



# Developing a Regional Cooperation Strategy for Scaling Up Climate-Smart Agriculture in South Asia

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# 1. INTRODUCTION

Climate change being a global environmental problem, a cooperative approach involving all the sovereign countries is required to achieve an optimal solution. Caused by the accumulation of greenhouse gases (GHG) in the atmosphere, including carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons, climate change has global effects that are independent of the geographical sources of these emissions. However, the adverse impacts of global warming and extreme weather events associated with climate change are not uniformly distributed, as vulnerable populations in less-developed countries bear the brunt of the damage. Some of these climate-vulnerable nations contribute less than 1 per cent of global GHG emissions, including Bhutan (0.0057%), Sri Lanka (0.072%), Nepal (0.105%), and Bangladesh (0.522%) in South Asia.<sup>1</sup>

Multilateral efforts for mitigation and adaptation to climate change began with the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988 to provide scientific information to determine the limit in temperature change for the planet.<sup>2</sup> This was followed by the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, a multilateral cooperation treaty that led to two climate mitigation treaties: the Kyoto Protocol in 1997 (enforced in 2005) and the Paris Agreement in 2015 (enforced in 2016).

Recognizing climate change as a stock pollution problem, the Kyoto Protocol incorporated commitments from industrialized countries and transition economies within the European Union (EU) to abate GHG emissions, while allowing them the flexibility to earn mitigation credits through projects hosted in less-developed countries. The Paris Agreement, however, extended obligations to developing economies as well, while allowing all parties the flexibility to nationally determine their contributions to emission abatement. Both treaties uphold the principle of common but differentiated responsibilities, based on the economic status of the member countries.

## 1.1. International Discourse on the Interface of Agriculture with Climate Change

In a recent synthesis report, the IPCC noted that during the last five decades, climate change has contributed significantly to desertification and has exacerbated land degradation, particularly in low-lying coastal areas and river deltas (IPCC 2023). This has led to a global slowdown in the growth of agricultural productivity. At the same time, ocean warming and acidification have negatively impacted fisheries and shellfish aquaculture.

The increased frequency of extreme weather events from climate change poses severe water risks to agriculture through intense drought, flooding, and erratic precipitation, increasing the

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<sup>1</sup> The largest emitter in the region is India (7.33 percent share), followed by Pakistan (1.01 percent). These country shares are based on annual emissions data for 2022, as reported in *GHG Emissions of All World Countries* (2023 Report, Office of the European Union. [https://edgar.jrc.ec.europa.eu/report\\_2023](https://edgar.jrc.ec.europa.eu/report_2023)).

<sup>2</sup> The IPCC was established by the United Nations Environmental Program and the World Meteorological Organization.

vulnerabilities of less-developed countries, where the majority of the population depends on the agriculture sector for its livelihood. In effect, climate change has increased the challenges of combating existing inequality in the world and ensuring food security and sustainable development, especially among the most vulnerable.

Amid the international dialogues, the IPCC projects that South Asia is one of the world’s most climate-vulnerable regions (IPCC 2023). Already strained by the initial conditions of population pressure, poverty, high incidence of stunting and wasting among young children, and food insecurity, the food system has been further stressed by climate change.

Among the South Asian nations, India has the largest economy and the largest agriculture sector (which includes agriculture, forestry, and fishing), followed by Pakistan, Bangladesh, Nepal, Sri Lanka, and Bhutan, as shown in Table 1. The development status of these six countries, as roughly indicated by the gross domestic product (GDP) per capita, is lowest in Nepal and Pakistan, where agriculture, forestry, and fishing constitute more than a 20 percent of GDP in terms of value added.

Table 1 shows that the land devoted to agriculture is especially high in Bangladesh, where 77 percent of available land is under agricultural use, followed by India with 60 percent, Pakistan with 47 percent, and Sri Lanka with 45 percent. It is also important to note that Bhutan has the highest share of land under forests (71 percent), followed by Nepal (41.6 percent) and Sri Lanka (34 percent). The agriculture sector is significant in providing employment to a large proportion of the labor force in each of these countries, particularly in Nepal (61 percent), Bhutan (44 percent), India (43 percent), Bangladesh (37 percent), and Pakistan (36 percent), and the proportion of employment is even higher when including people engaged in the overall agrifood sector. The high share of the labor force employed in agriculture in these countries underscores both the socioeconomic significance of the agriculture sector in South Asia and the extent of these societies’ vulnerability to climate change.

**Table 1.** Economic significance of the agriculture sector in the six South Asian countries, 2022

Country	GDP per capita (in constant 2015 US\$)	Agriculture, forestry, and fishing, value added in		Agricultural employment share in total (female)	Share of land under agriculture	Share of land under forest
		million constant US\$	% share of GDP			
Bangladesh	1,785	35,965	11.2%	36.86% (55%)	77.35%	14.47%
Bhutan	2,992	343	15.8%	43.96% (54%)	13.45%	71.50%
India	2,090	47,0378	16.7%	42.86% (59%)	60.05%	24.36%
Nepal	1,083	7,890	21.1%	61.39% (75%)	28.75%	41.59%
Pakistan	1,696	84,224	22.4%	36.43% (67%)	47.09%	4.78%

Sri Lanka	3,988	6,673	8.8%	26.41% (28%)	45.46%	34.11%
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**Source:** Compiled from the World Development Indicators database, World Bank.

**Note:** GDP = gross domestic product. Agriculture value-added data are for 2022 for all countries except Bhutan, for which 2021 data are used. The share of agricultural employment as the share of total employment (and total female employment) pertains to 2022 for all countries. The share of total land area under agriculture and forests pertains to 2021 for all countries. All monetary values are in constant US dollars, with 2015 as the base year.

Table 2 shows the direct climate impact of the agriculture sector in six countries in terms of GHG emissions of methane and nitrous oxide. Not surprisingly, emissions are highest in India, followed by Sri Lanka and Bangladesh. Environmental stress has reached critical levels because freshwater withdrawal for agriculture leads to water stress. These levels are acutely high in Pakistan, followed by India and Sri Lanka.

**Table 2.** Agricultural non-carbon-dioxide GHG emissions and freshwater withdrawals in the six South Asian countries, 2020

Country	Nitrogen oxide emissions in MMtCO <sub>2</sub> e*	Methane emissions in MMtCO <sub>2</sub> e*	Annual freshwater withdrawals for agriculture**	Level of water stress***
Bangladesh	25.21	60.37	87.82%	5.72
Bhutan	0.10	0.39	94.08%	1.41
India	230.51	500.26	90.41%	66.49
Nepal	1.74	4.39	98.14%	8.31
Pakistan	5.88	19.94	93.98%	116.31
Sri Lanka	59.79	135.41	87.36%	90.79

**Source:** Compiled from the World Development Indicators database, World Bank.

**Note:** GHG = greenhouse gases; MMtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent.

\* Emission data reported are the 3-year average for 2018–2020.

\*\* As percentage share of the country’s total freshwater withdrawal.

\*\*\* Also called water withdrawal intensity, this measure is defined as the ratio between total freshwater withdrawn by all major sectors to total renewable freshwater resources, after accounting for environmental water requirements. The main sectors include agriculture; forestry and fishing; manufacturing; the electricity industry; and services.

Because the environmental costs of economic activities are typically hidden—that is, not evident in market transactions—they need to be internalized in the economic system through proper policy interventions. Recently, the Food and Agriculture Organization of the United Nations (FAO) reported estimates of the hidden environmental costs of the agrifood sector due to climate change, withdrawal of blue water (fresh surface water and groundwater), land use changes, and nitrogen emissions (FAO 2023). It also provided estimates of hidden social costs (due to adverse productivity effects of malnutrition, undernourishment, and poverty) and hidden health costs (due to adverse productivity impacts of diet and high body mass index).

Table 3 summarizes the incidence of the environmental cost of the agrifood sector as estimated by the FAO. The cost is highest in India, followed by Pakistan, Bangladesh, Sri Lanka, and Nepal.

The hidden social cost due to agrifood worker poverty is highest in India, followed by Pakistan, Bangladesh, Nepal, and Sri Lanka.

**Table 3.** Components of hidden environmental and social costs of the agrifood system in the six South Asian countries (in millions 2020 PPP \$)

Country	Environmental cost				Social cost	
	Climate change	Agricultural blue water withdrawal	Land use changes	Nitrogen emissions	Agrifood worker poverty	Burden of disease (undernourishment)
Bangladesh	8,101	316	340	16,821	16,293	1,399
India	77,396	36,322	24,051	144,209	15,7360	15,253
Nepal	2004	243	55	1,474	2,089	148
Pakistan	16,485	5,226	76	7,254	16,216	4,681
Sri Lanka	859	149	36	3,116	341	38

**Source:** Compiled from estimates reported in FAO (2023, p. 98). Figures represent expected values based on data for 2014–2020.

**Note:** PPP = purchasing power parity.

Climate change has led to a decreased precipitation trend in the region, with an increased incidence of drought in Central Himalaya but increased flood disasters in the higher Indus, Ganges, and Brahmaputra, and with higher water stress in the western compared to the eastern parts of South Asia (Shaw et al. 2022, pp. 1485–1486). A large part of the region is estimated to experience worsening heat stress conditions, and countries such as India and Pakistan are particularly vulnerable because extreme climate conditions threaten food security in these agro-based economies (ibid, p. 1467). Studies have observed declines in crop yields and a rise in crop diseases due to climate extremes of floods, droughts, and heat waves in Pakistan (ibid, p. 1490).

## 1.2. The Need to Transition to Climate-Smart Agriculture: Broad Contours of Transitioning

These climate changes pose a serious challenge to providing nutritious, safe, and affordable food for all in the South Asian nations. In fact, development challenges in South Asia are effectively a function of climate change. It is therefore imperative to adopt climate-smart agriculture (CSA) practices that support adaptation to climate change through changes in irrigation and cropping systems—for example, growing crops that are heat tolerant and drought resistant. Climate-resilient agriculture would increase productivity and income and would also abate GHG through techniques such as fertigation or nano urea, zero tillage, strip tillage, alternate wetting and drying (AWD) irrigation, bed planting with residue retention, direct-seeded rice, improved livestock management, enhanced carbon sequestration of plants and soil, and agroforestry. In essence, recognizing the interlinkage between climate change and food security, CSA encompasses a

range of practices in the management of cropland, livestock, fisheries, and forests to enhance climate change resilience.

Transitioning to a climate-smart system also requires water-saving agricultural technologies and practices. The current consumption of freshwater for agriculture cannot be sustained, as blue water (surface freshwater resources and groundwater) is increasingly scarce in the region. The hidden cost of agricultural blue water withdrawal is estimated to be the highest in India, followed by Pakistan, Bangladesh, Nepal, and Sri Lanka (Table 3). Groundwater withdrawal has been very high, particularly in the three South Asian countries of India, Bangladesh, and Pakistan (Shaw et al. 2022, p. 1488). Almost 90 percent of groundwater extraction in India is for agriculture (NITI Aayog 2022, p. 23), resulting in severe aquifer depletion. It is critical to increase crop productivity with water-saving agricultural technologies such as drip irrigation and direct-seeded rice, which increase water efficiency.

Climate mitigation in agriculture and allied activities pertain mostly to the reduction of non-carbon-dioxide GHG. The agriculture sector contributes about 22 percent of global GHG (IPCC 2023), the largest source of non-carbon-dioxide GHG emissions, including methane and nitrous oxide.<sup>3</sup> These emissions are expected to reach 6,339 million metric tons of carbon dioxide (MMtCO<sub>2e</sub>) by 2030 due to growth in fertilizer consumption, crop production, and livestock population (EPA 2019, p. 53).

Although livestock accounts for most emissions, there is limited scope to reduce emissions in that sector. As a result, mitigation strategies have focused on cultivating specific crops, such as rice or paddy, which are estimated to have a relatively higher mitigation potential compared to livestock (Trang et al. 2020).

Consequently, the strategy for climate mitigation in agriculture has focused on reducing nitrous oxide emissions from fertilizer use, methane emissions from paddy rice, and nitrous oxide and methane through livestock manure management (Mbow et al. 2019). From 1990 through 2015, rice grown in non-Organization for Economic Co-operation and Development (OECD) Asian countries was estimated to account for more than 80 percent of global methane emissions from rice cultivation (EPA 2019, p. 62) and was expected to increase to 84 percent by 2030. Moreover, the increasing trend is expected to continue, with China and India accounting for the largest shares in 2030 (ibid, p. 63).

Among the mitigation technologies for paddy cultivation, direct-seeded rice has gained prominence because it does not require standing water in the fields, instead using AWD cycles. These cycles reduce both the amount of water used (thereby reducing the energy required for pumping water; hence carbon dioxide emitted in thermal power plants) and the methane emissions from the soil. The forestry sector helps to reduce GHG emissions directly through natural carbon sequestration in soil and serves as a significant strategy in offsetting emissions from other economic sectors. While some climate-smart practices have been adopted in agriculture, forestry, and other land use on a pilot basis in South Asia, these strategies need to be scaled up.

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<sup>3</sup> Includes emissions from agriculture, forestry, and other land use (AFLOU) in 2019.

This study reviews the policy landscape of six South Asian countries—Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka—that promote and support CSA. The analysis also compares the climate policy regimes across these countries, beginning with their commitments under the Paris Agreement and their corresponding domestic regulations, strategies, and targets.

Domestic climate policy regimes in these six countries were initiated three decades ago at the 1992 Earth Summit in Rio de Janeiro with the signing of the UNFCCC between November 1993 and August 1995 (Table 4), followed by accession to the Kyoto Protocol. The most significant domestic climate policies, however, took shape after the 2015 Paris Agreement was ratified.

Table 4 provides the ratification timelines of the multilateral climate agreements for the six countries. While five South Asian countries ratified the Paris Agreement in 2016, Bhutan did so in 2017. Except for Bangladesh and Pakistan, four of these countries have committed to a target year for achieving net zero carbon emissions or carbon neutrality ranging from 2030 to 2070, with Bhutan already being carbon neutral. These international commitments, reinforced by domestic policies, will influence regional developments.

**Table 4.** Engagement in multilateral environmental agreements\*: Ratification, accession, and net zero targets\*\* of the six South Asian countries

Country	UNFCCC, 1992	Kyoto Protocol, 1997	Paris Agreement, 2015	Net zero/carbon neutrality target status
Bangladesh	April 1994	October 2001 <sup>a</sup>	September 2016	Net zero by 2050 (in discussion)
Bhutan	August 1995	August 2002 <sup>a</sup>	September 2017	Carbon neutrality by 2030 (achieved)
India	November 1993	August 2002 <sup>a</sup>	October 2016	Net zero by 2070 (pledged)
Nepal	May 1994	September 2005 <sup>a</sup>	October 2016	Net zero by 2050 (pledged)
Pakistan	June 1994	January 2005 <sup>a</sup>	November 2016	Net zero by 2050 (in discussion)
Sri Lanka	November 1993	September 2002 <sup>a</sup>	September 2016	Carbon neutrality in electricity generation by 2050 <sup>#</sup> (pledged)

**Source:** Compiled from the United Nations Treaty Collection website. <https://unfccc.int/process-and-meetings/the-convention/status-of-ratification-of-the-convention>; <https://unfccc.int/process/the-paris-agreement/status-of-ratification>

**Note:** UNFCCC = United Nations Framework Convention on Climate Change.

\* The UNFCCC dated May 1992 entered into force in March 1994; the Kyoto Protocol to the UNFCCC dated December 1997 entered into force in February 2005; and the Paris Agreement dated December 2015 entered into force in November 2016.

\*\* Net zero target years are declared in the respective Nationally Determined Contributions (NDCs) of four of the South Asian countries (not including Bangladesh and Pakistan).

<sup>a</sup> Accession

<sup>#</sup> Sri Lanka's Nationally Determined Contribution states that it "expects to achieve its carbon neutrality by 2050."

This review traces the recent climate mitigation and adaptation strategies adopted for the agriculture sector, as evident in the national policy documents of the six South Asian countries, and explores whether these policies include specific priority CSA technologies. The CSA technologies and practices considered include bed planting with residue retention, strip tillage, zero tillage, sustainable land management, protected agriculture (polyhouse), drip irrigation,

resilient intercropping, AWD irrigation technique, solar-powered water pumps with micro-irrigation, multi-purpose soil conservation bunds, climate-resilient seeds, and agroforestry. The paper also examines the trade regimes governing CSA-related technological inputs and equipment across these countries, identifying tariff and nontariff barriers that restrict trade in such technologies and materials.

Section 2 provides a snapshot of the climate policy for the agriculture sector in each of the six countries, as reflected in their respective Nationally Determined Contributions (NDCs) and in domestic plans and policies. Section 3 reviews the trade policy regimes in these countries and identifies the tariff and nontariff barriers that hinder the adoption of priority CSA technologies in South Asia. Section 4 compares the regulatory regimes in seed certification, trade in agricultural equipment, and food safety and quality in the six countries. Section 5 concludes with a regional cooperation strategy for scaling up CSA in South Asia.

## 2. MULTILATERAL CLIMATE COMMITMENTS IN AGRICULTURE AND DOMESTIC POLICY REGIMES

In the last decade, much of the domestic climate policy action has aligned with commitments made under the 2015 Paris Agreement, the first multilateral climate agreement requiring developing nations to contribute to climate mitigation. This section traces the NDCs of six South Asian countries under the Paris Agreement to the UNFCCC, along with their most significant domestic climate policies since its ratification.

Given the contiguity of the six South Asian countries and their shared ecological subsystems—including riverine, marine, and coastal resources—these nations share agroclimatic zones that defy sovereign borders. This calls for a regional approach to climate change mitigation and adaptation in the agriculture sector, as cooperation is essential to achieving national targets amid regional interdependencies and spillovers.

This section highlights the climate commitments in the agriculture sector outlined in the NDCs and the national adaptation plans of each of the six countries. A comparison of these pledges finds that Bangladesh, one of the most climate-vulnerable countries, is a front-runner in committing to ambitious quantitative targets. Its climate commitments in the agriculture sector specify CSA technologies for scaling up, such as rice acreage using AWD, acreage with controlled fertilizer application, number of livestock with feed improvement to reduce enteric fermentation, and so on. The smaller and vulnerable landlocked countries of Bhutan and Nepal, followed by Sri Lanka, have also set some numerical targets. However, India, the largest economy, has made no specific declarations regarding CSA activities.

Given these countries' shared ecological resources, there is regional interdependency in achieving their country-specific climate targets. It is important to recognize that the region's smaller economies contribute to carbon sequestration and mitigation but bear the brunt of climate cost from the economic activities of larger countries. Regional cooperation in mitigation and

adaptation is therefore essential to reducing the region’s vulnerability and helping to achieve country pledges.

## 2.1. Bangladesh

Bangladesh is among the most climate-vulnerable countries in the world because of its biophysical and socioeconomic vulnerability. The country’s vulnerability has increased over the years following the trend of temperature increase, drought, erratic precipitation, floods, sea level rise, and saltwater intrusion.<sup>4</sup> Geographically, the country’s climate change hot spots are in the central and western coastal areas, the northwestern highlands, and along the main rivers (Bangladesh MOEFCC 2021, p. 28). The number of high heat index days are expected to increase further across all eight divisions of the country by the middle of the century.<sup>5</sup> There is a significant trend of decreasing precipitation in the eastern divisions, accompanied by a significant increase in precipitation across the western areas (World Bank 2024, p. 11). The incidence of extreme precipitation events is expected to increase during the next few decades, with heightened risk of climate hazards, including drought, floods, sea level rise, and tropical cyclones.

Climate change and associated extreme weather events pose a direct risk to the people of Bangladesh, with more than half the population living in “high climate exposure areas,” and climate change threatens to wipe out one-third of agricultural output by 2050 (World Bank 2024, p. 21). About 40 percent of the coastal area is susceptible to saltwater intrusion during the dry season, while 50 percent of the total land area is at risk of extreme flooding, and 47 percent is susceptible to extreme drought events (GED 2015, p. 451). With large tracts of land at risk of saltwater intrusion, floods, and drought, the agriculture sector is jeopardized, threatening food security and the livelihoods of most of Bangladesh’s population.

Although Bangladesh is a relatively small emitter of GHG globally, the country has been grappling with climate adaptation due to its frequent exposure to severe cyclones and floods, and it has committed to climate mitigation in earnest. Of its total GHG emissions, the majority come from the energy and fuel combustion sector (54 percent), followed by agriculture (34 percent) and waste (9.87 percent), while industrial processes and product use contribute the remaining 2 percent (Bangladesh DoE 2023).

The cultivation of rice paddy is the largest contributor to GHG emissions within agriculture in Bangladesh (CIAT and World Bank 2017). Unfortunately, more than 1 million hectares of cultivable land have been affected by salinity intrusion caused by slow- and rapid-onset events, leading to an estimated loss of 200,000 metric tons of crops (Bangladesh MoEFCC 2022, p. 64) and making the development of heat- and salinity-tolerant crops imperative.

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<sup>4</sup> Over the last five decades (1971–2020), the mean temperature of the country has increased by 0.16°C per decade, with the average minimum temperature rising by 0.20°C per decade and the average maximum by 0.18°C per decade (World Bank 2024, p. 10).

<sup>5</sup> The eight divisions of Bangladesh include Barisal (south), Khulna (southwestern), Rajshahi (northwestern), Dhaka (central north), Rangpur (northwest), Mymensingh (northeast), Sylhet (northeast), and Chittagong (southeast).

Agriculture in Bangladesh continues to play an important role in generating employment and reducing poverty. It includes both subsistence cultivation systems (with a large number of small and marginal farmers) and commercial farms with high-value crops, fisheries, and animal products (CIAT and World Bank 2017). Efforts have been made to adopt certain CSA practices, such as AWD irrigation methods to conserve water during the dry season of rice cultivation, deep placement of urea briquette to improve nitrogen recovery efficiency and enhance rice yields, a shift toward the cultivation of non-rice crops, and incorporation of rice straw into paddy soil to enhance soil fertility.

Given the increasing threat of sea level rise and tropical storm swells, strategies against saline intrusion are critical to protect the large number of smallholders in the flood-prone lowlands (CIAT and World Bank 2017). The traditional knowledge-based practice of *sorjan* cropping, involving alternate raised beds (for vegetables/dryland crops) and deep furrows (for fish), allows for an integrated cropping strategy in waterlogged lands. The aquaculture feed waste that collects at the bottom of the pond is taken out to serve as fertilizer for vegetables grown on the elevated beds. The *sorjan* technique emerged as a sustainable technique in the face of excessive rain and flooding in the southern coast of Bangladesh, as it improves soil drainage and allows for cultivation of crops/vegetables and fish year-round. Moreover, marginal coastal land that is otherwise unsuitable for traditional farming due to flooding or salinity can be brought under cultivation.

By channeling water in the troughs, the *sorjan* technique protects crop roots from waterlogging and salinity (as the roots in the elevated beds remain above the saline water table), while effectively providing irrigation during the dry months. Higher farm productivity from mixed cultivation has helped to increase farmers' income and has enhanced food security. The mixed intensive cropping has reduced soil erosion, helped increase organic matter in the soil, and increased carbon sequestration. A *sorjan* mixed farming project for growing multiple vegetables in Patuakhali, funded by the International Rice Research Institute, yielded positive profits despite heavy rains. The project noted that scaling up would be successful with financial help for initial setup, access to quality materials, and increased awareness and training (Ahmed et al. 2024).

In areas prone to prolonged flooding, farmers in Bangladesh have practiced floating agriculture for centuries. Vegetables and spice crops are grown in floating beds made from water hyacinth and other aquatic weeds, which form the base. The traditional method is used especially in the southern floodplains of the Barisal, Gopalganj, and Pirojpur districts.

### **2.1.1. Climate Mitigation Commitment in Agriculture under Paris Agreement**

Bangladesh has been an early participant in multilateral negotiations on climate change action over the past three decades. It ratified the 1992 UNFCCC in April 1994, followed by the Kyoto Protocol in October 2001 and the Paris Agreement in September 2016. While the Kyoto Protocol did not require emission reduction commitments from developing countries, the Paris Agreement required commitments from them through NDCs to abate global climate change.<sup>6</sup> Although

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<sup>6</sup> The Kyoto Protocol included a provision allowing developing countries to voluntarily generate carbon credits through the hosting of Clean Development Mechanism projects undertaken by industrialized countries with commitments.

Bangladesh's initial NDC submission to the UNFCCC did not include the agriculture sector, its updated NDC (submitted in August 2021) extended climate mitigation and adaptation commitments to the agriculture sector, along with the previously covered power, industry, and transport sectors.

Bangladesh's updated NDC outlined both unconditional and conditional (on support received from developed countries) emission reductions. It pledged unconditionally to reduce GHG by 27.56 MtCO<sub>2</sub>e—or 6.73 percent below business as usual (BAU) levels—by 2030, and it pledged conditionally to more than double that reduction—to 61.9 MtCO<sub>2</sub>e, or 15 percent below BAU—by 2030 (using 2012 as the base year).<sup>7</sup> The base year GHG emissions from the agriculture and livestock sector were 45.87 MMtCO<sub>2</sub>e, constituting 27.13 percent of total national emissions in 2012; and GHG emissions from energy use in agriculture (such as pumps, tractors, and harvesters) were 2.73 MMtCO<sub>2</sub>e, constituting 1.61 percent of total emissions (Bangladesh MOEFCC 2021, p. 3–4).

Of the unconditional emission reductions committed to by 2030, abatement from agriculture would constitute 2.3 percent, while the bulk would be from the energy sector (95.4 percent) and the remainder from the waste sector. Under conditional mitigation, the largest share of reductions is again pledged from the energy sector (96.46 percent), followed by 1.8 percent from the waste sector and 0.65 percent from the agriculture sector.

Table 5 summarizes Bangladesh's updated NDC, clearly outlining the strategies it may use to achieve both the unconditional and conditional (dependent on the receipt of climate finance) goals and those pertaining to agriculture and forestry. The mitigation policies for agriculture, forestry, and other land uses include reducing methane emissions from rice cultivation and enteric fermentation of livestock and manure management, as well as nitrous oxide emission from nitrogen-based fertilizers.

Notably, among the six South Asian countries, Bangladesh has committed to the most detailed targets for mitigating GHG emissions in the agriculture sector, including specifying the number of solar-based irrigation pumps and mini biogas plants to be installed by 2030.

The NDC clearly identifies the CSA techniques to be used to reach mitigation targets by 2030:

- Adopt AWD irrigation to reduce methane emissions from paddy cultivation, including extending the acreage under AWD in the dry season to 150,000 hectares (50,000 unconditionally and 100,000 conditionally).
- Extend cultivation of improved climate-resilient rice varieties to 3,240,000 hectares (1,111,000 unconditionally and 2,129,000 conditionally).
- To abate nitrous oxide emissions, reduce and better manage the use of nitrogen fertilizers on more than 1 million hectares using practices such as soil test-based fertilizer application, reduced tillage, barn management, and deep placement of urea in rice fields.

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<sup>7</sup> The updated NDCs drew lessons from Bangladesh's earlier submission of its Intended Nationally Determined Contribution to the UNFCCC in 2015, as well as from the NDC implementation roadmap and action plan of 2018.

Table 5 also shows the afforestation, reforestation, and forest conservation planned for carbon sequestration. Bangladesh has observed that, among the key challenges in implementing climate mitigation and adaptation strategies, government officials' lack of knowledge and awareness about NDCs in the relevant sectors have been significant. Another challenge is the lack of basic data collection in relevant sectors such as agriculture and forestry (Bangladesh MOEFCC 2021, p. 23).

**Table 5.** Agriculture sector commitments in Bangladesh's updated NDC for 2030

Unconditional contributions	Conditional contributions
<b>Renewable energy for agriculture</b>	
<ul style="list-style-type: none"> <li>Implementation of 5,925 solar irrigation pumps (generating 176.38 MW) for agriculture</li> </ul>	<ul style="list-style-type: none"> <li>Implementation of 4,102 solar irrigation pumps (generating 164 MW) for agriculture</li> </ul>
<b>Agricultural emission reduction</b>	
<p>Methane emission reduction from rice fields:</p> <ul style="list-style-type: none"> <li>AWD upscaling in dry season rice fields across 50,000 ha of croplands</li> <li>Rice varietal improvement for 1,111,000 ha of croplands</li> </ul> <p>Nitrous oxide emission reduction from nitrogen-based fertilizers:</p> <ul style="list-style-type: none"> <li>Management of 209,000 ha of croplands (e.g., leaf color chart, soil test-based fertilizer application, less tillage, barn management)</li> <li>Improvement of fertilizer management (e.g., deep placement of urea in rice field, training, awareness) in 50,000 ha</li> <li>Increase in area under pulse cultivation</li> </ul> <p>Methane emission reduction from enteric fermentation:</p> <ul style="list-style-type: none"> <li>Replacement of low-productive animals with high-productive crossbred cattle (large ruminant, 0.94 million; small ruminant, 0.89 million)</li> <li>Feed improvement using a balanced diet and beneficial microorganisms for livestock (large ruminant, 0.51 million; small ruminant, 0.68 million)</li> </ul> <p>Methane and nitrous oxide emissions reduction from manure management:</p> <ul style="list-style-type: none"> <li>Improved manure management through promotion of 57,000 mini biogas plants.</li> <li>Awareness and training program</li> </ul>	<p>Methane emission reduction from rice fields:</p> <ul style="list-style-type: none"> <li>AWD upscaling in dry season rice fields across 100,000 ha of croplands</li> <li>Rice varietal improvement for 2,129,000 ha of croplands</li> </ul> <p>Nitrous oxide emission reduction from nitrogen-based fertilizers:</p> <ul style="list-style-type: none"> <li>627,000 ha cropland management (e.g., leaf color chart, soil test-based fertilizer application, less tillage, barn management)</li> <li>Improvement of fertilizer management (e.g., deep placement of urea in rice field, training, awareness) in 150,000 ha</li> <li>Increase in area under pulse cultivation</li> </ul> <p>Methane emission reduction from enteric fermentation:</p> <ul style="list-style-type: none"> <li>Replacement of low-productive animals with high-productive crossbred cattle (large ruminant, 1.882 million; small ruminant, 1.776 million)</li> <li>Feed improvement using a balanced diet and beneficial microorganisms for livestock (large ruminant, 1.013 million; small ruminant, 1.355 million)</li> </ul> <p>Methane and nitrous oxide emissions reduction from manure management:</p> <ul style="list-style-type: none"> <li>Improved manure management through promotion of 107,000 mini biogas plants.</li> <li>Awareness and training program</li> </ul>
<b>Forest conservation/ restoration</b>	
<ul style="list-style-type: none"> <li>Increase forest cover</li> <li>Increase tree cover, from 22.37% (2014) to 24%.</li> </ul>	<ul style="list-style-type: none"> <li>Maintain forest cover and tree cover through collaborative forest management, social forestry, and other programs</li> </ul>

<ul style="list-style-type: none"> <li>• Afforestation and reforestation of 150,000 ha in the coastal areas, islands, and degraded areas</li> <li>• Restoration of 137,800 ha of deforested hill and Plainland Sal forests</li> <li>• Restoration of 200,000 ha of degraded hill and Plainland Sal forests</li> <li>• Plantation in roadsides, embankments, private lands, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Forest conservation by scale-up of alternative income-generating activity for forest-dependent communities consisting of 55,000 families</li> <li>• Co-management of 72,000 ha of protected areas</li> <li>• Additional coastal afforestation activities</li> <li>• Maintenance of restoration of degraded or deforested areas</li> <li>• Plantation in roadsides, embankments, private lands, etc.</li> </ul>
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**Source:** Bangladesh's updated Nationally Determined Contribution (NDC), 2021.

**Note:** AWD = alternate wetting and drying; ha = hectares; MW = megawatts.

### **2.1.2. Domestic Policies Aligned with CSA in Bangladesh**

Two decades ago, in 2005, the Bangladesh Ministry of Environment and Forests developed the National Adaptation Program of Action (NAPA), following the seventh Conference of Parties to the UNFCCC. Its aim was to identify and mainstream climate-change adaptation strategies and coping mechanisms for extreme events. Over the years, Bangladesh has systematically developed a rich set of work plans, strategies, and policies for effective climate adaptation and disaster preparedness to address its climate vulnerability.

In the agriculture and forestry sectors, NAPA 2005 recognized that coastal afforestation would help reduce climate change hazards and emphasized the importance of promoting drought-, flood-, and saline-tolerant crop varieties. It identified elevated temperatures as a cause of sterility in rice spikelet, which could significantly reduce yields of this staple cereal and worsen food insecurity.<sup>8</sup> While agriculture and fishery systems in the northeast and central regions of the country needed to adapt to flash floods, those in coastal areas needed to address enhanced salinity (Bangladesh MoEF 2005, p. 22). Another key priority was ensuring the provision of drinking water to coastal communities facing increased salinity due to sea level rise.

By 2008, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was developed, building on NAPA 2005 (following the 13th Conference of Parties to the UNFCCC). The BCCSAP was designed to guide the country's mitigation and adaptation efforts and enhance climate resilience over the next 10 years (2009–2018). With two-thirds of the country less than 5 meters above sea level and prone to floods and cyclones, Bangladesh had long been addressing ways to enhance resilience to natural disasters through investments in flood management embankments, coastal polders, and cyclone shelters. These structures need augmentation if sea level rise exceeds earlier projections. Coastal polders were built to prevent sea level rise from causing flooding and saline intrusion into aquifers and rivers. In the northeast and central areas, however, the risk remains from higher monsoon flows due to the rapid melting of Himalayan

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<sup>8</sup> On the other hand, moisture stress threatens the tea plantations in the northeast, while increased salinity threatens the Sundarbans mangrove forest and freshwater species. Moreover, increased salinity reduces the nutritional content of food, including rice, leading to deficiencies in zinc and other micronutrients (GED 2020, p. 287).

glaciers into the rivers that flow into Bangladesh from India, Nepal, Bhutan, and China (Bangladesh MoEF 2008, p. 3).<sup>9</sup>

The pro-poor, climate-resilient, and low-carbon development strategy in the BCCSAP was based on six pillars, the first of which was food security, social protection, and health (Bangladesh MoEF 2008, p. 2). This focus was critical, as the IPCC projected that by 2050, rice production could decline by 8 percent and wheat by 32 percent (compared to the base year, 1990) due to rising temperatures, droughts, altered precipitation patterns, floods, and increased salinity (ibid, p. 13).

The 7th Five-Year Plan 2016–2020 and 8th Five-Year Plan 2020–2025 (8th FYP) emphasized the need for climate-resilient agriculture while ensuring food security through access to nutritious, diversified (with animal protein) food. Although the agriculture sector's share of aggregate output has declined, it remains critically important for providing livelihood security to millions and ensuring national food security.

The 10-year National Food and Nutrition Security Policy 2021–2030 outlines priority interventions in an integrated manner through the 8th and 9th Five-Year Plan periods, aiming to achieve food and nutrition security sustainably aligned with international commitments by 2030. Its detailed action agenda includes the development of stress-tolerant, high-yielding varieties of major crops, including pulses, oilseeds, soybeans, and fruits and vegetables; the promotion of efficient surface irrigation; the production of quality feed and fodder; and the stabilizing of regional food trade. The policy also supports the adoption of specific climate-smart technologies, including AWD, zero tillage, and drip irrigation.

Bangladesh emerged as a surplus producer of two crops, rice and potato, but continues to be import-dependent for pulses and oilseeds. In fact, the domestic production and per capita availability of pulses have declined in the past decade (GED 2020, p. 289).<sup>10</sup> Bangladesh has achieved self-sufficiency in fish production and consumption. The fisheries sector contributes more than 25 percent of agricultural GDP, and more than 10 percent of the population depends on the sector for their livelihoods (GED 2020, p. 312).

With rice as the country's staple crop and more than 75 percent of the country's cultivated land under paddy cultivation, there is concern about food security in the community following the call to reduce emissions from rice cultivation. Another challenge is low soil fertility resulting from low organic content. To address this issue, Bangladesh has been working to balance the use of nitrogen-based fertilizers to reduce soil carbon emissions by increasing subsidies for non-urea fertilizers (GED 2020, p. 294).

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<sup>9</sup> The combined peak discharge of the three rivers in the delta region, Brahmaputra, Ganges, and Meghna, during the flood season is 180,000 m<sup>3</sup>/sec (Bangladesh MoEF 2008, p. 6). About a quarter of the country is inundated during years of average monsoons.

<sup>10</sup> The use of stress-tolerant, high-yielding variety seeds along with the use of modern technology mechanization and balanced chemical fertilizers are considered to result in enhanced rice productivity. Among the three paddy varieties grown—*aman* (sown in monsoon and harvested in winter), *boro* (sown in winter and harvested in early summer) and *aus* (sown in summer and harvested in autumn)—the highest productivity growth has been witnessed in *aus*, followed by *boro* and *aman* (GED 2020, p. 291).

It is important to note that the agriculture sector is the single largest consumer of freshwater in the country, accounting for about 70–80 percent of total freshwater withdrawals.<sup>11</sup> The groundwater table in northern Bangladesh has declined rapidly (GED 2020, p. 295), yet irrigation efficiency is abysmally low at barely 30–40 percent, indicating that 60–70 percent of the water supplied for irrigation is wasted. Climate change will adversely impact freshwater availability, especially in coastal areas affected by saline intrusion and flooding. To encourage more efficient water use, water pricing must change, a reform that would also incentivize farmers to diversify away from water-intensive paddy during the dry Boro season toward alternatives such as non-rice crops such as pulses, oilseeds, and vegetables.

Although the 8th FYP recognizes the climate challenges facing the agriculture sector and strategies for promoting climate-smart agroecosystems, it stops short of setting quantitative targets in this area. The only quantitative targets set are for enhancing the yield of major crops by 2025. However, the plan does set a quantitative target of developing 100 varieties of climate-resilient crops (GED 2020, p. 298) and sets quantitative goals on the number of programs providing training and information services to farmers on balanced fertilizer use (specifically, the use of urea and non-urea to control soil carbon emissions), as well as for updating soil and water salinity data for coastal areas (GED 2020, p. 299). The 8th FYP observed that 24,633 km of strip plantation was achieved during 2009–2020 (GED 2020, p. 504). Although this linear plantation is a positive change, it is not the same as strip tillage or planting, a water-saving technology used in CSA.

The Mujib Climate Prosperity Plan 2022–2041 has mainstreamed climate change mitigation and adaptation efforts into Bangladesh’s economic planning, with the vision to transform the country from climate vulnerable to climate resilient and prosperous by 2041. The plan envisions eradicating poverty by 2030, achieving prosperity by 2041, and positioning Bangladesh as a global and regional leader in the green energy economy. In particular, the goal is to make the agricultural and fisheries supply nature based and climate resilient, with a target of doubling agricultural productivity by 2030 (Bangladesh MoEFCC 2022, p. 18). To support this transformation, the plan estimated an investment of US\$2.02 billion for the development of a nature-based, climate-smart agricultural and fisheries supply chain, including national disaster risk financing and management to safeguard food security, nutrition, and water security (Bangladesh MoEFCC 2022, p. 102).

The Mujib Climate Prosperity Plan is aligned with the techno-economic Bangladesh Delta Plan 2100, which seeks to ensure water security through spatial planning, transboundary water resources management, and sustainable agriculture for food security and rural development, among other sectoral approaches, through 2050. The Mujib plan identifies regional partnerships in South Asia, including through the South Asian Association for Regional Cooperation (SAARC), as an important strategy. Greater connectivity is seen as instrumental in building resilient green supply chains and value engineering in agriculture, fisheries, and manufacturing (Bangladesh

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<sup>11</sup>According to the General Economics Division (Bangladesh Planning Commission), the share of freshwater withdrawal for agriculture is somewhat lower than that reported in the World Development Indicators (WDI) database, as shown in Table 2.

MoEFCC 2022, p. 110). To develop a CSA and fisheries supply chain, the goal is to set up supply chain access to meteorological services at 50 percent by 2025 and 100 percent by 2030, while boosting productivity by 2.5 percent annually by 2025 and 5 percent annually by 2030 (ibid, p. 66). The Bangladesh Delta Plan on water security directly builds in regional cooperation, and the Mujib plan reinforces this regional partnership.

The National Adaptation Plan (NAP) 2023–2050 outlines actions to reduce the country’s vulnerabilities to climate change impacts and build a climate-resilient nation. It states six national adaptation goals: (1) Protect against climate change variability and climate-induced national disasters; (2) develop climate-resilient agriculture to ensure food, nutrition, and livelihood security; (3) promote climate-smart cities to improve the urban environment and public well-being; (4) implement nature-based solutions for the conservation of forests, biodiversity, and community well-being; (5) impart good governance by integrating adaptation into the national planning process; and (6) ensure transformative capacity building and innovation for climate change adaptation.<sup>12</sup> These strategies are well aligned with the global sustainable development goals and several projects of the Bangladesh Delta Plan 2100 (Bangladesh MoEFCC 2022a).

Table 6 highlights the major policy documents promoting the adoption-specific CSA technologies. The most prominently featured CSA technologies are as follows:

- Climate-resilient seeds and solar-powered irrigation pumps (in seven of the major plans, specified with quantitative targets in the current 8th FYP).
- AWD irrigation (in six of the major plans).
- Zero tillage and agroforestry (in five of the major plans).
- Drip irrigation and bed planting with residue retention (in four of the major plans).

As noted earlier, the NDC specifically identifies the first four CSA technologies and reflects that the recent domestic policies for CSA are closely aligned with Bangladesh’s multilateral climate commitments.

**Table 6.** CSA technologies in Bangladesh’s domestic policies

CSA technology	Policy document recommending CSA technology	Specific CSA goals set in policy documents
<b>Bed planting with residue retention</b>	1) Agricultural Extension Manual 2016 2) Perspective Plan 2021–2041 3) 8th Five-Year Plan 2020–2025 4) National Adaptation Plan 2023–2050	
<b>Strip tillage</b>	1) 8th Five-Year Plan 2020–2025	
<b>Zero tillage</b>	1) Perspective Plan 2021-2041 2) Agricultural Extension Manual 2016	

<sup>12</sup> The plan primarily addresses climate adaptation in the eight sectors: (1) water resources; (2) agriculture; (3) fisheries, aquaculture, and livestock; (4) urban areas; (5) ecosystems, wetlands, and biodiversity; (6) disaster, social safety, and security; (7) policies and institutions; and (8) capacity development, research, and innovation. It also covers cross-cutting issues such as infrastructure, sanitation, and health.

	<ol style="list-style-type: none"> <li>3) National Agricultural Mechanization Policy 2020</li> <li>4) National Food and Nutrition Security Policy 2021</li> <li>5) National Adaptation Plan 2023–2050</li> </ol>	
<b>Sustainable land management</b>	8th Five-Year Plan 2020–2025	Numerical targets for soil analysis and fertilizer card distribution, farmer training on balanced fertilizer use, soil and water salinity data update
<b>Protected agriculture (polyhouse)</b>	National Agricultural Mechanization Policy 2020	
<b>Drip irrigation</b>	<ol style="list-style-type: none"> <li>1) Agricultural Extension Manual 2016</li> <li>2) National Agricultural Mechanization Policy 2020</li> <li>3) 8th Five-Year Plan 2020–2025</li> <li>4) National Food and Nutrition Security Policy 2021</li> <li>5) National Adaptation Plan 2023–2050</li> </ol>	
<b>Direct-seeded rice</b>	<ol style="list-style-type: none"> <li>1) Perspective Plan 2010–2021</li> <li>2) Delta Plan 2100</li> <li>3) National Adaptation Plan 2023–2050</li> </ol>	
<b>Resilient intercropping</b>	<ol style="list-style-type: none"> <li>1) National Agricultural Plan 2018</li> <li>2) Delta Plan 2100</li> <li>3) National Adaptation Plan 2023–2050</li> </ol>	
<b>Alternate wetting and drying irrigation technique</b>	<ol style="list-style-type: none"> <li>1) Agricultural Extension Manual 2016</li> <li>2) Perspective Plan 2010–2021</li> <li>3) 8th Five-Year Plan 2020–2025</li> <li>4) Perspective Plan 2021–2041</li> <li>5) National Food and Nutrition Security Policy 2021</li> <li>6) National Adaptation Plan 2023–2050</li> </ol>	
<b>Solar-powered water pumps coupled with micro-irrigation</b>	<ol style="list-style-type: none"> <li>1) Agricultural Extension Manual 2016</li> <li>2) 8th Five-Year Plan 2020–2025</li> <li>3) Mujib Climate Prosperity Plan 2022–2041</li> <li>4) National Agricultural Plan 2018</li> <li>5) National Agricultural Mechanization Policy 2020</li> <li>6) Perspective Plan 2021–2041</li> <li>7) National Adaptation Plan 2023–2050</li> </ol>	Guidelines for grid integration of solar irrigation pumps by 2020; already formulated in the 8th Five-Year Plan 2020–2025
<b>Multi-purpose soil conservation bunds</b>	<ol style="list-style-type: none"> <li>1) Delta Plan 2100</li> <li>2) National Adaptation Plan 2023–2050</li> </ol>	
<b>Climate-resilient seeds</b>	<ol style="list-style-type: none"> <li>1) National Adaptation Program 2005</li> <li>2) Agricultural Extension Manual 2016</li> <li>3) National Agricultural Plan 2018</li> <li>4) 8th Five-Year Plan 2020–2025</li> <li>5) National Food and Nutrition Security Policy 2021</li> <li>6) Delta Plan 2100</li> <li>7) National Adaptation Plan 2023–2050</li> </ol>	<ul style="list-style-type: none"> <li>➤ Development of salinity-tolerant rice species at BARI and BRR1*</li> <li>➤ Development of 100 climate-resilient non-rice crop varieties (8th Five-Year Plan 2020–2025)</li> </ul>

<b>Agroforestry</b>	<ol style="list-style-type: none"> <li>1) Perspective Plan 2010–2021</li> <li>2) National Agricultural Plan 2018</li> <li>3) 8th Five-Year Plan 2020–2025</li> <li>4) Mujib Climate Prosperity Plan 2022–2041</li> <li>5) National Adaptation Plan 2023–2050</li> </ol>	<p>➤ Increase forest tree cover to 24% of land area (8th Five-Year Plan 2020–2025)</p>
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**Source:** Based on authors’ analysis of Bangladesh’s recent national policy and plan documents cited in the table.

**Note:** CSA = climate-smart agriculture; BARI = Bangladesh Agricultural Research Institute; BRRI = Bangladesh Rice Research Institute.

## 2.2. Bhutan

The small Himalayan nation of Bhutan is extremely vulnerable to climate change due to its landlocked location in a fragile mountainous ecosystem and its economy’s heavy dependence on climate-sensitive sectors such as agriculture and hydropower. Agriculture in Bhutan is rain fed, making it particularly susceptible to climate change–induced shifts in precipitation patterns, glacier melt, floods, and landslides, all of which threaten food production, forests, and biodiversity. The country’s recent economic growth has been driven by large investments in hydropower (NEC 2022, p. 16).

However, mega hydropower projects have faced severe environmental challenges due to poor geological conditions (which have resulted in accidents and landslides)<sup>13</sup> and loss of forest cover. The Ministry of Agriculture and Forests (MoAF) observed that hydropower development has led to deforestation and loss of wildlife, with 2 hectares on average of forest having been lost for every megawatt of generation capacity.<sup>14</sup> The expansion of hydropower capacity to support its own energy needs and that of its neighbors (particularly India) therefore poses a trade-off with Bhutan’s goal of preserving large tracts of land as forest carbon stock, as pledged under the Paris Agreement (apart from its constitutional goal of maintaining 60 percent of its land under forest cover).

Ironically, although Bhutan has achieved carbon neutrality and is one of the few net carbon–sequestering countries, it faces an existential threat from climate change due to emissions from the rest of the world. Bhutan has negative net carbon emissions. In 2020, its total GHG emissions were 2,723.28 gigagrams of carbon dioxide equivalent (GgCO<sub>2</sub>e), while total carbon sequestration from forests (sink capacity) was 9,513.49 GgCO<sub>2</sub>e, resulting in net emissions of –6,790.21 GgCO<sub>2</sub>e (NEC 2022, p. 45).<sup>15</sup> As shown in Table 2, methane and nitrous oxide emissions from agriculture in Bhutan are minimal, amounting to barely 0.5 MMtCO<sub>2</sub>e.<sup>16</sup> Because

<sup>13</sup> For example, since 2013, the two large hydropower projects in Punatsangchhu have encountered landslides and slope collapses that have led to environmental concerns and delays. Chencho Dema, March 9, 2023, *Dialogue Earth*. <https://dialogue.earth/en/energy/bhutan-failed-hydropower-goal-and-geopolitics-of-energy/>

<sup>14</sup> Based on a 2017 report of the Ministry of Agriculture and Forest, *Business Bhutan*, August 5, 2020. <https://businessbhutan.bt/hydropower-constructions-challenge-bhutans-forest-cover-goals/>

<sup>15</sup> Note that 1 Gg is equivalent to 1,000 metric tons.

<sup>16</sup> The emissions from agriculture and livestock in 2020 were 512.69 GgCO<sub>2</sub>e (almost 19% of total emissions) and have remained steady through the years (NEC 2022, p. 56). Enteric fermentation

agriculture is constrained by land availability for farming and livestock emissions have remained static over the years—and are expected to remain so through 2050 (DoECC 2023, p. 34)—Bhutan’s mitigation strategy focuses primarily on carbon sequestration through its forests.

To achieve food security while maintaining carbon neutrality, Bhutan aims to implement climate-smart and resource-efficient agricultural practices, focusing especially on organic agriculture and sustainable livestock production. Bhutan has identified the key vulnerabilities it faces in developing climate-resilient agriculture and livestock production, including extreme weather events, water scarcity, climate-induced pests and diseases, natural disasters, loss of soil fertility, human–wildlife conflict, and the difficulties that crops and livestock face in adapting to a rapidly changing climate (DoECC 2023, p. 4).

Environmental sustainability and ecosystem resilience have long been an integral part of Bhutan’s economic development philosophy, exemplified in its objective of maximizing gross national happiness. Thus, the Five-Year Plans have incorporated sustainability objectives within the goals of the Ministry of Agriculture’s programs for crops, livestock, and forestry.

Bhutan’s extensive forest cover—71.5 percent of its total land area (Table 1)—has been instrumental in achieving the country’s carbon neutrality. However, carbon sequestration through forests is poised to come under threat soon. Land use change is accelerating, driven by growing needs for hydropower development and urbanization, and is projected to increase 1 percent annually beginning in 2025 (DoECC 2023, p. 36). Ironically, while the growth of hydropower in Bhutan will help provide more carbon-free energy to neighboring SAARC countries, it will reduce the scope for expanding forest-based carbon stock within the country.

### **2.2.1. Climate Mitigation Commitment in Agriculture under Paris Agreement**

Bhutan ratified the UNFCCC in August 1995, the Kyoto Protocol in August 2002, and the Paris Agreement in September 2017. As a net carbon-sequestering nation, Bhutan, in its most recent submission to the IPCC, observed that it “has already made a global commitment to remain a carbon-neutral country for all times to come, which in itself is explicit and more than its fair share of responsibility” (DoECC 2023, p. 24). It is indeed noteworthy that Bhutan achieved carbon neutrality in 2009, almost two decades ago.

Table 7 summarizes Bhutan’s second NDC, submitted to the UNFCCC in 2021. The submission outlines commitments to enhance renewable energy generation for agricultural use through the expansion of mini hydel (mini-hydropower) systems, solar energy, and biogas production. The committed cumulative emission reductions in agriculture, forestry, and other land uses are 301.15 GgCO<sub>2</sub>e by 2025, 1239.77 GgCO<sub>2</sub>e by 2030, and 4945.51 GgCO<sub>2</sub>e by 2050.<sup>17</sup>

To mitigate GHG emissions from agriculture, Bhutan has committed to the following targets:

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accounts for most of these emissions (66.5%), followed by agricultural soil (17.3%), manure management (9.6%), and rice cultivation (6.5%).

<sup>17</sup> That is, 0.301 million tons by 2025, 1.239 million tons by 2030, and 4.945 million tons by 2050, as 10<sup>6</sup> tons = 10<sup>9</sup> gm = 1 million tons = 1,000 Gg.

- Reducing continuous rice flooding by 200 hectares per year.
- Transitioning from synthetic to organic fertilizers by 5 percent per year.
- Improving dairy cattle breeds and feed management of 8,333 in number.
- Increasing soil biomass through perennial crop production on 17,495 hectares to improve soil management.
- Enhancing forest carbon stock and promote agroforestry on 15 acres.

**Table 7. Agriculture sector commitments in Bhutan’s second NDC for 2030**

<p><b>Renewable energy for agriculture/forests</b></p> <ul style="list-style-type: none"> <li>• Small and medium biogas production through 10,254 projects</li> <li>• Solar energy for wildlife sanctuary: An 80 kW decentralized solar PV plant to provide sustainable electricity supply to the Aja Ney community living inside the Bumdeling Wildlife Sanctuary, intended to enable access to clean energy for the community to curtail their dependence on firewood</li> <li>• A 500 kW mini-hydel to provide energy to the remote Lunana community and eliminate the need for a 97 km transmission line in a nationally protected area and avoid deforestation and degradation</li> </ul>
<p><b>Agricultural emission reduction (mitigation potential of 710 GgCO<sub>2</sub>e)</b></p> <ul style="list-style-type: none"> <li>• Improved agricultural practices on 14,971 ha</li> <li>• Methane emission reduction from rice fields: Reduction of continuous rice flooding of 200 ha/year</li> <li>• Emission reduction from synthetic fertilizers: Switch from synthetic to organic fertilizers at 5% annually</li> <li>• Increased biomass through perennial crop production on 17,495 ha</li> <li>• Methane emission from enteric fermentation: Improve dairy cattle production through breed improvement and feeding management target of 8,333 in number.</li> </ul>
<p><b>Forest conservation</b></p> <ul style="list-style-type: none"> <li>• Improved forest management and conservation—maintain 436 million tons of forest carbon stock outside protected area system</li> <li>• Maintenance of at least 50% of land under protected area—maintain 201 million tons of forest carbon stock in protected area system (51.44% of land area and 31% of forest area)</li> <li>• Enhanced plantation and restoration work on 2,000 ha of forest carbon stock</li> <li>• Initiation and promotion of 15 acres of agroforestry</li> <li>• Wetlands conservation—conduct wetland assessment for understanding organic carbon content</li> </ul>

**Source:** Bhutan’s second Nationally Determined Contribution (NDC), 2021.

**Note:** GgCO<sub>2</sub>e = gigagrams of carbon dioxide equivalent; ha = hectares; kw = kilowatt; PV = photovoltaic.

### **2.2.2. Domestic Policies Aligned with CSA in Bhutan**

Environmental sustainability has been a core principle of economic planning in Bhutan since the 1990 Paro Resolution on Environment and Sustainable Development.<sup>18</sup> Maximizing gross national happiness became the stated objective of development planning, with two of the four key areas being preservation and sustainable use of the environment, and good governance (RGoB 2002, p. 4).

<sup>18</sup> Chapter 9, 8th Five-Year Plan 1997–2002.

The 10th Five-Year Plan 2008–2013 outlined several development programs<sup>19</sup> in agriculture and related activities to increase crop and livestock productivity. These include Integrated Soil Fertility and Land Management, Seed and Plant Development, Organic/Natural Agriculture, Non-Wood Forest Resource Development, Participatory Forestry, Feed and Fodder Development, and Farm Mechanization (RGoB 2008). The 11th Five-Year Plan 2013–2018 introduced targeted strategies to increase agricultural productivity through the development of crop varieties and horticultural commodities tolerant to biotic and non-biotic stress caused by climate change, including drought, floods, and pest and disease outbreaks (RGoB 2013, p. 9–30).

The 12th Five-Year Plan 2018–2023 identified “Carbon Neutrality, Climate and Disaster Resilience” as one of the national key result areas (NKRA), which integrated environmental considerations in all sectoral and local government plans. The first program under the NKRA focused on devising and implementing climate-smart, disaster-resilient development policies in agriculture and farming (RGoB 2018, p. 55).

Bhutan formulated the Climate Change Policy 2020 with the vision of building a “prosperous, resilient, and carbon neutral Bhutan where the pursuit of gross national happiness for the present and future generations is secure under a changing climate” (NEC 2020, p. 1). The policy upholds key principles, including people’s well-being, intergenerational equity, and protection of the country’s pristine environment as per the Constitution, as well as the precautionary principle and polluter pays principle of the National Environment Protection Act 2007.

The Climate Change Policy 2020 outlined the mandate for climate action by each ministry and institution. The MoAF, as the custodian of Bhutan’s forest resources, was tasked with managing forests and soils as carbon sinks and areas for ecosystem-based adaptation. The MoAF was also made responsible for managing emissions from agriculture and livestock, as well as for ensuring the resilience of food systems, livestock, and biodiversity (NEC 2020, p. 20). The associated agricultural and environmental legislations include the Seed Act, Biodiversity Act, Food and Nutritional Policy, and National Forest Policy. The Seed policy is considered important in the goal of maintaining resilient, agro-diverse food systems and food security.

Recognizing the critical role of the renewable natural resources (RNR) sector in the livelihoods of the population and the climate change threats Bhutan faces, the country developed the RNR Strategy 2040 in 2021. The strategy aimed to build climate resilience within the sector and addressed several themes, including agricultural technologies, agribusiness, food and nutrition security, climate change, and biodiversity access and benefit sharing. Because climate vulnerabilities threaten agricultural output through extreme weather events such as flash floods and hailstorms—which wash away land and damage crops, and also cause biological disasters such as pest and disease outbreaks in crops and livestock (for example, armyworm, rice blast, bird flu, H1N1)—the RNR Strategy stressed the need to identify and implement appropriate technologies to prevent crop and livestock losses. It also recognized that as a net food importer, Bhutan would continue to be vulnerable to foodborne illnesses and emerging diseases transmitted through the global food supply chain unless it strengthened its sanitary and phytosanitary

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<sup>19</sup> The program targets were directly linked to the corresponding millennium development goals and sustainable development goals, including environmental sustainability, poverty eradication, improved nutrition, acceptable soil and water quality, and wetland conservation.

measures against biosecurity challenges. The RNR Strategy noted that improved seed varieties, scientific land management, mechanization, and irrigation systems have increased crop productivity by 95 percent in the last 15 years (MoAF 2021, p. 24). Research has been more intensive in staple crops such as rice,<sup>20</sup> where productivity more than doubled—from 2 tons per hectare in 1981 to 4.2 tons per hectare in 2017 (MoAF 2021, p. 20).

The RNR Strategy observed that certain policies are inconsistent. For example, the use of agrochemicals conflicts with the policy of organic farming (MoAF 2021, p. 31). To address such contradictions, it is important to have an overarching policy for the RNR sector to ensure a coherent, integrated, and systemic approach to growth. The Constitution of Bhutan mandates that a minimum of 60 percent of Bhutan’s land remain under forest cover, and the country exceeds this requirement, with 71 percent of its land forested (ibid, pp. 34, 52). The RNR Strategy set targets for achieving sustainable natural resources and a self-reliant food system by 2040<sup>21</sup> while enhancing resilience to climate change. These targets include developing 50 climate-resilient crop varieties, 25 climate-smart and gender-responsive technologies, and 25,895 hectares of plantation areas, as well as maintaining forest capacity to sequester 8.248 MtCO<sub>2</sub> (MoAF 2021, p. 56).

Bhutan’s National Adaptation Plan 2023 identified agriculture and livestock as one of the seven<sup>22</sup> priority sectors for adaptation to climate-induced water shortage; wildlife depredation of crops; pests and diseases; and the risk of soil erosion. Agricultural adaptation to ensure resilience in food production will be addressed through sustainable soil and land management, improved water-use efficiency, resilient irrigation systems, agroforestry, organic farming (fertilizers), and climate-resilient livestock management (MENR 2023, p. 36).

Bhutan’s Long-Term Low Greenhouse Gas Emission and Climate Resilient Development Strategy, released in 2023, emphasized that, for the country to remain carbon neutral and achieve food security, climate-smart and resource-efficient agricultural practices must focus on organic agriculture in crops and livestock and must integrate sustainable soil and land management technologies (DoECC 2023, pp. 8, 28). The strategy identified the following CSA technologies and practices (ibid, pp. 73–78):

- Improved agricultural practices such as tillage management, precision farming, and protected agriculture
- Transition from synthetic to organic fertilizers

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<sup>20</sup> The largest number of cereal varieties were released for rice (23 varieties), followed by maize (4), and other cereals (5). Bhutan also released 4 soybean varieties, 84 vegetable varieties, and 89 fruit varieties for cultivation (MoAF 2021, p. 24).

<sup>21</sup> Targets included developing a food and nutrition security index and a biosecurity index, developing and promoting 30 innovative technologies by 2030, establishing 20 research collaborations by 2040, increasing the contribution of the RNR sector to 30 percent of GDP (comprising 14 percent from crops, 17 percent from livestock, and 9 percent from forests), and attaining self-sufficiency ratios of 70 percent for rice and meat, 100 percent for dairy products, 150 percent for vegetables, and 200 percent for fruits by 2040 (ibid, pp. 39, 53).

<sup>22</sup> The other six sectors were water; forests and biodiversity; human settlements and climate-smart cities; health; energy; and climate services and disaster risk reduction (MENR 2023, p. 15).

- Increased biomass sequestration through perennial crop production and small-scale domestic biogas production
- Intermittent rice flooding
- Improved dairy cattle feed

Table 8 lists the set of domestic policies on the use of specific CSA technologies to achieve emission mitigation targets, in line with Bhutan’s agricultural commitments in its recent NDCs under the Paris Agreement.

**Table 8. CSA technologies in Bhutan’s domestic policies**

CSA technology	Policy document recommending CSA technology	Specific CSA goals set in policy documents
<b>Bed planting with residue retention/ use of crop residue</b>	1) Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy 2) National Adaptation Plan 2023	• Cumulative emission reduction of 442.5 GgCO <sub>2e</sub> by 2030 and 1,978.23 GgCO <sub>2e</sub> by 2050 through perennial crop production
<b>Tillage management</b>	Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy	• Cumulative emission reduction of 133.9 GgCO <sub>2e</sub> by 2030 and 953.23 GgCO <sub>2e</sub> by 2050 through tillage management and protected agriculture
<b>Sustainable land management/ organic fertilizers</b>	1) 11th Five-Year Plan 2013–2018 2) 12th Five-Year Plan 2018–2023 3) National Environment Strategy 2020 4) National Adaptation Plan 2023 5) Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy	• Cumulative emission reduction of 6.94 GgCO <sub>2e</sub> by 2030 and 57.3 GgCO <sub>2e</sub> by 2050 (Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy)
<b>Protected agriculture (polyhouse)</b>	1) 11th Five-Year Plan 2013–2018 2) National Environment Strategy 2020 3) Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy	• Cumulative emission reduction of 133.9 GgCO <sub>2e</sub> by 2030 and 953.23 GgCO <sub>2e</sub> by 2050 through tillage management and protected agriculture
<b>Drip irrigation</b>	1) National Environment Strategy 2020 2) National Adaptation Plan 2023 3) Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy	
<b>Alternate wetting and drying/ intermittent rice flooding</b>	Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy	• Cumulative emission reduction of 0.29 GgCO <sub>2e</sub> by 2030 and 1.34 GgCO <sub>2e</sub> by 2050 through intermittent rice flooding
<b>Solar-powered water pumps coupled with micro-irrigation/ small-scale biogas production</b>	1) National Adaptation Plan 2023 2) Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy 3) RNR Strategy 2040	• Cumulative emission reduction of 107,054 MtCO <sub>2e</sub> by 2030 and 409,031 MtCO <sub>2e</sub> by 2050 through biogas production • Promote clean energy production through biogas

<b>Multi-purpose soil conservation bunds</b>	National Environment Strategy 2020	
<b>Climate-resilient seeds/crop varieties</b>	National Adaptation Plan 2023	
<b>Agroforestry/ climate-smart livestock farming</b>	<ol style="list-style-type: none"> <li>1) National Environment Strategy 2020</li> <li>2) National Adaptation Plan 2023</li> <li>3) Long-Term Greenhouse Gas Emission and Climate Resilient Development Strategy</li> <li>4) RNR Strategy 2040</li> </ol>	<ul style="list-style-type: none"> <li>• Cumulative emission reduction of 19.4 GgCO<sub>2</sub>e by 2030 and 164.05 GgCO<sub>2</sub>e by 2050 through improved dairy cattle feed</li> <li>• Forest capacity to maintain carbon sequestration at 8.248 million tons of CO<sub>2</sub> equivalent (RNR)</li> </ul>

**Source:** Based on authors' analysis of Bhutan's recent national policy and plan documents cited in the table.

**Note:** GgCO<sub>2</sub>e = gigagrams of carbon dioxide equivalent; MtCO<sub>2</sub>e = metric tons of carbon dioxide equivalent; RNR = Renewable Natural Resources.

### 2.3. India

India, the largest country in South Asia, has also witnessed a significant and steady rise in the annual average temperature, at a rate of 0.61°C per hundred years since 1901, with an even higher increase in the maximum temperature. Moreover, the duration of heat waves during the pre-monsoon season has increased in the northwest, central peninsular, and eastern coastal regions (India MoEFCC 2021, p. 40). Over the past three decades, annual rainfall and monsoon season rainfall have shown a decreasing trend in the districts of eastern and central India, while districts in the western region have experienced an increase. The Himalayan glaciers, which feed the major northern rivers (Brahmaputra, Ganga, and Indus), have been retreating at an accelerated rate during the past few decades. Meanwhile, the sea level along coastal India is rising at a long-term average rate of 1.7 mm per year (India MoEFCC 2021, p. 41).

A climate vulnerability analysis indicates that India's western and southern zones are extremely vulnerable to agricultural droughts, while the northern, eastern, and central zones are moderately vulnerable to meteorological and agricultural droughts (India MoEFCC 2023, p. 38). The southern and eastern zones are also highly vulnerable to extreme cyclonic events, floods, and drought. About half of the agricultural land in the country is rainfed, making the sector highly vulnerable to climate-induced drought.

As in the other South Asian countries, the agriculture sector in India provides livelihoods for a large portion of the workforce (India MoEFCC 2023, p. 199). Because the sector largely consists of small and marginal farmers, millions of farmers are acutely vulnerable to climate change and extreme weather events that pose severe social and economic risks. The share of small and marginal operational holdings (less than 2 hectares) increased from 85.01 percent of total holdings in 2010–2011 to 86.08 percent in 2015–2016.

India's climate-mitigation strategy has focused on the energy and industrial sectors, while policy action in the agriculture sector is predominantly adaptation oriented. The energy sector accounts

for more than three-quarters of the total GHG emissions in the country.<sup>23</sup> Within this sector, electricity generation (which accounts for 39 percent of total emissions) is targeted for reduced reliance on fossil-fuel-based power capacity. India's strategy aims to prevent imposing the mitigation burden on the millions of small and marginal farmers in the agriculture sector.

GHG emissions in the agriculture sector are mostly in the form of methane, followed by nitrous oxides. Although the total emissions have increased over the years, the sector's share of the country's total emissions has been declining. India is the largest milk producer in the world, and livestock contributes the largest share of emissions in the agriculture sector. In 2019, the agriculture sector accounted for 13 percent of India's total carbon-equivalent emissions (India MoEFCC 2023, p. 72), with most of the emissions emanating from enteric fermentation, followed by agricultural soils, rice cultivation, manure management, and burning of agricultural residues.

India has the highest water withdrawal for agriculture in the world, with about 80 percent of the country's freshwater resource used in agriculture, while groundwater extraction is unregulated (MOEFCC 2019, p. 7). Enhancing resource efficiency in Indian agriculture and adopting water-saving technology are urgent needs. The draft National Resource Efficiency Policy (NREP), issued by the Ministry of Environment, Forest, and Climate Change in 2019, highlighted the urgency for action in light of the high resource extraction rate, low productivity, and widespread land degradation.

While CSA technologies have been encouraged and subsidized, policy inconsistency remains an issue. For instance, subsidies for zero tillage are offered alongside subsidies for conventional technology (Ishtiaque et al. 2024). In addition, mismanagement, local politics, elite capture, and similar challenges have undermined the effectiveness of custom hiring centers that provide rental services for expensive CSA technology machinery to smallholder farmers with financial constraints (ibid). These factors have hindered the widespread adoption and scaling-up of CSA technologies, despite programs promoting them. Weather-based crop insurance schemes in India have helped reduce risks for farmers from weather shocks such as rainfall, temperature, humidity, and windspeed, using indices derived from official weather station data. However, the number of weather stations need to be increased for more reliable weather-index-based insurance (CGIAR 2013).

### **2.3.1. Climate Mitigation Commitment in Agriculture under Paris Agreement**

India ratified the United Nations Framework Convention on Climate Change in November 1993, the Kyoto Protocol in August 2002, and the Paris Agreement in October 2016. Under the Paris Agreement, India updated its pledge to reduce emission intensity of its GDP by 45 percent from 2005 levels by 2030 (unconditionally) and to achieve carbon neutrality (net zero) by 2070 (GOI 2022). As part of its climate mitigation efforts to move toward a cleaner energy mix, India also committed to achieving 50 percent of cumulative electric power installed capacity from non-fossil-

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<sup>23</sup> The share of the agricultural sector in total energy consumption is around 18.5 percent and could be reduced further through the use of efficient pump sets (India MoEFCC 2023, p. 201).

fuel-based resources by 2030. Furthermore, it aims to create an additional carbon sink of 2.5 to 3 billion MtCO<sub>2e</sub> through forest and tree cover by 2030. However, India did not make any voluntary commitments to reduce emissions from the agriculture sector in its NDC.

Table 9 provides a snapshot of India’s overarching climate commitments and agricultural strategy in the updated NDC. In its most recent biennial report to the UNFCCC, India noted that agriculture plays a critical economic role, as the livelihoods of more than half the country’s workforce depends on agricultural and allied activities. Given the dominance of marginal and small farmers, whose average operational holding size is 1.08 hectares,<sup>24</sup> this sector is the most vulnerable to climate change and hence the most significant for adaptation efforts.

**Table 9. Agriculture sector commitments in India’s NDC for 2030**

<p><b>Overarching general targets</b></p> <ul style="list-style-type: none"> <li>• Reduce the emission intensity of GDP by 45% from 2005 levels by 2030.</li> <li>• Increase cumulative installed electric power capacity from non-fossil-fuel-based energy resources to 50% by 2030.</li> <li>• Create an additional carbon sink of 2.5 to 3 billion tons of CO<sub>2</sub> equivalent through additional forest and tree cover by 2030.</li> <li>• Reach net zero by 2070.</li> </ul>
<p><b>Adaptation strategy in agriculture*</b></p> <ul style="list-style-type: none"> <li>• Develop the National Mission on Sustainable Agriculture to ensure food security and protection of resources such as land, water, biodiversity, and genetics.</li> <li>• Adopt the National Initiative on Climate Resilient Agriculture to improve crop production, livestock and fisheries, and institutional interventions.</li> <li>• Promote the National Agroforestry Policy to protect and stabilize ecosystems and promote resilient farming through tree plantations integrated with crops and livestock.</li> </ul>
<p><b>Forest conservation under National Mission for Green India</b></p> <ul style="list-style-type: none"> <li>• Increase forest/tree cover by 5 million hectares of forest/non-forest lands and improve quality of forest cover on another 5 million hectares (a total of 10 million hectares).</li> <li>• Improve ecosystem services, including biodiversity, hydrological services, and carbon sequestration as a result of treatment of 10 million hectares.</li> <li>• Increase forest-based livelihood income of about 3 million households living in and around the forests.</li> <li>• Enhance annual CO<sub>2</sub> sequestration by 50 to 60 million tons in 2020.</li> </ul>

**Source:** GOI (2022).

\* Outlined in the first NDC (the 2015 Intended Nationally Determined Contribution). The updated NDC 2022 specified that “no change in the other sections or text or otherwise of the document containing existing first NDC is proposed.”

**Note:** As per the guidelines, in the Biennial Update Report (BUR) to the UNFCCC, only the sectors covered in voluntary declarations must be reported. India’s voluntary declaration does not cover activities in the agriculture sector.

As noted earlier, the agriculture sector is the main source of non-carbon-dioxide GHG, including methane and nitrous oxide. Methane emissions largely stem from livestock rearing (enteric

<sup>24</sup> The average size of operational holding has reduced over the years, from 1.15 hectares in 2010–2011. According to the Agriculture Census 2019, the total operated area in the country decreased from 159.59 million hectares in 2010–2011 to 157.82 million hectares in 2015–2016, while the number of operational holdings increased from 138.35 million hectares in 2010–2011 to 146.45 million hectares in 2015–2016 (India MoEFCC 2021, p. 99).

fermentation and manure management), followed by rice cultivation,<sup>25</sup> while nitrous oxide is primarily due to fertilizer use in soils.<sup>26</sup> More than half the emissions in the Indian agriculture sector come from enteric fermentation (54.6 percent), followed by fertilizer application (19 percent), rice cultivation (17.5 percent), manure management (6.7 percent), and burning of agricultural residues (2.2 percent) in the fields (India MoEFCC 2021, p. 164). Methane and nitrous oxides have both been increasing over the years, with the share of nitrous oxide steadily increasing (Some et al. 2019).

Forest land and cropland are net sinks of carbon dioxide (while grasslands are a source of emissions); thus these vegetation covers are accounted for under the category of Land Use, Land Use Change, and Forestry (LULUCF) under the UNFCCC. According to India's report to the UNFCCC, about 15 percent of India's total carbon emissions in 2016 were sequestered through LULUCF, and the net carbon stock in forests increased by 42.6 million tons during 2017–2019 (India MoEFCC 2021, p. 197).<sup>27</sup> As noted above, although India has emphasized carbon sequestration through forests, it has not committed to any emission mitigation in the agriculture sector in its NDCs under the Paris Agreement.

In its Third National Communication and Initial Adaptation Communication to the UNFCCC in 2023, India listed various CSA technologies that have been used or experimented with in agronomic and natural resource management. These include crop residue mulching, zero-till sowing, laser leveling, drip and sprinkler irrigation, direct-seeded rice, drum seeding of rice, drought- and flood-tolerant cultivars, and solar-powered water pumps, among others (India MOEFCC 2023, p. 310–312).

### **2.3.2. Domestic Policies Aligned with CSA in India**

The 2006 National Environmental Policy aimed to promote conservation of critical environmental resources, the efficient use of these resources, and intergenerational equity through good governance. It observed that the impacts of climate change fall disproportionately on developing countries—those least responsible for causing the problem—including India. These climate change impacts adversely affect precipitation patterns, ecosystems, agricultural potential, forests, and water resources while also increasing disease vectors (MOEF 2006, p. 42). In response, the policy emphasized the need to identify the country's key vulnerabilities to climate change

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<sup>25</sup> Between 2014 and 2016, methane emissions from anaerobic decomposition of soil organic material in flooded rice paddies declined by 2.1 percent following a reduction in area under rice cultivation. Of the total land under rice cultivation, 33.19 percent is drought prone, 16.44 percent uses single aeration, 15.89 percent is under continuous flooding, 13.02 percent is upland, 12.42 percent uses multiple aeration, 5.90 percent is flood prone, and 3.15 percent falls under the deep-water rice system (India MoEFCC 2021, p. 167)

<sup>26</sup> GHG emissions from soils declined by 3.41 percent during 2014–2016 following a decline in the use of synthetic fertilizer-based nitrogen (India MoEFCC 2021, p. 168).

<sup>27</sup> The carbon stock in India's forests was estimated at 7,124.6 million tons in 2019, an increase of 42.6 million tons compared to the previous assessment in 2017. However, forest cover loss occurred in Manipur, Arunachal Pradesh, Mizoram, and Meghalaya, while forest cover gains occurred primarily in Karnataka, Andhra Pradesh, and Kerala. (India MoEFCC 2021, p. 252).

impacts—particularly in water, coastal areas, agriculture, and health—and to assess the need and scope for climate adaptation in these sectors.

In 2008, the National Action Plan on Climate Change (NAPCC) recognized that the Indian economy is “closely tied to its natural resource base and climate sensitive sectors such as agriculture, water and forestry.” The NACPP contained eight separate missions, with one devoted exclusively to promoting sustainability in agriculture: the National Mission for Sustainable Agriculture (NMSA). In addition, four other missions were geared toward climate adaptation that supported CSA: the Solar Mission, Mission on Sustainable Habitat, Mission on Water Use Efficiency, and Mission for Safeguarding Himalayan Glaciers and Mountain Ecosystems. Closely related to sustainable agriculture under the NAPCC is the National Water Mission, which promotes integrated water resource management to conserve water, minimize wastage, and ensure equitable distribution across users.

The NMSA, launched under the 2008 NAPCC and implemented beginning in 2014–2015, aimed to make Indian agriculture more resilient to climate change through various schemes on irrigation water management and conservation, crop productivity in rainfed areas, and soil health management. Its Rainfed Area Development program, promoted a cluster approach and was implemented “across all States and UTs except Punjab and Goa” (India MoEFCC 2021, p. 102). Four years into its implementation, the NMSA was brought under the umbrella scheme of the Green Revolution–Krishonnati Yojana in 2018–2019 and subsequently subsumed under the Rashtriya Krishi Vikas Yojana in 2022–2023 (GOI 2023, pp. 83).

The NMSA also promoted a Farm Water Management scheme to improve water use efficiency by promoting drip and sprinkler technologies, an efficient water application and distribution system, and the development of secondary storage. This scheme was subsumed under the Per Drop More Crop program of the Pradhan Mantri Krishi Sinchayee Yojana 2015–2016, which aims to conserve water in agriculture while expanding the area under irrigation. The program seeks to replace flood irrigation methods with micro-irrigation systems, which reduce electricity consumption for pumping water. These systems are considered both energy- and water-efficient, as they provide water to the root zone. By 2019–2020, more than 3.3 million hectares in India had been brought under micro-irrigation, with 1.7 million hectares under drip irrigation and 1.6 million hectares under sprinkler irrigation (India MoEFCC 2021, p. 246). Improvements in farm water efficiency and the expansion of cultivable area under assured irrigation are estimated to have reduced emissions by 11.979 MtCO<sub>2</sub> during 2017–2018 and 2018–2019 (India MoEFCC 2021, p. 197).

In 2011, the National Innovations in Climate Resilient Agriculture (NICRA) program was launched<sup>28</sup> as a to support research and pilot projects aimed at developing climate-resilient farms and villages. It seeks to build climate-resilient agriculture, including crops, livestock, and fisheries at the farm level by developing and applying improved production and risk management

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<sup>28</sup> Launched in 2011 by the Indian Council of Agricultural Research (under the Ministry of Agriculture and Farmers Welfare).

technologies for climate adaptation. NICRA has been implemented in 151 districts involving more than 100,000 farm families across the country.

Although agroforestry has long been practiced in India, it was the first country to adopt a national agroforestry policy in 2014 with the introduction of the National Agroforestry Policy. The policy was designed to protect ecosystems and promote climate-resilient farming by increasing tree plantation in a complementary and integrated manner, along with crops and livestock. Its goals are to enhance productivity and generate employment and rural livelihoods while ensuring ecological stability. Agroforestry promotes the production of food, fuel, fodder, timber, fertilizer, and fiber in a sustainable ecosystem. By strategically integrating a mix of species, agroforestry enables agricultural land to become more resilient to extreme weather events driven by climate change (GOI 2014). The policy recognizes that small farmers typically rely on a diverse range of livelihood activities (not just single crop systems), including trees, crops, water, livestock, and other farm-based enterprises. It therefore emphasizes integrated planning to improve productivity, employment, income, and the livelihoods of rural households, especially those of small and marginal farmers. In addition, it aims to protect and stabilize ecosystems, promote resilient cropping and farming systems to reduce risk during extreme climatic conditions, and increase tree cover to promote ecological stability, especially in vulnerable regions. According to the ministry, agroforestry activities contributed to emission reductions of 0.1318 MtCO<sub>2</sub> from 2017–2018 to 2018–2019 (India MoEFCC 2021, p. 245).

India also promotes organic farming through the Paramparagat Krishi Vikas Yojana, a program that aims to maintain soil health and support farmers by reducing the cost of cultivating and marketing organic products. In addition, the Mission for Organic Value Chain Development for Northeastern Region (2015–2016 to 2017–2018) focuses on developing certified organic products through a value chain approach, linking growers with consumers and supporting the development of entire value chains—from inputs, seeds, and certification to facilities for collecting, aggregating, processing, marketing, and brand-building (India MoEFCC 2021, p. 102).

In 2015, the Soil Health Card Scheme was launched under the Integrated Nutrient Management Division of the Ministry of Agriculture and Farmer Welfare to establish additional soil-testing laboratories across the country, improve access to irrigation, and enhance water efficiency (MoEFCC 2021, p. 105). In 2016, India made neem-oil-coated urea mandatory, requiring both imported as well as indigenously produced urea to be neem-coated (India MoEFCC 2021, p. 249). Neem-coated urea improves nitrogen absorption efficiency, reduces nitrogen loss by suppressing nitrification in the soil, and reduces nitrous oxide emissions from soil.

In 2019, the Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) scheme was launched to replace diesel pumps with emission-free, solar-powered pumps. The goal was to achieve a total solar capacity of 30.8 GW through installation of small solar power plants (up to 2 MW capacity) on barren, fallow, pasture, or marshy land owned by farmers. By 2022, the target was to replace 2 million diesel pumps with stand-alone solar pumps and solarization of 1.5 million grid-connected agriculture pumps. This decarbonizing strategy was expected to avert 27 MtCO<sub>2</sub> emissions annually (India MoEFCC 2021, p. 246).

The Integrated Farming System (IFS) program promotes crops and cropping systems integrated with activities such as horticulture, livestock, fisheries, agroforestry, and apiculture. It enables farmers to maximize farm returns while mitigating the impacts of drought, floods, or other extreme weather events by offering alternate income opportunities through allied activities. It aims to enhance productivity and minimize risks associated with climatic variability. Under the Mission for Integrated Development of Horticulture, fruit crops (which produce relatively higher biomass) are retained in the field for extended periods to sequester carbon both above and below ground. From 2017–2018 to 2018–2019, this program contributed an estimated carbon sequestration of 108.96 MtCO<sub>2</sub> (India MoEFCC 2021).

The Bharatiya Prakritik Krishi Paddhati (BPKP) scheme, implemented in 2019, promotes natural farming aligned with agroecology, largely based on on-farm biomass recycling, biomass mulching, cow dung–urine formulations, and soil aeration. An estimated 2.5 million farmers across India are practicing agroecology (NITI Aayog 2022, p. 40).

Table 10 highlights the domestic policies discussed in this section that promote the use of specific CSA technologies. Mitigation initiatives that reduce emission intensity have been implemented through rice intensification systems, direct-seeded rice cultivation, solar pumps, micro-irrigation, a neem-coated urea scheme, biofertilizers, and balanced feedstock. It is noteworthy that the National Food Security Mission, launched in 2007, aimed to increase crop productivity, particularly of wheat, rice, pulses and coarse cereals, by enhancing farm-level productivity through restoration of soil fertility, intercropping of cereals and pulses, integrated pest management, and use of micro-irrigation techniques such as drip and sprinkler irrigation.

**Table 10.** CSA technologies in India’s domestic policies

CSA technology	Policy document recommending CSA technology	Specific CSA goals set in policy documents
<b>Bed planting with residue retention/mulch</b>	1) National Mission for Sustainable Agriculture 2008 2) Bharatiya Prakritik Krishi Paddhati 2019	
<b>Strip tillage</b>	National Innovations in Climate Resilient Agriculture 2011	
<b>Zero tillage</b>	National Innovations in Climate Resilient Agriculture 2011	
<b>Drip irrigation</b>	1) National Food Security Mission 2007 2) National Mission for Sustainable Agriculture 2008 3) Rainfed area development (Rashtriya Krishi Vikas Yojana) 2011 4) Pradhan Mantri Krishi Sinchayee Yojana 2015–2016	
<b>Direct-seeded rice</b>	1) National Food Security Mission 2007 2) National Innovations in Climate Resilient Agriculture 2011	
<b>Resilient intercropping</b>	1) National Food Security Mission 2007 2) National Mission for Sustainable Agriculture 2008	

	3) National Innovations in Climate Resilient Agriculture 2011	
<b>Solar-powered water pumps coupled with micro-irrigation</b>	Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) 2019	Avoid 27 MMtCO <sub>2</sub> emissions per year through use of solar pumps instead of diesel pumps
<b>Multi-purpose soil conservation bunds</b>	1) National Food Security Mission 2007 2) National Innovations in Climate Resilient Agriculture 2011	
<b>Climate-resilient seeds</b>	National Innovations in Climate Resilient Agriculture 2011	
<b>Agroforestry</b>	1) National Mission for Sustainable Agriculture 2008 2) National Innovations in Climate Resilient Agriculture 2011	

**Source:** Based on authors' analysis of India's recent national policy and plan documents cited in the table.

**Note:** CSA = climate-smart agriculture, MMt= million metric tons.

## 2.4. Nepal

Like Bhutan, Nepal is also a landlocked country in the Himalayan Mountain range. Although abject poverty has declined over time, Nepal remains one of the poorest countries in the world, with approximately 19 percent of its population living below the poverty line (GON 2021). Reliance on remittances is high, accounting for one-fifth of the GDP. The country's three core economic sectors—agriculture, tourism, and hydropower—are all extremely climate sensitive.

The country has been experiencing steady warming since the 1970s, with the maximum temperature increasing at a significant rate of 0.056°C per year and the annual mean temperature projected to rise by 0.9–1.10C in the medium term (2016–2045) (GON 2021, p. 5). Average precipitation is also increasing. Located in a fragile mountain ecosystem, Nepal is among the most vulnerable countries to the adverse impacts of climate change and extreme weather events.<sup>29</sup>

Agriculture in Nepal contributes one-quarter of the country's aggregate output, engages two-thirds of the population (GON 2021, p. 6), uses about 29 percent of the land (GON 2021, p. 63), and is largely based on traditional methods. In recent years, mechanization has increased in tillage and threshing, with diesel accounting for 95 percent of total energy input (GON 2021, p. 49). Rice is a staple crop, grown primarily under rainfed conditions or with limited irrigation, although some paddy is cultivated using continuous flooding (GON 2021, p. 69).

In the agriculture and forestry sector, Nepal has identified as key mitigation strategies such as intercropping or successional planting, zero tillage, forest management, and dietary changes in livestock. Forests and woodlands cover around 45 percent of the country's land area (GON 2021,

<sup>29</sup> Nepal has five physiographic regions: the Terai (elevation below 500 m), covering 14 percent of the land area; the Siwalik (elevation 500–1,000 m), covering 13%; the middle mountains (elevation 1,000–3,000 m), covering 30%; the high mountains (elevation 3,000–5,000 m), covering 20%; and the high Himal (>5000 m), covering 23%. (GON 2021, p. 12)

p. 63), with forest ecosystems spanning 10 major groups, including alpine and subalpine scrub, temperate coniferous, tropical, and subtropical coniferous forests (GON 2021, p. 26). Ten wetlands in Nepal are listed as Ramsar sites.<sup>30</sup>

In its NDCs to the UNFCCC, Nepal emphasized the principle of common but differentiated responsibilities and respective capabilities, in line with its national circumstances. On the energy front, its abundant water resources make hydropower the predominant source of electricity. However, primary energy consumption is largely based on biomass (GON 2021, p. 43).

### 2.4.1. *Climate Mitigation Commitment in Agriculture under Paris Agreement*

Nepal ratified the UNFCCC in May 1994, the Kyoto Protocol in September 2005, and the Paris Agreement in October 2016. While not specifying any numerical targets, Nepal has pledged to increase access to CSA technologies for women, indigenous people, and small and marginal farmers. It also aims to promote intercropping, agroforestry, conservation tillage, and livestock and agricultural waste management, and to support the use of climate-resilient indigenous seeds and crop varieties through community seed banks and national gene banks.

Table 11 summarizes the quantitative targets pledged by Nepal in its updated NDC under the Paris Agreement. In its submission to the UNFCCC, Nepal emphasized the need for a transformation in agriculture needs through better cultivation practices, a rice intensification system, better manure management; enrichment of soil organic matter, soil management practices such as low soil tillage, adaptive and resilient varieties and livestock breeds, expanded adoption of controlled-release or stabilized fertilizers, improved enteric fermentation processes, and the promotion of agroforestry and other sustainable agriculture systems. It also stressed the important of scaling up sustainable forest management and agroforestry, along with improving monitoring and database systems to track progress.

**Table 11.** Agriculture sector commitments in Nepal’s second NDC for 2030

<p><b>Overall energy target</b> Ensure that 15% of the total energy demand is supplied from clean energy sources by 2030.</p>
<p><b>Agricultural emission reduction</b></p> <ul style="list-style-type: none"> <li>• Increase soil organic matter content of agriculture land to 3.95% by 2030.</li> <li>• Expand mulberry and fruit orchard areas to 6,000 hectares by 2030.</li> <li>• Increase the number of improved cattle sheds to 500,000 for quality farm-yard manure production and use by 2030.</li> <li>• Increase the number of organic fertilizer production plants to 100 by 2030.</li> <li>• Integrate climate change into the upcoming revised Agriculture Policy.</li> <li>• Update the Rangeland Policy and develop plans for the sustainable management of rangelands by 2025.</li> <li>• Establish 200 climate-smart villages and 500 climate-smart farms by 2030.</li> </ul>
<p><b>Forest conservation</b></p> <ul style="list-style-type: none"> <li>• Maintain 45% of the country’s total area under forest cover (with other wooded land limited to less than 4%) by 2030.</li> </ul>

<sup>30</sup> A Ramsar site is a wetland designated as internationally important for conservation under UNESCO.

- Sustainably manage 50% of Tarai and Inner Tarai forests and 25% of middle hills and mountain forests, including through funding from REDD+ initiatives, by 2030.
- Ensure that forests under community-based management comprise at least 60% of the total forest area, with management committees including 50% women and proportional representation of Dalits and Indigenous People in key positions.

**Source:** Second Nationally Determined Contribution (NDC) (GON 2020).

**Note:** REDD+ = Reducing Emissions from Deforestation and Forest Degradation, with additional forest-related activities like conservation and sustainable management

Nepal has pledged to achieve net zero emissions by 2050. In its long-term strategy for reaching this goal, it has aligned emission reductions in the agriculture sector with its targets for electricity production and the use of energy-efficient technologies. The strategy aims to transition to renewable energy and hydrogen technologies for supplying energy to the industrial, commercial, and agriculture sectors (GON 2021a). Moreover, Nepal's NDC target to establish 200 climate-smart villages and 500 climate-smart farms by 2030 is aligned with the broader strategy of scaling up CSA practices across the country.

#### **2.4.2. Domestic Policies Aligned with CSA in Nepal**

In 2010, Nepal established the Climate Change Management Division within its Ministry of Environment, with an exclusive focus on developing climate change strategy. Recognizing the adverse impacts from climate-induced disasters—such as rapid snowmelt, expanding glacier lakes, intense rain, and prolonged droughts—climate adaptation plans were placed on the national agenda.

The National Adaptation Program of Action 2010 (NAPA) was the government's first comprehensive response to climate change. It addressed six themes: agriculture, forest biodiversity, water resources, health, infrastructure, and disaster (GON 2021, p. 32). To operationalize NAPA's priority actions, the National Framework for Local Adaptation Plans for Action 2011 (LAPA) was developed, and the adaptation planning process was launched in 2015 under the UNFCCC Cancun Adaptation Framework. The National Adaptation Plan 2021–2050, submitted to the UNFCCC under the Paris Agreement, outlines Nepal's adaptation strategy to achieve its second NDC.

Released in 2011 as a companion document to NAPA, the LAPA framework emphasized the active participation of local communities in identifying and prioritizing community needs, recognizing this was essential for effective climate adaptation. Agriculture, forestry, and watersheds were identified as priority sectors, in addition to health, water and sanitation, and microfinance. Four guiding principles shaped climate adaptation planning and resilience at both the local and national levels: the planning should be bottom-up, inclusive, responsive, and flexible (GoN 2011). The bottom-up approach was critical in identifying the most vulnerable communities, understanding why they were vulnerable, and designing interventions to reduce their vulnerability.

The first Climate Change Policy of 2011 highlighted the importance of channeling funds for climate adaptation, mitigation and carbon sequestration to the grassroots level. In agriculture, it promoted the development and expansion of low-methane-emitting agricultural technologies, as well as varieties and species tolerant to drought and floods.

The new National Climate Change Policy 2019, which replaced the Climate Change Policy of 2011, is the core legislation for climate action and continues to promote the key aspects of the 2011 policy. Thus, in the agriculture sector, identification and promotion of drought-resistant crops and those suitable for waterlogged areas remain critical. The policy also promotes water-efficient irrigation technology, crop diversification, organic farming, and the development of agroforestry using multi-purpose tree species. The policy aims to build a resilient society by minimizing the risks posed by climate change, through strategies in eight thematic areas and four inter-thematic areas.<sup>31</sup> For Nepal, increasing forest-carbon sequestration is a high priority, along with mobilizing international funding through initiatives such as Reducing Emissions from Deforestation and Forest Degradation and the Clean Development Mechanism.

In its fourth chapter, the Environment Protection Act of 2019 provides the umbrella legislation for climate change regulation and management. It states that climate adaptation and mitigation action should be guided by periodic studies and formulated by governments at the federal, provincial, and local levels. Climate adaptation strategies must prioritize groups that are vulnerable to climate change, including women, persons with disabilities, children, senior citizens, and indigenous communities. The act authorizes the government of Nepal to determine necessary technical standards for developing climate mitigation and adaptation technologies and to participate in carbon trading.

To transform traditional agriculture into a more productive, competitive, and sustainable sector, Nepal formulated the Agriculture Development Strategy 2015–2035 to incorporate structural changes. It set clear short-, medium-, and long-term targets for self-reliance in foodgrains; sustainability in areas such as year-round irrigation, soil organic matter, forest cover, and agricultural land productivity; improved competitiveness and reduction of the trade deficit; inclusiveness; enhanced livelihoods; and food and nutrition security. To enhance agricultural productivity, the strategy promotes a range of climate-smart technologies that increase irrigation efficiency and intensity, improve farmers' resilience through early warning systems, develop stress-tolerant varieties and integrated soil fertility, and advance renewable energy based on biogas and biomass use.

The 15th Five-Year Plan 2019- 2023 set a clear mandate to alleviate poverty and ensure environmental security, identifying climate change as a cross-cutting issue. Its agriculture goal was to develop a sustainable, competitive, climate-resilient, self-reliant, and export-oriented industry that ensures food and nutrition security, in line with the Agriculture Development Strategy 2015–2035. To this end, the strategy includes the development and expansion of agricultural technologies, including climate-adaptive and climate-resilient organic farming that uses organic fertilizers derived from biogas and other sources. Irrigation efficiency needed to be improved, and an irrigation expansion aligned with climate adaptation would focus on developing an underground and lift irrigation system powered by solar energy. In water-scarce areas, using a

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<sup>31</sup> These themes are (1) agriculture and food security; (2) forests, biodiversity, and watershed conservation; (3) water resources and energy; (4) rural and urban settlements; (5) industry, transport, and physical infrastructure; (6) tourism and natural and cultural heritage; (7) health, drinking water, and sanitation; and (8) disaster risk reduction and management. The cross-cutting themes are (1) gender equality and social inclusion, livelihoods, and good governance; (2) awareness raising, technology development, and extension; (3) research, technology development, and extension; and (4) climate finance management.

combination of technologies—rainwater harvesting, drip irrigation, and sprinkler irrigation—would be given priority.

The Forest Policy 2018 addresses the sustainable management of forests, biodiversity, and watersheds. This policy aims to increase carbon stock for climate mitigation and garner international funds through REDD+ for watershed conservation. The National REDD+ Strategy 2018 also covers the rehabilitation of degraded forests, in addition to preserving existing forests to increase carbon sequestration and promotes ecosystem-based forest, biodiversity, and watershed conservation, as well as participatory ecotourism (GON 2021, p. 88).

Nepal is the second country in the world (after India in 2014) to implement a national agroforestry policy, the National Agroforestry Policy 2019, which promotes an integrated practice of cultivation, livestock rearing, and forest management on the same agricultural land to ensure a climate-resilient ecosystem. The policy also prioritizes identifying barren, fallow, and marginalized land for agroforestry development (GON 2019).

In the plan document Nepal’s Food Systems Transformation: Context, Pathways and Action (2021), the National Planning Commission emphasized that the country’s food system is unsustainable, and its unique mountain food system is highly vulnerable to climate change and other natural disasters. It recognized the need for a systemic transformation through policy coherence in governance to enhance agricultural productivity, adopt an agroecosystem-based resilient food system, monitor food quality, revitalize indigenous foods, conserve biodiversity, promote value chains, and ensure food and nutrition security. The commission observed that Nepal’s agricultural system was affected by increasing imports and food dumping and needed to align with global, regional, and bilateral trade agreements and become competitive (NPC 2021, p. 4). It also recognized the importance of educating people on the biodiversity–climate–food–health system nexus to support the transformation. The plan suggested developing climate-resilient villages and food systems with climate-smart technologies in agriculture and animal husbandry. To improve irrigation efficiency, it recommended drip and sprinkler irrigation in rainfed and water-deficient areas (ibid, p. 30). In addition, the plan called for the development of a system using climate-resilient and genetically diverse seeds, with increased access through community seed banks and seed fairs in partnership with the government at federal, provincial, and local levels (ibid, pp. 44, 52–55).

Table 12 summarizes the set of domestic policies that promote specific CSA technologies discussed in this section.

**Table 12.** CSA technologies in Nepal’s domestic policy documents

CSA technology	Policy document recommending CSA technology	Specific CSA goal set in policy documents
<b>Conservation tillage/ strip/ zero tillage</b>	1) Climate Change Policy 2011 2) Agriculture Development Strategy 2015–2035 3) National Adaptation Plan 2021–2050	

<b>Sustainable land management/soil and nutrient management</b>	<ol style="list-style-type: none"> <li>1) Agriculture Development Strategy 2015–2035</li> <li>2) 15th Five-Year Plan 2019–2023</li> <li>3) National Climate Change Policy 2019</li> <li>4) National Adaptation Plan 2021–2050</li> </ol>	Increase soil organic matter to 2% in the short term and 4% in the medium and long term
<b>Protected agriculture (polyhouse)</b>	Agriculture Development Strategy 2015–2035	
<b>Drip irrigation/water efficient agriculture</b>	<ol style="list-style-type: none"> <li>1) National Climate Change Policy 2019</li> <li>2) Agriculture Development Strategy 2015–2035</li> <li>3) 15th Five-Year Plan 2019–2023</li> <li>4) Nepal’s Food System Transformation 2021</li> <li>5) National Adaptation Plan 2021–2050</li> </ol>	
<b>Direct-seeded rice</b>	National Adaptation Plan 2021–2050	
<b>Resilient intercropping</b>	<ol style="list-style-type: none"> <li>1) Agriculture Development Strategy 2015–2035</li> <li>2) National Adaptation Plan 2021–2050</li> </ol>	
<b>Solar-powered water pumps coupled with micro-irrigation</b>	<ol style="list-style-type: none"> <li>1) 15th Five-Year Plan 2019–2023</li> <li>2) National Adaptation Plan 2021–2050</li> </ol>	Set annual targets on installing solar drinking water and irrigation pumps
<b>Climate-resilient seeds/crop varieties</b>	<ol style="list-style-type: none"> <li>1) Climate Change Policy 2011</li> <li>2) Agriculture Development Strategy 2015–2035</li> <li>3) National Climate Change Policy 2019</li> <li>4) 15th Five-Year Plan 2019–2023</li> <li>5) Nepal’s Food System Transformation 2021</li> <li>6) National Adaptation Plan 2021–2050</li> </ol>	
<b>Agroforestry</b>	<ol style="list-style-type: none"> <li>1) National Climate Change Policy 2019</li> <li>2) Agriculture Development Strategy 2015–2035</li> <li>3) Fifteenth Five-Year Plan 2019–2023</li> <li>4) National Adaptation Plan 2021–2050</li> </ol>	

**Source:** Based on authors’ analysis of Nepal’s recent national policy and plan documents cited in the table.

**Note:** CSA = climate-smart agriculture.

## 2.5. Pakistan

Pakistan is among the most highly climate-vulnerable countries of the world, having experienced rising temperatures, altered precipitation patterns, and moderate to severe food insecurity (MOEEEC 2022, p. 22). The country is at risk from extreme weather events and natural hazards, including floods, tropical cyclones, droughts, glacial lake outburst floods, and landslides, that threaten the agriculture–food–water nexus as well as urban infrastructure. Sea level rise and saline intrusion are threatening agriculture, fisheries, and aquaculture. Because the country’s freshwater resources are based on snowmelt, glacier melt, and monsoon rains, climate change is leading to water stress. Consequently, water conservation and water security have become policy priorities.

Pakistan contributes to less than 1 percent of global GHG emissions but remains among the 10 countries most severely affected by climate change (MOCCEC 2023, p. 12). Recent climate shocks, such as the unprecedented heatwave, droughts, and floods in 2022, have led to severe losses in lives and livelihoods, with one-third of the country submerged in the devastating floods. The total damage was estimated at 4.8 percent of GDP in 2022 (World Bank 2022, p. 5).

Agriculture is a critical sector for the country's economic well-being, central to growth, employment, poverty reduction, and food security. It accounts for more than 20 percent of GDP and employs 40 percent of the labor force (MOCCEC 2023, p. 3). Due to its dependence on the monsoon and the glacier-fed Indus Basin, this sector is extremely vulnerable to short-term climate variability and long-term climate change. Thus, adaptation measures for water security are critical to ensuring food security as well.

Crop loss and livestock damage from increasing heat could amount to 2–3 percent of GDP by 2050, according to recent projections (World Bank 2022, p. 13). Together with the adverse impacts on human health, productivity losses, and infrastructure damage, the total economic loss could lead to a 9 percent decline in GDP by 2050 (ibid, p. 14).

Pakistan's agriculture sector—including agriculture, forestry, and other land use (AFLOU)—is the largest source of GHG emissions, contributing 45.6 percent of total GHG emissions in 2018, followed by the energy sector at 44.7 percent (MOCC 2022, p. 21). Within the AFLOU sector, livestock accounted for the highest share of GHG emissions at 48.8 percent, while rice cultivation contributed 3.5 percent of the sector's total carbon-equivalent emissions.

### **2.5.1. *Climate Mitigation Commitment in Agriculture under Paris Agreement***

Pakistan ratified the UNFCCC in June 1994, the Kyoto Protocol in January 2005, and the Paris Agreement in November 2016. In its Intended Nationally Determined Contribution (INDC) under the Paris Agreement, or its first NDC, Pakistan observed that almost 90 percent of its total GHG emissions emanate from the energy sector and agriculture, with the latter contributing 43 percent of the total (GOP 2016, p. 21). The INDC observed that because Pakistan is highly vulnerable to extreme climate events, there is a “state of forced adaptation,” and underscored the principle of Common but Differentiated Responsibilities under the Paris Agreement, which would enable the country to implement climate mitigation plans only with international support (GOP 2016, p. 4). The INDC also noted that mitigation technologies in the energy, agriculture, and transport sectors had not been harnessed due to financial and technical challenges (ibid, p. 12). It recognized the potential for rationalizing fertilizer use and enhancing soil carbon management in the agriculture sector. Because Pakistan is an arid region where 90 percent of the country's agricultural production depends on irrigated land (GOP 2016, p 14), improving water resource management was deemed imperative.

In its updated NDCs (2021), Pakistan committed to abating GHG emissions by 50 percent (15 percent unconditionally and 35 percent conditionally) by 2030 compared to BAU levels, with the reduction driven by an increased share of renewable energy. The target was to increase the share of renewables (including hydropower) to 60 percent of total power generation by 2030, which would require large-scale estimated investments in the energy system for a just transition. The

NDC stated that international financial support of \$101 billion would be needed to meet this energy transition target (GOP 2023, p. 62), in accordance with the articles in the Paris Agreement to aid developing country members in implementing climate action.

With almost 30 percent of the population living below the poverty line in the country (GOP 2023, pp. 24–25), climate vulnerability is most acute in the agriculture sector (agriculture–food–water nexus), with the poor being most at risk given their dependence on agriculture, livestock, fisheries, and forests for their livelihoods. Agriculture supports the livelihoods of 68 percent of Pakistan’s rural population (ibid, p. 25).

The agriculture sector consumes 95 percent of the total freshwater withdrawals, with the four major crops—wheat, sugarcane, cotton, and rice accounting for 80 percent of this consumption (GOP 2023, p. 38). CSA practices are being implemented through the introduction of climate-resilient seed varieties, improved irrigation, and water management for “more crop per drop,” promotion of green manure and soil fertility improvement practices, and agroforestry (GOP 2023, pp. 35, 47). Under the Eco-System Restoration Initiative 2019–2030, 5 percent of the degraded cropland is to be restored.<sup>32</sup>

In the forestry sector, forest conservation and planting are estimated to sequester 148.76 MtCO<sub>2</sub>e. Apart from enforcing a ban on open burning of rice stubble and crop residue, there are no specific mitigation or adaptation commitments in the agriculture sector.

Table 13 provides a snapshot of the overall emissions mitigation and reduction targets and agriculture sector strategy outlined in Pakistan’s latest NDC.

**Table 13. Agriculture sector commitments in Pakistan’s updated NDC, 2021**

Unconditional/voluntary targets	Conditional targets
<b>Overall emissions reduction target</b>	
<p>Of the overall 50% emissions reduction (base year 2015), 15% is an unconditional reduction in business as usual (BAU) projected emissions by 2030.</p> <p>The transition to a new energy mix includes a goal of achieving 60% from renewable sources.</p>	<p>Of the total 50% emission reduction relative to 2015 levels, 35% is a conditional emission reduction in BAU projected emissions by 2030, contingent on international financial support.</p>
<b>Agricultural emission reduction and adaptation</b>	
<ul style="list-style-type: none"> <li>• Reduce basmati rice crop burning with a ban on open burning of rice stubble, solid waste, and other hazardous material.</li> <li>• Dispose of crop residue in an environmentally friendly manner.</li> <li>• Increase irrigation efficiency in agriculture.</li> <li>• Introduce drought-tolerant crop varieties.</li> <li>• Implement climate early warning systems, monitoring, and forecasting.</li> <li>• Transform the Indus Basin through climate-resilient agriculture and water management.</li> <li>• Enhance farmers’ resilience through skill and capacity development.</li> </ul>	

<sup>32</sup> Other targets include restoring 30 percent of degraded forest, 6 percent of degraded grassland, and 10 percent of degraded wetlands by 2030 (GOP 2023, pp. 39, 45).

<b>Forest conservation</b>	
<ul style="list-style-type: none"> <li>• The Ten Billion Tree Tsunami Program, launched in 2016, aims to sequester 148.76 MtCO<sub>2</sub>e.</li> <li>• The Protected Areas Initiative seeks to increase protected areas from 12% to 15% by 2023.</li> <li>• Protect critical mangrove forests in Sindh and Baluchistan; establish new mangrove plantations over 16,552 hectares to support climate mitigation, biodiversity conservation, and the livelihoods of local communities through fisheries and eco-tourism.</li> </ul>	

**Source:** Second Nationally Determined Contributions (NDC), 2021.

**2.5.2. Domestic Policies Aligned with CSA in Pakistan**

Recognizing the potential catastrophic impact of climate change, Pakistan created the National Ministry of Climate Change and introduced the National Climate Change Policy in 2012 to comprehensively address climate mitigation and adaptation, with a provision for periodic review and updates. The policy aimed to build climate resilience in economically and socially vulnerable sectors such as agriculture, water, energy, and forestry. Although this policy provided guidelines for adaptation and mitigation across sectors, it appears to have had little impact in practice on sectoral programs (World Bank 2022, p. 19).

The National Climate Change Policy was updated in 2021 to include a more comprehensive coverage of sectors, including agriculture. Among its core objectives was the development of climate-resilient agriculture and food systems for all agro-ecological zones in the country. It recognized that because global warming affects the water cycle, the rainfed agriculture and livestock sectors needed to adapt to climate change. The policy recommended integrating indigenous knowledge with the latest scientific technology to achieve an ecologically sustainable green revolution. To reduce methane emissions from agricultural soils, it advocated the promotion of no-till farming and the introduction of low-water-dependent rice varieties.

Following its INDC in 2015 under the Paris Agreement, Pakistan legislated the Climate Change Act in 2017 to meet its “obligation under international conventions relating to climate change and address the effects of climate change.” It recognized that increased salinity intrusion in the Indus region is adversely affecting coastal agriculture, mangroves, and fisheries.

The Punjab Agriculture Policy 2018 observed that a significant share of Pakistan’s GHG emissions reduction commitment under the Paris Agreement would likely have to come from Punjab’s agriculture sector (GOP 2018, p. 47). Most emissions in this sector emanate from “enteric fermentation in livestock, chemical fertilizers and manure, paddy rice cultivation, and soil disturbance through tillage” (ibid, p. 48). The policy advocated the adoption of CSA practices that would help increase agricultural productivity while protecting farmers from adverse climate impacts. CSA strategies must address vulnerabilities arising from changes in precipitation and temperature, extreme weather events, and unsustainable land and water management. This would entail developing crop varieties “adapted to varied weather conditions and tolerant to associated emerging pests and diseases” and “breeding crop varieties those are adapted to effects of climate change like flooding, drought, strong winds, hailstorms, heat waves and frost”

(GOP 2018, p. 48). The weather information system also requires improvement, as accurate and timely climate information is critical for decision making across the crop value chain and for ensuring that the CSA policies are effective. Mitigation efforts should promote energy-efficient technologies in pumping and irrigation and minimize the use of fire in rangeland and cropland management.

To curb emissions from crop residue burning, the National Clean Air Policy 2023 imposed an immediate and complete ban in March 2023 (MOCC 2023, p. 12). It also called for the promotion of circular economy practices in agricultural waste management and the introduction of large-scale measures to reduce emissions from the livestock sector.

The Alternative and Renewable Energy Policy 2019 (ARE), following the Policy for Development of Renewable Energy for Power Generation 2006–2018, encouraged the growth of renewable energy and mandated that 30 percent of power generation come from renewable sources of solar, bagasse, and wind sources by 2030. Moreover, with more than 30 percent hydel power, the share of emission-free electricity generation would be around 65 percent (GOP 2021, p. 27).

The recent National Adaptation Plan 2023 (NAP 2023) provided a holistic approach to climate adaptation aimed at managing natural and human capital for prosperity while ensuring gender, youth, and social inclusion. Warming in Pakistan has exceeded the global average, with the country's average temperature rising at more than twice the global rate during 1981–2005 (MOCCEC 2023, p. 16). Climate change has increased the frequency of both devastating floods—mostly glacial lake outburst floods in the northern regions and cyclonic rains near the coast—and severe droughts in southern Baluchistan and Sind. Annual water availability has been declining and almost reached the scarcity threshold level.

Pakistan has lost almost 2 million acres of arable land to saline intrusion in the Indus Delta region due to reduced river flow and rising sea levels (MOCCEC 2023, p. 18). Reduced irrigation water and change in growing periods have adversely affected crop productivity, especially for staples such as wheat, maize, and rice, thereby exacerbating food insecurity in the country.<sup>33</sup> NAP 2023 emphasized the urgent need for a comprehensive, long-term agricultural growth plan in Pakistan centered on CSA that promise the responsible use of water, soil, and biodiversity. Although CSA technologies such as alternative crops, precision irrigation, tunnel farming, and integrated pest control have achieved success at the pilot level and on a small scale, the CSA adoption rate remains low in the country, especially among smallholder farmers (ibid, p. 38). Policy coherence is needed to align research, extension services, and access to finance and appropriate technology and create a highly productive, climate-resilient agriculture and water sector. A modern, demand-responsive irrigation system with user-based charges is essential for transforming the agriculture–food system. Agricultural research and extension services must be improved, with a focus on climate-resilient crop varieties, regenerative agriculture practices for land preparation, efficient and sustainable fertilizer application, improved farm water management, intercropping and crop diversification, sowing, and harvesting. Access to credit for adopting on-farm technology and purchasing inputs for CSA should be expanded, with the government supporting the creation of

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<sup>33</sup> In 2018, about 23.5 percent of households in Pakistan were estimated to be moderately to severely food insecure, a figure that is projected to rise to distressing levels by 2050 (MOCCEC 2023, p. 18).

producer groups that facilitate collaboration between small farmers and other actors in crop-specific value chains that help farmers access national and international markets (ibid, p. 39).

Table 14 summarizes Pakistan’s domestic policy documents that promote the use of priority CSA technologies; however, none of these documents include specific goals for their implementation.

**Table 14.** CSA technologies in Pakistan’s domestic policy documents

CSA technology	Policy document recommending CSA technology
Zero tillage	National Climate Change Policy 2021
Sustainable land management	1) Punjab Agriculture Policy 2018 2) National Adaptation Plan 2023
Drip/precision irrigation	National Adaptation Plan 2023
Resilient intercropping	National Adaptation Plan 2023
Energy-efficient water pumps	Punjab Agriculture Policy 2018
Climate-resilient seeds/crop varieties	1) Punjab Agriculture Policy 2018 2) National Climate Change Policy 2021 3) National Adaptation Plan 2023

**Source:** Based on authors’ analysis of Pakistan’s recent national policy and plan documents cited in the table.

**Note:** CSA = climate-smart agriculture.

## 2.6. Sri Lanka

Sri Lanka is a densely populated island nation that is highly vulnerable to climate change, with most of its population dependent on natural resources, as they continue to engage in small-scale farming and fisheries. Although agriculture constitutes only 7 percent of gross output, it employs 24 percent of the country’s workforce (MoAPI 2022),<sup>34</sup> and together with fisheries and tourism, the sector provides livelihoods to more than 40 percent of the population (MOE 2022, p. 40).

Agriculture in Sri Lanka is largely state subsidized and characterized by low productivity and low farm income, poor management of resources (land, water, and soils), and weak farm–market linkages. The sector is highly dependent on imports for agricultural inputs and technology, and investment in technology and information dissemination remains low (MoAPI 2022).

### 2.6.1. *Climate Mitigation Commitment in Agriculture under Paris Agreement*

Sri Lanka ratified the UNFCCC in November 1993, the Kyoto Protocol in September 2002, and the Paris Agreement in September 2016. In its NDCs under the Paris Agreement, it committed to carbon neutrality in electricity generation by 2050 and to 70 percent renewable energy in electricity generation by 2030.

<sup>34</sup> The Sri Lankan economy is service-driven, with the services sector accounting for 58 percent of aggregate output.

Table 15 provides a snapshot of Sri Lanka’s climate commitments in its latest NDC under the Paris Agreement. In the agricultural and livestock sectors, Sri Lanka has committed to abate 7 percent of GHG emissions by 2030, compared to a BAU scenario, of which 4 percent is unconditional and 3 percent conditional (that is, on funding from developed countries). Emission mitigation would be achieved through enhanced input efficiency, particularly in the use of water and fertilizers (Table 15). Because rice is the staple cereal, the focus is on increasing paddy productivity by 10 percent unconditionally during 2021–2030 (and an additional 5 percent conditionally). Integrated pest management and integrated plant nutrition management for sustainable agriculture, longstanding components of Sri Lanka’s agricultural policy, also features in the NDC. In the livestock sector, ambitious targets have been set to increase milk yield productivity. To build a climate-resilient fisheries sector, Sri Lanka aims to protect aquaculture in 50 perennial reservoirs through barricades and protect 30 lagoons that are most vulnerable to climate change. It has also committed to increasing carbon sequestration through forests by 7 percent, of which 2 percent is unconditional and 5 percent is conditional.

**Table 15. Agriculture sector commitments in Sri Lanka’s updated NDC, 2021**

<b>Unconditional contributions</b>
Reduce GHG emissions by 14.5% during 2021–2030 (from electricity generation, transport, industry, waste, forestry, and agriculture). Achieve carbon neutrality by 2050 in electricity generation.
<b>Agricultural emission reductions</b> Mitigate GHG emissions by 7% in agriculture and livestock compared to BAU (of which 4% is unconditional and 3% is conditional).
<ul style="list-style-type: none"> <li>• Reduce postharvest losses.</li> <li>• Increase crop productivity, including paddy yield in tons/ha by 10% (unconditionally) and 5% (conditionally) by 2030.</li> <li>• Improve fertilizer use efficiency by 10% (unconditionally) and 5% (conditionally) by 2030.</li> <li>• Improve water use efficiency.</li> <li>• Promote precision agriculture.</li> <li>• Promote integrated pest management and integrated plant nutrition system in the most vulnerable areas.</li> <li>• Enhance sustainable land and water management practices in areas where climate vulnerability is anticipated to be severe (including promoting farm rainwater harvesting to cover 75% of target area stormwater management in 25% of target area, climate-tolerant crop varieties in 50% of target area, and soil conservation measures in 50% of target area).</li> <li>• Improve adoption of renewable energy for crop farming.</li> <li>• Expand aquaculture and culture-based fisheries to address climate-related food security issues, including installing fish barricade devices in 50 perennial reservoirs affected by frequent floods to prevent fish escape, in consultation with the Irrigation Department).</li> <li>• Breed climate-change resilient and commercially important aquatic resources.</li> <li>• Increase the production capabilities of fisheries and aquatic resources in 30 lagoons that are highly vulnerable to climate change.</li> <li>• Improve dairy sector productivity by through better herd management, herd health, feed, and welfare. The goal is to increase milk yield/cattle by 40% (unconditionally) and 55% (conditionally) by 2030. In addition, increase the share of productive milking cows in the herd by up to 40% (conditionally).</li> </ul>
<b>Forest conservation</b> Increase carbon sequestration capacity by 7% compared to BAU (of which 2% is unconditional and 5% is conditional).

- Increase forest cover to 32% by 2030.
- Develop forest management plans for natural forests to ensure sustainable management by 2025.
- Implement forest restoration program (18,000+ ha of non-forest land to be reforested/afforested, including mangrove forests) by 2030.
- Improve quality of growing stock of degraded forests (200,000 ha) by 2030.
- Improve quality of forest plantations of 78,000 ha in state-owned lands by 2030.

**Source:** Updated Nationally Determined Contribution (NDC) (MOE 2021).

**Note:** BAU = business as usual; GHG = greenhouse gases; ha = hectares

### **2.6.2. Domestic Policies Aligned with CSA in Sri Lanka**

The National Agricultural Policy 2007 called for promoting environmentally friendly agriculture by increasing the productivity of water and land and using organic and bio-fertilizers. It also aimed to maintain seed security by keeping buffer stocks of certified seeds and discouraging the import of crop varieties with terminator genes. The new National Agriculture Policy 2021 promotes a paradigm shift from subsistence agriculture to a demand-driven, export-oriented agriculture that improves livelihoods, while focusing on an ecologically friendly agricultural environment. The new policy set a target to double resource productivity by 2030 (with 2020 as the base year) through sustainable, eco-friendly agriculture practices and to increase the agrifood system's contribution to 15 percent of the national output (MOAPI 2021, p. 4). It also set a target to increase locally developed technology along the agrifood value chain by at least 50 percent and to increase the local production of high-quality and high-yielding seed and planting material by 50 percent of the national requirement. It aims to establish a government-regulated food and feed control system supporting certification standardization and to build a climate-resilient agrifood system. To improve water-use efficiency in agriculture, it advocated for the use of drip irrigation where applicable, rainwater harvesting, rehabilitation of reservoirs, and the adoption of third-season cultivation in paddy fields using residual moisture (ibid, p. 10).

In 2010, Sri Lanka released the National Climate Change Adaptation Strategy for Sri Lanka 2011–2016 to provide a comprehensive framework for action in response to the country's increasing climate vulnerabilities. To check threats to food security, the strategy emphasized building resilience in sectors such as agriculture, fisheries, and irrigation. Among the priority adaptation measures identified were improvements in weather forecasting and information dissemination; expanded access to seed stock alternatives to counter rainfall variability, and the conservation of genetic resources for future crop and livestock improvement. In the pursuit of food security, the strategy recommended that paddy cultivation incorporate zero tillage, micro-irrigation, and straw mulching to conserve water, along with the promotion of flood-, drought-, and salinity-tolerant rice varieties (MOE 2010, pp. 42, 53). Enhancing the resilience of coastal and marine ecosystems was another priority area, given that the marine and lagoon fishing communities are highly vulnerable to climate change. Coastal ecosystems, especially coral reefs and associated species, have been adversely affected by rising temperatures, sea level rise, and acidification (ibid, p. 20). The strategy also noted that integrated coastal zone management and special area management would require an increase in public awareness of the value of aquatic ecosystems.

The National Climate Change Policy of Sri Lanka 2012 set the goal for adaptation and mitigation of climate change impacts within the framework of sustainable development. The foremost priority for adaptation was ensuring food production and food security through the adoption of climate-resilient technologies in crop production, fisheries, and animal husbandry. In terms of mitigation, the highest priority was given to the energy sector, transport, and industry, followed by agriculture and livestock. However, the policy document did not include specific numerical targets or timelines.

Following the National Adaptation Plan 2010 and the submission of the intended NDCs under the Paris Agreement, a more detailed strategy was developed in 2016: the National Adaptation Plan for Climate Change Impacts in Sri Lanka 2016–2025. It identified agriculture and fisheries among the sectors most vulnerable to climate change, along with coastal and marine ecosystems, biodiversity, human health, infrastructure, and human settlements. Under food security, the priority areas included rice, other food crops, horticultural crops, sugarcane, livestock, fisheries, and land degradation (MOE 2016, p. 33). Under water resource management, the highest priority was assigned to water use in agriculture. To increase water efficiency in agriculture and reduce irrigation water loss, the plan advocated for the use of micro-irrigation, drip irrigation, and rainwater harvesting and the re-use of drainage and wastewater (ibid, p. 60). For germplasm improvement, proposed budgets were demarcated for developing heat-, drought-, salinity-, and alkalinity-tolerant varieties of paddy and other food crops, as well as heat-tolerant livestock breeds. Funding was also designated for pest-resistant varieties of paddy and other food crops, horticulture, and disease-resistant breeds of livestock and poultry (ibid, pp. 54–56, 143). In water resource management, the plan emphasized strengthening salinity exclusion structures and barriers to control sea water intrusion, which had led to a decline in agricultural productivity and loss in cultivation land for coconut, cinnamon, and cashew crops (ibid, 138).

For Sri Lanka, the three agricultural commodities of tea, rubber, and coconut account for a large share of the export basket, followed by spice crops, floriculture, aquaculture products, and herbal products (MOE 2016, p. 85). Accordingly, the National Adaptation Plan for Climate Change identified tea, rubber, coconut, coffee, cocoa, spices, and cashew for export promotion, where improved germplasm (climate-resilient varieties tolerant to heat and water stress) would be introduced and farm management practices improved with drip irrigation, mulching, intercropping, use of soil quality indices, and so on. (ibid, p. 86). Agroforestry and shade trees were also recommended as adaptive measures for climate resilience in crop farms and plantations (ibid, p. 88).

Rice is recognized as the most important crop of the country, providing 45 percent of the total calorie and 40 percent of the total protein requirement of an average Sri Lankan. Thus, the new Plan of the Department of Agriculture 2022–2030 focused on enhance productivity in the cultivation of rice and other priority field crops to achieve food security (DOA 2022). The plan recognized that among several threats faced by rice cultivation, the lack of climate-resilient varieties and the risk of pest and disease infestations need particular attention in research and development.

The Sri Lankan economy is heavily dependent on its natural resource base, with agriculture, fisheries, and tourism providing livelihoods to more than 40 percent of its population (MOE 2022,

p. 40). In the National Environmental Action Plan 2022–2030, the Ministry of Environment identified priority areas for building climate resilience, including agriculture, biodiversity, coastal and marine fisheries, livestock, health, and tourism. For instance, the plan emphasized the need to preserve traditional knowledge and practices in farming and in soil, water, and pest management to support biodiversity conservation.<sup>35</sup> The plan also recognized that the blue carbon ecosystems—mangroves, intertidal flats, saltmarshes, and seagrass meadows—sequester carbon at a higher rate than tropical forests and recommended that these marine ecosystems be identified and managed as protected areas.

In agriculture, it recommended promoting integrated pest management and integrated plant and nutrition systems in the most vulnerable areas. In addition, it advocated the development or introduction of crop varieties resistant or tolerant to biotic and abiotic stress particularly for rice, vegetables, and fruits (MOE 2022, p. 76). Climate-smart irrigation is critical, as 88 percent of annual freshwater withdrawals in Sri Lanka are used for agriculture (ibid, p. 189). Sustainable land and water management practices would be enhanced in areas of severe anticipated climate vulnerability. Salinity barriers would be established in three rivers—Kelani Ganga, Kalu Ganga, and Malathi Oya—where intakes are subject to climate change-induced saline water intrusion during the drought season. In addition, 25 major and medium reservoirs and 300 minor irrigation systems, as well as 200 km of irrigation canals, would be restored, rehabilitated, and augmented for climate resilience in the agriculture sector (ibid, p. 84). To increase irrigation efficiency and water conservation in agriculture, drip and sprinkler irrigation would be facilitated through low-cost interest rate loans and tax relief, and new techniques such as laser leveling, land consolidation, and wet and dry irrigation would be introduced (ibid, pp. 198–200). Aquaculture would be expanded through fish barricades (with a target of 50) in perennial reservoirs, along with the promotion of climate-tolerant fingerlings (ibid, p. 81).

In promoting sustainable land resource management, the action plans included rehabilitation of saline-affected agricultural lands, an inventory of underutilized agricultural lands for rehabilitation and crop diversification; the establishment and implementation of a quality control system for organic and bio-fertilizers; the conversion of unproductive and marginal tea lands to other perennial crops, and the planting and reforestation of denuded hilltops above 1,000 m of mean sea level (ibid, pp. 144–146). Agroforestry programs would be supported under sustainable land resource management while ensuring gender mainstreaming (ibid, p. 154) and used for conservation in landslide prone areas.

In 2023, Sri Lanka's Climate Prosperity Plan laid out a strategy for accelerated climate adaptation in the most vulnerable sectors, including agriculture and fisheries. Its aim was to climate-proof the national food system, enhance food security and reduce dependence on food imports, and safeguard livelihoods. The Climate Prosperity Plan covering the 2020–2050 period and mapped in detail through 2040 aims to achieve CSA, mobilize finance for the maximum potential renewable energy and grid modernization, build resilience to heat- and climate-sensitive diseases, and protect livelihoods. The target was to ensure that by 2040, 90–100 percent of rural

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<sup>35</sup> The policy noted that traditional knowledge and practices in land preparation, paddy cultivation, water sharing, and eco-friendly pest control have been lost over time. Similarly, 600 traditional, long-lived wild rice varieties have disappeared (MOE 2022, p. 48).

communities have adopted sustainable land and water management practices, 100 percent of threatened reefs have been restored, and 100 percent of workers are protected from extreme heat (GOS 2023, p. 24). Because reef restoration is critical to preserving marine biodiversity, ensuring food security, and sustaining ocean-based livelihoods, climate mitigation and adaptation efforts are expected to generate a significant number of green jobs in the 2030–2040 period.

Table 16 lists the national policies and plans that promote the use of the priority CSA technologies.

**Table 16.** CSA technologies in Sri Lanka’s domestic policy documents

CSA technology	Policy document recommending CSA technology	Specific CSA goals set in policy documents
Strip tillage	National Adaptation Plan for Climate Change for Sri Lanka 2016–2025	Planting strips of rice and coconut in coastal areas
Sustainable land management	1) National Environmental Action Plan 2022–2030 2) Climate Prosperity Plan 2023	Climate Prosperity Plan 2023: Reduce the salinity impact on agriculture by 25% and 50% by 2025 and 2030, respectively (and increase coastal food production yields by 25% and 50%, respectively).
Resilient intercropping	National Adaptation Plan for Climate Change for Sri Lanka 2016–2025	
Alternate wetting and drying	National Environmental Action Plan 2022–2030	
Solar-powered water pumps	1) National Agriculture Policy 2007 2) National Agriculture Policy 2021	
Climate-resilient crop varieties	1) National Adaptation Plan for Climate Change for Sri Lanka 2016–2025 2) National Environmental Action Plan 2022–2030	
Agroforestry	1) National Adaptation Plan for Climate Change for Sri Lanka 2016–2025 2) National Environmental Action Plan 2022–2030	

**Source:** Based on authors’ analysis of Sri Lanka’s recent national policy and plan documents cited in the table.

**Note:** CSA = climate-smart agriculture.

## 2.7. Comparing the CSA Technologies in the NDCs and NAPs of the Six South Asian Countries

Comparing the commitments for the agriculture sector by the six South Asian countries under the Paris Agreement, we find that Bangladesh and Bhutan have set the most extensive and explicit targets, followed by Nepal and Sri Lanka. On the other hand, India has not committed to any

emission mitigation or climate adaptation goals in the agriculture sector. Similarly, Pakistan has not made any specific commitments in the agriculture sector but has indicated use of several CSA technologies in its climate adaptation efforts.

Table 17 summarizes the CSA technologies specifically identified in the NDCs of the six countries, along with those in the National Adaptation Plans (NAPs) submitted by the six countries to the UNFCCC as of October 2024. In the NAPs, Bangladesh again is found to have incorporated CSA technologies most extensively, followed by Nepal, Sri Lanka, Bhutan, and Pakistan. Although India has incorporated various CSA technologies in climate adaption initiatives, as reported in its Third National Communication to the UNFCCC (India MOEFCC 2023), it has not submitted a comprehensive NAP to the UNFCCC.

**Table 17.** Comparison of CSA technologies in the NDCs and NAPs submitted to the UNFCCC by the six South Asian countries

Country	CSA technologies identified in NDC (specific commitments)	CSA technologies identified in NAP
Bangladesh	<ul style="list-style-type: none"> <li>• <b>Alternate wetting and drying:</b> Upscale alternate wetting and drying in dry season rice fields on 150,000 ha of croplands by 2030.</li> <li>• <b>Climate-resilient crop varieties/seed:</b> Improve rice varieties for 3,240,000 ha of croplands by 2030.</li> <li>• <b>Fertilizer improvement:</b> Improve fertilizer management with deep placement of urea on 200,000 ha of rice fields by 2030.</li> <li>• <b>Install solar pumps</b> for irrigation.</li> </ul>	<ul style="list-style-type: none"> <li>• Alternate wetting and drying in high yielding variety boro rice cultivation system</li> <li>• Reduced tillage</li> <li>• Drip/sprinkler irrigation</li> <li>• Direct wet-seeded rice</li> <li>• Intercropping</li> <li>• Floating bed cultivation</li> <li>• Solar-powered irrigation pump</li> <li>• Climate-stress-tolerant varieties</li> <li>• Bund management</li> <li>• Agroforestry</li> </ul>
Bhutan	<ul style="list-style-type: none"> <li>• <b>Reduce continuous rice flooding</b> by 200 ha/year.</li> <li>• Switch from synthetic to <b>organic fertilizers</b> at 5 percent/year.</li> <li>• <b>Increase biomass</b> through perennial crop production on 17,495 ha.</li> <li>• <b>Improve dairy cattle production through breed improvement</b> and feeding management (for 8,333 cattle).</li> </ul>	<ul style="list-style-type: none"> <li>• Increased use of crop residue</li> <li>• Sustainable land management</li> <li>• Drip/sprinkler irrigation</li> <li>• Solar-powered water pumps</li> <li>• Climate-resilient crop varieties</li> <li>• Agroforestry</li> </ul>
India	<ul style="list-style-type: none"> <li>• <b>Develop sustainable</b> and climate-resilient agriculture.</li> </ul>	<ul style="list-style-type: none"> <li>• (NAP not submitted)</li> </ul>
Nepal	<ul style="list-style-type: none"> <li>• <b>Increase soil organic matter content of agricultural land</b> to 3.95% by 2030.</li> <li>• Increase <b>organic fertilizer production plants</b> to 100 by 2030.</li> <li>• Increase the number of <b>improved cattle sheds</b> to 5,00,000 for quality farm-yard manure production and use by 2030.</li> </ul>	<ul style="list-style-type: none"> <li>• Zero/minimum tillage</li> <li>• Sustainable land management</li> <li>• Drip/sprinkler irrigation</li> <li>• Direct-seeded rice</li> <li>• Intercropping</li> <li>• Alternate wetting and drying</li> <li>• Solar-powered water pumps</li> <li>• Climate-resilient crop varieties</li> <li>• Agroforestry</li> </ul>

Pakistan	<ul style="list-style-type: none"> <li>• <b>Increase irrigation efficiency</b> in agriculture.</li> <li>• <b>Use drought-tolerant crop varieties.</b></li> <li>• <b>Implement climate early warning</b> system, monitoring, and forecasting.</li> <li>• <b>Transform Indus Basin</b> with climate-resilient agriculture</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable land management</li> <li>• Precision irrigation</li> <li>• Intercropping and crop diversification</li> <li>• Tunnel farming and integrated pest management</li> <li>• Drought-tolerant seeds for crops</li> </ul>
Sri Lanka	<ul style="list-style-type: none"> <li>• <b>Increase productivity of rice cultivation</b> yield in tons/ha by 10% unconditionally and additional 5% conditionally.</li> </ul>	<ul style="list-style-type: none"> <li>• Strip tillage</li> <li>• Drip irrigation, micro-irrigation</li> <li>• Heat-, drought-, and salinity-tolerant crop varieties</li> <li>• Pest-resistant and early-maturing rice varieties</li> <li>• Intercropping</li> <li>• Heat-tolerant livestock and poultry breeds</li> <li>• Increased organic content in soil</li> </ul>

**Source:** Based on Updated Nationally Determined Contributions and National Adaptation Plans of the respective countries  
**Note:** CSA = climate-smart agriculture; ha = hectares; NAPs = National Adaptation Plans; NDCs = Nationally Determined Contributions; UNFCCC = United Nations Framework Convention on Climate Change.

Table 18 compares the relative prominence of priority CSA technologies in the national policy documents of the six countries. Within the domestic climate and agricultural policies, Bangladesh has the most comprehensive coverage of the specific CSA technologies, followed by Bhutan, India, Nepal, Sri Lanka, and Pakistan. Among the CSA technologies, agroforestry is a top priority, as it features in most domestic policies of Bangladesh, Bhutan, and Nepal, and it a medium priority for India and Sri Lanka. Drip and sprinkler irrigation to enhance irrigation efficiency with “more crop per drop” has high priority for India, Nepal, and Sri Lanka. Climate-resilient crop varieties and seeds have high priority for Bangladesh, Nepal, and Pakistan. Sustainable land management has the highest priority among the land-locked nations of Bhutan and Nepal.

**Table 18.** Relative priority of CSA technologies in key domestic policy documents of the six South Asian countries

CSA Technologies	Bangladesh	Bhutan	India	Nepal	Pakistan	Sri Lanka
Bed planting with residue retention	Medium (4)	Medium (2)	Medium (2)			
Strip tillage	Low (2)	Low (1)	Low (1)	High (3)		Low (1)
Zero/minimum tillage	High (5)		Low (1)		Low (1)	
Sustainable land management	Low (1)	High (5)		High (4)	Medium (2)	Medium (2)
Protected agriculture (polyhouse)	Low (1)	Medium (3)		Low (1)		
Drip/sprinkler/precision irrigation	Medium (4)	Medium (3)	High (4)	High (4)	Low (1)	High (4)
Direct-seeded rice	Medium (3)		Medium (2)	Low (1)		

Resilient intercropping	Medium (3)		High (3)	Medium (2)	Low (1)	Low (1)
Alternate wetting and drying irrigation	High (6)	Low (1)				Low (1)
Solar-powered water pumps/micro-irrigation	High (7)	Medium (3)	Low (1)	Medium (2)	Low (1)	Medium (2)
Soil conservation bunds	Low (2)	Low (1)	Medium (2)			
Climate-resilient seeds/crop varieties	High (7)	Low (1)	Low (1)	High (3)	High (3)	Medium (2)
Agroforestry	High (5)	High (4)	Medium (2)	High (4)		Medium (2)

**Note:** CSA = climate-smart agriculture. The relative priority of a CSA technology for a country is scaled by the number of domestic policy documents for that country and the highest frequency of documents mentioning a CSA technology (the number of documents mentioning a CSA technology is in parentheses). A frequency of 0%–33% is assigned low priority, 33%–66% is medium priority, and 66%–100% is high priority.

### 3. TRADE POLICY REGIMES FOR CSA TECHNOLOGIES

The transition to CSA needs to be supported by internal (domestic) policies as well as external policies. The previous section highlighted the domestic climate and agricultural policies adopted by the six South Asian countries, following their commitments under the UNFCCC and its agreements (the Kyoto Protocol and the Paris Agreement). This section reviews the trade policy regimes in the six countries as they relate to CSA.

The impact of trade policy on the environment, and the impact of environmental policy on the pattern of trade, are well established in the literature. Under the former, the environmental impact of trade liberalization occurs through three channels: scale effect, composition effect, and technique effect. Because trade liberalization leads to an increase in the scale of economic activities (including transport), it increases environmental pollution and degradation. However, the environmental impact due to the composition or structural effect depends on whether the country specializes (due to comparative advantage) in a pollution-intensive or a clean commodity. If the country specializes in and exports pollution-intensive commodities, the composition effect has a detrimental environmental effect. On the other hand, the technique effect using cleaner production techniques leads to an improvement in environmental quality.<sup>36</sup> The aggregate of the three components determines the environmental impact of trade liberalization for a country. In the absence of optimal environmental policies, trade liberalization exacerbates environmental degradation, but openness typically leads to strengthening of environmental regulations and also provides greater access to more efficient technologies.

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<sup>36</sup> The adoption of cleaner production technique stems from enhanced environmental regulations in the country, as increased income (due to increased trade) leads to increased demand for environmental quality (Copeland and Taylor 1994). There may also be a direct regulatory effect, independent of the income channel. For example, a developing country may adopt more stringent environmental regulations exporting to a developed country to ensure market access (Stevens 1993).

In the context of climate change, rising average temperatures, altered precipitation patterns, desertification, salinity intrusion, and land degradation have direct ramifications on trade. These changes threaten traditional comparative advantages based on natural resource endowments and climate, especially in the agriculture sector. A recent report noted that 1°C rise in temperature reduces the annual export growth of developing countries by 2 percent to 5.7 percent (WTR 2022a, pp. 27). On the other hand, international trade can also support climate mitigation and adaptation by facilitating access to equipment and technologies that reduce emissions and enhance the capacity to prepare for and adapt to climate change.

International trade can play a vital role in transitioning to climate-resilient agriculture and tackling food security challenges by providing access to climate-change adaptation technologies such as drought-resistant and salinity-tolerant crop seeds, early warning weather systems, and water conservation and storage systems (WTR 2022a). In the face of a climate disaster, trade enables affected countries to access essential food supplies. Moreover, trade can support climate mitigation through enhanced access to clean and renewable energy equipment, as well as energy- and resource-efficient agricultural machinery. Regional and multilateral cooperation, along with conducive trade regimes that support climate-resilient food systems, are essential tools for supporting climate-change strategies in South Asia.

Unfortunately, South Asia remains one of the least-integrated regions of the world, despite the South Asian Free Trade Agreement (SAFTA) having been in effect since 2006. SAFTA continues to retain sensitive lists<sup>37</sup> of goods that remain outside the purview of preferential tariffs, citing reasons such as food security concerns and protection for infant industries or small-scale manufacturing. This precludes the region from engaging in mutually beneficial trade in goods and services, including those pertaining to climate-smart agricultural materials, inputs, and equipment.

Given the overlapping agroclimatic zones across the six countries, there are commonalities in the appropriate CSA technologies across multiple geographical areas. The development of climate-resilient crop varieties, or the revival of hardy ancient grains, in one country can hold the solution for climate adaptation in other countries within the region. For instance, several indigenous rice varieties from the Sundarbans (Ganges-Brahmaputra Delta) are salt tolerant, and scientists have further developed stress-tolerant strains from these varieties<sup>38</sup> that would be useful for coastal farming and saline lands. Easing regional trade would facilitate the transfer of such CSA technologies embodied in seeds and other inputs. While quarantine safeguards are essential, it is important to ensure that import approvals are not cumbersome and do not become barriers to the transfer and scaling of CSA in the region.

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<sup>37</sup> The sensitive list for least-developed countries was distinct from that for other developing countries. Bilateral free trade agreements among South Asian countries also maintain sensitive lists.

<sup>38</sup> The Central Soil Salinity Research Institute, in collaboration with the International Rice Research Institute's Stress-Tolerant Rice for South Asia project (2007–2019), developed 120 stress-tolerant rice varieties. Source: "Salt-Tolerant Rice, Innovations Help Farmers Deal with Salinity in the Sundarbans," V. Chandrashekhar, Mongabay, July 2020. <https://india.mongabay.com/2020/07/salt-tolerant-rice-innovations-help-farmers-deal-with-salinity-in-the-sundarbans/>

### 3.1 The Six Countries in the Multilateral Trading System and Graduation Effects

The six South Asian countries in this study are rather disparate in size, economic structure, development, and vulnerability to climate change. While India, Pakistan, and Sri Lanka are classified as developing countries, the smaller, more vulnerable economies of Bangladesh, Bhutan, and Nepal are categorized as least-developed countries (LDCs) under the United Nations classification.<sup>39</sup> Recently, however, Bhutan graduated to developing country status in December 2023, while Bangladesh and Nepal are scheduled for graduation in 2026 (UNCTAD 2023).

The multilateral trading system has long distinguished between developed, developing, and least-developed countries to account for their differing capacities in implementing agreements and commitments. Because underdevelopment is driven by structural, historical, and/or geographical factors, developing countries and the LDCs have been granted concessions and preferential treatment in the multilateral trading system under the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO).

The Generalized System of Preferences (GSP), effective under GATT since 1979, has provided greater market access to developing country members in developed country markets as an exception to the Most Favored Nation clause (MFN) principle of non-discrimination. The aim is to promote export diversification and economic development in the developing countries. The GSP allows for non-reciprocal, duty-free market access in the industrialized countries for several commodities exported by developing nations.<sup>40</sup> Under the GSP, the group of LDCs have been entitled to greater concessions compared to non-LDC developing countries.

The six South Asian countries considered here have benefited from the GSP (with different conditions) extended by industrialized economies and countries such as the EU, the United States, and Japan, especially the LDCs among them. These nonreciprocal concessions typically meant zero tariffs in these markets.<sup>41</sup> Thus, graduation to “developing country” status would result in the loss of LDC trade preferences and concessions, which would likely cut into their export earnings.

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<sup>39</sup> According to the World Bank income-group classification (based on the per capita income criterion), all six nations are classified as lower-middle-income countries. The United Nations reviews the list of least-developed countries every three years, using criteria that include per capita income, a human assets index, and an economic and environmental vulnerability index. While graduation from least-developed to developing country status can be granted based on “income only” thresholds, it may be deferred when there are concerns about the development sustainability.

<sup>40</sup> The GSP was instituted by UNCTAD in 1971 to grant greater market access in industrialized countries for exports from developing countries. It was incorporated into GATT in 1979 as the “Enabling Clause,” formally titled the “Decision on Differential and More Favourable Treatment, Reciprocity and Full Participation of the Developing Countries.” Developed economies and countries have implemented the GSP through various programs. For example, the EU has different GSP mechanisms, including standard GSP, which has reduced tariffs on several products for all developing countries; GSP+, which removes all tariffs on several products for certain developing countries; and Everything But Arms, which grants zero tariffs and no quotas for all goods except arms from LDCs.

<sup>41</sup> The United States, however, withdrew GSP benefits for India in 2019.

Apart from the GSP, the provision for special and differential (S&D) treatment of developing countries includes greater flexibility in commitments and the use of policy instruments (for example, concessions in implementing tariff reductions), longer transitional time periods, greater trade opportunities (for example, higher market access), technical assistance, and a requirement for WTO members to safeguard the interests of developing country members. For LDCs, additional provisions apply, such as those in the WTO Agreement on Agriculture, the Agreement on Trade Facilitation, and others. Although Bhutan has not yet become a WTO member, it has benefited from market access concessions in developed countries and from developing country neighbors, including India and Sri Lanka.

Considering the extent of openness in terms of most-favored nation (MFN) applied import duties across the six countries, Sri Lanka, Pakistan, and Bhutan have the most liberalized import regimes, as reflected by the trade-weighted customs duty rates applied on all commodities. Pakistan, Bhutan, and Nepal have significantly lower customs duties on agricultural commodities (Table 19). India, on the other hand, has the most protectionist regime for agricultural products, with a weighted applied customs duty of 48.5 percent, but relatively low applied tariffs on nonagricultural goods.

Table 19 presents the trade-weighted MFN applied tariffs on agricultural and nonagricultural goods in the six countries. The extent of import liberalization is also reflected in the share of duty-free MFN imports in total imports, both overall and disaggregated by agricultural and nonagricultural products. Sri Lanka again has the most liberal import regime, with the highest share of duty-free imports, followed by Pakistan (Table 19).

**Table 19.** MFN applied import tariffs in the six South Asian countries: Agricultural vs. non-agricultural goods, 2021–2022

Country	Trade-weighted average MFN applied tariffs on products (%)			Share of MFN duty-free imports in total imports (%)		
	All	Agricultural	Non-agricultural	All	Agricultural	Non-agricultural
Bangladesh*	14.4	17.9	13.5	–	–	–
Bhutan*	9.8	12.7	9.3	–	–	–
India	11.4	48.5	9.2	5.6	0.2	5.9
Nepal	13.4	13.4	13.4	7.4	0.4	9.3
Pakistan	8.7	6.4	9.2	36.6	16.1	40.5
Sri Lanka	5.4	17.8	3.5	68.2	25.5	74.6

Source: WTO, ITC, and UNCTAD World Tariff Profiles 2023.

Note: \* The data corresponds to the simple average most-favored nation (MFN) applied tariffs in 2022, not trade-weighted averages. “–” = data not available.

Apart from tariff barriers—non-tariff barriers, such as institutional requirements, procedural delays for permits or clearances, and deficiencies in connectivity and port infrastructure—can significantly impede trade. When comparing the costs for border compliances for export and import (including time costs, costs to clear customs regulations, and inspection procedures of other government agencies), Bhutan and Nepal rank the highest, with the lowest costs for both

exporters and importers. They are followed by India, Pakistan, Sri Lanka, and Bangladesh (Table 20). In Bangladesh, the cost to import is exceptionally high, at \$900 for shipment clearance. Logistical challenges due to poor transport-related infrastructure also impede trade in these South Asian countries. Bhutan, Nepal, Pakistan, Bangladesh, and Sri Lanka fare poorly on the Logistics Performance Index, with scores ranging from 2.2 to 2.4 out of 5, while India fares better at 3.2 out of 5 (Table 20).

Table 20 illustrates that food trade constitutes a significant share of total merchandise trade across all six South Asian nations, while agricultural raw materials play a comparatively smaller role. In Nepal, agricultural raw materials and food exports constitute 50 percent of total merchandise exports, followed by Sri Lanka (26 percent), Pakistan (18 percent), India (12 percent), Bhutan (7 percent), and Bangladesh (3 percent). Bangladesh is relatively more dependent on imports of agricultural raw materials and food, which constitute 23 percent of its total merchandise, followed by Nepal (19 percent), Pakistan (18 percent), Sri Lanka (16 percent), and Bhutan (14 percent). In India, while agricultural raw material and food are very significant in exports, they are less significant in imports, comprising just 6 percent of total merchandise imports.

**Table 20.** Selected agri-trade and institutional indicators of the six countries, 2022

Country	Agri raw material X (% merchandise X)	Agri raw material M (% merchandise M)	Food X (M) % merchandise X (M)	Cost in US\$ to <sup>#</sup>		Logistics index <sup>*</sup>	EoDB score <sup>+</sup>
				Export	Import		
Bangladesh	0.75 <sup>a</sup>	6.4 <sup>a</sup>	2.7 (16.6) <sup>a</sup>	408.2	900.0	2.3	45.0
Bhutan	0.76 <sup>b</sup>	2.5 <sup>b</sup>	6.9 (13.7) <sup>b</sup>	59.2	110.1	2.2	66.0
India	1.21	1.6	11.1 (4.7)	211.9	266.1	3.2	71.0
Nepal	1.31	1.2	49.4 (17.9)	102.9	190.0	2.2 <sup>^</sup>	63.2
Pakistan	1.81	5.4	17.5 (13.2)	288.0	287.0	2.2 <sup>^</sup>	61.0
Sri Lanka	2.92	2.3	23.3 (13.9)	366.1	299.7	2.4	61.8

**Source:** Compiled from the World Development Indicators database.

<sup>#</sup>The cost to export and import for border compliance reflects the time and cost associated with compliance with the country's customs regulations and other mandatory inspections required to cross the economy's border, as well as the time and cost for handling at its port or border. Data correspond to the year 2019. Agricultural (Agri) raw materials exports (imports) as share of merchandise exports (imports) are the average for 2021 and 2022 for all countries, except Bangladesh and Bhutan.

<sup>a</sup> Data for Bangladesh correspond to 2015.

<sup>b</sup> Data for Bhutan correspond to 2012.

<sup>\*</sup> The Logistics Performance Index refers to the quality of trade and transport-related infrastructure (1 = lowest performance; 5 = highest performance).

<sup>+</sup> EoDB is the Ease of Doing Business 2020 score related to regulatory performance (0 = lowest performance; 100 = best performance). Data pertain to 2019.

<sup>^</sup> Data correspond to 2018.

Considering the extent of global integration of the six countries through international trade, as indicated by the share of total merchandise and services trade (exports plus imports) in GDP, Bhutan has the highest degree of external integration, followed by Nepal, India, Sri Lanka, Bangladesh, and Pakistan (based on WDI data). However, for the two small landlocked countries,

Bhutan and Nepal, the external sector integration is dominated by intraregional trade, most prominently with India (as shown in Table 21).

Table 21 highlights that, while regional integration through trade remains abysmally low in South Asia, the two small climate-vulnerable economies of Bhutan and Nepal are critically dependent on regional partners, especially India. In contrast, the main trading partners for the larger South Asian countries continue to be extra-regional countries and economies. The United States and the EU are the foremost destination markets for merchandise exports from Bangladesh, India, Pakistan, and Sri Lanka. China, meanwhile, is among the top import source countries for Bangladesh, Pakistan, India, and Sri Lanka. Only in the smaller land-locked economies of Bhutan and Nepal does intraregional trade account for the bulk of international trade—and that too is predominantly with India. India is also the largest source of imports for Sri Lanka, followed by Bangladesh. For India itself, however, only Bangladesh is among its top five export destinations; none of the other South Asian countries feature among India’s top export destinations or import sources.

**Table 21.** Main export and import partners in merchandise trade of the six South Asian countries, 2021–2022

Country	Main export destinations*	Main import origins*
Bangladesh	EU 43.5%, US 19.3%, UK 11%, Canada 3.3%	China 21.5%, India 12.2%, Singapore 9.2%, EU 5.6%, Hong Kong 5.5%
Bhutan	India 93.7%, Bangladesh 4.1%, EU 0.9%, Nepal 0.4%	India 78.8%, EU 4.5%, Korea 3.1%, China 2.5%
India	US 17.7%, EU 16.2%, UAE 6.9%, China 3.3%, <b>Bangladesh</b> 3.1%	China 14%, EU 7.5%, UAE 7.4%, US 7.1%, Saudi Arabia 6.3%
Nepal	<b>India</b> 80.1%, US 8%, EU 4.6%, UK 1.4%	<b>India</b> 60.5%, China 15.1%, Argentina 2.9%, UAE 2.6%
Pakistan	EU 26.4%, US 21.1%, China 10.5%, UK 7.3%	China 28.3%, UAE 10.1%, EU 6.7%, Indonesia 5.8%, US 5.3%
Sri Lanka	US 25.5%, EU 23.6%, UK 7.4%, <b>India</b> 6.7%	<b>India</b> 26.4%, China 20%, EU 7.5%, UAE 5.5%

Source: WTO Trade Profiles 2023.

Note: EU = European Union; UK = United Kingdom; UAE = United Arab Emirates; US = United States.

\* Country shares in total merchandise exports or imports. Data for main export destinations and import origins for India and Sri Lanka correspond to 2022; for Nepal and Pakistan, 2021; for Bangladesh, 2015; and for Bhutan, 2012.

### 3.2 Preferential Trade Regimes within the Six South Asian Countries: Regional and Bilateral Agreements

The six countries are members of the South Asian regional free trade agreement and maintain several bilateral preferential trade agreements among themselves.

Initially, the South Asian Preferential Trade Agreement (SAPTA) between the seven countries of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, signed in 1993 and effective in December 1995, promoted trade and cooperation among the seven countries of SAARC through tariff concessions on a positive list of products. SAPTA was later superseded by the South

Asian Free Trade Agreement (SAFTA), signed in 2004 and effective in January 2006, which further enhanced regional cooperation by liberalizing trade in all commodities except those included in the member states' negative lists.<sup>42</sup> SAFTA has a broader membership, including Afghanistan, which joined SAARC in 2008. Although trade under SAFTA has diminished through the years, the value of trade under SAFTA has increased. However, the intra-regional trade volume remains well below its potential.

As in the multilateral trade agreement, SAFTA too contains a provision for greater market access for LDC members. Under this provision, non-LDC members were required to reduce their tariffs to 0–5 percent on goods from LDC members within three years of the agreement's entry into force. Notably, India and Sri Lanka have provided a duty-free, quota-free preference scheme (except for goods on their respective sensitive lists) to Bangladesh, Bhutan, and Nepal under SAFTA.

Apart from SAFTA, the six countries also have several bilateral preferential or free trade agreements among themselves, including the Bangladesh–Bhutan Preferential Trade Agreement (signed in 2020, effective in 2022), the India–Bhutan Agreement on Trade, Commerce and Transit (signed in 1972, revised in 2016), the India–Nepal Treaty of Trade (revised and effective in 2009), the India–Sri Lanka Free Trade Agreement (FTA) (signed in 1998, effective in 2000), and the Pakistan–Sri Lanka FTA (signed in 2002, effective in 2005).

Despite the existence of these various preferential and free trade agreements in force among the six neighboring countries, the bulk of their trade by value continues to be with developed country markets. As shown in Table 20, intra-regional trade is a small fraction of the countries' total international trade.

### **3.3 Environmental Provisions in Free and Preferential Trade Agreements of the Six South Asian Countries**

GATT, established in 1947 to promote liberalization of multilateral trade, incorporated significant provisions for ecological and environmental protection. Article XX(b) permits exceptions to free trade if “necessary to protect human, animal or plant life or health,” while Article XX (g) allows for measures to conserve “exhaustible natural resources,” provided such measures are applied in conjunction with restrictions on domestic production and consumption.” These allowed for an exception to free trade based on environmental, sanitary, and phytosanitary protection, as long as they were not applied in a discriminatory manner (Charnovitz 1991). Subsequently, the Preamble establishing the WTO recognized “sustainable development” as a central principle, and the Agreement on Application of Sanitary and Phytosanitary Measures (SPS) came into effect to improve human, animal, and plant health through harmonization of rules and standards,

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<sup>42</sup> Bangladesh, India, and Sri Lanka are also members of the Asia Pacific Trade Agreement (APTA; formerly the Bangkok Agreement), along with China and the Republic of Korea. The agreement was signed in 1975 and revised in 2005. However, trade volume among the three South Asian countries under this preferential trade agreement is relatively low.

supplementing the GATT provisions (revised as of 1994). The General Agreement on Trade in Services (GATS), adopted in 1995, contained a similar exception in its Article XIV(b) for measures “necessary to protect human, animal, or plant life or health.” In their bilateral and plurilateral free or preferential trade agreements, WTO member countries have often incorporated environmental provisions similar to those in GATT, GATS, and the SPS agreement.

A recent analysis of the depth of preferential trade agreements found that the scope and number of environmental provisions have expanded over the years. There has also been a growing trend toward referencing the environment or sustainable development in these agreements. While the North–South and North–North agreements have WTO-like and WTO-plus environmental provisions, South–South agreements contain fewer such provisions (Monteiro and Trachtman 2020). This pattern is evident in the environmental provisions and SPS provisions contained in the bilateral free and preferential trade agreements of the six South Asian countries, as well as in their regional agreement, SAFTA.<sup>43</sup>

SAFTA allows for a general exception to protect “human, animal or plant life and health” in Article 14b(ii), similar to GATT Article XXb, but it does not include a clause to conserve exhaustible natural resources. SAFTA also does not anchor itself on the principle of sustainable development, nor does it mention international environmental obligations to which all member countries are parties. Despite the significance of agricultural trade, there is no chapter or clause on SPS in the SAFTA. Nonetheless, members agreed to consider harmonization of standards, reciprocal recognition of testing and accreditation of laboratories, and certification of products (Article 8 on additional measures), and to remove barriers to intra-SAARC investment. In addition, the provision for cooperation includes assistance for improving national capacity in SPS and technical barriers to trade (TBT) measures, as well as in implementing the WTO Agreement on Agriculture and Subsidies (Annex II, SAFTA).

Of the bilateral preferential or free trade agreements among the six countries, the India–Nepal Treaty allows for exceptions to the agreement to protect “human, animal and plant life” under Article 9(b), but it does not include a provision for protecting exhaustible natural resources. However, its SPS provision goes further by allowing for the mutual recognition of SPS certificates and health certificates issued by the competent authority of the exporting country for agricultural and food trade (Article II.6). Agricultural imports are permitted entry based on these certificates, “subject to meeting the mandatory requirement of the importing country.”

Most of the bilateral trade agreements among the South Asian countries contain a general exception for measures necessary to protect human, animal, and plant life, similar to GATT Article XX(b), such as Article VI (ii) of the India–Bhutan Agreement on Trade, Commerce and Transit, Article IV of the India–Sri Lanka Free Trade A, and Article IV of the Pakistan–Sri Lanka FTA. However, while the Pakistan–Sri Lanka FTA also invokes Article IV of the WTO SPS Agreement, the India–Bhutan and India–Sri Lanka agreements do not include SPS provisions.

In contrast, the environmental provisions in some of the bilateral free trade agreements among South Asian countries and partners outside the region are significantly more comprehensive. The

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<sup>43</sup> Based on the Deep Trade Agreements Database, World Bank.  
<https://datatopics.worldbank.org/dta/table.html>

Comprehensive Economic Partnership Agreement Between the Republic of India and Japan (2011) contains the most extensive environmental provisions among such bilateral agreements. The agreement's preamble recognizes the interdependence of economic development, social development, and environmental protection, and the exclusive clause on environmental protection (Article 8) acknowledges the importance of domestic regulations for ensuring adequate environmental safeguards and emphasizes the need for compliance. It also encourages "trade and dissemination of environmentally sound goods and services" in Article 8.3(b) and reaffirms the parties' obligations under international environmental agreements to which both India and Japan are members.

In addition, it goes further by explicitly referencing key Indian environmental legislation, such as the Environmental Protection Act of 1986 and "all regulations/rules/orders issued thereunder." While it allows 100 percent foreign direct investment under the automatic route for seed development in India, businesses are required to comply with national laws governing genetically modified organisms for seeds and planting material. Trade in wheat, maize, and rice seeds remains restricted, but trade in photovoltaic (PV) solar cells was completely liberalized (with zero customs duty), and import duties on agricultural machines such as sprayers, no-till seeders, and planters import duties were reduced annually and now stand at zero.<sup>44</sup>

The Comprehensive Economic Partnership Agreement Between the Republic of India and the Republic of Singapore also establishes the founding principle of sustainable development in its preamble, recognizing that "economic and trade liberalisation should allow for the optimal use of natural resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment." The agreement retains the parties' authority parties to adopt measures necessary to protect "human, animal or plant life or health" (Article 5.11 (c), chapter on standards, technical regulations, sanitary and phytosanitary measures). The chapter on investment has a GATS-plus exclusion clause allowing measures "necessary to protect human, animal or plant life or health" as well as for the "conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption" (Article 6.11(b) and (e), chapter on investment).

Similarly, the Free Trade Agreement between the Government of the Islamic Republic of Pakistan and the government of the People's Republic of China 2006 recognizes in its preamble the goal of promoting sustainable development consistent with environmental protection and conservation. However, a general exception clause on environmental grounds, corresponding to GATT Article XXb and g, is conspicuously missing. Its chapter on sanitary and phytosanitary measures (Chapter VI) is anchored in the SPS WTO Agreement, and the chapter on technical barriers to trade refers to the WTO Agreement on TBT. The agreement establishes a Committee on SPS matters (Article 34) to enhance mutual understanding of the partner country's regulatory processes and to facilitate consultations in connection with meetings of various international organizations (such as the WTO SPS Committee, Codex committees, and the International Plant Protection Convention).

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<sup>44</sup> Based on the TRAINS database, WITS, World Bank.

While WTO-compatible and some WTO-plus environmental provisions have been accepted by India and Pakistan in their bilateral free trade agreements with extra-regional partners, the bilateral and plurilateral agreements among South Asian countries fall abysmally short of the WTO provisions. There is much room to upgrade the SAFTA to promote sustainable development through regional trade, build cooperation on obligations under multilateral environmental agreements, and support the achievement of climate mitigation under the Paris Agreement, along with synergistic adaptation to climate change.

### **3.4 Import Barriers in CSA Technology-Associated Commodities**

To evaluate the trade regimes for CSA technologies in the six countries, it is necessary to track the tariff and nontariff barriers by the corresponding identified commodities, as import duties are levied based on commodity classification under the multilateral trading system.

The CSA technologies highlighted in the NDCs and domestic climate adaptation policies can be mapped to Harmonized Commodity Description and Classification System (HS codes) used by the countries. The commodity codes are harmonized across countries up to 6 digits only, however, individual countries often use further disaggregation at the 8- or 10-digit level, which is typically not harmonized across countries. Because the 8-digit codes are not harmonized across the countries, the rates discussed in this section refer to the current customs duty rates at the 6-digit HS 2022 classification for the years 2023 or 2024.

Note that the commodities mapped to the HS codes are typically not unique to CSA technologies but are merely representative. For example, HS code 100111 refers to durum wheat seeds for planting. However, this does not necessarily indicate climate-resilient varieties—such as heat- or salinity-tolerant seeds—as these have yet to be widely commercialized or assigned distinct HS codes.

#### ***3.4.1. Multiplicity of Trade Agreements among the Countries and Effective Import Tariffs***

The effective intra-regional trade regime in South Asia is determined by a multiplicity of trade agreements: multilateral commitments under the GATT/WTO, the regional free trade agreement under SAFTA, and the bilateral preferential or free trade agreements across country pairs.

Regional cooperation and commercial agreements among South Asian countries have evolved over the last century,<sup>45</sup> including the early development of conformity standards. For example, in

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<sup>45</sup> For instance, India's first bilateral trade agreement in the region dates back to 1950 with the Treaty of Trade and Commerce between the governments of India and Nepal, followed by the Treaty of Trade and Transit in 1960 and 1971 and the Treaty of Trade in 1978. With Bhutan, India signed its first Agreement on Trade and Commerce in 1971. With Bangladesh, the Trade Agreement was initiated in 1972, with the most recent revised agreement signed in 2006. [www.commerce.gov.in/international-trade/trade-agreements/](http://www.commerce.gov.in/international-trade/trade-agreements/)

2004, the Bureau of Indian Standards and the Nepal Bureau of Standards and Metrology entered into a cooperation agreement for conformity of national standards. Similarly, cooperation on water resource sharing and hydropower development also has a long history.<sup>46</sup> By the time the regional agreements of SAPTA<sup>47</sup> and SAFTA<sup>48</sup> came into effect in 1995 and 2006, respectively, several bilateral preferential arrangements were long in effect among the members. SAPTA concessions were based on a positive list of more than 6,500 products, while SAFTA promoted broader trade liberalization across all commodities except those included on each country's Sensitive or Negative Lists. Not surprisingly, this has led to numerous tariff concessions, and for many products (as classified under the HS system), the lowest applicable tariff rate may be found under a bilateral trade agreement rather than under SAFTA.

To determine the actual applied import tariff for the commodities associated with CSA technologies, the customs duties under each applicable trade agreement must be examined, given the multiplicity of trade agreements currently in force. The Rules of Origin (RoO) criteria for imports, which determine eligibility for preferential duty rates, also vary across these agreements. In addition, the share of domestic value added in the country of origin must be checked to assess the effective import duty.

Considering the key CSA technologies identified for the region, Table 22 summarizes the MFN applied customs duties imposed by the six countries. The Table also reports in parentheses the preferential tariff rates applicable to each product code under the existing bilateral trade agreements as well as SAFTA. The bilateral agreements include the India–Nepal Treaty of Trade, the India–Sri Lanka FTA, and the Pakistan–Sri Lanka FTA. The table also shows the concession for LDCs—the Zero Duty Preference scheme—under the WTO.

For a more precise identification of CSA technology products, a product code classification finer than the 6-digit HS codes—standardized across countries—is required. However, the more disaggregated codes beyond the 6-digit level are country specific. To track the customs duty rates of the 6-digit products listed in Table 22, we checked the relevant 8-digit product codes, as used by the respective countries.

While Table 22 presents products according to the 6-digit HS code (based on the HS 2022 classification), the duty rates typically reflect the customs duties imposed at the 8-digit HS code level, as used by each country. For instance, the most disaggregated HS code used by the respective country customs departments for “No-till direct seeders, planters and transplanters” is 84323100 in Bangladesh, Bhutan, India, Nepal, and Pakistan, but in Sri Lanka, it is simply listed as 843231, with no further disaggregation. On the other hand, the most disaggregated code for

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<sup>46</sup> Early cooperation agreements for the development of irrigation projects and power generation also began with the Agreement Between India and Nepal for the Construction of Minor Irrigation Works and Water Supply Projects in 1954, followed by the Agreement for the Construction of Trisuli Hydro-Electric Project in 1958. Later agreements for mutual benefit began with the Agreement on the Gandak Irrigation and Power Project in 1959. Similarly, India and Bhutan initiated cooperation agreements for hydroelectric projects beginning in 1974 ([www.mea.gov.in/TreatyList.htm?1](http://www.mea.gov.in/TreatyList.htm?1), Indian Treaties Database, Ministry of External Affairs, GOI).

<sup>47</sup> Among Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka.

<sup>48</sup> SAFTA members included Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka, with Afghanistan joining the group later.

“Photovoltaic DC generators of an output exceeding 50W: Solar cells assembled into modules or made up into panels and equipped with elements mounted to facilitate output” is 85017200 in Bhutan, India, and Nepal; however, it is 85017210 in Pakistan and Sri Lanka. Bangladesh uses four separate codes based on output size: 85017210 (for >50W but <750W), 85017220 (for >750W but <75 kW), 85017230 (for >75 kW but <375 kW), and 85017240 (for >375 kW). When customs duties across the range of disaggregated 8-digit products differ, the entire range is reported under the corresponding 6-digit code in the table.

Table 22 provides a comparative overview of the import tariff regimes in CSA-associated commodities across the six countries, presenting both the MFN applied customs duties and preferential duties under various free-trade agreements. A comparison of the MFN applied customs duties for the selected CSA technology-associated products shows that Bhutan, Bangladesh, Sri Lanka, and Pakistan have the lowest rates, followed by Nepal and India. India has the most protective import regime in CSA technology products, particularly with its “restricted” import policy on seeds: Customs duties on seeds for planting cereals such as wheat, rice, and maize range from 50 to 100 percent. The import policy for seeds requires a permit granted under the Plants Quarantine (Regulation of Imports into India) Order 2003. For agricultural machinery imports, the customs rate is 7.5 percent; for solar PV cells, 25 percent; and for solar PV modules, 40 percent.

India offers concessional tariff rates for SAFTA members: Maize seeds for planting are subject to a lower duty of 8 percent, but there is no customs duty for imports from Nepal and Sri Lanka, or on wheat or rice seeds. For agricultural machineries, solar cells, and modules, the concessional customs duty is 5 percent for SAFTA members, but zero for Bangladesh, Bhutan, Nepal, and Sri Lanka. It is pertinent to note that India maintains a “restricted” trade regime for agricultural goods, and the four types of seeds listed in Table 22 (durum wheat seeds, other wheat seeds, maize seeds, and rice in husk) are included in India’s Sensitive List under SAFTA, along with other agricultural products. In contrast, Sri Lanka imposes no customs duty on most of the CSA technology products considered here, but it does impose a 15 percent duty on non-durum wheat seeds and a 20 percent duty on rice seeds, with a concessional zero duty for non-durum wheat seeds only for imports from Pakistan.

**Table 22.** Applied MFN and preferential customs duties\* on selected CSA goods in the six South Asian countries, 2023–2024

HS code	HS 2022 description	Related CSA technology	Bangladesh	Bhutan <sup>b</sup>	India	Nepal <sup>c</sup>	Pakistan	Sri Lanka
100111	Durum wheat seed	Climate-resilient seed	0 or 5 <sup>a</sup>	0	100 (SF: 0, LDC: 100 INp: 0, IL: 0)	10 (SA: 6, INp: 5)	11	0
100191	Other wheat seed	Climate-resilient seed	0 or 5 <sup>a</sup>	0	100 (SF: 0, LDC: 100 INp: 0, IL: 0)	10 (SA: 9 INp: 5)	11	15% or Rs 12/kg Pk: 0

HS code	HS 2022 description	Related CSA technology	Bangladesh	Bhutan <sup>b</sup>	India	Nepal <sup>c</sup>	Pakistan	Sri Lanka
100510	Maize/corn seed	Climate-resilient seed	0	0	50 (SF: 8, LDC:50 INp: 0, IL: 0)	10 (SA: 9 INp: 5)	3	0
100610	Rice in the husk (paddy or rough)	Climate-resilient seed	0	0	80 (SF: 0, LDC: 0 INp: 0, IL: 0)	10 (SA: 9, INp: 5)	3	20% or Rs 80/kg
841370	Other centrifugal pumps, primarily designed to handle water	Solar water pump	1	10	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	15 <sup>d</sup> (SA: 6)	11 <sup>e</sup>	20
842441	Agricultural or horticultural sprayers: portable sprayers (under mechanical appliances)	Drip irrigation/ precision irrigation	1	0	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	1 (SA: 1)	0	0
842449	Agricultural or horticultural sprayers: other (under mechanical appliances)	Drip irrigation/ precision irrigation	1	0	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	1 (SA: 1)	0	0
842482	Other similar agricultural or horticultural appliances	Drip/ precision irrigation	1	0	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	1 (SA: 1)	0	0
843231	No-till direct seeders, planters, and transplanters (under agricultural, horticultural, or forestry machinery for soil preparation)	Zero-tillage seeder	1	0	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	1 (SA: 1)	0	0
843241	Manure spreaders (under agricultural, horticultural,	Soil fertility management	1	0	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	1 (SA: 1)	0	0

HS code	HS 2022 description	Related CSA technology	Bangladesh	Bhutan <sup>b</sup>	India	Nepal <sup>c</sup>	Pakistan	Sri Lanka
	or forestry machinery for soil preparation)							
843242	Fertilizer distributors (under agricultural, horticultural, or forestry machinery for soil preparation)	Soil fertility management/ deep root fertilizing	1	0	7.5 (SF: 5, LDC: 0 Np: 0, IL: 0)	1 (SA: 1)	0	0
843280	Other machinery (agricultural, horticultural, or forestry machinery for soil preparation)	Soil fertility management	1	0	7.5 (SF: 5, LDC: 0 INp: 0, IL: 0)	1 (SA: 1)	0	15 (SF: 4, LDC: 1.5 IL: 0; Pk: 0)
850171	Photovoltaic DC generators with an output not exceeding 50 W	Solar energy for pumps	1	10	7.5 (SF: 5, INp: 0, IL: 0)	15 (SA: 7.25)	0	0
850172	Photovoltaic DC generators with an output exceeding 50W	Solar energy for pumps	1 <sup>f</sup>	10	7.5 (SF: 5, INp: 0, IL: 0)	15 (SA: 7.25)	0	0
8501800	Photovoltaic AC generators	Solar energy for pumps	1 <sup>g</sup>	10	7.5 (SF: 5, INp: 0, IL: 0)	15 (SA: 7.25)	0	0
854142	Photovoltaic cells not assembled in modules or made into panels	Solar energy for pumps	0	0	25 (SF: 5, LDC: 0 INp: 0, IL: 0)	0	0	0
854143	Photovoltaic cells assembled in modules or made into panels	Solar energy for pumps	1	0	40 (SF: 5, LDC: 0 INp: 0, IL: 0)	0	0	0

**Source:** Compiled from respective country official customs tariff schedules: *National Customs Tariff FY:2024–2025*, Bangladesh Customs; *Bhutan Trade Classification & Tariff Schedule 7<sup>th</sup> Edition 2022*, Department of Revenue and Customs, Bhutan Ministry of

Finance; *Customs Tariff Data Online*, Central Board of Indirect Taxes and Customs, Ministry of Finance, India; *Customs Tariff 2023/2024*, Department of Customs, Ministry of Finance, Nepal; *Pakistan Customs Tariff FY 2023–2024*, Federal Board of Revenue, Government of Pakistan; *Sri Lanka Customs National Import Tariff Guide 2024*, Sri Lanka Customs.

**Note:** CSA = climate-smart agriculture; HS = Harmonized System; MFN = most-favored nation.

\* Preferential basic import duty under agreements SAFTA (SF), India–Nepal Treaty of Trade (INp), India–Sri Lanka Free Trade Agreement (IL), Least-Developed Country–Zero Duty Preference scheme (LDC) under WTO; SAARC (SA); and Pakistan–Sri Lanka Free Trade Agreement (Pk).

<sup>a</sup> Seeds wrapped/canned up to 2.5 kg have a 5% customs duty and a 5% advanced tax (AT); seeds other than wrapped/canned up to 2.5 kg are duty-free.

<sup>b</sup> Bhutan has had an agreement with India on Trade, Commerce and Transit since 1972 (revised in 2016). Bhutan also grants preferential treatment to imports from SAARC countries with an accompanying Certificate of Origin.

<sup>c</sup> Nepal has a two-tier customs duty: MFN and preferential duty for SAARC member countries (shown in parentheses).

<sup>d</sup> Nepal imposes different duty rates by capacity: Centrifugal pumps with a 2–8 horsepower capacity have an MFN customs duty of 1 percent; SAARC duty is also 1 percent.

<sup>e</sup> Pakistan imposes different duty rates by size: Submersible pumps with a diameter of 5–10 inches diameter are subject to 11%; others, 3 percent.

<sup>f</sup> Bangladesh classifies generators by output size—for example, exceeding 50 W up to 750 W, exceeding 750 W up to 75 kW, and exceeding 75 kW up to 375 kW. However, the duty rate is 1% for all sizes.

<sup>g</sup> Bangladesh also classifies generators by output capacity—for example, not exceeding 75 kVA, exceeding 75 kVA up to 375 kVA, exceeding 375 kVA up to 750 kVA; and exceeding 750 kVA. However, the duty rate is 1% for all capacities.

### **3.4.2. Non-tariff Measures in Agricultural Imports**

The time costs and fees required to obtain border clearance of shipments—as well as challenges in logistics and the ease of doing business, as discussed in Section 3.1 based on country policies—effectively restrict the movement of goods across borders. This section focuses on the nontariff measures that particularly affect trade in CSA-associated commodities. Technical barriers to trade (TBT), including licensing and testing procedures and product standards, often impose greater limitations on trade than customs duties.<sup>49</sup> In addition, SPS measures applied to agricultural commodities (including fisheries and livestock products) are imposed to protect plant, human, and animal health in the importing countries.

CSA technology products—such as agricultural equipment ranging from seeders to tractors, as well as solar energy products that support energy-efficient irrigation—are subject to TBT measures including product standards and certification requirements. For example, imports of solar PV cells, whether or not assembled in modules or made into panels (crystalline type/thin film) (HS code 85414000), and solar PV generators consisting of photocell panels (HS codes 850131, 850132), are subject to several conformity tests. In Pakistan, their imports require compliance with the quality and safety standards approved by the Pakistan Standards and Quality Control Authority, as follows: “(i) Provided that the test report shall be issued by accredited laboratory in the country of origin or exporting country for the scope of testing/calibration, in accordance with the requirements of ISO/IEC 17025, and (ii) Provided further that the Certificate of Conformance shall be issued by accredited Product Certification Body in the country of origin or exporting country for the type of certification in accordance with the requirements of ISO/IEC

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<sup>49</sup> Trade also faces other political barriers. For instance, in Pakistan, barring therapeutic products regulated by the Drug Regulatory Authority of Pakistan, all goods of Indian origin or imported from India are banned.

17065, Conformity assessment—Requirements for bodies certifying products and services”. Conformity of product certification across countries is essential to facilitate trade in these goods.

To the extent CSA technology is embodied in agricultural commodities, such as drought-resistant, heat-tolerant, and flood-tolerant seeds, SPS measures impact trade in these products. Although such measures are essential to safeguarding environmental and human health, the associated certifications and procedural delays often impede trade in agricultural raw materials like seeds. Under the multilateral trading system governed by the WTO, plant health and protection standards are based on those developed by the International Plant Protection Convention (IPPC). Accordingly, member countries maintain WTO-SPS and IPPC representatives within their countries, typically in their ministries of agriculture.

Bangladesh requires an import permit for agricultural commodities from the Ministry of Agriculture. Although the director of the WTO Cell at the Ministry of Commerce is the SPS notifying authority and National Enquiry Point,<sup>50</sup> the Director of the Plant Protection Wing in the Department of Agricultural Extension is responsible for issuing the phytosanitary certificate for imports. The import of several agricultural products, including seeds (of grains and vegetables), requires a mandatory testing for radioactivity.<sup>51</sup> In addition, imports of genetically modified or engineered products must comply with Bangladesh Biosafety Rules 2012 and the labeling requirements outlined in the Food Safety (Labeling) Regulations of 2017.

The import of rice seeds in Bangladesh is subject to several conditions, including (1) a Quarantine Certificate from the original supplier and a phytosanitary certificate, along with export documents from the government agency of the seed-exporting country; (2) in the case of hybrid rice seeds, a Phytosanitary Certificate that the seeds have been purified with hot water treatment and approved pesticides; (3) a Quarantine Certificate from the Plant Protection Authority for clearing the imported rice seeds from the Customs Authority in Bangladesh; and (4) submission of the import permit issued by the Plant Protection Authority for importing rice seeds at the time of opening the Letter of Credit. The Phytosanitary Certificate is issued by the Department of Agricultural Extension in accordance with the Plant Quarantine Act of 2011.<sup>52</sup> In Bangladesh, the Plant Quarantine Wing of the Department of Agricultural Extension in the Ministry of Agriculture operates several laboratories responsible for testing.

In Bhutan, the import of plants and plant products is subject to prior approval and an import permit from the Bhutan Food and Drug Authority (BAFDA), Ministry of Health,<sup>53</sup> which is the designated National Codex Contact Point since 2003. The Plant and Animal Biosecurity Division of BAFDA serves as the SPS Enquiry Point and regulates the import of plants, plant products, animals, and animal products to protect consumers, plants, and animals from SPS risks. The Bhutan Agriculture and Food Regulatory Authority (BAFRA) is responsible for biosecurity and food safety

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<sup>50</sup> Bangladesh SPS Information Management System, <https://sps.apaari.org/index.php/bangladesh-fsa/>; WTO, SPS, and TBT Platform website, <https://eping.wto.org/en/EnquiryPoint/sps-nep>

<sup>51</sup> Import Policy Order, Bangladesh Trade Portal. <https://bangladeshtradeportal.gov.bd/index.php?r=searchMeasures/view&id=154>

<sup>52</sup> Bangladesh Trade Portal. [www.bangladeshtradeportal.gov.bd/index.php?r=searchMeasures/view&id=154](http://www.bangladeshtradeportal.gov.bd/index.php?r=searchMeasures/view&id=154)

<sup>53</sup> The erstwhile Bhutan Agriculture and Food Regulatory Authority (BAFRA) was merged with the Drug Regulatory Authority and Bhutan Narcotics Control Authority to form BAFDA. [www.bfda.gov](http://www.bfda.gov)

under the provisions of the Food Act of Bhutan 2005, the Plant Quarantine Act of Bhutan 1993, the Biosafety Act of Bhutan 2015, and other relevant legislation.

BAFRA is mandated to protect Bhutan's rich biodiversity, its environment, and the agriculture sector from invasive species, pests and diseases, and genetically modified organisms, while also ensuring food safety. All import consignments are required to have a Phytosanitary Certificate at the port of entry (and zoo-sanitary certificate for animal consignments). Approval criteria for importing seeds and germplasm are as follows: (1) the varieties must be notified as be notified as released by the Seed Board, (2) A Phytosanitary Certificate must be obtained from the competent authority of the exporting country, (3) GMO-free certificate is required for notified varieties, and (4) a pest risk analysis must be conducted.<sup>54</sup> The National Food Testing Laboratory of BAFRA facilitates trade through inspection, testing, and certification.

In India, the Plant Protection Division in the Department of Agriculture and Farmers Welfare, Ministry of Agriculture, is the WTO-SPS as well as the IPPC contact. Trade in agricultural products is governed by a restricted import policy, under which a range of plants and plant materials are "permissible with recommendation of authorized institutions with additional declarations and special conditions." These products include fruits, vegetables, cereals, forest plants, and more, with seeds for sowing of rice (*Oryza sativa*) and wheat (*Triticum* spp.) included in this classification.

Rice seeds are permitted for import into India if they are free from granary weevil, sheath brown rot, seedling rot, bacterial halo blight, and quarantine weed seeds. As per the import regulations of the updated Plant Quarantine Order 2003, rice seeds intended for sowing require approval of the Indian Department of Agriculture, as well as recommendation, supervision, monitoring, and testing by the National Bureau of Plant Genetic Resources in New Delhi or the Directorate of Rice Research in Hyderabad.

On the other hand, wheat seeds for sowing must be free from dwarf bunt, ergot, spike rot, granary weevil, and quarantine weed seeds, and a post-entry quarantine of one growing season is required. Approvals must be obtained from the Department of Agriculture, as well as recommendation, supervision, monitoring, and testing by the National Bureau of Plant Genetic Resources in New Delhi or the Directorate of Wheat Research in Karnal. However, under the Plant Quarantine Management System's list of prohibited country products, the import of wheat seeds and grains from Bangladesh and Latin American countries are banned due to the incidence of wheat blast, a fungal disease.<sup>55</sup>

Under additional declarations and special conditions, India permits the import of corn/maize seeds for sowing from any country, provided the seeds are free from 14 pests, viruses, and conditions; free from soil and quarantine weed seeds; and have been approved by the Department of Agriculture. Although the Department of Agriculture and Farmers Welfare in the Ministry of Agriculture serves as the Enquiry Point for plant health and phytosanitary issues, the Food Safety and Standards Authority of India, under the Ministry of Health and Family Welfare, serves as the

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<sup>54</sup> BAFRA import permit and clearance procedure. [www.bafra.gov.bt/index.php/import-permit-and-clearance-2/](http://www.bafra.gov.bt/index.php/import-permit-and-clearance-2/)

<sup>55</sup> Plant Quarantine Management System, Ministry of Agriculture and Farmers Welfare, government of India.

SPS Enquiry Point; and the Department of Animal Husbandry, Dairying and Fisheries, is the Enquiry Point for animal-health-related issues.

In Nepal, the Department of Food Technology and Quality Control is the national SPS Enquiry Point, while the Plant Quarantine and Pesticide Management Centre under the Ministry of Agriculture and Livestock Development is the IPPC contact and is responsible for SPS regulation and monitoring. The import of plant and plant products requires an import permit, which is issued by the Plant Quarantine office of the Department of Agriculture. Such import permits are required for plant and plant products, including fruits, leaves, and seeds, under the Plant Protection Act 1972 and Plant Protection Rules 1975.<sup>56</sup> While there are quarantine checkpoints at eight customs posts to conduct quarantine examinations and issue import permits and phytosanitary certificates, import consignments are typically cleared based on the phytosanitary certificate issued by the country of origin. According to the Ministry of Industry, Commerce and Supplies, “only doubtful cases are examined at the quarantine customs checkpoints.”<sup>57</sup> Nepal’s liberal trade regime allows imports without licenses, except for prohibited and quantitatively restricted goods. Imports from India are further facilitated because payment is allowed in Indian currency as well as in hard currency.

In Pakistan, the Ministry of National Food Security and Research is responsible for formulating and implementing sanitary and phytosanitary measures (including animal and plant quarantine and pesticide regulation), while the Department of Plant Protection is in charge of forestry, other plant-related measures, and quarantine.<sup>58</sup> The Department of Plant Protection is the Enquiry Point for plant health, and the Animal Quarantine Department is the Enquiry Point for animal health measures.

The major SPS regulations include the Agriculture Pesticide Ordinance 1971, the Pakistan Plant Quarantine Act 1976, the Pakistan Plant Quarantine Rules 2019, the Pakistan Animal Quarantine Ordinance 1979, the Pakistan Animal Quarantine Rules 1980, and the Pakistan Fish Inspection and Quality Control Act 1997. Pakistan is a member of Codex Alimentarius Commission, the World Organization for Animal Health (International Office of Epizootics), the International Plant Protection Convention (IPPC), and the Asia and Pacific Plant Protection Commission, and it follows FAO guidelines.<sup>59</sup> The import of plant and plant products are guided by the above plant quarantine regulations (as well as Codex and IPPC guidelines) in conjunction with the latest Import Policy Order.

Import permits and export phytosanitary certificates for agricultural products are issued by the Department of Plant Protection (DPP) of Pakistan.<sup>60</sup> For the seeds identified in this study, the

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<sup>56</sup> Processed food, packed and dried fruits and vegetables, and tea and cocoa do not require import permits.

<sup>57</sup> Trade and Export Promotion Centre, Ministry of Industry, Commerce and Supplies.

[www.tepc.gov.np/pages/imports-transit-procedure](http://www.tepc.gov.np/pages/imports-transit-procedure)

<sup>58</sup> *Trade Policy Review: Pakistan*, report by the Secretariat, WTO, July 2022 (WT/TPR/S/424/Rev.1).

<sup>59</sup> Pakistan allows import of seeds classified as genetically modified organisms or living modified organisms with a valid license from the Pakistan Environmental Agency for research and development. These are governed by the Pakistan Biosafety Rules 2005. Pakistan has also ratified the Cartagena Protocol on Biosafety (WTO 2022).

<sup>60</sup> Now available through the Pakistan Single Window facility. [www.psw.gov.pk/dpp](http://www.psw.gov.pk/dpp)

import of wheat seeds (durum wheat, common wheat, and meslin), maize (corn), and rice in the husk (paddy or rough) seeds is allowed with (1) a valid import permit issued by the DPP, (2) a phytosanitary certificate from the National Plant Protection Organization of the country of origin and a phytosanitary certificate for re-export (if the exporting country is other than the county of origin); (4) a Plant Protection Release Order issued by the DPP, and, (4) if intended for sowing, the imported seeds are subject to variety registration of sample drawing, and well as testing for quality and conformity to standards set by the Federal Seed Certification and Research Department, Ministry of National Food Security and Research.<sup>61</sup>

In Sri Lanka, the sanitary and phytosanitary regulations under the Food Act No. 26 (1980) govern food imports, while the Animal Diseases Act No. 59 (1992) governs animal and veterinary products, and the Plant Protection Act No. 35 (1999) governs plant imports. The National Plant Quarantine Service (NPQS), under the Seed Certification and Plant Protection Center, Department of Agriculture, is the national plant protection organization that is responsible for plant safety, while the Ministry of Health serves as the SPS Enquiry Point and SPS Notification Authority for food safety and SPS measures under the WTO.<sup>62</sup> The NPQS is also responsible for ensuring that exported products meet safety and quality standards, including inspection of export orchards and packing houses. To ensure quality and promote exports of processed foods, the Ministry of Industry and Commerce provides financial support to exporters for obtaining food safety and hygiene certification (WTO 2017, p. 95).

NPQS issues import permits for plants and plant materials and facilitates the expedited entry of permissible plants and plant products. Import of field crop seeds (such as rice and wheat) have special requirements before commercial approval: two seasons of evaluation trials in the relevant research institute and a large-scale demonstration trial in a farmer's field. These trials results, along with the catalogue of new varieties to be imported, must be submitted to the relevant director of the Department of Agriculture's research institute.<sup>63</sup>

### **3.4.3. *India's Bilateral Trade in CSA Technology-Associated Goods with Regional Partners***

To gauge the extent of trade in CSA technology-associated goods among the South Asian countries, we consider the case of India, the largest economy of the region, focusing on crop seeds, agricultural machinery such as zero-till direct seeders, water pumps, sprayers, and solar PV cells over the past three years. It is also pertinent to recall that sensitive lists continue to restrict regional, as items on these lists are not eligible for concessional tariffs. India's sensitive list for non-LDCs in the region include durum wheat, other wheat, maize seeds, and rice in husk, covering CSA-associated seeds of major cereals.

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<sup>61</sup> Import Policy Order 2022, Ministry of Commerce, Islamic Republic of Pakistan. [www.commerce.gov.pk/sros/](http://www.commerce.gov.pk/sros/)

<sup>62</sup> Department of Agriculture, Sri Lanka, home page. <https://doa.gov.lk/npqs-home-en/>

<sup>63</sup> Department of Agriculture, Sri Lanka, import services. <https://doa.gov.lk/npqs-services-import/>

Table 23 depicts India’s volume of trade in CSA-associated goods and the share of the trade with its South Asian partners. India is a net exporter of maize and rice seeds, with the two neighboring countries of Bangladesh and Nepal providing significant export destination markets. India imports a small volume of rice in husk of seed quality, more than 90 percent of which came from Nepal during 2021–2022 and 2023–2024. On the other hand, trade in wheat seeds (durum and other) is negligible. India is also a net exporter of centrifugal water pumps, with a small share exported to Bangladesh and Nepal, totaling 10–15 percent of India’s total annual exports. Although India is a net importer of agricultural machinery such as sprayers, no-till seeders and planters, and other agricultural appliances, it is a net exporter within the region, with Nepal and Bangladesh as the main destination markets and Sri Lanka to a lesser extent.

**Table 23.** India’s export and import of CSA-associated goods with South Asian partners, 2021–2024

HS code and description	India’s trade	2021–2022		2022–2023		2023–2024	
		Export	Import	Export	Import	Export	Import
10011100: Durum wheat seed	Total (US\$ million) <i>Share of which with:</i>	0.04	~0	0.04	–	0.01	–
	Bangladesh	–	–	–	–	–	–
	Bhutan	–	–	–	–	–	–
	Nepal	25%	–	–	–	–	–
	Pakistan	–	–	–	–	–	–
	Sri Lanka	–	–	–	–	–	–
10019100: Other wheat seed	Total (US\$ million) <i>Share of which with:</i>	0.91	~0	0.04	–	0.13	~0
	Bangladesh	–	–	–	–	–	–
	Bhutan	–	–	–	–	–	–
	Nepal	3.96%	–	100%	–	–	–
	Pakistan	–	–	–	–	–	–
	Sri Lanka	–	–	–	–	–	–
10051000: Maize seed	Total (US\$ million) <i>Share of which with:</i>	64.37	0.73	46.36	0.93	57.31	0.86
	Bangladesh	46.14%	–	39.78%	–	42.92%	–
	Bhutan	0.43%	–	–	–	0.05%	–
	Nepal	17.04%	–	8.63%	–	9.79%	–
	Pakistan	–	–	–	–	–	–
	Sri Lanka	–	–	0.71%	–	–	–
10061010: Rice in husk of seed quality	Total (US\$ million) <i>Share of which with:</i>	56.57	0.37	44.27	0.01	45.3	0.12
	Bangladesh	16.07%	–	16.65%	–	18.19%	–
	Bhutan	–	–	–	–	–	–
	Nepal	14.27%	97.30%	12.83%	–	16.17%	91.67%
	Pakistan	–	–	–	–	–	–
	Sri Lanka	–	–	–	–	–	–
84137010: Other centrifugal pumps:	Total (US\$ million) <i>Share of which with:</i>	134.52	69.14	147.15	78.65	174.29	82.66
	Bangladesh	6.93%	0.14%	5.21%	0.13%	3.80%	0.17%

HS code and description	India's trade	2021–2022		2022–2023		2023–2024	
		Export	Import	Export	Import	Export	Import
Primarily designed to handle water	Bhutan	0.39%	–	0.33%	0.01%	0.52%	–
	Nepal	9.25%	0.06%	6.23%	0.01%	5.85%	~0
	Pakistan	–	–	–	–	0.01%	–
	Sri Lanka	0.56%	–	0.35%	0.01%	0.24%	–
84244100: Agricultural or horticultural sprayers: Portable sprayers	Total (US \$ million) Share of which with:	0.58	26.77	0.68	23.04	0.42	20.57
	Bangladesh	9.10%	–	52.25%	–	10.99%	–
	Bhutan	9.85%	–	2.04%	–	1.21%	–
	Nepal	24.82%	–	14.19%	–	23.39%	–
	Pakistan	–	–	–	–	–	–
	Sri Lanka	5.50%	–	0.16%	–	0.48%	–
84244900: Agricultural or horticultural sprayers: Other	Total (US \$ million) Share of which with:	1.31	30.4	1.29	23.29	1.75	26.59
	Bangladesh	3.68%	–	0.64%	–	0.1%	–
	Bhutan	3.02%	–	2.16%	–	0.82%	–
	Nepal	43.56%	–	30.54%	–	28.16%	–
	Pakistan	–	–	–	–	–	–
	Sri Lanka	3.48%	–	0.58%	–	7.11%	–
84248200: Other agricultural or horticultural mechanical appliances	Total (US\$ million) Share of which with:	26.80	65.44	21.79	47.63	28.24	58.16
	Bangladesh	1.94%	–	2.25%	–	1.42%	–
	Bhutan	0.45%	–	0.50%	–	0.35%	–
	Nepal	5.41%	–	3.40%	–	3.22%	~0
	Pakistan	0.07%	–	–	–	–	–
	Sri Lanka	0.97%	–	0.60%	–	0.39%	–
84323100: No-till direct seeders, planters, and transplanters	Total (US\$ million) Share of which with:	1.39	6.76	0.85	4.67	7.09	8.25
	Bangladesh	4.32%	–	–	–	–	–
	Bhutan	0.06%	–	0.01%	–	0.02%	–
	Nepal	3.97%	–	2.02%	–	0.63%	–
	Pakistan	–	–	–	–	–	–
	Sri Lanka	3.02%	–	0.21%	–	0.03%	–
85414200*: Photovoltaic cells not assembled in modules or made up into panels	Total (US \$ million) Share of which with:	28.95	1,137.86	1.12	1,310.28	54.67	1,853.05
	Bangladesh	0.24%	–	9.82%	–	–	–
	Bhutan	0.38%	–	0.89%	–	–	–
	Nepal	2.18%	–	~0	–	–	–
	Pakistan	0.17%	–	–	–	–	–
	Sri Lanka	0.90%	–	–	–	–	–
85414300**: Photovoltaic cells assembled in	Total (US\$ million) Share of which with:	83.52	3,363.20	1,031.37	943.52	1,969.13	4,353.51
	Bangladesh	0.036%	–	–	–	0.002%	–

HS code and description	India's trade	2021–2022		2022–2023		2023–2024	
		Export	Import	Export	Import	Export	Import
modules or made into panels	Bhutan	0.072%	–	0.003%	–	0.004%	–
	Nepal	0.299%	–	0.080%	–	0.032%	–
	Pakistan	-	–	0.153%	–	0.004%	–
	Sri Lanka	0.108%	–	0.018%	–	0.018%	–

**Source:** Compiled and calibrated from Export–Import Data Bank, Ministry of Commerce and Industry, government of India.

<https://tradestat.commerce.gov.in/eidb/default.asp>

**Note:** CSA = climate-smart agriculture; HS = Harmonized System.

\* HS code effective 2022–2023; the corresponding HS code in 2021–2022 was 85414011.

\*\* HS code effective 2022–2023; the corresponding HS code in 2021–2022 was 85414012.

“–” denotes zero trade or no data reported; “~0” denotes negligible trade with no data recorded.

As evident from Table 23, more than 90 percent of India's imports of no-till direct seeders, planters, and transplanters (HS 84323100), as well as portable agricultural sprayers (HS 84244100), have been sourced from China, with none imported from its SAFTA members during the last three years. Similarly, more than 80 percent of other agricultural sprayers have also been imported from China, with none from regional partners. Finally, for solar PV cells—both those not assembled into module or panels (HS 85414200) and those assembled in modules/panels (HS 85414300)—India is a net importer, with substantive volumes coming largely from China, Malaysia, and Thailand. Trade in solar PV products with India's South Asian neighbors is negligible.

## 4. COMPARATIVE ASSESSMENT OF REGULATORY REGIMES ACROSS SIX SOUTH ASIAN COUNTRIES

### 4.4. Seed Certification

International trade in seeds provides a direct access to climate-resilient varieties of crops that may not be available to a country's farmers. Quality assurance for seeds in the global market is achieved through internationally recognized seed testing and certification. The widely recognized International Seed Testing Association (ISTA), established in 1924, has been developing seed testing methods and facilitated the trade of quality seeds. Seed certification schemes such as the OECD Schemes for the Varietal Certification of Seed, established in 1958, certify seeds produced and officially controlled according to harmonized procedures.

Among the six South Asian countries, only three countries—Bangladesh, India, and Pakistan—have ISTA- accredited laboratories for testing and certifying seeds. Participation in the OECD schemes for certification is even more limited; of the six countries, only India is a member participating in the certification of six categories: grasses and legumes, crucifers and other oil or

fiber species, cereals, sorghum, and vegetables.<sup>64</sup> In reviewing the seed certification regimes of these six countries, this section also examines seed import guidelines, which are key to determining the ease of transfer of CSA technology embodied in genetically edited seeds, such as those with drought- or pest-resistant traits.

In Bangladesh, the Seed Certification Agency, established in 1974, is an autonomous government agency responsible for the certification and quality control of seven core crops, including rice and wheat, that are produced and marketed in the country.<sup>65</sup> The agency has a network of 7 regional Seed Certification Offices and 64 District Seed Certification Offices.

The National Seed Policy 2018 recognized that the government supply of quality seed falls short of demand and outlined measures to support increased production by the private sector alongside the public sector. The policy focused on strengthening the seed sector's institutional capacity and advocated for the liberalization of seed and seed processing machinery imports by simplifying import procedures. It recommended an open policy for procuring improved varieties of seeds and planting materials that would allow their import through private seed enterprises and encourage joint ventures with foreign seed companies. In addition, it encouraged private entrepreneurs and agencies to engage in plant breeding and permitted them to import breeder and foundation seeds of notified crops.

The Seeds Act 2018, enacted in 2021, required that seeds intended for export and import conform to quality standards (such as germination rate, purity rate, and seed moisture) and be labeled with relevant details about the seeds. It stated that seeds of a crop or variety may be notified for regulated sale, trade, and use, while those deemed to be harmful or potentially harmful to agriculture may be banned.

Barring plant quarantine safeguards, there are no restrictions on the import of non-notified seeds. Approved varieties of rice, wheat, jute, potatoes, and sugarcane can be imported for commercial sale, and registered growers are permitted to import small quantities of these seeds for adaptability testing. The policy also calls for a review and revision of the Plant Quarantine Regulations to simplify procedures and facilitate the import of high-quality seeds and planting material.

The Seed Rules 2020 for seed import and export required the seed holder to furnish a label with the seed attributes, including the crop name and variety, seed quantity, seed moisture, germination capacity, and expiration date. Prior government approval was required for larger quantities—more than 20 kg of controlled crop seeds and more than 5 MTs of uncontrolled crop seeds.

In Bhutan, the MoAF, under the Seeds Act of Bhutan 2000, established the provision for a seed certification agency, BAFRA. The agency certifies only those varieties notified by the National Seed Board. The Seeds Act regulates import and export of agricultural seeds to prevent the introduction of plant diseases into the country.

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<sup>64</sup> OECD Seed Schemes. [www.oecd.org/en/topics/sub-issues/seeds.html](http://www.oecd.org/en/topics/sub-issues/seeds.html)

<sup>65</sup> Seed Certification Agency website. <https://sca.gov.bd/>

The Seed Rules and Regulations of Bhutan 2018<sup>66</sup> allowed seed imports that met the requirements of the Plant Quarantine Act of Bhutan (1993), the Plant Quarantine Rules and Regulations 2003, the Biodiversity Act of Bhutan 2003, and other relevant laws. Seed imports must be from notified seed varieties and require a permit from BAFRA. The import of notified seed varieties for direct sale must comply with the Minimum Standards for Seed and Planting Materials for certification. Import of non-notified seed varieties is prohibited, except for research purposes or for multiplication and re-export, subject to prior approval from the Variety Release Committee. Seed import into Bhutan is permitted only through designated entry points identified in the Plant Quarantine Rules and Regulations, and import of genetically modified seeds is prohibited under the country's biosafety laws. The Seed Rules and Regulations of Bhutan has provisions for BAFRA to allow imports of seeds certified by recognized foreign certification agencies, provided they are of notified varieties and comply with applicable laws. The import and distribution of hybrid seeds is administered by the National Seed Centre of the Department of Agriculture in Paro. The types and varieties of hybrid seeds to be imported are subject to approval by the National Seed Board.

In 2019, the Minimum Seed Standards of Bhutan reiterated that the purpose of seed certification is to maintain high-quality seeds and planting materials of notified species, ensuring genetic identity and purity, in addition to meeting prescribed standards.

In India, seed certification was introduced under the Seeds Act 1966 to maintain and make available high-quality seeds and propagating materials of notified varieties to ensure genetic identity and purity. Under the provisions of the act, individual states established their official Seed Certification Agencies. Currently, there are 25 seed certification agencies operating across different states.<sup>67</sup> The Seeds Bill 2004 provided for the establishment of the Central Seed Committee, which would be responsible for setting standards for registration, certification, and seed testing, among other functions. The committee, in consultation with state governments, could establish a State Seed Certification Agency or accredit other organizations to carry out certification based on fulfilling certain criteria. The bill also includes a provision for the central government to recognize seed certification agencies established in any foreign countries.

The Seeds Bill 2004 allows the import of only identifiable seed varieties that meet the minimum standards for germination and genetic and physical purity, and that comply with the provisions of the Plant Quarantine (Regulation of Import into India) Order 2003 or corresponding order under Section 3 of the Destructive Insects and Pests Act 1914. Import of an unregistered variety may be permitted by notification of the central government, but only for research purposes.

Climate-smart crop seeds typically involve gene editing to build resilience to droughts, pests, and diseases. In this regard, it is noteworthy that India has eased the regulatory pathway for the introduction of genome-edited crops that do not contain exogenous (introduced) genes through a notification from the Ministry of Environment, Forest and Climate Change in March 2022. Gene-edited plants developed using site-directed nucleases I and II (SDN-1 and SDN-2) have been distinguished from genetically modified or transgenic crops (MST 2022). Later that year, the

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<sup>66</sup> The earlier Seed Rules and Regulations of Bhutan 2006 was repealed and replaced by this regulation in 2018.

<sup>67</sup> Listed in the Seednet India Portal. <https://seednet.gov.in/Material/SSCA.aspx>

Department of Biotechnology, Ministry of Science and Technology, released the *Guidelines for the Safety Assessment of Genome Edited Plants* to ensure proper appraisal of biosafety concerns and safeguard both environmental and human health (ibid).

In Nepal, the Seed Quality Control Center (SQCC), under the Ministry of Agriculture and Cooperatives, is responsible for quality assessment and certification of seeds.<sup>68</sup> The SQCC is also mandated to formulate plans, determine seed quality, and register seed varieties in collaboration with various institutions. The Center has acknowledged that maintaining seed quality control in line with international standards is challenging in the country.

The key legislation governing seed production, processing, and testing is the Seeds Act 1988 (amended in 2010), which aims to maintain high-quality standards to enhance crop productivity in Nepal. The import and export of notified seeds are allowed with a permit from the relevant authority.

The National Seed Vision 2013–2025 aims to increase crop productivity through import substitution and the promotion of quality seed exports. The strategy includes encouraging joint ventures between national and international seed companies, especially for hybrid varieties, and harmonizing seed import and export regulations with WTO and SAARC standards. The Vision document observed that encouraging hybrid research through investment would reduce dependence on imported seeds.

In Pakistan, under the Seed Act 1976 (amended in 2015), the Federal Seed Certification and Registration Department is responsible for crop variety registration, crop inspection, and seed testing for quality control. The department, which is attached to the Ministry of National Food Security and Research (formerly the Ministry of Agriculture), maintains a seed testing system established under the Seed (Truth-in-Labeling) Rules 1991 which tests samples from all seed consignments for analytical purity and germination. A new comprehensive national seed policy has been drafted in Pakistan and is expected to be approved soon. It aims to enhance crop production by addressing investment, imports, etc., of seed businesses and issues faced by seed technology companies.<sup>69</sup>

In 2019, the Central Seed Testing Laboratory of the Federal Seed Certification and Registration was accredited by the ISTA, following upgrades supported by technical assistance from the United Nations Industrial Development Organization (UNIDO).<sup>70</sup>

In Sri Lanka, seed certification services are provided by the Department of Agriculture's Seed Certification and Plant Protection Center.<sup>71</sup> The center is responsible for quality control of seeds and planting material, facilitation of the import and export of quality plants and plant products, prevention of dangerous pests within the country, regulation of pesticides, and conservation of

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<sup>68</sup> Seed Quality Control Center, Ministry of Agriculture website. [www.sqcc.gov.np/pages/introduction](http://www.sqcc.gov.np/pages/introduction)

<sup>69</sup> "Seed Policy in Final Stage, Says Secretary," *Dawn*, December 14, 2024. [www.dawn.com/news/print/1878592](http://www.dawn.com/news/print/1878592)

<sup>70</sup> "Federal Seed Testing Lab Accredited by Swiss Association," *Dawn*, July 11, 2019. [www.dawn.com/news/1493367](http://www.dawn.com/news/1493367)

<sup>71</sup> The center functions through five units: Seed Certification Service, National Plant Quarantine Service, Plant Protection Service, Office of the Registrar of Pesticide, and Plant Genetic Resource Center. Department of Agriculture website. <https://doa.gov.lk/scppc-home/>

genetic resources of agricultural crops. It enforces the implementation of the Seed Act 2003 to safeguard farmers and seed handlers against malpractice in the seed industry. The center also enforces the implementation of the Plant Protection Act 1999 and the Control of Pesticide Act 1980 to protect agriculture, ensure high-quality pesticides, and promote effective pest management to minimize harm to human health and the environment.

Table 24 provides a comparison of the regulatory regimes for seed certification and seed import across the six South Asian countries. It shows that while quarantine safeguards are applied at the border in all six countries, testing and approval processes are more elaborate in India, which maintains a “restricted” seed import policy.

**Table 24.** Regulatory regimes for seed certification and import in the six South Asian countries

Country	Key policies	Certifying agencies	Permits and sanitary measures required for seed import	International accreditation*
Bangladesh	<ul style="list-style-type: none"> <li>• Seeds Act 2018</li> <li>• National Seed Policy 2018</li> <li>• Seed Rules 2020</li> <li>• Plant Quarantine Act 2011</li> <li>• Bangladesh Biosafety Rules 2012</li> </ul>	<ul style="list-style-type: none"> <li>• Seed Certification Agency</li> <li>• Department of Agricultural Extension</li> </ul>	<ul style="list-style-type: none"> <li>• Labels with seed attributes</li> <li>• Prior government approval for import of large quantities (&gt;20 kg of controlled crop seeds and &gt;5 metric tons of uncontrolled crop seeds).</li> <li>• For import of rice seeds, quarantine certificate from the original supplier and a phytosanitary certificate of the seed-exporting country</li> <li>• For hybrid rice seeds, a phytosanitary certificate that the seed is purified with hot water treatment and approved pesticides is</li> <li>• Phytosanitary certificate issued by the Department of Agricultural Extension</li> <li>• Quarantine certificate from the Plant Protection Authority for clearing the imported rice seeds from the Customs Authority</li> <li>• Import permit issued by the Plant Protection Authority for importing rice seeds at the time of Letter of Credit opening</li> </ul>	One ISTA-accredited private laboratory
Bhutan	<ul style="list-style-type: none"> <li>• Seeds Act of Bhutan 2000</li> <li>• Seed Rules and Regulations of Bhutan 2018</li> <li>• Minimum Seed Standards of Bhutan 2019</li> </ul>	<ul style="list-style-type: none"> <li>• Bhutan Agriculture and Food Regulatory Authority (BAFRA)</li> </ul>	<ul style="list-style-type: none"> <li>• Import of GM seeds prohibited (biosafety law)</li> <li>• Import of notified varieties with BAFRA permit</li> <li>• Import of notified varieties through designated entry points as per Plant Quarantine Rules</li> <li>• Import of seeds (notified varieties) certified by recognized foreign agencies</li> </ul>	-

Country	Key policies	Certifying agencies	Permits and sanitary measures required for seed import	International accreditation*
	<ul style="list-style-type: none"> <li>Plant Quarantine Rules and Regulation 2003</li> <li>Biosafety Act of Bhutan 2015</li> </ul>		<ul style="list-style-type: none"> <li>Import of hybrid seeds subject to approval by National Seed Board</li> </ul>	
India	<ul style="list-style-type: none"> <li>Seeds Act 1966</li> <li>Seeds Bill 2004</li> <li>Plant Quarantine (Regulation of Import into India) Order 2003</li> </ul>	<ul style="list-style-type: none"> <li>State Seed Certification Agencies (25 across the country)</li> <li>Department of Agriculture</li> <li>National Bureau of Plant Genetic Resources</li> </ul>	<ul style="list-style-type: none"> <li>Import of only identifiable varieties that meet minimum standards for germination and genetic and physical purity and that comply with the provisions of the Plant Quarantine Order 2003</li> <li>Rice seeds for sowing must be free from granary weevil, sheath brown rot, seedling rot, bacterial halo blight, and quarantine weed seeds. Approval required from the Department of Agriculture, and testing/ recommendation from the National Bureau of Plant Genetic Resources, New Delhi, or the Directorate of Rice Research, Hyderabad.</li> <li>Wheat seeds for sowing must be free from dwarf bunt, ergot, spike rot, granary weevil, and quarantine weed seeds. Post-entry quarantine for one growing season is required, as are approvals from the Department of Agriculture, and testing/ recommendation from the National Bureau of Plant Genetic Resources or the Directorate of Wheat Research, Karnal.</li> <li>Import of maize seeds for sowing is allowed if free from 14 pests, viruses, and conditions and from soil and quarantine weed seeds, with approval by Department of Agriculture</li> </ul>	Nine ISTA-accredited laboratories (seven private labs and two public sector labs)
Nepal	<ul style="list-style-type: none"> <li>Seeds Act 1988</li> <li>Plant Protection Act 1972</li> <li>Plant Protection Rules 1975</li> </ul>	<ul style="list-style-type: none"> <li>Seed Quality Control Center, Ministry of Agriculture</li> <li>Plant Quarantine and Pesticide Management Centre, Ministry of Agriculture</li> </ul>	<ul style="list-style-type: none"> <li>Phytosanitary certificate issued by the country of origin is required; import consignments are often cleared with only this certificate</li> <li>Import and export of notified seeds are allowed with a permit from the Plant Quarantine office</li> </ul>	-
Pakistan	<ul style="list-style-type: none"> <li>Seed Act 1976 (amended 2015)</li> </ul>	<ul style="list-style-type: none"> <li>Federal Seed Certification and Registration Department</li> </ul>	<ul style="list-style-type: none"> <li>Seed import permit issued by DPP</li> <li>Phytosanitary certificate from National Plant Protection Organization of country of origin</li> </ul>	The government laboratory, Central Seed

Country	Key policies	Certifying agencies	Permits and sanitary measures required for seed import	International accreditation*
	<ul style="list-style-type: none"> <li>• Pakistan Plant Quarantine Act 1976</li> <li>• Pakistan Plant Quarantine Rules 2019</li> </ul>	(FSCRD), Ministry of National Food Security and Research <ul style="list-style-type: none"> <li>• Department of Plant Protection (DPP)</li> </ul>	<ul style="list-style-type: none"> <li>• Plant protection release order by DPP</li> <li>• Only seeds of enlisted varieties intended for sowing that conform to FSCRD quality and standards are permitted</li> </ul>	Testing Laboratory of the FSCRD is ISTA-accredited
Sri Lanka	<ul style="list-style-type: none"> <li>• Seed Act 2003</li> <li>• Plant Protection Act No. 35, 1999</li> </ul>	<ul style="list-style-type: none"> <li>• Seed Certification and Plant Protection Center, Department of Agriculture</li> <li>• National Plant Quarantine Service (NPQS)</li> </ul>	<ul style="list-style-type: none"> <li>• Import permits for permissible plants issued by NPQS</li> <li>• Import of field crop seeds such as rice and wheat require two-season evaluation trials at relevant research institute, Department of Agriculture</li> </ul>	-

Source: Compiled from seed policy regulations of the six countries.

\* Accreditation by the Swiss agency the International Seed Testing Association (ISTA).

#### 4.5. Trade Regimes in Agricultural Equipment: Incidence of Customs Duties and Other Cesses/Taxes

Freer trade in certain types of agricultural equipment that embody climate-smart technology would lead to easier access to CSA techniques. For example, no-till direct seeders, planters, and transplanters reduce the release of soil GHG emissions and save time, water, and energy. For example, a zero tiller enables wheat to be sown in the soil immediately after rice harvest without burning the straw, as it mulches the straw into the sown area. While the previous section analyzed the applied import tariff rates imposed by the six South Asian countries on crop seeds and agricultural equipment, this section focuses on the entire gamut of taxes and duties applied to CSA agricultural equipment in four countries—Bangladesh, Bhutan, India, and Sri Lanka—based on data availability.

The comprehensive set of taxes, along with the customs duties, applied to each selected CSA equipment types, is summarized in Table 24. The table shows that Bangladesh imposes a value-added tax (VAT) of 15 percent and an advanced income tax (AIT) of 5–5 percent on most agricultural machinery, except for sprayers.<sup>72</sup> India has additional duties on machinery, such as the integrated goods and services tax (IGST) ranging from 12 to 18 percent<sup>73</sup> and a social welfare surcharge (SWS) ranging from 0 to 8 percent. Sri Lanka imposes an 18 percent VAT on all these commodities along with additional cases and/or a port-airport development levy (PAL) on several products.

<sup>72</sup> Wheat and maize/corn seeds for planting are exempt from VAT or AIT, except for paddy seeds, which are subject to 5 percent AIT. [https://customs.gov.bd/files/TRF\\_2023\\_2024\\_01062023.pdf](https://customs.gov.bd/files/TRF_2023_2024_01062023.pdf) (accessed September 22, 2024).

<sup>73</sup> Whereas IGST on seeds ranges from 0 to 5 percent.

In India, within the category of agricultural equipment, power tillers have been carved out for import restrictions. In particular, the import of rotary tillers (8432 80 20) is classified as “restricted” under the Import Policy for Power Tillers and Its Components (Notification No. 19/2015–2020, dated July 15, 2020).<sup>74</sup>

Table 25 shows the incidence of customs duties and other cases/taxes for the selected CSA-associated goods in four South Asian countries (based on available data). Among them, Bhutan has the most liberal regime for CSA agricultural equipment, followed by Sri Lanka, Bangladesh, and India. Although Bangladesh and Sri Lanka have relatively low customs duties compared to India, their VAT rates are rather steep. For Bangladesh, the VAT rate is zero only for agricultural sprayers (categorized under irrigation equipment), resulting in a lower total tax incidence compared to other agricultural equipment such as seeders and ploughs.

**Table 25.** Total tax on import of agricultural equipment in four countries, 2023–2024

Item description	HS code	Bangladesh	Bhutan	India	Sri Lanka				
Portable sprayers (under agricultural or horticultural sprayers)	84244100	Customs duty	1 0	Customs duty	0 5	Basic duty	7.5 0.75	General duty	0 18
		SD	0	Sales tax	0	Health CSS	0	PADL	5
		VAT	5	Green tax		IGST	18	CEC	0
		AIT	0					SSCL	2.5
		RD	5						
		Advance tax	11.0		5	Total	27.73	Total	25.5
		Total	5	Total	5				
Other sprayers (under agricultural or horticultural sprayers)	84244900	Customs duty	1 0	Customs duty	0 5	Basic duty	7.5 0.75	General duty	0 18
		SD	0	Sales tax	0	Health cess	0	PADL	5
		VAT	5	Green tax		IGST	18	CEC	0
		AIT	0					SSCL	2.5
		RD	5						
		Advance tax	11.0		5	Total	27.73	Total	25.5
		Total	5	Total	5				
Other appliances: Agricultural or horticultural	84248200	Customs duty	1 0	Customs duty	0 0	Basic duty	7.5 0.75	General duty	0 18
		SD	15	Sales tax	0	Health cess	0	PADL	5
		VAT	5	Green tax		IGST	18	CEC	0
		AIT	0					SSCL	2.5
		RD	5						
		Advance tax	26.2		0	Total	27.73	Total	25.5
		Total	0	Total	5				
Ploughs	843210	Customs duty	1 0	Customs duty	0 0	Basic duty	7.5 0.75	General duty	0 18

<sup>74</sup> A power tiller is defined as agricultural machinery used for soil preparation, equipped with a single axle. The direction of travel and control during field operation are performed by the operator. It is self-propelled and can pull a cultivator, harrow, plough, various seeders, harvesters, and other suitable attachments. The equipment may be of the walk-behind or riding attachment type and should be able to couple with a trailer that can be used for transportation of goods with a capacity of not less than 1 ton. The maximum speed of the power tiller when coupled to a trailer shall not exceed 22kmph. The minimum rated horsepower output of the power tiller engines shall not be less than 8 bhp (brake horsepower).

Item description	HS code	Bangladesh	Bhutan	India	Sri Lanka
		SD 15 VAT 5 AIT 0 RD 5 Advance tax <b>26.2</b> <i>Total</i> <b>0</b>	Sales tax 0 Green tax  <b>0</b> <i>Total</i>	Health cess 0 IGST 12  <b>21.24</b> <i>Total</i>	PADL 0 CEC 0 SSCL 2.5 <b>20.5</b> <i>Total</i>
Disc harrows (under harrows, scarifiers, cultivators, weeders, and hoes)	84322100	Customs 1 duty 0 SD 15 VAT 5 AIT 0 RD 5 Advance tax <b>26.2</b> <i>Total</i> <b>0</b>	Customs 0 duty 0 Sales tax 0 Green tax  <b>0</b> <i>Total</i>	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12  <b>21.24</b> <i>Total</i>	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5 <b>20.5</b> <i>Total</i>
Other (under harrows, scarifiers, cultivators, weeders, and hoes)	843229	Customs 1 duty 0 SD 15 VAT 5 AIT 0 RD 5 Advance tax <b>26.2</b> <i>Total</i> <b>0</b>	Customs 0 duty 0 Sales tax 0 Green tax  <b>0</b> <i>Total</i>	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12  <b>21.24</b> <i>Total</i>	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5 <b>20.5</b> <i>Total</i>
No-till direct seeders, planters, and transplanters (under seeders, planters, and transplanters)	84323100	Customs 1 duty 0 SD 15 VAT 5 AIT 0 RD 5 Advance tax <b>26.2</b> <i>Total</i> <b>0</b>	Customs 0 duty 0 Sales tax 0 Green tax  <b>0</b> <i>Total</i>	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12  <b>21.24</b> <i>Total</i>	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5 <b>20.5</b> <i>Total</i>
Other (under seeders, planters, and transplanters)	84323900	Customs 1 duty 0 SD 15 VAT 5 AIT 0 RD 5 Advance tax <b>26.2</b> <i>Total</i> <b>0</b>	Customs 0 duty 0 Sales tax 0 Green tax  <b>0</b> <i>Total</i>	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12  <b>21.24</b> <i>Total</i>	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5 <b>20.5</b> <i>Total</i>
Manure spreaders (under manure spreaders and fertilizer distributors)	84324100	Customs 1 duty 0 SD 15 VAT 5 AIT 0 RD 5 Advance tax <b>26.2</b> <i>Total</i> <b>0</b>	Customs 0 duty 0 Sales tax 0 Green tax  <b>0</b> <i>Total</i>	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12  <b>21.24</b> <i>Total</i>	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5 <b>20.5</b> <i>Total</i>
Fertilizer distributors (under manure spreaders and fertilizer distributors)	84324200	Customs 1 duty 0 SD 15 VAT 5 AIT 0 RD 5	Customs 0 duty 0 Sales tax 0 Green tax	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5

Item description	HS code	Bangladesh	Bhutan	India	Sri Lanka
		Advance tax <b>26.2</b> Total <b>0</b>	<b>0</b> Total	Total <b>21.24</b>	Total <b>20.5</b>
Other machinery *	843280	Customs 1 duty 0 SD 0 VAT 5 AIT 0 RD 5 Advance tax <b>11.0</b> Total <b>5</b>	Customs 0 duty 0 Sales tax 0 Green tax  <b>0</b> Total	Basic duty 7.5 SWS 0.75 Health cess 0 IGST 12  Total <b>21.24</b>	General duty 0 VAT 18 PADL 0 CEC 0 SSCL 2.5  Total <b>20.5</b>

**Source:** Compiled from country customs schedules.

**Note:** AIT = advance income tax; CEC = Customs excise and cess; HS = Harmonized System; IGST = integrated goods and services tax; PADL = port and airport development levy; RD = regulatory duty; SD = supplementary duty; VAT = value-added tax; SSCL = social security contribution levy; SWS = social welfare surcharge.

\* India has finer classifications of agricultural and horticultural machinery under this item description, namely lawn or sports ground rollers (8432 80 10), rotary tillers (8432 80 20), and other (8432 80 90).

# The 8-digit HS codes reported by commodity description are common to Bangladesh, Bhutan, and India, whereas Sri Lanka uses only a 6-digit classification for the same. The 6-digit HS codes are reported for equipment where the 8-digit classifications did not match across the four countries.

## 4.6. Food Safety and Quality Regulatory Regimes

Within the SPS measures discussed in Section 3.3.2, food safety and quality regulations protect public health. Climate change exacerbates food safety hazards by increasing the risk of incidence and virulence of pathogens. Higher temperatures and changes in precipitation affect microbial biodiversity, which could lead to changes in plant and animal diseases through changes in host susceptibility, as well as heightened pest infestations. Extreme weather events such as floods contaminate agricultural land, water, food, and animal feed with pathogens and chemicals from sewage and industrial waste streams (Tirado et al. 2010). Thus, food safety regulatory authorities must address the new and evolving health risks arising from climate change.

Moreover, some CSA technologies entail the use of environmental inhibitors, which reduce methane emissions in the livestock sector, or the use of nitrogen inhibitors, which increase fertilizer efficiency. But such inhibitors also affect non-target organisms that raise food safety concerns and questions about trade implications. Specific methanogenesis inhibitors target microorganisms that produce methane “by acting on enzymes which are not present in non-methanogenic species” (FAO 2023, p. 6). However, non-specific methanogenesis inhibitors can affect wider microbial populations (ibid, p. 9), for which potential hazard assessments are incomplete. In addition to biological inhibitors, synthetic inhibitors used to reduce GHG leave residues in food and wildlife, for which toxicity profile information is limited (ibid, p. 40).

The use of environmental inhibitors in CSA technology underscores the need for ensuring that such technology is safe for human and ecological health. In the context of trade, this calls for developing and adopting international standards for CSA technologies under the Codex Alimentarius, as well as the harmonization of regulatory framework across countries to ensure food safety of their populations and environments.

The food safety and quality regulatory system typically involves multiple ministries and departments, as controls are implemented at different stages in the food system, from the farm to processing to distribution. In reviewing the food safety regimes across the six South Asian countries, this section highlights the dichotomy between higher food safety standards maintained for food destined for export to developed economies or countries such as the EU and the United States, and the laxer enforcement of food safety standards for domestically consumed food. This contrast is evident in the most recent responses of national food safety authorities in India and Pakistan to the rejection of their food export consignments.

#### **4.6.1. Bangladesh**

In Bangladesh, the Food Safety Act 2013 is the key regulation ensuring the safety of the country's food system. The Bangladesh Food Safety Authority (BFSA), established in 2015,<sup>75</sup> is the apex regulatory body that sets the standards (such as the maximum residue levels of pesticides in food). The BFSA coordinates the activities of various agencies involved with food safety control, including updating guidelines; determining permissible limits of contaminants and residues, additives, preservatives, and radiation in food; establishing procedures for accrediting food testing laboratories, and regulating imports, processing, stockpiling, marketing, and more.<sup>76</sup> As discussed in Section 3.3.2, the Department of Agricultural Extension, under the Ministry of Agriculture, is responsible for ensuring plant protection and quarantine (an SPS measure), as well as pesticide regulation and food safety. The Department of Fisheries and the Department of Livestock Services are responsible for fisheries and meat. However, beyond the farm stage, other agencies implement market standards and testing.

In 2018, the Bangladesh Standards and Testing Institution Act<sup>77</sup> reaffirmed the role of the Bangladesh Standards and Testing Institution (BSTI; established in 1985) in setting quality standards for marketed commodities (for example, measurements of size, weight, volume, and mass) on a national and international basis. BSTI, under the Ministry of Industry, continues to be the standard-setting and certifying body for the quality of produce and other articles, including food materials for domestic consumption, export, and import. This includes testing the physical, chemical, and bacteriological properties of food.

In Bangladesh, the import of agricultural and processed food products requires a health certificate from a competent laboratory in the exporting country, certifying that the product is “fit for human consumption.” It must also be accompanied by a radiation-level test certificate (indicating the level of Cs-137 per kg of goods shipped) from the competent authority in the exporting country, a sanitary inspection certificate for fish and fish products, and a certificate of country of origin from the exporting country.

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<sup>75</sup> Food quality was guided by the Bangladesh Pure Food Ordinance 1959 until its repeal in 2013.

<sup>76</sup> The Bangladesh Food Safety Authority. <https://sps.apaari.org/index.php/bangladesh-fsa/>

<sup>77</sup> This act repealed and re-enacted the Bangladesh Standards and Testing Institution Ordinance of 1985.

A phytosanitary capacity evaluation of Bangladesh, conducted in 2019, identified gaps in the phytosanitary system that led to non-compliance with the WTO SPS agreement, particularly in the pest risk analysis system, the structure and processes of the National Plant Protection Organization, the export certification system, and the import inspection system (Khetarpal 2019). The systemic weaknesses were legislative, technical, and structural, and also included deficiencies in human resources. The development of human resources and processes was assessed to be more important than infrastructure development.<sup>78</sup> In addition, a recent review of the food safety system in Bangladesh found that enforcement of domestic laws and regulations is weak, and that most food establishments are not registered with BFSA but with the Bangladesh Standards and Testing Institute (BSTI) under the Ministry of Industries (Suman et al. 2021, p. 10).

While both BFSA and BSTI are responsible for standards and food samples testing, the former has been observed to be more resource strapped in personnel as well as in technical capacity. The shortage of human resources has resulted in underutilization of food testing equipment (much of which was developed by donor agencies), and few of the food testing laboratories hold accreditations for certain tests (Suman et al. 2021). Microbiological contamination testing is problematic, as conventional methods are time-consuming. Affordable rapid pathogen detection kits must be adopted more widely within the country. The BFSA needs to strengthen the framing and implementation of procedures to address food safety hazards and ensure that complete data are available on registered food manufacturing facilities and services, especially as the country prepares to scale up the adoption of CSA technologies.

#### **4.6.2. Bhutan**

Food safety inspection and certification are administered by BAFRA under the MoAF. Within BAFRA, the Food Quality and Safety Division<sup>79</sup> is responsible for ensuring food safety and quality through the implementation of the Food Act of Bhutan 2005; the Food Rules and Regulations of Bhutan 2017, which are designed to prevent foodborne diseases and food poisoning, and the Biosafety Act of Bhutan 2015, which aims to protect human, animal, and environmental health from the unintended effects of genetically modified organisms. BAFRA's Food Quality and Safety Division is the national focal point for the Codex Alimentarius Commissions and the International Food Safety Authorities Network. It supports regulatory research in food safety and quality, promotes standardization with international norms to facilitate food trade and provides certification for food, agricultural, and livestock products and agricultural production systems such as the Organic and Good Agricultural Practices (MoAF 2020, p. 5).

Under the rules and regulations of the Food Act of Bhutan 2005, all food businesses are required to be licensed or registered with BAFRA, which inspects and tests food in its field offices. BAFRA's Food Quality and Safety Division oversees the National Food Testing Laboratory (NFLT), which

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<sup>78</sup> For example, following the introduction of the fall armyworm pest, wheat blast disease, and gap in import inspection, the Plant Quarantine Act 2011 required enhancement, along with development of the manual for inspection and treatment (Khetarpal 2019, p. 22).

<sup>79</sup> The other department of BAFRA, the Plant and Animal Biosecurity Division, is responsible for biosecurity of the farming system.

conducts mandatory analytical and diagnostic tests in microbiology, chemical contaminants, and biotechnology (that is, genetically modified organisms). Efforts are underway to increase the testing scope of NFLT, as Bhutan continues to rely on accreditation from India's National Accreditation Board for Testing and Calibration Laboratories for several test parameters (MoAF 2020).<sup>80</sup>

A food safety surveillance of ready-to-eat foods conducted by BAFRA from 2019 to 2021 across five districts, found that more than 12 percent of the samples were not fit for consumption due to contamination by an indicator organism (such as *E. coli* or yeast mold), indicating poor hygiene and food quality (Chhetri and Dorji 2021). A large proportion of the food samples with indicator organism contamination also had pathogenic organism contamination, and samples collected during the monsoon season had the highest levels of microbial contamination.

The MoAF acknowledged in a recent report that coordination and implementation of food safety measures across the country's various institutions have been challenging due to incomplete domestic food legislations, the absence of a national food control strategy, and overlapping mandates among domestic agencies. Limited infrastructure, equipment, knowledge, and skilled personnel; inadequate scientific and technical resources for food inspection and ensuring compliance with a food safety assurance system; and a weak capacity to effectively participate in international bodies or agreements governing food trade adversely affect food safety in the country (MoAF 2020, p. 6).

#### **4.6.3. India**

The Food Safety and Standards Authority of India (FSSAI) is responsible for implementation and compliance of food safety regulations in the country. Established under the Food Safety and Standards Act 2006, FSSAI operated under the Ministry of Health and Family Welfare and consolidates all previous legislations and orders related to food safety.<sup>81</sup> The 2006 act designated FSSAI as a single reference point for all issues concerned with food safety and standards, regulations, and enforcement. It also envisioned a regime shift from a purely regulatory approach to a system based on self-compliance with food safety management standards. FSSAI sets science-based standards for food manufacturing, storage, distribution, sale, and import, including permissible limits of contaminants, toxins, residues, additives, and microbial count, as well as guidelines on packaging and labeling). Surveillance and enforcement of FSSAI-mandated standards are assigned to state governments through the state Commissioner for Food Safety and local panchayat or municipal bodies.

The major food safety regulations and rules were published in 2011. The various Food Safety and Standards Regulations 2011 include Licensing and Registration of Food Businesses; Food Product Standards and Food Additives; Prohibition and Restriction of Sales; Contaminants, Toxins, and Residues; and Laboratory and Sampling Analysis. The regulations have been

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<sup>80</sup> BAFRA is accredited for ISO/IEC 17065:2012 by the National Accreditation Board for Certification Bodies of India. In conformity with ISO IEC 17065:2012, BAFRA can provide third-party certification marks for several products.

<sup>81</sup> Food Safety and Standards Authority of India website. <https://fssai.gov.in/cms/about-fssai.php>

augmented over the years, notably Food Recall Procedure (2017); Food Safety Auditing (2018); and Labeling and Display (2020).

As envisioned in the Food Safety Act 2006, achieving excellence in food safety standards formulation in India requires that domestic measures be consistent with international food policy standards. Moreover, to facilitate trade in safe food products, the Food Safety and Standards (Import) Regulation 2017 (as amended in 2022) includes a provision for risk-based food import clearance. Under this scheme, the Food Authority of India “may enter into a Memorandum of Agreement with relevant agencies in exporting countries on reciprocal basis to facilitate ease of doing business and accelerated clearance of food imports from the countries” after due profiling of the importer, manufacturer of the imported product, country of origin, source country, compliance history, and other relevant factors (Chapter VII of the regulation).

However, food export consignments from India continue to face rejections due to the presence of contaminants or residues, which sometimes forces FSSAI to take action. In April 2024, Hong Kong and Singapore banned the import of some Indian spices due to the presence of the carcinogenic pesticide ethylene oxide. While there is no Codex standard for this carcinogen, several other economies and countries have a strict regulation on its maximum residue limit, including the EU, Japan, South Korea, Taiwan, and Thailand.<sup>82</sup> Testing for ethylene oxide had already been mandatory for export consignments to the EU and the United Kingdom, and in April 2024, the Ministry of Commerce extended this requirement to spice exports to Singapore and Hong Kong.<sup>83</sup> Subsequently, FSSAI conducted safety checks and revoked the manufacturing licenses of more than 100 spice producers that failed to meet basic quality standards, the majority of which were small producers.<sup>84</sup>

The administration, implementation, and enforcement of the Food Safety and Standards Act 2006 are detailed in the Food Safety and Standards Rules 2011 (as amended in 2024). However, despite this extensive body of rules and regulations, challenges in compliance with food safety standards have persisted. A 2019 review of India’s food safety regulatory ecosystem observed that weak administrative capacity—stemming from inadequate technical capacity, limited human and financial resources, and the prevalence of corruption—has contributed to enforcement challenges (Mehdi et al. 2019, p. 21)

#### **4.6.4. Nepal**

The Food and Feed Act of Nepal is the key legislation governing food safety and quality. The Department of Food Technology and Quality Control (DFTQC), under the Ministry of Agriculture and Livestock Development, is responsible for implementing the act and ensuring the safety,

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<sup>82</sup> Codex Committee on Contaminants in Foods, 17th Session, 15–19 April 2024, CX/CF 24/17/19, Codex Alimentarius Commission, FAO and WHO.

<sup>83</sup> “Government Mandates Compulsory Ethylene Oxide Testing for Spice Exports to Singapore, Hong Kong,” *Business Today*, April 25, 2024.

<sup>84</sup> “FSSAI Cancels Manufacturing Licences of 111 Spice Producers across India,” *The Times of India*, July 11, 2024.

quality, and nutrition of the country's food and feed.<sup>85</sup> All food and feed firms are required to be licensed by DFTQC. The department also serves as the SPS National Enquiry Point, houses the Codex and International Food Safety Authorities Network (INFOSAN) Secretariat, and administers the National Food and Feed Reference Laboratory (DFTQC 2023).

DFTQC's Food and Feed Safety and Quality Regulation Division is responsible for inspecting and certifying food import and export consignments for safety and quality. The Department of Agriculture and the Department of Livestock Services also help govern food safety and quality, while the Nepal Bureau of Standards and Metrology<sup>86</sup> offers voluntary standards in food safety.

Recently, the government enhanced food safety regulations with the implementation of the National Food Safety Policy 2076,<sup>87</sup> the revision of permissible limits for heavy metals and nutritional ingredients in food in 2022<sup>88</sup> and the enactment of the Food Hygiene and Quality Act 2081 in 2024, which amended and consolidated existing laws relating to food hygiene and quality.

#### **4.6.5. Pakistan**

The Ministry of National Food Security and Research is responsible for ensuring food safety in Pakistan. In addition to the country's SPS regulations, quarantine requirements, and risk analysis of plant- and animal-based imports, which were outlined in the previous section, food imports are subject to safety measures based on Codex standards. These standards cover food additives, preservatives, vitamins, maximum residue limits (MRLs) of pesticides, and other related measures (WTO 2022). The ministry is also responsible for issuing phytosanitary certificates for agricultural exports from Pakistan.

Following multiple rejections of Pakistani rice consignments by the EU over the past three years—due to contamination with pesticide residue, aflatoxin,<sup>89</sup> and genetically modified organisms (which are prohibited in the EU)<sup>90</sup>—calls for corrective action grew urgent to avert a crisis. Because rice is Pakistan's most important agricultural export commodity, it was important to respond effectively. Lapses by two departments under the ministry—the Federal Seed Certification and Registration Department and the Pakistan Agricultural Research Council, which

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<sup>85</sup> The Department of Food Technology and Quality Control has two divisions: Food and Feed Safety and Quality Regulation Division, and the Food Technology Development and Nutrition Division.

<sup>86</sup> The bureau is under the Ministry of Industry, formulates standards (based on international practices for various consumer and industrial products, test methods, management systems, etc.) that are mostly voluntary.

<sup>87</sup> The official document is available only in Nepalese language. Department of Food Technology and Quality Control, Ministry of Agriculture and Livestock Development. <https://dftqc.gov.np/>

<sup>88</sup> This covers nine types of heavy metals, including lead, copper, arsenic, tin, zinc, cadmium, mercury, chromium, and nickel, in different food products. The Food Standard Fixation Committee also set new standards for infant food, in alignment with international standards, *Kathmandu Post*, January 4, 2023.

<sup>89</sup> Indian rice consignments have also a faced large number of rejections due to non-compliance with MRLs. "Rice Exports at Risk," *Dawn*, July 1, 2024. [www.dawn.com/news/1843121](http://www.dawn.com/news/1843121)

<sup>90</sup> "Pakistan Pledges Swift Action as EU Flags Contaminated Rice Shipments," *The News*, December 20, 2024. [www.thenews.com.pk/print/1263485-pakistan-pledges-swift-action-as-eu-flags-contaminated-rice-shipments](http://www.thenews.com.pk/print/1263485-pakistan-pledges-swift-action-as-eu-flags-contaminated-rice-shipments)

are responsible for testing and registering rice varieties—was sharply criticized. It is possible that the GMO contamination resulted from the use of imported Chinese rice seeds (ibid).

In response to the failure of existing quality control departments and to restore the credibility of Pakistan's rice exports, a new food safety regulatory authority is in the works. In January 2025, the Pakistani government passed a draft bill to establish the National Food Safety, Animal, and Plant Health Regulatory Authority, aimed at aligning with international standards.<sup>91</sup>

#### **4.6.6. Sri Lanka**

The Food Control Administration Unit of the Ministry of Health is responsible for food safety in Sri Lanka, including domestic food, export certification of food items, and control of food imports, except animal or animal products and plant or plant products.<sup>92</sup> As noted in the earlier section on SPS measures, plant and plant product imports are controlled by the Plant Quarantine Office of the Department of Agriculture.

Sri Lanka's key food safety legislation is the Food Act 1980 (amended in 2011) and its associated regulations. The country has been a member of the Codex Alimentarius since 1972. While the Food Control Administration Unit implements the mandatory food safety regulations, the Sri Lanka Standards Institution (SLSI), under the Ministry of Science, manages voluntary food safety standards, which are based on international standards.

As the country's national standards board, SLSI is a member of the International Organization for Standardization (ISO). SLSI's Systems Certification Division<sup>93</sup> provides the ISO 22000 Food Safety Management System and SLS1266 HACCP Food Safety Certification Scheme, among its certification services.

However, domestic food safety hazards continue to pose threats, as rigorous testing of food for home consumption is lacking, and adherence to safety and quality standards receives far less attention than that given to food exports (NSF 2022, p. 5). Recently, aflatoxin contamination in imported coconut oil for human consumption and in coconut animal feed has raised concerns, as did heavy metal contamination from the use of cheap imported fertilizers (ibid, p. 3).

There are now concerted efforts to address microbial resistance through the Ministry of Health's National Strategic Plan for Combating Antimicrobial Resistance 2023–2028, which aims to protect human health, food systems, and agriculture, including fisheries and livestock.

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<sup>91</sup> "New Food Safety Authority Planned," *The Tribune*, January 14, 2025.

<https://tribune.com.pk/story/2521932/new-food-safety-authority-planned>

<sup>92</sup> Food Control Administration Unit, Ministry of Health.

[https://eohfs.health.gov.lk/food/index.php?option=com\\_content&view=article&id=43&Itemid=186&lang=en](https://eohfs.health.gov.lk/food/index.php?option=com_content&view=article&id=43&Itemid=186&lang=en)

<sup>93</sup> The Sri Lanka Standards Institute is accredited by the Sri Lanka Accreditation Board for Conformity Assessment, under the purview of the Ministry of Trade Commerce and Food Security. The board is the National Accreditation Authority and a member of several international accreditation groups, including the International Accreditation Forum for Food Safety Systems. [www.iafcertsearch.org/accreditation-body/d5ffc70a-98c0-5121-aa81-a7cf0e82f06e](http://www.iafcertsearch.org/accreditation-body/d5ffc70a-98c0-5121-aa81-a7cf0e82f06e)

## 4.7. Comparative Assessment of the Regulatory Regimes

The review of South Asia's import regimes for agricultural products, as presented in the previous sections, reveals that all six countries have similar phytosanitary certification requirements and quarantine procedures. However, Nepal has the most liberal system, allowing easy clearance at quarantine customs checkpoints based on certification from the country of origin, with only doubtful cases subject to further examination. Import of seeds in all countries requires import permits and is allowed for notified varieties. Bangladesh and Sri Lanka require compliance with additional tests—and Bhutan requires GMO-free certification—in addition to the import permit. Pakistan allows the import of seeds for sowing, subject to the variety being enlisted by the certification department.

India has the most protected regime, with agricultural products such as rice falling under a “restricted import policy.” The import of rice and wheat seeds for sowing requires additional approval from specialized agencies. India also maintains a list of prohibited country products in the Plant Quarantine Management System, identifying sources from which plant materials or products are banned due to the presence of diseases or pests.

Similarly, the import regime for agricultural equipment and appliances, such as water pumps, sprayers, and zero tillage seeders was found to be the most liberal in Bhutan, Bangladesh, Pakistan, Nepal, and Sri Lanka, and the most protected in India due to high import tariffs, even after accounting for concessions under free or preferential trade agreements (Tables 21 and 23).

A comparison of the regulatory regimes in food safety across the six South Asian countries shows that, while legislative regulations and other guidelines on quality standards exist in all the countries, their enforcement has been problematic. Common food safety constraints include weak administrative capacity, limited skilled human resources, and inadequate technical capacity. In particular, Bhutan and Nepal have inadequate infrastructure capacity and skilled personnel. More recently, Nepal has attempted to consolidate food safety regulations and agencies. In Bangladesh, non-compliance in pest risk analysis and microbial contamination have been observed, with underutilization of testing equipment provided by a donor agency, pointing to a skills gap. In India, corruption has been cited as a contributing factor to enforcement challenges.

The rejection of some food export consignments in developed country markets in both India and Pakistan led to internal scrutiny of their food safety certification systems, the shutting down of several spice manufacturers in India, and the proposal to establish a new food safety authority in Pakistan. This development showcases the dichotomy within food systems in these countries as they rush to comply with higher food safety standards for exports to developed country markets but have little incentive to enforce domestic standards.

All six South Asian countries are also voluntary members of international organizations associated with food safety standards and certification, such as the Codex Alimentarius and the ISO. Bangladesh, India, Nepal, and Sri Lanka are also members of the international group concerned with food safety—the International Food Safety Authorities Network (INFOSAN)—in which the secretariat coordinates information exchange between countries' national agencies and could facilitate technical assistance on request in response to a food safety incident.

The seed certification process in most South Asian countries is centralized and handled by one national body, except in India, where given the large size of the country, seed certification agencies function at the state level. Seed imports require permits in all the countries, and import is allowed only for notified varieties. Nepal has acknowledged that seed quality control is challenging, and is encouraging joint ventures by domestic and international seed companies.

In the seed testing and certification arena, world-class capacity is constrained in the region. Only three countries have ISTA-accredited laboratories, with only one ISTA-accredited laboratory each in Bangladesh and Pakistan, and nine in India.<sup>94</sup> In Bangladesh, the National Seed Testing Laboratory and the Bangladesh Agricultural Development Corporation are nonaccredited laboratory members, while the only ISTA-accredited laboratory member is a private seed business enterprise.<sup>95</sup> On the other hand, Pakistan's ISTA-accredited laboratory is under the government's Federal Seed Certification and Registration Department. Although India has the largest number of ISTA-accredited laboratories<sup>96</sup> in South Asia, the Indian Minimum Seed Certification Standards are not considered to be on par with international standards, and only a small proportion of seed testing laboratories in the country (relative to its size) are accredited by ISTA.

Overall, food safety technical capacity and institutional capacity are highest in India compared with its neighbors. Not surprisingly, efforts have been initiated for collaborative capacity building, such as the Global Food Safety Partnership in 2017. A World Bank public-private initiative launched a partnership with FSSAI for capacity building to strengthen food control systems in South Asia.<sup>97</sup> More recently, Bhutan, India, and Nepal have proposed to work together under a WHO project for more active participation in the Codex Alimentarius standard-setting process (WHO 2020, p. 7).

Earlier efforts to achieve conformity in standards with freer trade led to the creation of regional institutions of regulatory cooperation. As part of this effort, SAARC member states set up the SAARC Standards Coordination Board in 2006 when SAFTA came into effect. This was followed by the establishment of the South Asian Regional Standards Organization (SARSO) in 2011, aimed at easing technical barriers to trade within the region. While encouraging the adoption of international standards, SARSO is also tasked with developing standards for products of particular interest to the region.<sup>98</sup> In 2017, the Agreement on 'Multilateral Arrangement on Recognition of Conformity Assessment' came into effect. The agreement aims to facilitate the member states to accept results of the conformity assessment within the SAARC region. The

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<sup>94</sup> As of October 16, 2024, International Seed Testing Association.

[www.seedtest.org/en/membership/member-search.html](http://www.seedtest.org/en/membership/member-search.html)

<sup>95</sup> MNT Seed Testing Lab of Lal Teer Seed Limited.

<sup>96</sup> Seven private labs (Namdhari Seeds Pvt. Ltd., Mahyco Private Ltd., Indo-American Hybrid Seeds (India) Pvt. Ltd., Nuziveedu Seeds Ltd., Kalash Seeds Pvt. Ltd., East West Seeds India Pvt. Ltd., and Advanta Enterprises Ltd) and two public sector labs (Seed Testing Laboratory of the Department of Seed Certification and Organic Certification, and Telangana State Seed of the Organic Certification Authority). [www.seedtest.org/en/membership/member-search.html?memberType=Accredited+Laboratory+Member&country=India&testType=&testMethod=](http://www.seedtest.org/en/membership/member-search.html?memberType=Accredited+Laboratory+Member&country=India&testType=&testMethod=)

<sup>97</sup> Food Safety and Standards Authority of India website. <https://fssai.gov.in/cms/multilateral-engagements.php>

<sup>98</sup> [www.saarc-sec.org/index.php/saarc-specialized-bodies](http://www.saarc-sec.org/index.php/saarc-specialized-bodies)

Board of Conformity Assessment (BCA) established under this agreement will be responsible for planning, coordinating, and monitoring all conformity assessment work carried out by SARSO.

## 5. CONCLUSION

### 5.1 Regional Cooperation Strategy to Scale Up CSA among SAARC Countries

The review in the preceding sections highlight that countries most vulnerable to climate change in South Asia have set the most ambitious mitigation and adaptation goals (Bangladesh), contribute to net carbon sequestration through forest cover (Bhutan), and produce clean hydropower (Nepal and Bhutan). A comparison of countries' climate commitments in the agriculture sector under the Paris Agreement showed that the country with the largest economy, India, has remained shy of any ambitious quantifiable targets despite implementing elaborate programs in sustainable and climate-resilient agriculture. Given the shared ecosystem resources of the six countries, including river basins, coastal wetlands, and forests, it is essential to have a coordinated effort in addressing the transboundary problem of climate change. Moreover, regional cooperation is crucial to achieving the individual country climate commitments and food security and preparing the agriculture sector for climate shocks.

The SAARC members have long understood the need for cooperation in environment, climate change, and natural disasters, as well as recognizing that the development process and prospects of the South Asian countries are severely undermined by these challenges. Indeed, the member states at "successive Summits since 1987, have reiterated the need to strengthen and intensify regional cooperation to preserve, protect and manage the diverse and fragile eco-systems of the region, including the need to address the challenges posed by climate change and natural disasters."<sup>99</sup>

In the 14th SAARC Summit 2007 in New Delhi, the Council of Ministers recognized the need to make the region resilient to climate change through rapid social and economic development to overcome its limited capacities and vulnerabilities. In 2008, the Dhaka Declaration of the SAARC Environment Ministerial meeting adopted the SAARC Action Plan on Climate Change and also called upon the Annex-I countries to fulfill their commitments under the UNFCCC to provide additional resources. Soon after, in 2009, the Delhi Statement on Cooperation in Environment of the SAARC Environment Ministers reaffirmed the action plan and underscored the need to fully implement the commitments under the UNFCCC in accordance with its principle of equity and common but differentiated responsibilities and respective capabilities. At the 16th SAARC Summit 2010 in Thimphu, members adopted the Statement on Climate Change to promote climate resilience in the region and reiterated the principles of equity and common but differentiated

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<sup>99</sup> SAARC Secretariat. [www.saarc-sec.org/index.php/areas-of-cooperation/environment-natural-disasters-biotechnology](http://www.saarc-sec.org/index.php/areas-of-cooperation/environment-natural-disasters-biotechnology)

responsibilities and respective capabilities within the UNFCCC. The SAARC Convention on Cooperation on Environment was signed to strengthen regional cooperation through collaboration and exchange of best practices, knowledge, capacity building, and transfer of eco-friendly technologies, including those pertaining to climate change, eco-system management for sustainable livelihoods, and more.

The SAARC Action Plan on Climate Change 2009–2011 identified areas for regional cooperation, including adaptation (covering sectors such as water, agriculture, and fisheries), mitigation (including sharing best practices on nationally appropriate mitigation actions and sustainable forest management), and technology transfer, among seven thematic areas. The action plan prioritized exchange of meteorological data and information on disaster preparedness and extreme climate events, as well as mutual consultation in international negotiation process. Finally, with respect to regional cooperation, the action plan proposed that existing institutional arrangements within SAARC could be effectively leveraged. Thus, existing trade arrangements and other agreements can serve as a foundation for fostering greater cooperation in building a climate-resilient South Asian region.

## **5.2 Strategy to Scale Up CSA**

Greater trade and investment within the region can serve as the conduit for diffusion of CSA technologies and support their scaling up across the six countries. Sharing climate-smart technologies developed in one country with countries that have with similar agro-climatic conditions can generate positive externalities and spur further innovations. For instance, commercially viable climate-resilient seeds developed for staple cereals like rice in Bangladesh or India can be made more readily available in the region for large-scale use.

SAFTA, the existing regional free trade agreement, has had little impact on enhancing integration over the last two decades, and South Asia remains among the least-integrated regions in the world due to its restrictive trade regime. Yet, as noted in Section III.3, bilateral free trade agreements between South Asian countries and extra-regional partners have long incorporated deep trade liberalization measures anchored in sustainable development (such as the India–Japan 2011 agreement). The lack of economic integration and coordinated environmental action within the region has led to loss of potential trade and environmental benefits.

Similarly, despite the 2011 agreement establishing the SAARC Seed Bank to ensure seed security for food regional food security and to facilitate seed trade through harmonized seed testing and certification, actual trade in staple cereals has been negligible. This is especially true for India, which maintains a restricted policy in this sector.

The region needs to deepen the SAFTA to foster more meaningful and coordinated regional cooperation. Greater regional trade should be aligned with sustainable development goals through an augmented SAFTA that affirms members' commitments under the Paris Agreement. It should specifically encourage trade liberalization and dissemination of CSA technology. In summary, deepening SAFTA would:

- Anchor trade liberalization in SAFTA on the principle of sustainable development.

- Include provisions on environmental protection regulations and mechanism for ensuring their compliance in member countries.
- Encourage trade and dissemination of CSA goods and services, while reaffirming member states' obligations under the Paris Agreement.
- Incorporate a clear SPS clause to facilitate trade in food and agricultural materials, including climate-resilient seeds.

Finally, as the region's largest economy, India needs to take a leading role in strengthening SAARC and increasing regional integration. Doing so would align with the principle of common but differentiated responsibilities and capabilities in environmental action, as well as the principle of special and differential treatment in trade—both of which India has long been committed to advancing. This would involve India moving toward greater liberalization of trade in CSA technology products and materials, thereby facilitating the scaling up of CSA practices across the region.

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## REFERENCES

- Ahmed, Sharif, Manik Debnath and Humnath Bhandari (2024) *Sorjan Farming: A Sustainable Solution for Climate Resilience in Coastal Bangladesh*, International Rice Research Institute.
- Bangladesh DoE (2023) *Bangladesh: First Biennial Update Report to the United Nations Framework Convention on Climate Change*, Department of Environment, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, June 2023.
- Bangladesh MoEFCC (2023) *Bangladesh: First Biennial Update Report to UNFCCC*, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, June 2023.
- Bangladesh MoEFCC (2022) *Mujib Climate Prosperity Plan 2022-2041*, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh.
- Bangladesh MoEFCC (2022a) *National Adaptation Plan 2023-2050*, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh.
- Bangladesh MoEFCC (2021) *Nationally Determined Contributions 2021: Bangladesh (Updated)*, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, 26 August 2021.

- CGIAR (2013) *Climate-smart agriculture success stories from farming communities around the world*, CGIAR Research Program on Climate Change, Agriculture and Food Security, and the Technical Centre for Agricultural and Rural Cooperation.
- Charnovitz, Steve (1991) "Exploring the Environmental Exceptions in GATT Article XX", *Journal of World Trade*, Volume 25(5): 37-55.
- Chhetri, V. and T. Dorji (2021) "Food safety surveillance in Bhutan: conducted from 2019 to 2021", *Journal of Food Safety and Hygiene*, Vol 7(4), 215-225.
- CIAT and World Bank (2017) *Climate-Smart Agriculture in Bangladesh*. CSA Country Profiles for Asia Series, International Center for Tropical Agriculture (CIAT); World Bank. Washington, D.C.
- DoECC (2023) *Bhutan's Long-Term Low Greenhouse Gas Emission and Climate Resilient Development Strategy*, Department of Environment and Climate Change, Ministry of Energy and Natural Resources, Royal Government of Bhutan.
- EPA (2019) *Global Non-CO2 Greenhouse Gas Emission Projections and Mitigation 2015-2050*, EPA-430-R-19-010, United States Environmental Protection Agency, Washington D.C.
- DFTQC (2023) *Annual Bulletin 2078/79 (2021/22)*, Department of Food Technology and Quality Control, Ministry of Agriculture and Livestock Development, Government of Nepal.
- Diagne, M. Langston, Nagano, A., and Bernoux, M. (2023) *Climate Change Mitigation Options in Agrifood Systems: Summary of the Working Group III contribution to the Intergovernmental Panel on Climate Change Sixth Assessment Report (AR6)*, Food and Agriculture Organization of the United Nations, Rome.
- FAO (2023) *The State of Food and Agriculture 2023 – Revealing the true cost of food to transform agrifood systems*. Food and Agriculture Organization of the United Nations, Rome. <https://doi.org/10.4060/cc7724en>
- FAO (2023a) *Food Safety Implications from the Use of Environmental Inhibitors in Agrifood Systems*, Food Safety and Quality Series, No. 24, Food and Agriculture Organization of the United Nations, Rome. <https://doi.org/10.4060/cc8647en>
- FAO, IFAD, UNICEF, WFP and WHO (2023) *The State of Food Security and Nutrition in the World 2023*, Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Program, World Health Organization. FAO, Rome. <https://doi.org/10.4060/cc3017en>
- GED (2020) *8<sup>th</sup> Five Year Plan July 2020-June 2025: Promoting Prosperity and Fostering Inclusiveness*, General Economics Division, Bangladesh Planning Commission, Government of People's Republic of Bangladesh.
- GED (2020a) *Making Vision 2041 a Reality: Perspective Plan of Bangladesh 2021-2041*, General Economics Division, Bangladesh Planning Commission, Government of People's Republic of Bangladesh.
- GED (2015) *7<sup>th</sup> Five Year Plan FY2016-FY2020: Accelerating Growth, Empowering Citizens*, General Economics Division, Bangladesh Planning Commission, Government of People's Republic of Bangladesh.
- GOI (2023) *Annual Report 2022-23*, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.
- GOI (2022) *India's Updated First Nationally Determined Contribution Under Paris Agreement (2021-2030)*, August 2022 Submission to UNFCCC.
- GOI (2014) *National Agroforestry Policy 2014*, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.
- GON (2021) *Nepal's Third National Communication to the United Nations Framework Convention on Climate Change*, Ministry of Forests and Environment, Government of Nepal, Kathmandu.
- GON (2021a) *Nepal's Long-term Strategy for Net-zero Emissions*, Government of Nepal, Kathmandu.
- GON (2021b) *National Adaptation Plan (NAP) 2021-2050*, Government of Nepal.
- GON (2020) *Second Nationally Determined Contributions*, Government of Nepal, Kathmandu.
- GON (2019) *National Agroforestry Policy 2019 (2076)*, Government of Nepal, Kathmandu.

- GON (2011) *National Framework on Local Adaptation Plans for Action*, Ministry of Environment, Climate Change Management Division, Government of Nepal, Kathmandu.
- GOP (2021) *Pakistan: Updated Nationally Determined Contributions 2021*, Government of Pakistan.
- GOP (2018) *Punjab Agriculture Policy 2018*, Ministry of Agriculture, Government of Punjab, Pakistan.
- GOP (2016) *Pakistan's Intended Nationally Determined Contributions (PAK-INDC)*, Government of Pakistan.
- GOS (2023) *Sri Lanka Climate Prosperity Plan: Preliminary Report*, Government of Sri Lanka, Climate Vulnerable Forum, and Vulnerable Twenty Group.
- India MoEFCC (2023) *India: Third National Communication and Initial Adaptation Communication to the United Nations Framework Convention on Climate Change*, Ministry of Environment, Forest and Climate Change, Government of India, New Delhi.
- India MoEFCC (2022) *India's long-term low-carbon development strategy*, submission to the United Nations Framework Convention on Climate Change, Ministry of Environment, Forest and Climate Change, Government of India.
- India MoEFCC (2021) *India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change*, Ministry of Environment, Forest and Climate Change, Government of India, New Delhi.
- IPCC (2023) *Climate Change 2023: Synthesis Report*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, Geneva, Switzerland.
- IPCC (2022) "Asia", Chapter 10, *Climate Change 2022: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva, Switzerland.
- Ishtiaque, A., T. J. Krupnik, V. Krishna, et al. (2024) "Overcoming barriers to climate-smart agriculture in South Asia", *Nature Climate Change*, Volume 14: p111-113. <https://doi.org/10.1038/s41558-023-01905-z>
- Khetarpal, R. K. (2019) "Phytosanitary Capacity Evaluation of Bangladesh Plant Quarantine System", Consultant Project Report, United States Department of Agriculture.
- Mbow, C., C. Rosenzweig, L.G. Barioni, T.G. Benton, M. Herrero, M. Krishnapillai, E. Liwenga, P. Pradhan, M.G. Rivera-Ferre, T. Sapkota, F.N. Tubiello, Y. Xu (2019) "Food Security", chapter in *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, Intergovernmental Panel on Climate Change.
- Mehdi, A., P. Tomar, D. Chaudhry, and P. Joshi (2019) *Streamlining Food Safety Compliance Ecosystem in India*, Indian Council for Research on International Economic Relations, New Delhi, India.
- MENR (2023) *National Adaptation Policy (NAP) of the Kingdom of Bhutan*, Department of Environment and Climate Change, Ministry of Energy and Natural Resources, Royal Government of Bhutan.
- MoAF (2021) *RNR Strategy 2040*, Policy and Planning Division, Ministry of Agriculture and Forests, Thimphu, Bhutan.
- MoAF (2020) *National Food Safety Index 2019-2020*, Bhutan Agriculture and Food Regulatory Authority, Ministry of Agriculture and Forests, Thimphu, Bhutan.
- MOAPI (2021) *National Agriculture Policy 2021*, Ministry of Agriculture and Plantation Industries, Government of Sri Lanka. <https://www.agrimin.gov.lk/web/index.php/en/downloads/policy>
- MOCCEC (2023) *National Adaptation Plan: Pakistan 2023*, Ministry of Climate Change and Environmental Coordination, Government of Pakistan.
- MOCC (2023) *National Clean Air Policy*, Ministry of Climate Change, Government of Pakistan
- MOCC (2022) *Pakistan's First Biennial Update Report (BUR-1) to the United Nations Framework Convention on Climate Change*, Ministry of Climate Change, Government of Pakistan.
- MOCC (2021) *National Climate Change Policy*, Ministry of Climate Change, Government of Pakistan.
- MOE (2022) *National Environmental Action Plan 2022-2030: Pathway to sustainable development*, Ministry of Environment, Sri Lanka.

- MOE (2021) *Updated Nationally Determined Contributions*, Ministry of Environment, Sri Lanka.
- MOE (2016) *National Adaptation Plan for Climate Change Impacts in Sri Lanka: 2016-2025*, Climate Change Secretariat, Ministry of Mahaweli Development and Environment, Ministry of Environment, Sri Lanka.
- MOE (2010) *National Climate Change Adaptation Strategy for Sri Lanka: 2011 to 2016*, Climate Change Secretariat, Ministry of Environment, Sri Lanka.
- Monteiro, J.A. and J.P. Trachtman (2020) "Environmental Laws" in Aditya Mattoo, Nadia Rocha and Michele Ruta eds. *Handbook of Deep Trade Agreements*, World Bank, pp. 553-582.
- MST (2022) *Guidelines for the Safety Assessment of Genome Edited Plants 2022*, Ministry of Science and Technology, Government of India.
- NEC (2022) *First Biennial Update Report to the UNFCCC*, National Environment Commission, Royal Government of Bhutan
- NEC (2020) *Climate Change Policy of the Kingdom of Bhutan 2020*, National Environment Commission, Royal Government of Bhutan.
- NITI Aayog (2024) *Working Group Report on Crop Husbandry, Agriculture Inputs, Demand and Supply*, National Institution for Transforming India, Government of India.
- NITI Aayog (2022) *A New Paradigm for Indian Agriculture: From Agroindustry to Agroecology*, National Institution for Transforming India, Government of India.
- NPC (2021) *Nepal's Food System Transformation: Context, Pathways and Actions*, Outcome of the National and Provincial Food Systems Dialogue as a part of the UN Food Systems Summit 2021. National Planning Commission, Singha Durbar, Kathmandu, Nepal.
- RGoB (2021) *Second Nationally Determined Contribution*, submission to UNFCCC, Kingdom of Bhutan, Royal Government of Bhutan.
- RGoB (2018) *Twelfth Plan Main Document (2018-2023)*, Planning Commission, Royal Government of Bhutan.
- RGoB (2013) *Eleventh Plan Main Document (2013-2018)*, Planning Commission, Royal Government of Bhutan.
- RGoB (2008) *Tenth Plan Main Document (2008-2013)*, Planning Commission, Royal Government of Bhutan.
- RGoB (2002) *Ninth Plan Main Document (2002-2007)*, Planning Commission, Royal Government of Bhutan.
- Shaw, R. et al (2022) "Asia", Chapter 10, *Climate Change 2022: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Geneva, Switzerland.
- Shaw, R., Y. Luo, T.S. Cheong, S. Abdul Halim, S. Chaturvedi, M. Hashizume, G.E. Insarov, Y. Ishikawa, M. Jafari, A. Kitoh, J. Pulhin, C. Singh, K. Vasant, and Z. Zhang (2022) "Asia", in *Climate Change 2022: Impacts, Adaptation and Vulnerability*, Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Lösche, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1457–1579.
- Some, Shreya, Joyashree Roy and Arpita Ghose (2019) "Non-CO<sub>2</sub> emission from cropland based agricultural activities in India: A decomposition analysis and policy link", *Journal of Cleaner Production*, 225: 637-646.
- Suman, Saujahya, S. Manyam, K. V. Satyanarayana, and K. Vijayaraghavan (2021) "Food Safety System in Bangladesh: Current Status of Food Safety, Scientific Capability, and Industry Preparedness", Consultant Report, Feed the Future: Innovation Lab for Food Safety, USAID.
- Tirado, M.C., R. Clarke, L.A. Jaykus, A. McQuatters-Gollop, and J.M. Frank. (2010) "Climate change and food safety: A Review", *Food Research International*, 43: 1745-1765.
- Trang, Vu H., Nelson KM, Rose S, Khatri-Chhetri A, Wollenbeg E, Sander BO. (2020) "Rice cultivation ambition in the new and updated Nationally Determined Contributions: 2020-2022: Analysis of agricultural sub-sectors in countries' climate change strategies". *CCAFS Info Note*. Wageningen, The Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security.

WHO (2020) *Framework for Action on Food Safety in the WHO South-East Asia Region*, Regional Office for South-East Asia, World Health Organization.

World Bank (2024) *Climate Risk Country Profile: Bangladesh*, The World Bank Group, Washington D.C.

World Bank (2022) *Pakistan: Country Climate and Development Report*, The World Bank Group, Washington D.C.

WTO (2022) *Trade Policy Review: Pakistan*, Report by the Secretariat, Trade Policy Review Body, (WT/TPR/S/424/Rev.1), World Trade Organization.

WTO (2022a) *World Trade Report: Climate Change and International Trade*, World Trade Organization

WTO (2017) *Trade Policy Review: Sri Lanka*, Report by the Secretariat, Trade Policy Review Body, (WT/TPR/S/347/Rev.1), World Trade Organization.

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