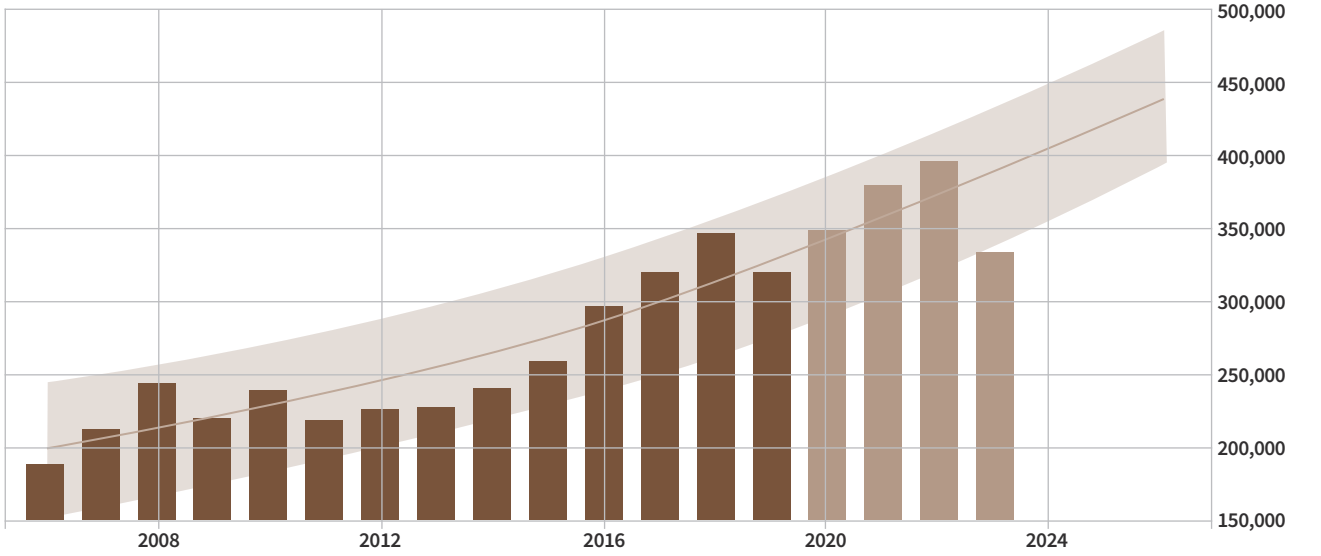
Source: Lodi, S. H., et al., 2013

"industry" status (Zulfikar, 2020; The News 2020; Dawn, 2020). It is expected that these policy decisions will not only boost the country's economy, they will also help transform the brick kiln sector into an environment-and-worker-friendly sector. Policy level changes geared towards strengthening the country's construction sector are likely to increase demand for brick production. These changes will contribute to optimal operation of existing brick kilns and increase the rate of construction of new brick kilns on zig-zag footings (ICIMOD, 2019).

The global macro-economic trading models also suggest that the construction sector's contribution to Pakistan's GDP will reach PKR 313,292 million by the end of 2020 (Figure 4). It is expected to trend around PKR 321,125 million in 2021, and PKR 332,365 million in 2022 (State Bank of Pakistan, 2020).

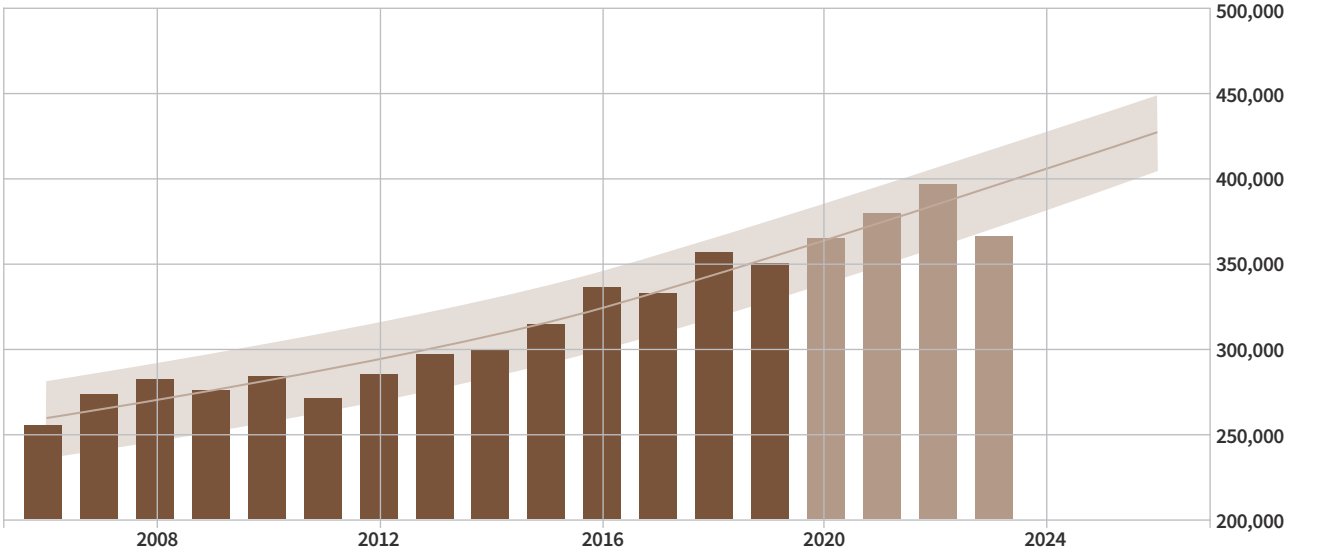
Similarly, the mining sector including coal mining substantially contributes to the construction industry in Pakistan. Contribution of the mining sector to the national GDP is expected to reach PKR 344,439 million by the end of 2020 (Figure 5). It is expected to trend around PKR 353,050 million in 2021, and PKR 365,406 million in the year 2022 (State Bank of Pakistan, 2020).

FIGURE 4 **CONTRIBUTION OF THE CONSTRUCTION SECTOR TO THE GDP OF PAKISTAN (PKR IN MILLION)**



Source: State Bank of Pakistan, 2020

FIGURE 5 **CONTRIBUTION OF THE MINING SECTOR TO THE GDP OF PAKISTAN (PKR IN MILLION)**



Source: State Bank of Pakistan, 2020

SECTION II

Why zig-zag kilns

On an average, there are around 300,000 kilns worldwide. However, 75% of global brick production is concentrated mainly in four countries, namely China (54%), India (11%), Pakistan (8%), and Bangladesh (4%) (ICIMOD, 2019; CATF, 2010). Generally, in most countries, including Pakistan, China, India and Bangladesh, the rate of brick production is determined by population growth and resulting urbanisation. In developing countries, emissions and associated pollutants have already exceeded the levels recommended by the World Health Organization (WHO) (Khan et al., 2011; Colbeck et al., 2009; Lodhi, 2006). South Asia is the largest brick producing region in the world. Brick kilns in this region mainly rely on centuries-old brick producing technology, which is not environment-friendly and is notorious for unhealthy emissions (Skinder et al., 2014). According to WHO estimates, in Pakistan, in 2015 alone around 0.135 million people died due to exposure to hazardous PM2.5 (HEI, 2017). This problem is particularly severe in Bangladesh, India, Nepal, and Pakistan, where baked bricks are being produced using the centuries-old Fixed Chimney Bull's Trench Kiln (FCBTK) (S. Nasim and F. Sharif, 2020). In Punjab province of Pakistan, there are 10,394 functional brick kilns of which more than 78% use such old technologies. On an average brick kilns across Pakistan consume 3025.5 metric tonnes of coal (CEIC, 2020). However, in 2006 coal consumption reached an all-time high of 4221.8 metric tonnes. Other studies suggest that brick kilns that use traditional technologies and fuel sources also emit carcinogens (Zavala et al., 2018; Chen et al., 2017; Stockwell et al., 2016). Primarily, brick kiln workers face the risk of exposure to carcinogens (S. Nasim and F. Sharif, 2020). Emissions from kilns not only contribute to ambient air pollution but also have negative impacts on the health of communities residing in the vicinity of brick kilns (ICIMOD, 2019; Sangeet, N., et al., 2019; Kim, B.M., et al., 2015; Schmidt, C.M., et al., 2013; Shaikh, S., 2012).

In South Asia, coal is used as a primary source of fuel for firing and baking clay bricks. This produces greenhouse gas emissions and associated harmful particulate matter, including $PM_{2.5}$, sulfur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxide (NO_x), methane (CH_4), and black carbon (S. Nasim and F. Sharif, 2020; Skinder et al., 2014; Croitoru, L and Sarraf, M., 2012). Brick kiln operators often mix coal with other hazardous additives such as used tires and industrial plastic waste, further adding to hazardous emissions in the air (Sanjel et al., 2016; Mondal et al., 2017; Tahir et al., 2010).

Besides having negative impacts on human health and the environment, hazardous air quality leads to poor visibility, causing air and land traffic delays, accidents (Sager, 2016; Gilliland et al., 2001). Hazardous air quality also affects the ability of plants and agricultural crops to undergo photosynthesis, causing damage and stunting their growth (Adrees, M., et al., 2016). Apart from these impacts, brick kiln emissions have other indirect negative impacts on social and environmental well-being. (S. Nasim and F. Sharif, 2020). It is hence important for policy makers in developing and least developed countries to take concrete action to improve ambient air quality.

Induced Draft Zig-Zag Kilns (IDZZK) or zig-zag kilns are not only environment-friendly, but also less polluting, and hence have huge potential for improving ambient air quality and reducing negative impacts on the environment and human health (S. Nasim and F. Sharif, 2020; Nepal, S. et al., 2019). Another advantage of the zig-zag kiln is that this technology can be easily retrofitted and smoothly integrated into the traditional FCBTK model through installation of an electric fan

in the funnel outlet that synthetically produces and adjusts draft across bricks stacked in a zig-zag manner in the kiln (Nepal, S. et al., 2019; Rajarathnam et al., 2014; Weyant et al., 2014). Other studies also strongly suggest that the zig-zag kiln is a better alternative to the traditional FCBTK because a zig-zag kiln allows for more efficient fuel combustion than FCBTK, emits comparatively less pollutant smoke and is hence cost effective and environment friendly. As a result of proper combustion of coal and equal distribution of heat in the chamber, over 35% more high-quality bricks could be produced with over 30% less primary fuel cost in IDZZK compared to FCBTK. (S. Nasim and F. Sharif, 2020; Nepal, S. et al., 2019; Sharma, S., et al., 2019; Jayarathne et al., 2018; Stockwell et al., 2016; Weyant et al., 2014; Rajarathnam et al., 2014; Tehzeeb and Bhuiyan, 2014; Maithel et al., 2014).

2.1 The brick kiln sector of Pakistan

The brick industry, which is considered an informal sector in Pakistan, is grappling with a number of environmental and socioeconomic issues. The sector is gradually being transformed but at a slow pace and on a low scale. The rapid urbanisation and ever widening gap between the available and required number of housing units has led to an increased demand for construction materials. The demand for burnt clay bricks is also expected to grow because of the government's emphasis on infrastructure and housing sector development. Therefore, in addition to building energy-efficient and low-cost housing infrastructure, it is necessary to ensure that building materials, especially bricks, are produced with minimum emissions of greenhouse gases (GHG) and black carbon (BC)

The vast majority of brick kilns in Pakistan are Fixed Chimney Bull Trench Kilns (FCBTK), Moving Chimney Bull Trench Kilns (MCBTK), and Vertical Shaft Brick Kilns (VSBK). They employ straight line firing configuration for baking green bricks, which is highly inefficient and exhaustive both in terms of energy consumption and combustion, and hence highly polluting, labour intensive, and expensive (S. Nasim and F. Sharif, 2020; APN, 2016). Besides, they are often poorly constructed and suffer from excessive air leakage, resulting in heat loss, inefficient fuel usage, and high air pollutant emissions.

A feasible alternative for converting traditional, environmentally unfriendly brick kilns into relatively environment-friendly brick kilns is to change the brick stacking pattern from straight line to zig-zag. This increases energy efficiency and improves combustion while retaining the FCBTK structure. Stacking green bricks in a zig-zag pattern improves air flow and results in better combustion. For every brick that is produced in a zig-zag kiln, black carbon emission is approximately 90% less compared to straight line firing.

If all FCBTKs in South Asia are converted into zig-zag kilns, it is estimated that the total black carbon emissions from the brick kiln sector would be reduced by 60%. Zig-zag kilns reduce coal consumption by 20%, providing a 'win-win' situation for brick kiln entrepreneurs and the environment.

Green brick making is largely manual work and is therefore a major source of employment for the rural poor. Although green brick making is labour intensive, it does not require major capital investment. Manual green brick making, as is practiced, does not require any formal training; rather the skill is transferred from worker to worker on the brick making site. However, this process is linked to several problems such as low production, higher wastage during the handling of green bricks, higher labour requirement, poor working conditions and occupational hazards. Alternatively, mechanised green brick making has major advantages like high production, less wastage, lower labour requirement, and consistent brick quality. However, mechanised brick making options require upfront capital investment for machinery as well as technically skilled human resources for running the machinery. Mechanised green brick making options are slowly gaining popularity in Pakistan. Brick kiln entrepreneurs have started using locally fabricated green brick making machines.

2.2 Policies governing the brick kiln sector in Pakistan

Although the clay brick making sector in Pakistan contributes 1.5% to overall GDP of the country (Abrar Ahmad 2009), the sector at large is highly unregulated. It is not officially recognised as an industry nor as a sector under any government-recognised industry. However, rules and regulations prescribed by different ministries and line departments are deemed applicable to the brick kiln sector in Pakistan. Secondly it is not a trade organization, rather an association of brick kiln owners). Existing policies governing the country's brick kiln sector include but are not limited to the following:

Labour laws: The brick kiln sector in Pakistan is bound to follow all the policies and regulations prescribed under the National Labour Law Profile of the Islamic Republic of Pakistan (ILO, 2020).

Labour rights prescribed in the constitution of Pakistan: Constitutional provisions related to labour rights (Article 11: Prohibition of all forms of slavery, forced labour, and child labour; Article 17: Freedom of association; Article 25: Rights to equality; Article 37: Provision of just and humane working conditions) are applicable to the brick kiln sector in Pakistan (National Assembly of Pakistan, 2004).

Environmental laws (e.g., Ambient Air Quality Law): Brick kilns operating in Pakistan are required to comply with ambient air quality standards of provinces where the respective brick kilns are located. In case of brick kilns and other smoke-emitting industries operating in Punjab province, the provincial government of Punjab has prescribed the following ambient air quality standards (Table 2).

Implementation of prescribed laws: The judiciary of Pakistan through mandated institutions ensures implementation of prescribed laws and framework conditions applicable to the brick kiln sector. For example, over the years, Lahore High Court (LHC) has taken the following directives to ensure just implementation of labour and environmental laws in Pakistan in public interest litigation (Mohsin Raza Malik, 2020):

- To regulate the brick kiln industry, the judiciary of Pakistan has advised provincial Labour and Human Resource Department to ensure registration of brick kilns in Punjab province under the Factories Act, 1934.
- Directed the government of Punjab, Pakistan to notify the District Labour Committees (DLCs) across the province for effective implementation and monitoring of the Punjab Prohibition of Child Labour at Brick Kilns Act, 2016. This Act strictly prohibits brick kiln owners to employ workers below 14 years of age. However, more broadly in Pakistan, it is illegal to employ someone under 16 years of age.

TABLE 2 **AMBIENT AIR QUALITY PRESCRIBED FOR SMOKE-EMITTING INDUSTRIES IN PUNJAB, PAKISTAN**

Pollutant	Time-weighted average	Approved concentration in ambient air
Sulfur dioxide (SO_2)	Annual average	80mg/m^3
	24 hours	120mg/m^3
Oxides of Nitrogen (NO)	Annual average	40mg/m^3
	24 hours	40mg/m^3
Suspended particulate matter (SPM)	Annual average	360mg/m^3
	24 hours	500mg/m^3
Respirable particulate matter (PM_{10})	Annual average	120mg/m^3
	24 hours	150mg/m^3
Respirable particulate matter ($PM_{2.5}$)	Annual/ 1 hour average	15mg/m^3
	24 hours	35mg/m^3
Lead (Pb)	Annual average	01mg/m^3
	24 hours	1.5mg/m^3
Carbon monoxide (CO)	8 hours	05mg/m^3
	1 hour	10mg/m^3
Ozone (O_3)	1 hour	130mg/m^3

Source: Government of Punjab, Pakistan, 2016

Note: Other relevant environment related policies governing brick kilns include Environmental Protection Act 1997; National Environmental Quality Standards 2000; National Climate Change Policy 2012, and Framework for Implementation of Climate Change Policy 2013; National Energy Efficiency and Conversion Act 2016; and Pakistan Vision 2025.

- To ensure adherence to Punjab Prohibition of Child Labour at Brick Kilns Act, 2016, the judiciary of Pakistan has directed all offices of the Deputy Commissioners in Punjab province to ensure registration of brick kiln workers and their family through the National Database & Registration Authority (NADRA).
- Directed the government of Punjab to establish Provincial Vigilance Committees (PVCs) and District Vigilance Committees (DVCs) to ensure effective compliance with and implementation of Punjab Bonded Labour Act, 1992.
- To ensure compliance with the Punjab Bonded Labour Act, 1992, the judiciary has prohibited brick kiln owners and management from providing an advance/loan, known as peshgi, above PKR 50,000 to brick kiln workers and their families, and directed brick kiln managers to maintain proper records of advance/loan disbursed to brick kiln workers.
- To ensure social security benefits, the judiciary has issued directives for registration of brick kiln workers under the Provincial Employees Social Security Ordinance, 1965. In this regard, the judiciary has directed the government of Punjab to ensure implementation of Minimum Wage Act, 2019. The directives also require brick kiln owners to provide basic health and education facilities to children of brick kiln workers.

2.3 Framework conditions supporting the brick kiln sector in Pakistan

Over the years the government of Pakistan has taken the following steps to support conversion of traditional, environmentally unfriendly brick kilns into zig-zag kilns:

Adoption and scaling up of zig-zag kilns: The Ministry of Climate Change (MoCC), Government of Pakistan (GoP), along with the provincial government of Punjab, has extended a lot of support for transforming the brick kiln sector into an environment-friendly industry. By the end of 2021, the Environmental Protection Department (EPD) under the government of Punjab aimed to convert all the brick kilns in Punjab province into zig-zag technology, and to strengthen technical capacity for using zig-zag kilns through the Technical Education & Vocational Training Authority (TEVTA) (Government of Punjab, Pakistan 2020). The MoCC-GoP has issued directives to only purchase bricks produced in zig-zag kilns for public sector construction projects.

Banning construction of new kilns using traditional technologies: The MoCC-GoP and the provincial government of Punjab have banned construction of new brick kilns using traditional technologies. Further, every year during smog season, traditional brick kilns are not allowed to operate for 2 to 3 months. Only zig-zag kilns are allowed to operate during smog season. The Provincial Disaster Management Authority (PDMA), Punjab is playing a proactive role in promulgating these regulations in Punjab province.

Green financing: The State Bank of Pakistan, Punjab has issued a written notification stating that it will be providing subsidised loans for the construction of zig-zag kilns, and retrofitting of traditional kilns into zig-zag kilns.

SECTION III

Background of the study

Pakistan joined the Climate and Clean Air Coalition (CCAC) in 2017. Pakistan became a focus country for the CCAC's programme, Brick Production Initiative (BPI), which aims to reduce emissions of black carbon and other pollutants from brick kilns through a range of technology and policy approaches. ICIMOD is coordinating the CCAC-BPI activities in South Asia. The government of Pakistan (GoP), along with the Brick Kiln Owners Association of Pakistan (BKOAP), is keen to convert traditional kilns into zig-zag technology. The GoP has identified this as a priority area in their Global Environment Facility (GEF) funding. Following successful piloting of zig-zag kilns in Nepal, ICIMOD has started providing technical support to brick kiln entrepreneurs in Pakistan, starting with Punjab province. For this, ICIMOD is closely collaborating with the BKOAP, the Ministry of Climate Change, and the Environmental Protection Agency, GoP. The UN Environment Programme and the Asian Development Bank (ADB) with co-funding from the GEF provided ICIMOD a grant to create baseline information for developing a GEF proposal for Pakistan. More specifically, the grant aimed to create baseline information on:

- The political economy of the brick kiln sector of Punjab, Pakistan
- Number and types of brick kilns operating in Punjab province, Pakistan
- Emissions measurement in the brick kiln sector of Pakistan
- Distribution of brick kilns, the type and nature of fuel being used in Pakistan
- Production of bricks and socioeconomic conditions of workers at brick kilns in Pakistan

A study was designed to establish a baseline scenario through the documentation of the overall governance situation of the sector, existing brick-making practices, and the socioeconomic conditions of brick kiln workers. This report provides important insights into the overall situation of the brick kiln sector in Punjab province of Pakistan. It highlights key findings of the baseline study and makes recommendations for the development of the brick kiln sector of Punjab in particular and of Pakistan in general.

3.1 Methodology of the study

The baseline study allowed us to collect a significant amount of data on the brick kiln sector in Punjab, Pakistan. Both quantitative and qualitative data were collected through a survey of brick kilns and interviews with brick kiln entrepreneurs, operators, female and male brick kiln workers and their families. Baseline data was collected from a total of 440 brick kilns located across 11 districts in Punjab province. Three sets of questionnaires were filled out for each brick kiln surveyed. Baseline information related to operations and management of brick kilns and the production capacity of brick kilns was collected through face-to-face interviews with brick kiln entrepreneurs, operators, and managers of the respective brick kiln(s). In addition, a total of 440 female and male workers were interviewed to gather baseline data on the socioeconomic and working conditions of brick kiln workers and their families. To obtain a holistic picture of the socioeconomic and working conditions of brick kiln workers and their families, attempts were made to ensure adequate representation of workers at different sites of a brick kiln (Table 3). Information on policies governing the brick kiln sector, regulatory frameworks and

TABLE 3 **BRICK KILN WORKERS AND WORKER FAMILIES INTERVIEWED AND SITES COVERED DURING BASELINE SURVEY**

Brick kiln site	Worker families surveyed (N=10,394, n=440)	Average age of respondents (N=10,934, n=440)
Soil preparation for brick making	22%	41
Transportation of green bricks for stacking	17%	42
Stacking of green bricks for baking	23%	38
Coal crushing	19%	38
Offloading of baked bricks	19%	38

Source: Survey data, 2020

Note: N=Total number of brick kilns in Pakistan; n=Total number of brick kilns surveyed during this study

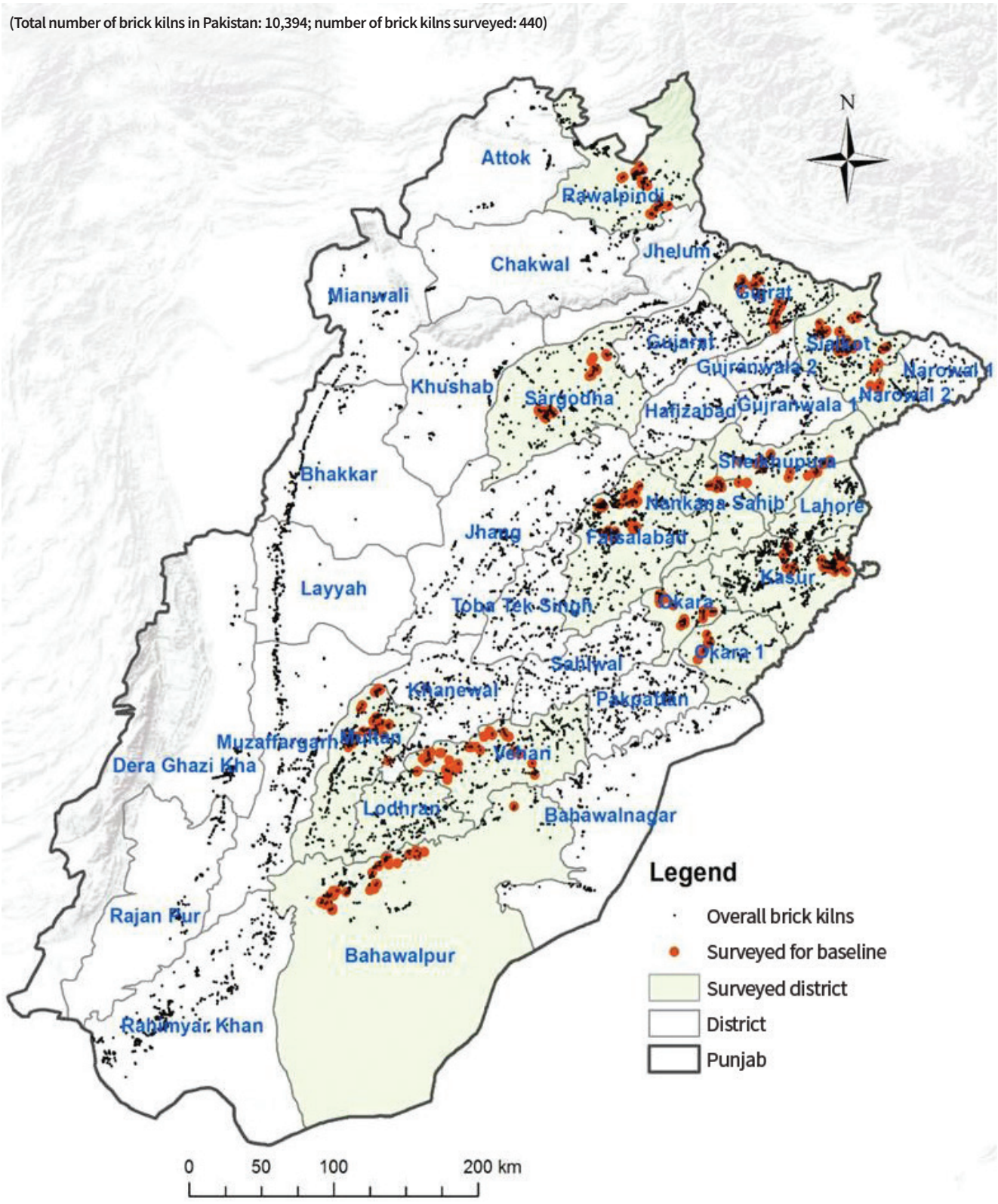
framework conditions supporting the brick kiln sector was collected from secondary sources and a review of relevant literature. Table 3 shows the different sites where the brick kiln workers and their families were interviewed during the baseline survey.

At the same time, observation-based data pertaining to brick kiln operations and management, safety practices being observed at the brick kilns, type and nature of work being done manually and by using mechanised options, status of housing, education and agricultural activities in the surroundings of the kilns was also collected from each brick kiln. Where possible, available secondary data has been used to supplement the findings of the study.

Multiple consultations were held with the Brick Kiln Owners' Association of Pakistan (BKOAP) to identify districts and tehsils within those districts where operational brick kilns are concentrated within Punjab province. A total of 11 such districts and 30 tehsils within these districts were identified as target districts for the baseline survey. The 11 districts were selected based on the high number of brick kilns in those districts. Given the available resources, baseline data was collected from 40 brick kilns in each district. Within the target districts, brick kilns for baseline data collection were selected on the basis of their geographical spread, concentration of brick kilns in a specified area, and the volume of brick kiln operation. Since the districts were selected based on the high number of brick kilns, the sample has limitations, and the authors caution against generalising the study results beyond the province level. Figure 6 presents the map of Punjab province showing the total number of brick kilns identified through geotagging vis-à-vis the brick kilns surveyed for the baseline.

FIGURE 6 MAP SHOWING NUMBER OF BRICK KILNS AND KILNS SURVEYED IN PUNJAB

(Total number of brick kilns in Pakistan: 10,394; number of brick kilns surveyed: 440)



Source: Geospatial Unit, ICIMOD

SECTION IV

Findings of the study

4.1 Brick kilns in Punjab

Brick kilns are scattered across Punjab province and are concentrated in the suburbs of the towns. However real time data received from BKOAP shows that a total of 10,394 brick kilns are operating across 36 districts in Punjab province (Table 4).

Real-time data shared by BKOAP suggests that as of November 2020, a total of 1400 kilns were already converted into zig-zag kilns. Retrofitting of remaining 930 kilns onto zig-zag footings was ongoing and expected to be completed by the end of November 2020. This suggests that 22.4% of the total brick kilns were converted to zig-zag kilns by the end of November 2020.

4.2 Brick kilns by their year of establishment in target districts

It appears that the surveyed brick kilns in Punjab were established after independence in 1947. Baseline data suggests that the number of brick kilns in Punjab gradually increased with increase in population and demand for houses and other infrastructure. It was found that out of 440 brick kilns surveyed for the baseline, a total of 49 brick kilns (11.1%) were established during the first 50 years after the independence of Pakistan (Table 5). During this period, majority of the brick kilns were established in Sialkot district followed by Bahawalpur and Sargoda districts. Remaining 391 (89.8%) were found to have been established after 1995. Table 5 presents the time period in which the sampled brick kilns were established.

4.3 Types of brick kilns by firing practices

Mainly four types of brick kilns are mainly operational in Punjab province of Pakistan. These include Fixed Chimney Bull Trench Kilns (FCBTK); Moving Chimney Bull Trench Kilns (MCBTC); Vertical Shaft Brick Kilns (VSBK); and ICIMOD-introduced Fixed Chimney Zig-Zag Bull Trench Kilns (zig-zag kilns). They differ in their firing and fuel feeding practices, and hence emit different amounts of black carbon (BC) into the atmosphere. Among these types, research has shown that zig-zag kilns emit the least amount of BC. Besides, zig-zag kilns require less upfront capital investment, consume less coal and produce better quality bricks compared to FCBTK and MCBTK. Therefore, ICIMOD and its partners are advocating for zig-zag kilns in the South Asia region. Among the 440 brick kilns surveyed for the baseline in Punjab, 89% were found to be FCBTK, 9% were MCBTK and the remaining 2% were zig-zag kilns. Five of the FCZBTK brick kilns were found in Sialkot district, followed by one each in Faisalabad, Kasur, Okara, and Sheikhupura districts (Table 6). Through BKOA, ICIMOD has been providing hands-on trainings on retrofitting traditional kilns into zig-zag kilns and their management to brick kiln entrepreneurs in Punjab since 2017. According to BKOA's database, around 250 brick kilns have been converted into zig-zag kilns in Punjab province. Brick kiln entrepreneurs say that the maximum upfront investment required for establishing a brick kin is around PKR 30,500,000 (average amount being PKR 4,168,191 depending on the size of the brick kiln), and the average payback period is calculated to be 5.2 years. Table 6 provides a district wise summary of different types of brick kilns surveyed for the baseline.

TABLE 4 NUMBER OF TRADITIONAL AND ZIG-ZAG BRICK KILNS IN PUNJAB, PAKISTAN

No.	District	Total number of brick kilns	Number of zig-zag kilns (as of November 2020)	
			Total converted, being converted	Percent converted, being converted
01	Attock	250	07	2.8%
02	Rawalpindi	220	32	14.5%
03	Jehlam	163	03	1.8%
04	Chakwal	118	16	13.6%
05	Sargodha	403	19	4.7%
06	Khushab	156	25	16.0%
07	Mianwali	158	00	0.0%
08	Chiniot	67	2	3.0%
09	Gujrat	254	61	24.0%
10	Mandi Bahauddin	245	75	30.6%
11	Hafiz Abad	93	62	66.7%
12	Narowal	205	105	51.2%
13	Sialkot	265	60	22.6%
14	Gujranwala	332	74	22.3%
15	Sheikhopura	312	91	29.2%
16	Nankana	107	35	32.7%
17	Faisalabad	607	207	34.1%
18	Toba Tek Singh	415	15	3.6%
19	Jhang	280	03	1.1%
20	Bhakhar	198	01	0.5%
21	Layyah	254	01	0.4%
22	Mufaffargharh	426	07	1.6%
23	D.G. Khan	156	00	0.0%
24	Multan	614	12	2.0%
25	Rajanpur	162	01	0.6%
26	Rahim Yar Khan	350	10	2.9%
27	Bahawalpur	450	25	5.6%
28	Lodhran	292	07	2.4%
29	Vehari	380	74	19.5%
30	Bahawalnagar	248	82	33.1%
31	Pakpatan	221	20	9.0%
32	Khanewal	320	24	7.5%
33	Sahiwal	230	59	25.7%
34	Okara	332	129	38.9%
35	Kasur	834	736	88.2%
36	Lahore	277	250	90.3%
	Total	**10,394**	**2330**	**22.4%**

Source: Real-time brick kiln statistics received from BKOAP, November 2020

TABLE 5 YEAR OF ESTABLISHMENT OF THE BRICK KILNS SURVEYED FOR THE BASELINE

District	Year of establishment of sampled brick kilns		
	1947–1972	1971–1996	1995–2019
Multan	0	3	37
Gujrat	0	6	34
Sialkot	0	17	23
Okara	0	0	40
Faisalabad	0	3	37
Bahawalpur	1	9	30
Kasur	0	0	40
Vehari	0	0	40
Sheikhupura	0	4	36
Sargoda	0	6	34
Rawalpindi	0	0	40
Total	**1**	**48**	**319**

Source: Survey data, 2020

TABLE 6 TYPES OF BRICK KILNS BY DISTRICT

District	Zig-zag kilns	MCBTK	FCBTK
Multan	0.0%	97.5	2.5%
Gujrat	0.0%	0.0%	100%
Sialkot	12.5%	2.5%	85%
Okara	2.5%	0.0%	97.5%
Faisalabad	2.5%	0.0%	97.5%
Bahawalpur	0.0%	0.0%	100%
Kasur	2.5%	0.0%	97.5%
Vehari	0.0%	2.5%	97.5%
Sheikhupura	2.5%	0.0%	97.5%
Sargodha	0.0%	0.0%	100%
Rawalpindi	0.0%	0.0%	100%

Source: Survey data, 2020

SECTION V

Governance of brick kilns

5.1 Brick Kilns Owners' Association of Pakistan

The brick sector in Pakistan is not under the direct jurisdiction of any specific ministry or line department. However, rules and regulations prescribed by different ministries and line departments apply to the sector. The sector is recognised neither as an industry nor as a sector under any government-recognised industry. . As the number of new brick kilns was increasing year by year, brick kiln entrepreneurs required a platform that could assemble them under a formal setup. BKOA was established in 1987 to organise the brick kiln sector and provide technical, legal and administrative support for modernising brick kilns in Pakistan. BKOA encouraged brick kiln entrepreneurs to register their brick kilns with this informal body. Baseline survey findings suggest that 358 of the brick kilns (81.3%) surveyed in Punjab are registered with BKOA, 52 (12%) are not registered, and the remaining 30 brick kilns (6.8%) are in the process of being registered with this body.

5.2 Status of land under brick kilns

Brick kilns in Punjab operate on land owned by brick kiln entrepreneurs or entrepreneurs acquire land on lease. Baseline survey indicates that 40% of the brick kilns surveyed are established on land owned by brick kiln entrepreneurs, whereas 60% are built on land acquired on lease. Majority of the brick kilns surveyed in Shikupura district (87.5%) are built on land owned by brick kiln entrepreneurs, followed by 65% in Kasur district, 62.5% in Sialkot district, and 57.5% in Sargodha district. Meanwhile, majority of brick kilns surveyed in Multan district (95%) are constructed on leased land, followed by 87.5% in Vehari district, 80% in Bahawalpur district, and 72.5% in both Okara and Rawalpindi districts.

5.3 Land lease amount and payment mechanism

Of the brick kilns established on leased land, 62% of the brick kiln operators are paying the lease amount in advance, 21% are paying in installments, 16% of the operators are paying the amount on an annual basis, and the remaining 1% are paying as and when required by the landowner or at the end of the lease period. District wise analysis indicates that all brick kiln operators in Faisalabad district are paying the lease amount in advance followed by 83% in Rawalpindi district, 76% in Okara district, and 71% in Gujrat district. Whereas 50% of the brick kilns operators in Multan district are paying the lease amount in installments followed by 35% in Sargodha district and 29% in Gujrat district. The average annual lease amount is PKR 329,733.[1] A total of 10 brick kiln operators (2.2% of the total surveyed brick kilns) pay an annual lease amount of more than PKR 1 million, 11.3% pay between PKR 0.5 to 1 million, 28% pay between 0.1 and 0.5 million. Remaining 58.5% of the brick kiln operators pay an annual lease amount of less than PKR 0.1 million. Land lease term ranges from 4 to 11.5 years.

[1] 1 USD = PKR. 140 at the time of baseline

5.4 Land area covered by brick kilns

Land area covered by a brick kiln includes land that falls within the demarcated boundary of the brick kiln. The average land area (in kanals)[2] covered by brick kilns is found to be higher by 7.1 kanals for brick kilns established on land owned by brick kiln entrepreneurs compared to the area covered by brick kilns constructed on leased land. Average land area covered by brick kilns constructed on the brick kiln entrepreneur's land is found to be 51.8 kanals, whereas the average land area of brick kilns constructed on leased land is found to be 44.7 kanals.

5.5 Brick kiln entrepreneurs owning more than one brick kiln

Baseline data analysis shows that a total of 18.4% of the brick kiln entrepreneurs surveyed for the baseline own at least one more brick kiln in Punjab province. Ownership of at least one additional brick kiln is 1% higher among entrepreneurs who operate brick kilns on leased land compared to entrepreneurs who operate brick kilns on their own land. A total of 18.8% of entrepreneurs operating brick kilns on leased land operate at least one more brick kiln compared to 17.1% of entrepreneurs who run brick kilns on their own land.

[2] 1 kanal = 20 marla; 4 kanal = 1 bigha; 8 kanal = 1 acre

SECTION VI

Brick kiln operations and management

6.1 General information on workers

Generally, brick kiln workers are employed as permanent workers or transient workers. Permanent workers are those who return to work at the same brick kiln. Transient workers are those who work at a brick kiln part of the year or throughout the year for a livelihood and might or might not come back to work at the same kiln. The brick kiln owner has to provide incentives to retain workers. Baseline data shows that 42% of the surveyed brick kilns employ a mix of permanent and transient workers while at 12% of the brick kilns surveyed, all workers are reported to be permanent workers. Whereas 46% of the brick kilns surveyed were found to employ only transient workers. District wise analysis indicates that a mix of permanent and transient labour force is employed in 92.5% of the brick kilns in Vehari followed by 90% in Kasur and Sheikhupura districts. Faisalabad is the only district where the entire labour force is permanent. Whereas majority of workers employed at brick kilns surveyed in Bahawalpur, Rawalpindi, Sargodha, Gujrat and Multan districts are transient workers. Table 7 provides further details on the type of workers employed in the brick kilns surveyed for the baseline.

TABLE 7 STATUS OF PERMANENT AND TRANSIENT WORKERS AT BRICK KILNS IN PUNJAB

Districts	Mix of permanent and transient workers	All permanent workers	All transient workers
Multan	40.0%	2.50%	57.5%
Gujrat	05.0%	0.00%	95.0%
Sialkot	57.5%	7.50%	35.0%
Okara	77.5%	7.50%	15.0%
Faisalabad	0.00%	100.0%	0.00%
Bahawalpur	2.50%	0.00%	97.5%
Kasur	90.0%	7.50%	2.50%
Vehari	92.5%	2.50%	05.0%
Sheikhupura	90.0%	10.0%	0.00%
Sargodha	2.50%	0.00%	97.5%
Rawalpindi	2.50%	0.00%	97.5%

Source: Survey data, 2020

6.2 Number of brick kiln workers by role and gender

Workers carry out different tasks at the different sites of a brick kiln. These tasks include coal crushing, coal feeding, stacking of green bricks, offloading of baked bricks, and molding and drying of green bricks. Baseline data shows that both female and male workers perform green brick molding activities such as soil mixing for brick making and drying of green bricks. Male workers are mostly hired for comparatively harder activities including coal crushing, fuel feeding, and offloading of baked bricks. Brick kiln workers are paid for completion of specific tasks such as molding of 1000 bricks, transportation, stacking of 1000 green bricks, offloading of 1000 bricks.

Baseline data suggests that a family working at a brick kiln in Punjab usually includes the father and mother, adult female/male children, their aunts and uncles, and, in some cases, the grandfather and grandmother. Generally worker families carry out green brick molding processes, whereas individually hired workers carry out a range of other tasks at the kiln. However, depending on their capabilities, adult members of a family working at a brick kiln can also work at different sites of a brick kiln.

Baseline data shows that a total of 4543 such families are earning their livelihoods in 440 brick kilns surveyed for the baseline in Punjab. Reportedly, 15% of such transient families lock up their homes and migrate for work during the brick making season, and the remaining 85% leave behind some family members at their places of origin. On an average 10 such families are working at a brick kiln, though the number may vary depending on the scale of operations at each kiln. Baseline data indicates that 65% of brick kiln entrepreneurs surveyed in Punjab have hired up to 10 families; 25% have hired up to 20 families; and the remaining 8% are employing more than 21 such families for different types of work at the brick kilns.

This suggests that around 94,590 families are likely working at the 9459 brick kilns in Punjab. Thus, in one province alone, a significant number of people are earning their livelihood from the brick kiln sector. Around 20,000 brick kilns across Pakistan employ more than 0.2 million families. These are ultra-poor families (representing the poorest stratum of the society), often lacking technical training and educational qualifications required for entry into the mainstream employment sector of Pakistan. Improving the brick kiln sector will eventually improve the life conditions of this stratum of population. Improving the brick kiln sector is also imperative given that women make up a significant proportion of the brick kiln workforce. Baseline data shows that a total of 21,178 (female=4145, and male=17,042) permanent and transient workers[3] are employed in 440 brick kilns surveyed across 11 districts in Punjab. This suggests that on an average 49 (female=10, and male=39) workers are employed per kiln in Punjab province. This further suggests that the brick kiln sector in Punjab province alone is providing employment to 463,491 (female=94,590, and male=368,901) workers in 9459 brick kilns. This means that the brick kiln sector of Pakistan employs more than 0.98 million female and male workers. The number of transient workers is found to be higher by 15.6% compared to permanent workers. In terms of gender, the number of male permanent workers is higher by 73.3% compared to female permanent workers. Similarly, the number of male transient workers is also higher by 77.4% compared to female transient workers. Table 8 provides an overview of the number and type of workers employed in the brick kilns surveyed for the baseline.

Baseline data relating to the type of work that permanently employed workers generally perform shows that in 59% of the brick kilns, permanent workers mainly perform technical work pertaining to fire operations, green brick stacking, generator operations, machines operations, coal feeding, and manual green brick making. However 41% of brick kiln entrepreneurs interviewed during the baseline reported that permanent workers also perform nontechnical labour such as soil mixing, drying of green bricks, green brick transportation for stacking, and offloading of green bricks.

Baseline data analysis further shows that almost all the brick kiln workers surveyed for the baseline in Punjab had come from areas within Punjab province. Brick kiln entrepreneurs of the 440 selected kilns reported 'zero' number of workers coming from other provinces, suggesting no intra-province migration for work in the brick kiln sector. Thus, yet another positive contribution of the brick kiln sector in Pakistan is that this sector accommodates the workforce required within the province.

[3] Permanent workers are those who return to work at the same brick kiln every brick-making season as they are provided the incentive to do so. Transient workers are those who work at a brick kiln part of the year or throughout the year for a livelihood and who might or might not come back to work at the same kiln.

TABLE 8 NUMBER AND TYPE OF WORKERS EMPLOYED IN BRICK KILNS SURVEYED IN PUNJAB

District	Permanent			Transient			Total
	Female	Male	Total	Female	Male	Total	
Multan	160	430	590	294	1424	1718	2308
Gujrat	40	90	130	509	983	1492	1622
Sialkot	179	429	608	268	1087	1355	1963
Okara	315	516	831	144	1083	1227	2058
Faisalabad	50	2433	2483	00	00	00	2483
Bahawalpur	00	50	50	00	1942	1942	1992
Kasur	465	1383	1848	197	938	1135	2983
Vehari	252	994	1246	21	396	417	1663
Sheikhupura	404	717	1121	2	143	145	1266
Sargodha	20	20	40	383	856	1239	1279
Rawalpindi	00	00	00	442	1128	1570	1570
Total	**1885**	**7062**	**8947**	**2260**	**9980**	**12,240**	**21,187**

Source: Baseline survey, 2020

SECTION VII

Type of work vis-à-vis earning

The GoP has specified a daily wage of PKR 960 for labourers (Faras Ghani, 2019). In the case of brick kilns, workers at different sites of a brick kiln perform different types of activities, such as coal crushing, coal/fuel feeding, staking/loading of green bricks, and offloading of baked bricks. Their wages and salaries vary according to the task.

7.1 Number of years workers work at a brick kiln

District wise information on the number of years families and individual female/male workers work at the respective brick kilns was obtained from the 440 brick kilns surveyed across 11 districts in Punjab. The objective of collecting this information was also to understand the workers' reasons for working at a brick kiln for consecutive years. Table 9 presents a summary of the number of years families and male/female workers work at different sites of a brick kiln. Baseline data suggests that on an average 10 transient families are working at a brick kiln in Punjab. Depending on their capabilities, adult members of a family working at a brick kiln usually work at different sites of the kiln. Out of the 440 worker families and individual female/male workers interviewed during the study, 16.8% said they had been working at the respective brick kiln for more than five years, 44.8% had been working for two to four years, and 38.4% had been working for one year or less. Formal discussions with these workers revealed that majority of them continue to work for up to three years in a brick kiln and partially leave the kiln in the fourth year.

Baseline data suggests that there are multiple factors for workers working at the same brick kiln for more than two years. In majority of the cases (44% of the working families, male/female workers interviewed), workers work at the same brick kiln for several years because of the positive and accommodating attitude of the brick kiln owner, operator, or supervisor. Whereas 28% of the total working families, male/female workers responded that they work for several years at the same brick kiln because they have to earn a livelihood and pay off the loan taken from the brick kiln entrepreneur, operator, or contractor.

TABLE 9 NUMBER OF YEARS FAMILIES AND INDIVIDUAL MALE/FEMALE WORKERS WORK AT A BRICK KILN BY SITE

Brick kiln site	Number of years of work by brick kiln site					
	Less than 1 year	1 year	2 years	3 years	4 years	5 years or more
Soil preparation	14.4%	20.6%	20.6%	6.2%	14.4%	23.7%
Transportation of green bricks for baking	24.6%	20.5%	11.0%	8.2%	15.1%	20.6%
Stacking of green bricks for baking	12.0%	18.0%	26.0%	10.0%	19.0%	15.0%
Coal crushing and delivery	23.2%	32.9%	13.4%	6.1%	9.8%	14.6%
Offloading of baked bricks	7.1%	23.5%	29.4%	17.6%	15.3%	5.1%
N=440 brick kilns	n=69	n=100	n=90	n=42	n=65	n=74

Source: Baseline survey, 2020

7.2 Payment arrangements for workers

Baseline information on salary/wage payment arrangements for workers shows that 66% of the brick kiln workers are paid on a weekly basis, usually each Thursday. Workers at the green brick molding site usually get their wages on a weekly basis. Whereas 19% of the workers are paid a monthly salary. Workers engaged in coal crushing and coal feeding usually earn a monthly salary. Around 8% of the workers earn a daily wage. The remaining 7% receive a lump sum payment after completing the assigned work. Green brick transportation workers and workers who offload baked bricks often earn a daily wage or a lump sum payment after completing their work.

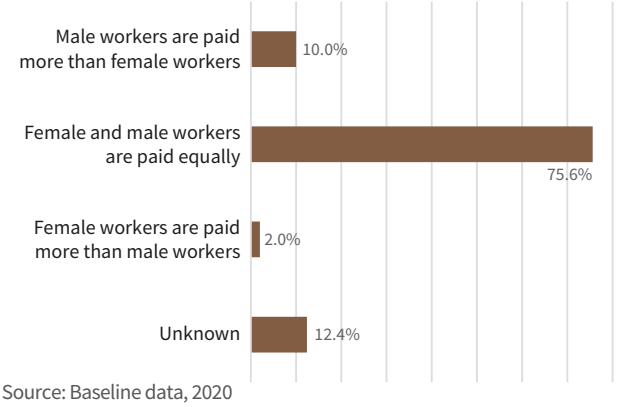
7.3 Remuneration of female and male brick kiln workers

It is highly encouraging to see that brick kilns entrepreneurs in majority of the brick kilns in Punjab province pay equal wages to female and male workers. To obtain baseline data on remuneration, 85 female workers, 105 male workers, and 250 couples (husband and wife working at kilns) were interviewed in 440 brick kilns across 11 districts in Punjab. 75.6% of the workers interviewed reported that they were receiving equal pay irrespective of their gender; 10% of the workers said male workers were being paid more than female workers; and 2% of the workers reported that women were being paid more than their male counterparts. A total of 12.4% of the workers interviewed responded that they didn't know the amounts being paid to other workers (Figure 7).

7.4 Earning of workers engaged in coal crushing

Baseline data shows that 70% of the total brick kilns included in the survey employ up to three workers, while 27% employ up to six workers and the remaining 3% were found to be employing more than six workers. Coal crushing workers are often paid on a monthly basis. Average monthly income of coal crushing workers ranges between PKR 13,051 and PKR 18,138.

FIGURE 7 REMUNERATION OF BRICK KILN WORKERS BY GENDER



Source: Baseline data, 2020

7.5 Earning of workers engaged in coal/fuel feeding

Baseline data reveals that 76% of the brick kilns included in the survey hire up to six workers for coal feeding, 21% hire up to three workers, and the remaining 3% employ more than six workers for fuel feeding. Two brick kiln operators each in Faisalabad and Kasur districts are using fuel feeding machines. Coal feeding workers receive wages on a daily or monthly basis. Average monthly earning of coal feeding workers ranges between PKR 13,600 and PKR 21,153.

7.6 Earning of workers engaged in offloading baked bricks

Baseline data on workforce hired for offloading baked bricks shows that 87% of the brick kilns surveyed for the baseline in Punjab hire up to 10 labourers and 13% employ up to 20 workers for offloading baked bricks. These workers are paid wages on a weekly basis. Their average weekly wage ranges between PKR 4,513 and PKR 6,689.

7.7 Working hours vis-à-vis remuneration of green brick molding workers

Workers engaged in various stages of green brick molding are paid a fixed daily wage, a lump sum, or a piece rate (i.e., paid by the number of green bricks produced). These workers usually work long hours to meet the production target or to earn some more money by producing more green bricks. Baseline data suggests that these workers work for 8 to 16 hours a day. Data indicate that 7% of the brick kilns surveyed for the baseline hire them to work for 8 hours a day and the remaining 93% hire them to work for more than 8 hours a day. Table 10 provides an overview of working hours at 440 brick kilns surveyed for the baseline.

A worker involved in green brick molding activity – from soil mixing to green brick making and drying, earns an average of PKR 954 for molding 1000 green bricks. Actual remuneration across 440 brick kilns surveyed for the baseline ranges between PKR 700 and 1500. Green brick molding workers are usually paid on a weekly basis.

TABLE 10 WORKING HOURS OF LABOUR FORCE ENGAGED IN GREEN BRICK MAKING

Working hours	Number of brick kilns (N=10,394, n=440)
Eight hours a day	31 (7.0%)
Twelve hours a day	04 (1.0%)
Sixteen hours a day	31 (7.0%)
Until agreed-upon target is achieved	88 (20%)
As per the worker's capacity	286 (65%)

Source: Baseline data, 2020

7.8 Remuneration for transportation of green bricks to kiln site for baking

Molding of green bricks generally takes places in an area near the kiln. The task of transporting dried green bricks to the kiln site for baking is labour intensive. Various options are used to carry out this task. In Punjab, mainly animals are used for transporting dried green bricks. Table 6 provides an overview of transportation mechanisms used for carrying dried green bricks to the baking site. Baseline data analysis shows that in 91% of the surveyed brick kilns, dried green bricks are transported to the kiln site for baking using animal driven carts. Motorised transportation seems to be an efficient option. However only 5% of the overall kilns surveyed for the baseline were found to be using motorised options for this purpose. Besides, in 4% of the 440 brick kilns surveyed for the baseline, dried green bricks are transported to the baking site using human labour only (Table 11).

Workers engaged in this task get paid per 1000 dried green bricks transported to the kiln site for baking. Remuneration varies according to the distance between the kiln and green brick drying site. Baseline data shows that average payment for transporting every 1000 dried green bricks is PKR 257, ranging between PKR 176 and PKR 400.

TABLE 11 MEANS OF GREEN BRICK TRANSPORTATION TO BAKING/STACKING SITE AT KILN

Means of green brick transportation	Number of brick kilns (N=10,394, n=440)
Using mix of human human labour and working animals	400 (91%)
Using mix of human labour and motorised options	22 (5.0%)
Manually – using human labour	18 (4.0%)

Source: Survey data, 2020

7.9 Animals used as workforce in brick kilns

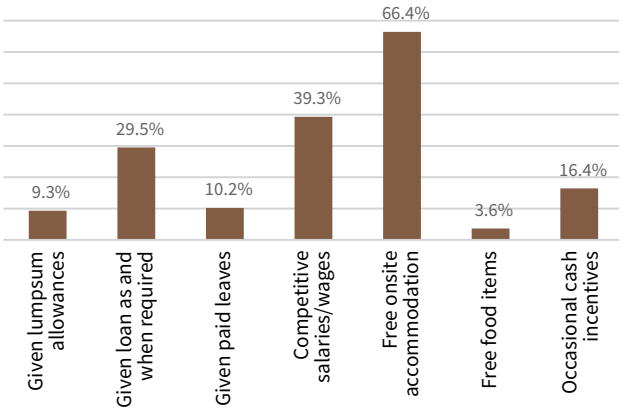
Baseline data analysis shows that a total of 7706 animals are employed in 424 out of the 440 brick kilns surveyed for the baseline. These include 1651 mules, 1586 horses, 2911 donkeys, and 1576 bulls. Six to 10 animals are being used in 49% of the selected brick kilns, 1 to 5 animals in 43% of the brick kilns, and 11 to 25 animals in the remaining 8% of the brick kilns. No animals were found to be employed in 16 brick kilns (3.6%).

Observation-based data collected during the baseline further suggests that animals being used as labour force across 77% of the brick kilns are healthy and physically active. Whereas majority of the workforce animals in the remaining 23% of the brick kilns were found to be physically weak and unhealthy.

7.10 Other incentives for retaining workers

To retain permanent workers in particular and transient workers in general, brick kiln entrepreneurs provide different types of incentives. Besides competitive wages, such incentives mostly include provision of easy loans to workers when they need them, free onsite residence, and provision of allowances and cash incentives on special occasions, e.g., Eid, Christmas, and major family events such as weddings. Figure 8 provides an overview of incentives brick kiln workers receive.

FIGURE 8 TYPES OF INCENTIVES FOR RETAINING BRICK KILN WORKERS



Source: Survey data, 2020

SECTION VIII

Source of soil for brick making

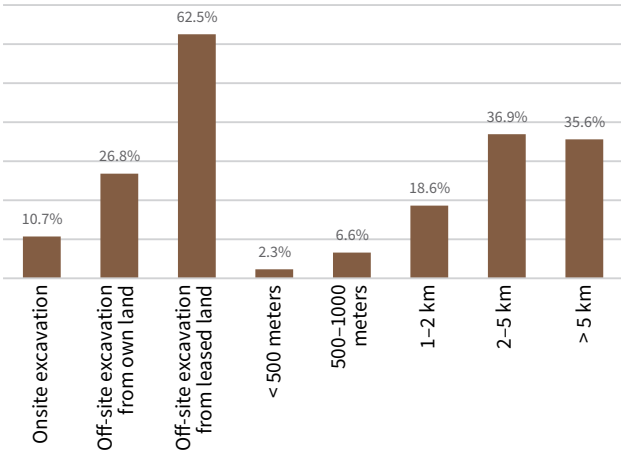
Brick kiln operators generally get soil for brick making from three sources:

- On-site excavation of land surrounding brick kiln premises
- Off-site excavation of a piece of land owned by the brick kiln operator
- Off-site excavation of a piece of land taken on lease

Off-site excavation incurs additional cost for leasing land as well as for transportation; this cost has to be borne by the brick kiln entrepreneurs. Baseline data shows that 89.3% of the brick kiln operators surveyed for the baseline get soil for brick making from off-site sources, and 10.7% from onsite excavation. Those who lease land for obtaining soil pay an average of PKR 250,348 per kanal for the leased excavation site. In addition, brick kiln operators pay an average of PKR 307,828 per year for transporting soil from the off-site resource.

Off-site excavation for brick-making soil takes place in areas located at various distances from the respective brick kilns, the minimum being less than 500 metres and maximum being more than 5 km. Baseline data shows that 35.6% of the brick kiln operators transport soil across a distance of more than 5 km, and 36.9% cover a 2–5 km distance from their respective brick kilns. Baseline information relating to soil excavation shows that in 100 (22.7%) out of the 440 brick kilns surveyed, kiln operators employ a workforce to excavate soil, whereas the remaining 340 brick kiln entrepreneurs have awarded soil excavation work on a fixed cost basis. Brick kilns with small operations employ up to 10 workers. Out of the 440 brick kilns, 34 (7.7%) employ 11–20 excavation workers (Figure 9).

FIGURE 9 SOURCES OF SOIL FOR BRICK MAKING VIS-À-VIS DISTANCE FROM BRICK KILNS

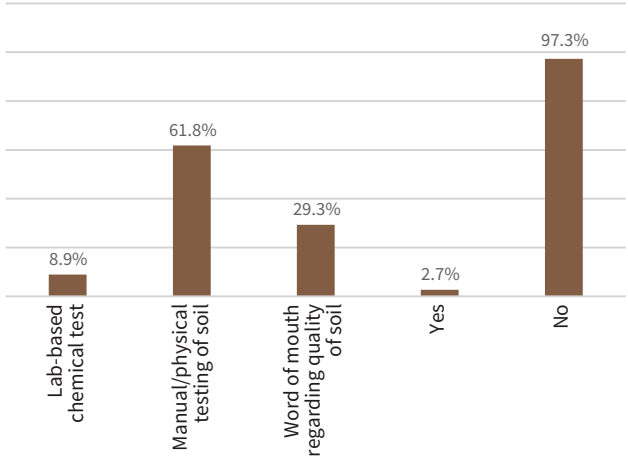


Depending on the amount of excavation, the salary of excavation workers varies from PKR 14,250 to PKR 25,800 each.

8.1 Soil and coal selection for brick making

To produce good quality bricks in a cost-effective and environment-friendly manner, it is important to measure the chemical composition of soil used for brick making and coal used for baking bricks. Baseline data shows that chemical testing of both soil and coal is seldom practiced in brick kilns in Punjab province. Out of the 440 brick kilns surveyed for the baseline, only 8.9% of brick entrepreneurs test the chemical ingredients of brick-making soil. Similarly, only 2.7% assess the chemical properties of coal before purchasing it (Figure 10).

FIGURE 10 **PROCEDURE FOR SELECTION OF SOIL AND COAL USED AT BRICK KILNS IN PUNJAB, PAKISTAN**



8.2 Amount and cost of coal used in brick kilns

Baseline data shows that a total of 144,430 tonnes of coal is used in one year in 440 brick kilns surveyed for the baseline across 11 districts in Punjab province. This suggests that on an average one brick kiln in Punjab burns 328.2 tonnes of coal for annual brick production. This further suggests that in the 10,394 brick kilns across Punjab province, a total of 3.1 million tonnes of coal is used for brick making. The brick kiln sector of Pakistan consumes 6.5 million tonnes of coal per year, which makes it one of the largest sectors consuming coal in the country.

Baseline data shows that brick kiln gate price of coal varies across brick kilns and districts. According to brick kiln entrepreneurs, it depends on the distance between a brick kiln and the nearest coal mine as well as the preferred location of brick kiln entrepreneurs for buying coal. Baseline data collected from 440 brick kilns shows that during the year 2018 a brick kiln entrepreneur paid an average of PKR 9,939 per tonne of coal for brick making.

SECTION IX

Production capacity of brick kilns

Gross production capacity of brick kilns surveyed during the baseline was calculated by assessing green brick stacking capacity of brick kilns, i.e., the capacity of a brick kiln baking area to accommodate the total number of green bricks in one cycle of baking, multiplied with the total number of cycles a brick kiln operated in the previous year. Baseline data was also collected on the total number of green bricks molded in a typical year, which indicates the total number of green bricks produced in a brick kiln. The average green brick stacking capacity of a brick kiln in Punjab was calculated to be 542,267 per brick kiln per baking cycle. However, green brick stacking capacity varies depending on the total stacking area of a brick kiln. The minimum and maximum stacking capacity was found to be 70,000 and 850,000 green bricks per cycle of baking, respectively. Discussions with brick kiln operators indicated that in a normal year a brick kiln completes a minimum of seven cycles of baking of green bricks (Table 12). This means that the 10,394 brick kilns across Punjab province has the capacity to produce 35,905.12 million baked bricks in a normal production year. However, the average number of green bricks molded per brick kiln in the 440 selected

TABLE 12 **BRICK PRODUCTION CAPACITY VIS-À-VIS GREEN BRICKS MOULDED DURING THE YEAR 2018**

District	Green brick stacking capacity	Green brick production during the year before baseline survey (N=392, n=40 brick kilns*)			
	Average stacking capacity per baking cycle	Actual number	Average number	Minimum number	Maximum number
Multan	596,857	20,725,000	628,030	450,000	800,000
Gujrat	603,750	21,930,000	577,105	400,000	800,000
Sialkot	621,250	29,350,000	621,250	450,000	850,000
Okara	529,750	21,235,000	530,875	350,000	800,000
Faisalabad	629,375	21,980,000	646,471	350,000	900,000
Bahawalpur	381,750	7,890,000	375,714	300,000	500,000
Kasur	450,263	32,110,000	917,428	80,000	6,500,000
Vehari	370,450	16,165,000	404,125	250,000	700,000
Sheikhupura	604,000	38,450,154	1,039,193	200,000	1,600,000
Sargodha	594,250	20,590,000	541,842	300,000	700,000
Rawalpindi	583,250	21,750,000	543,750	400,000	800,000

Source: Survey data, 2020. *no response received from 48 kilns

kilns in 2018 was reported to be 620,526 green bricks, suggesting that a total of 5869.6 million green bricks are molded in the 10,394 brick kilns of Punjab province.

Variation between the average annual gross production capacity of brick kilns and the average number of green bricks molded during the year 2018 could be due to the fact that brick kilns all over Pakistan were closed for almost three months in 2018. There could be a number of other reasons: brick kilns might not have been able to operate optimally and produce according to their normal capacity; brick baking cycles might vary across districts; labour shortage and other factors might limit molding capacity and result in lower production of green bricks.

During the fog season in 2018, following an order from the Government of Pakistan, non-zig-zag kiln entrepreneurs across Punjab province stopped kiln operations for almost three months. Operators of the 440 brick kilns surveyed for the baseline reported an average loss of PKR 987,660 per brick kiln during those three months.

9.1 Brick grades and kiln gate prices

Baked bricks can be classified into three grades: Grade A bricks are sold at the highest price followed by Grade B and C. Given an equal number of bricks are baked in a zig-zag kiln and an FCBTK, the proportion of Grade A bricks produced in a zig-zag kiln is 25% higher than those produced in an FCBTK (S. Nasim and F. Sharif, 2020). Consumers' choice of bricks depends on the purpose for which they are buying them. Consumers sometimes buy a mix of all categories at a lump sum price. Baseline information on different grades of brick obtained from the 440 kilns shows that 60% of the bricks produced are A Grade followed by 18% Grade B and 9% Grade C. The data also indicate that 13% of the bricks produced by brick kilns are mixed bricks. This suggests that majority of bricks produced at the selected kilns are of good quality. Reportedly, quality parameters vary across districts. The highest number of Grade A bricks are produced in Sialkot district followed by Sheikhupura district. Average factory price of Grade A bricks in Punjab is PKR 7.10 per brick, and that of Grade B and C are PKR 5.7 and 3.3 per brick respectively. The average factory price of mixed bricks was found to be PKR 2.8 per brick (Table 13).

TABLE 13 **PERCENTAGE OF DIFFERENT GRADES OF BRICKS**

Districts	Categories of bricks produced (N=440, n=40)			
	Grade A	Grade B	Grade C	Mixed bricks
Multan	57.9%	18.1%	12.5%	11.5%
Gujrat	60.6%	16.9%	10.6%	11.9%
Sialkot	66.1%	17.1%	6.2%	10.6%
Okara	61.2%	16.2%	9.1%	13.5%
Faisalabad	59.5%	14.7%	12.6%	13.2%
Bahawalpur	52.8%	25.9%	11.6%	9.7%
Kasur	60.1%	17.4%	11.5%	11.0%
Vehari	61.5%	15.8%	2.5%	20.2%
Sheikhupura	62.0%	18.6%	4.3%	15.1%
Sargodha	58.6%	17.2%	9.9%	14.3%
Rawalpindi	58.0%	19.1%	10.2%	12.7%
Average selling price/brick (PKR) at the brick kiln	7.10	5.7	3.3	2.8

Source: Survey data, 2020

Grade A bricks: These are bricks that are baked well, i.e., they receive the right amount of heat for the right amount of time. Bricks of this type are even shaped with unbroken edges. They are considered strong enough for construction purposes.

Grade B bricks: These are bricks that are baked inadequately, i.e., they receive insufficent heat during baking. They are not considered strong enough for construction purposes.

Grade C bricks: These are bricks that receive excessive heat during baking. Generally, bricks at the bottom of the stack receive too much heat as well as bear the weight of the entire stack. Hence they are often out of shape and cracked, with broken edges.

9.2 Bricks damaged during offloading

Out of the 440 brick kilns surveyed for the baseline, a total of 235 (53%) brick kiln operators reported the amount of bricks that get damaged during baking and offloading. In a typical brick production year, on an average 12% of baked bricks in a brick kiln either get overburnt during the baking process or get damaged during the offloading process. These bricks can neither be sold for mainstream construction purposes, nor are they recyclable. The highest number of damaged bricks was reported in Kasur district followed by Bahawalpur and Multan. However, damaged bricks are usually sold for landfill purposes and road construction related work. Baseline data analysis shows that brick kiln operators earn an average of PKR 97,851 a year from selling damaged bricks. Net earnings from the sale of damaged bricks vary across brick kilns, ranging between PKR 500,00 and 550,000 in a typical year. Offloading bricks using mechanised options would likely reduce brick damage compared to manual offloading.

SECTION X

Coal feeding schedule in brick kilns

The coal feeding schedule is an important factor in determining both the quality of bricks as well as the amount of black carbon (BC) emission generated during the firing process. A precise calculation of the amount of coal required to produce a good quality brick needs to be made. This, along with correctly timed coal feeding and a correctly implemented stacking pattern for baking green bricks, can increase the quality of bricks produced and help decrease black carbon emissions into the atmosphere. Stacking green bricks in a zig-zag pattern and feeding bricks every 10 minute improves the quality of bricks and produces less black carbon emissions, compared to other coal feeding practices such as random coal feeding, and coal feeding as and when required. Table 14 provides a summary of coal feeding schedules of brick kilns surveyed for the baseline. It was found that 10% of brick kiln operators feed coal on a continuous basis at 10-minute intervals, 38% feed coal at random intervals, and 52% feed coal as and when required at 5–60 minute intervals. Irrespective of the timing of coal feeding, except five zig-zag kilns in Sialkot district, and one each in Faisalabad, Kasur, Okara and Sheikhupura districts, all kilns surveyed for the baseline were found to be practicing straight-line stacking of green bricks for baking.

TABLE 14 **DISTRICT WISE COAL FEEDING SCHEDULE AT BRICK KILNS**

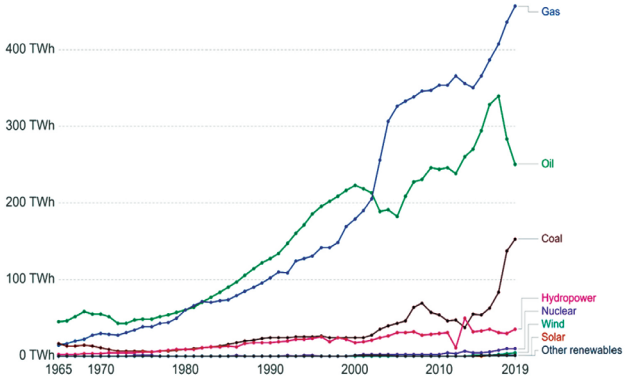
District	Continuous, at 10-min intervals (N=440, n=40)	Continuous, at random intervals (N=440, n=40)	As and when needed (N=440, n=40)
Multan	2.5%	2.5%	95%
Gujrat	25%	67.5%	7.5%
Sialkot	12.5%	31.1%	56.4%
Okara	7.5%	7.5%	85%
Faisalabad	2.5%	0.0%	97.5%
Bahawalpur	2.5%	30%	60.5%
Kasur	2.5%	97.5%	0.0%
Vehari	25%	2.5%	67.5%
Sheikhupura	7.5%	30%	62.5%
Sargodha	15%	72.5%	12.5%
Rawalpindi	26.3%	65.8%	7.9%

Source: Survey data, 2020

10.1 Fuel being used in kilns

Baseline data on fuel being used for baking green bricks shows that all the selected brick kilns in Kasur, Multan and Sialkot districts are only using pure coal, followed by 97.5% of selected kilns in Gujrat and Kasur districts, and 92.5% in Rawalpindi district. Brick kiln operators also use coal mixed with other additives. Analysis shows that all the selected brick kilns in Bahawalpur district are using coal mixed with other additives including agricultural residue, timber powder, gutka, poultry waste etc., followed by 92.5% of selected kilns in Vehari district, and 80% in Okara district. A few brick kilns located in Vehari, Sheikhupura, Sargodha and Gujrat districts mix coal with rubber (Table 15).

FIGURE 11 A HISTORICAL OVERVIEW OF PRIMARY DIRECT ENERGY CONSUMPTION BY SOURCE, PAKISTAN



Source: Global Change Data Lab, 2020

TABLE 15 DISTRICT WISE SUMMARY OF TYPES OF COAL USED FOR BAKING GREEN BRICKS

District	Pure coal	Coal mixed with other additives	Coal mixed with rubber
	(N=440, n=40)	(N=440, n=40)	(N=440, n=40)
Multan	100%	2.5%	0.0%
Gujrat	97.5%	0.0%	2.5%
Sialkot	100%	2.5%	0.0%
Okara	22.5%	80%	0.0%
Faisalabad	97.5%	2.5%	0.0%
Bahawalpur	2.5%	100%	0.0%
Kasur	100%	7.5%	0.0%
Vehari	0.0%	92.5%	7.5%
Sheikhupura	87.5%	15%	2.5%
Sargodha	82.5%	17.5%	2.5%
Rawalpindi	92.5%	5.0%	0.0%

Source: Survey data, 2020

To provide a comparison of primary direct consumption of coal vis-à-vis other commercially traded fuel options, Figure 11 presents a historical overview of primary direct energy consumption by different sources of energy, i.e., commercially traded fuel including coal, oil, gas, and modern renewables measured in terawatt-hours (TWh).

10.2 Fuel being used for initial ignition of kiln

The most common fuel used for initial ignition of fire at the selected brick kilns is wood, followed by wood mixed with rubber tyres. A few brick kilns were found to be using Liquefied Petroleum Gas (LPG) introduced by ICIMOD, which is cost effective and emits less black carbon. Table 16 provides the district wise percentage of different fuels being used for ignition at brick kilns in Punjab, Pakistan.

TABLE 16 **FUEL USED FOR IGNITION OF KILN**

District	Wood (N=440, n=40)	LPG (N=440, n=40)	Wood mixed with rubber tyres (N=440, n=40)
Multan	95%	0.0%	5%
Gujrat	100%	0.0%	0.0%
Sialkot	97.5%	2.0%	0.0%
Okara	97.5%	0.0%	2.5%
Faisalabad	97.5%	0.0%	2.5%
Bahawalpur	93.5%	2.5%	5%
Kasur	17.5%	2.5%	80%
Vehari	80%	0.0%	20%
Sheikhupura	62.5%	0.0%	37.5%
Sargodha	100%	0.0%	0.0%
Rawalpindi	100%	0.0%	0.0%

Source: Survey data, 2020

It was also found that 4% of the brick kiln entrepreneurs surveyed for the baseline operate at least one diesel/petrol-run power generator. On an average 22.2 litres of fuel per day is used to operate power generators in these brick kilns.

10.3 Mechanised options used for brick making

Adopting mechanised options can make the brick making process more efficient and improve the quality of bricks. Baseline data suggests that only 13% of the selected brick kiln entrepreneurs in Punjab province are using their own machinery for soil excavation while the remaining 87% either source out excavation work or excavate soil manually. Regarding use of mechanised options for soil mixing, only 8% of the brick kiln entrepreneurs were found to be using machinery while the remaining 92% of brick kilns are mixing soil manually. Only 7% of the 440 brick entrepreneurs use motorised options for offloading baked bricks. Machinery being used for brick molding include soil mixing, clay making and green brick making machines.

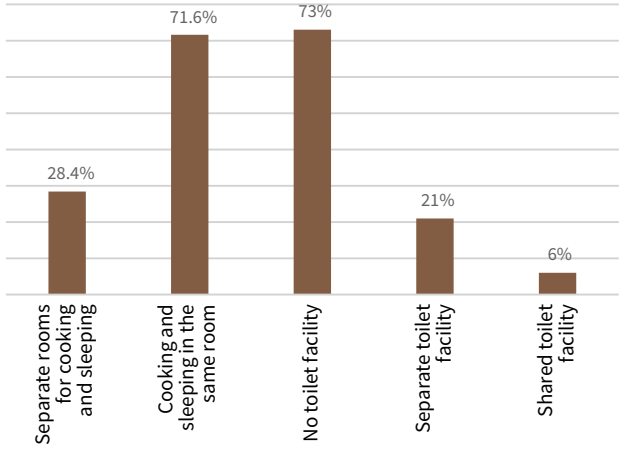
SECTION XI

Working conditions

11.1 Living conditions of brick kiln workers

Brick kiln workers in Punjab province generally live in a temporary shelter (Kacha Makan) or a permanent shelter (pakka makaan) provided by the brick kiln owner, usually in the vicinity of the brick kiln. However, brick kiln workers who have their own accommodation near the brick kiln usually do not avail themselves of housing provided by the brick kiln owner. Of the 440 workers interviewed, 62.5% reported that they were being provided accommodation by the brick kiln owner in the vicinity of the brick kiln. 23.8% of the workers were being provided 'pakka makaan' and 38.6% workers were being provided 'kachha makaan'. Remaining 37.6% of the workers lived in homes they owned or rented in the vicinity of the brick kiln, or at friends'/relatives' homes in a nearby area. Figure 12 shows the living conditions of workers in the accommodation provided to them by brick kiln entrepreneurs.

FIGURE 12 LIVING CONDITIONS OF BRICK KILN WORKERS



Source: Baseline data

11.2 Meal breaks given to brick kiln workers

Interviews conducted with workers revealed that in 63% of the surveyed brick kilns, kiln operators had designated specific times as meal breaks. Whereas in 35% of the brick kilns, workers take meal breaks by turns, and in 2% of the kilns, workers do not get designated meal breaks (Table 17).

11.3 Education of children accompanying brick kiln workers

In situations where brick kiln workers have no one to take care of their children in their place of origin, they bring their children to their work destination. The children's education suffers if they cannot go to school at the new location. Figure 13 presents an overview of the schooling status of brick kiln workers' children at origin and at their parents' work destinations. Baseline data shows that children of 35% of workers interviewed during the study had migrated to their parent's work destination. Among them, 64% were going to school, 36% either did not go to school or were below school age. Children of 11.5% of the brick kiln workers were already above school age and children of 40.9% of brick kiln workers were not attending school even at their place of origin. About 12% of the parents working at brick kilns reported that they had left their children behind for schooling at their place of origin.

11.4 Child care givers in workers' families

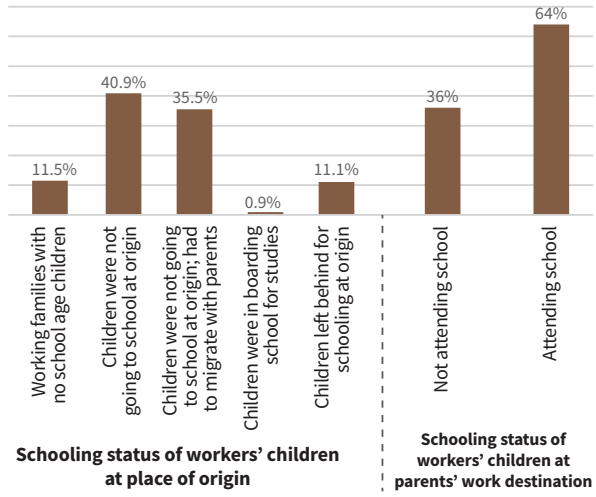
Baseline information on child caregivers in workers' families shows that in 63% of working families,

TABLE 17 DISTRICT WISE STATUS OF MEAL BREAKS GIVEN TO BRICK KILN WORKERS

Districts	No designated meal breaks	Meal breaks by turns	Meal breaks at scheduled intervals
	(N=440, n=40)	(N=440, n=40)	(N=440, n=40)
Multan	0.0%	5.0%	95%
Gujrat	0.0%	22.5%	77.5%
Sialkot	0.0%	32.5%	67.5%
Okara	0.0%	10%	90%
Faisalabad	5.0%	95%	0.0%
Bahawalpur	0.0%	17.5%	82.5%
Kasur	2.5%	90%	7.5%
Vehari	7.5%	50%	42.5%
Sheikhupura	2.5%	10%	87.5%
Sargodha	0.0%	37.5%	62.5%
Rawalpindi	2.5%	12.5%	85%

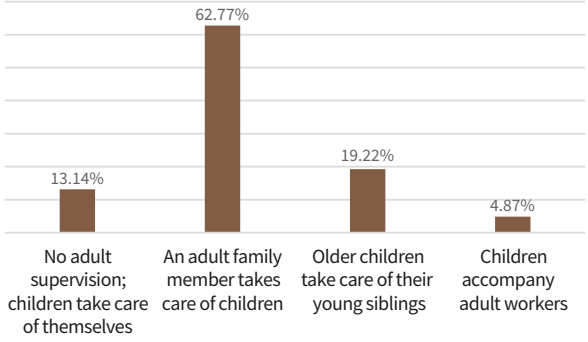
Source: Baseline data, 2020

FIGURE 13 SCHOOLING STATUS OF WORKERS' CHILDREN AT ORIGIN AND AT THEIR PARENTS' WORK DESTINATION



Source: Baseline data, 2020

FIGURE 14 OVERALL STATUS OF CHILDCARE IN WORKERS' FAMILIES



Source: Baseline data, 2020

generally an elderly person takes care of the children while the adults are working at the brick kiln. In 19.22% of the working families, an older child in the family takes care of the younger ones, while 13.14% of families working at brick kilns leave their children at home without any supervision. Baseline data analysis further indicates that 4.87% of the workers' children accompany adult members at their workplace (Figure 14).

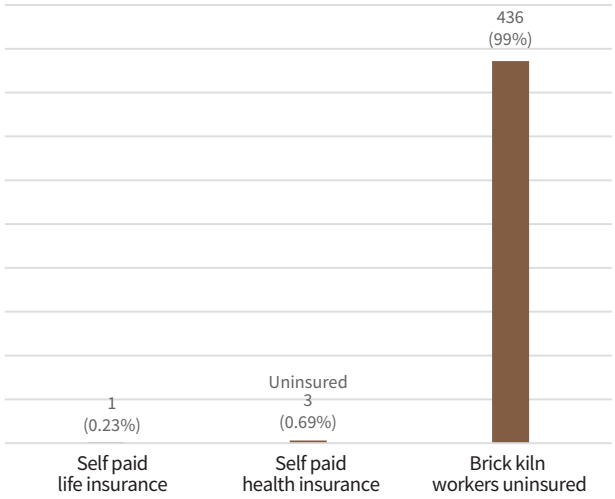
11.5 Insurance of brick kiln workers by type

Baseline information relating to insurance of brick kiln workers surveyed during the baseline shows that 436 workers (99%) out of 440 do not have any type of insurance. Remaining 1% have either health or life insurance for which they pay from their own pocket (Figure 15).

11.6 Occupational safety environment

Brick making involves crude techniques, and workers are often exposed to occupational hazards. These include exposure to the sun for long hours, exposure to high concentrations of dust. Coal feeding workers are exposed to high temperatures. While regulating kiln fire, they are required to walk on hot surface on

FIGURE 15 STATUS OF INSURANCE OF BRICK KILN WORKERS BY TYPE OF INSURANCE



Source: Baseline data, 2020

top of the brick kiln furnace. At the same time, they are also exposed to high concentrations of suspended particulate matters as the furnace chamber is covered with ash which acts as an insulator. Therefore, safety is an important factor to consider while working at a brick kiln. Likely hazards include exposure to fire, smoke, dust, burns, cuts and wounds, and their impacts. Workers at different sites of a brick kiln are required to follow certain standard operating procedures (SoPs). Brick kiln operators generally keep a first-aid box handy at an accessible location. At a minimum, SoPs for workers include wearing basic protective gear while working. Basic protective gear generally includes a breathing mask, hand gloves, footwear, safety glasses, and a safety helmet. Wearing a breathing mask and hand gloves is a must for brick kiln workers' health and safety. Across 96% of the brick kilns surveyed for the baseline, none of the workers at excavation sites, green brick molding sites, green brick loading (for stacking) sites, and coal crushing sites were found to be wearing proper protective gear. However, workers at coal feeding sites were wearing partial protective gear in 30% of the brick kilns, and full protection gear in 12% of the brick kilns surveyed for the baseline (Table 18).

TABLE 18 STATUS OF OCCUPATIONAL SAFETY ENVIRONMENT OBSERVED IN BRICK KILNS

Safety status by brick kiln site	Soil excavation site	Green bricks molding site	Green bricks loading (for stacking) site	Coal crushing site	Coal feeding site
None of the workers wearing proper protective gear	433 (98.4%)	435 (98.9%)	426 (96.8%)	412 (93.6%)	419 (66.1%)
All workers wearing proper protective gear	01 (0.2%)	01 (0.2%)	00	00	05 (1.1%)
All workers wearing partial protective gear	05 (1.1%)	3 (0.7%)	13 (3.0%)	20 (4.5%)	132 (30%)
Some workers wearing full protective gear but others wearing partial	01 (0.2%)	01 (0.2%)	01 (0.2%)	08 (1.8%)	12 (2.7%)

Source: Baseline data, 2020

SECTION XII

Key findings

1. Brick kilns in Punjab are scattered all over the province and are generally located in the suburbs of the towns. A total of 10,394 brick kilns are operating across Punjab; they make up 52% of the brick kilns operating in Pakistan. The brick kiln sector of Pakistan is unregulated. The sector does not fall under the jurisdiction of any ministry or line department; however, rules and regulations of different ministries and line departments are deemed applicable to the brick sector.

2. Four main types of brick kilns are operating in Punjab, Pakistan. These include Fixed Chimney Bull Trench Kilns (FCBTK); Moving Chimney Bull Trench Kilns (MCBTC); Vertical Shaft Brick kilns (VSBK); and ICIMOD-introduced Fixed Chimney Zig-Zag Bull Trench Kilns (zig–zag kilns). They differ in their firing and fuel feeding practices, and hence emit different amounts of emissions into the atmosphere. Among these types, zig-zag kilns emit the least amount of Black Carbon. Besides, a zig-zag kiln requires less upfront capital investment for its establishment, consumes less coal, and produces better quality bricks compared to FCBTK and MCBTK. ICIMOD and its partners have been advocating for zig-zag kilns in the South Asia region.

3. Among the 440 brick kilns surveyed for the baseline, 89% of the brick kilns are found to be FCBTK, 9% are MCBTK and the remaining 2% are zig-zag kilns. Since 2017, through BKOA, ICIMOD has been providing necessary capacity building and technological support to brick kiln entrepreneurs in Pakistan to convert traditional brick kilns into zig-zag kilns. As per BKOA's database, around 250 brick kilns have been converted into zig-zag kilns in Punjab province.

4. A total of 4543 families earn their livelihood from the 440 brick kilns surveyed for the baseline in Punjab. Across 10,394 brick kilns in the whole of Punjab province, 107,318 families are likely earning their livelihood from this sector. Across Pakistan, the brick kiln sector employs more than 0.2 million families. These families represent the poorest stratum of the society. In terms of individual female and male workers, a total of 21,178 (female=4,145, and male=17,042) workers are employed in 440 brick kilns surveyed across 11 districts in Punjab. In the whole of Punjab, this sector employs 463,491 (female=94,590, and male=368,901) workers, whereas across Pakistan, brick kilns employ more than 0.98 million workers.

5. The workforce engaged in various stages of green brick molding is often paid a fixed daily wage, a lump sum or a piece rate (i.e., paid by the number of bricks produced). In 7% of the brick kilns surveyed for the baseline, the labour force is hired for 8 hours a day. In the remaining 93% of the brick kilns, workers work more than 8 hours a day. They usually work long hours to meet the production target or to earn some extra money by producing more green bricks. In 63% of the brick kilns surveyed for the baseline, kiln operators provide designated meal breaks. Whereas in 35% of brick kilns, workers take meal breaks by turns, and in 2% of 440 brick kilns surveyed for the baseline, workers do not get any designated meal breaks.

6. A total of 7706 animals are employed in 424 out of the 440 brick kilns surveyed for the baseline. These include a total of 1651 mules, 1586 horses, 2911 donkeys, and 1576 bulls.

7. Brick kiln entrepreneurs suffered an average loss of PKR 987,660 per brick kiln when the government banned kiln operations during the fog season of 2018.

8. Mechanised options for soil excavation, soil mixing, brick molding, stacking and offloading are used in only 13% of the brick kilns surveyed for the baseline. Regarding use of mechanised options for soil mixing, only 8% of brick kiln entrepreneurs surveyed for the baseline are using machinery while the remaining 92% are mixing soil manually. Only 7% of the 440 brick entrepreneurs use motorised options for offloading baked bricks.

9. Children of 35% of the workers had to migrate to their parents' work destinations. Among them, 64% of the children attend school at their parents' work destination, and 36% either do not attend school or are below school age. In 63% of working families, generally an elderly family member takes care of children while the adults are working; in 19.22% of the working families, an older child in the family takes care of the younger ones; 13.14% of families working at brick kilns leave their children at home without any supervision; and 4.87% of the workers' children accompany their parents at their workplace.

10. Workers at 436 brick kilns (99%) out of the 440 do not have any type of insurance. Remaining 1% have health or life insurance for which they pay from their own pocket.

11. Regarding workers' occupational safety environment in the 440 selected brick kilns, in 96% of the brick kilns, none of the workers at soil excavation sites, green brick molding sites, green brick loading (for stacking) sites, and coal crushing sites were found to be wearing basic protective gear. However, workers at coal feeding sites were wearing partial protective gear in 30% of the brick kilns, and full protection gear in 12% of the brick kilns surveyed for the baseline.

12. Recommendations

    - The brick kiln sector drives many other sectors. It not only provides fundamental inputs to the formal and informal construction sector, but is also a major source of employment, especially for the rural poor. However, the brick kiln sector is still unorganised and unregulated. Public sector authorities including the Environmental Protection Authority (EPA) have issued standards and quality control statutes for industries and products but brick kiln specific standards which are necessary for regulating this sector are nonexistent. There is a need to regulate the sector through appropriate interventions. It is recommended that GoP officially recognises the brick kiln sector as an industry to enable this sector to avail itself of industrial privileges and contribute more to the country's GDP.

    - Traditional brick kiln design and construction is generally non-engineered and heavily depends on masons, resulting in cracks in kilns and heat leakages. Therefore, it is imperative to formulate legislation on kiln design, quality standards for bricks, and emission standards specific to brick kilns.

    - The emerging need of the brick kiln sector of Punjab province in particular and of Pakistan in general is conversion of traditional brick kilns into zig-zag kilns through modifying existing straight line brick stacking practices to zig-zag patterns, and increasing energy efficiency and combustion efficiency while retaining the FCBTK structure. zig-zag kilns are not only environment-friendly, but also energy efficient and cost effective.

    - As the brick kiln sector in Pakistan isn't officially recognised as an industry or a sector, access to finance for this sector is highly limited, which hinders conversion of traditional brick kilns into modernised options. It is important to identify and address the barriers faced by the brick kiln sector in raising bank finance so that targeted interventions can be carried out to improve brick kiln entrepreneurs' access to finance, preferably at subsidised return rates.

    - Mass awareness campaigns including seminars, workshops and trainings involving relevant stakeholders are required to improve understanding of modern technologies for the brick kiln sector and their impact on the environment, health and production efficiency.

    - Baseline scenarios should be developed for the brick kiln sector in other provinces of Pakistan.

    - It is important to develop a package of practices for zig-zag kilns and build a critical mass of technically skilled human resources in brick kiln sector. A critical mass of master trainers such as brick kiln supervisors, master stackers, master molders, fire masters, and extruder operators should be developed. Training modules on retrofitting of FCBTKs into energy-efficient zig-zag kilns should be designed and implemented on a regular basis.

- As a representative forum of brick kiln entrepreneurs in the country, Brick Kiln Owners Association of Pakistan (BKOA) should explore possibilities of collaboration with the Ministry of Climate Change, and Provincial Environmental Protection Agencies to develop and facilitate implementation of a set of SoPs including occupational safety and social security standards for brick kiln workers.
- Brick kiln entrepreneurs, operators and managers have limited knowledge of innovative technologies geared towards energy conservation. They should be provided technical support for moving towards energy conservation measures. Efforts might include but are not limited to:
- Availability of a green brick making manual, guidelines on efficient firing techniques, modified kiln designs, construction drawings and technical troubleshooting checklists for the zig-zag kilns.
- Trainings for improving green brick making practices and on procedures such as soil selection, soil testing, mixing of internal fuel, maturing and ensuring optimal moisture content at the time of loading bricks into the kiln.
- Trainings on firing efficiency, selection of good quality coal, appropriate stoking of coal and kiln fire monitoring for temperature adjustments.
- Create awareness about improvements needed, methods for carrying out recommended interventions and the resulting benefits. For this, information and communication materials should be prepared and disseminated.
- Establish showcase zig-zag kilns, and zig-zag Technology Incubation Centres (TIC) in Punjab province.
- Support TEVTA of the Provincial Government of Punjab in building a critical mass of technical human resources for smooth operations of zig-zag kilns.

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