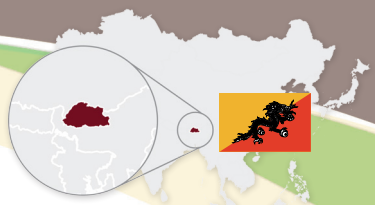

Climate-Smart Agriculture in Bhutan

Climate-smart agriculture (CSA) considerations

P I $ Bhutan's economy is dependent on the agriculture, livestock and forest sectors, which provide livelihoods for about 57% of the total population. The contribution of these sectors to the Gross Domestic Product (GDP) has been increasing in absolute terms year-on-year but the overall contribution to national GDP has been decreasing (from 22.57% in the year 2005 to 16.18% in 2013). This decrease is a result of booming economic development in secondary and tertiary sectors [14].

P I Subsistence farming is an integral part of the Bhutanese economy, though efforts and programs targeted towards semi-commercialization have been undertaken by the Ministry of Agriculture and Forests (MoAF) through farmers groups and primary cooperatives development. Farming in Bhutan is mostly at a small scale and dominated by rain fed dry land and wetland farming. It depends on the monsoon rain, which accounts for 60 to 90% of annual precipitation. Livestock rearing (mainly dairy and poultry) remains another main activity for farmers.

P A Amongst the various challenges facing the farming communities (such as shortage of irrigation water, manpower for agriculture, marginal land holding, high transportation costs for inputs and marketing, remote and scattered location of rural households) the impact of climate change is being manifested in the form of glacier lakes outburst, flash floods, windstorms, erratic rainfall, outbreak of new pests and diseases, increasing human-wildlife conflicts with wild animals damaging the crops, and increasing incidences of forest fire.

P A M I $ The Royal Government of Bhutan (RGoB), recognizing the potential impacts of climate change to the Renewable Natural Resources (RNR) sector, identified Climate Smart Agriculture as one of the key strategies for adaptation to climate change in the ongoing 11th Five Year Plan (2013 – 2018). However, farmers' awareness of CSA and the associated opportunities and challenges is poor; the availability of CSA technologies is limited; and farmers do not have any safety nets or alternative sources of livelihoods if investment activities fail.

A Adaptation M Mitigation P Productivity I Institutions $ Finance

The climate-smart agriculture (CSA) concept reflects an ambition to improve the integration of agriculture development and climate responsiveness. It aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and reduce/remove greenhouse gases (GHGs), and require planning to address tradeoffs and synergies between these three pillars: productivity, adaptation, and mitigation [7]. The priorities of different countries and stakeholders are reflected to achieve more efficient, effective, and equitable food systems that address challenges in environmental, social, and economic dimensions across productive landscapes. While the concept is new, and still evolving, many of the practices that make up CSA already exist worldwide and are used by farmers to cope with various production risks [8]. Mainstreaming CSA requires critical stocktaking of ongoing and promising practices for the future, and of institutional and financial enablers for CSA adoption. This country profile provides a snapshot of a developing baseline created to initiate discussion, both within countries and globally, about entry points for investing in CSA at scale.

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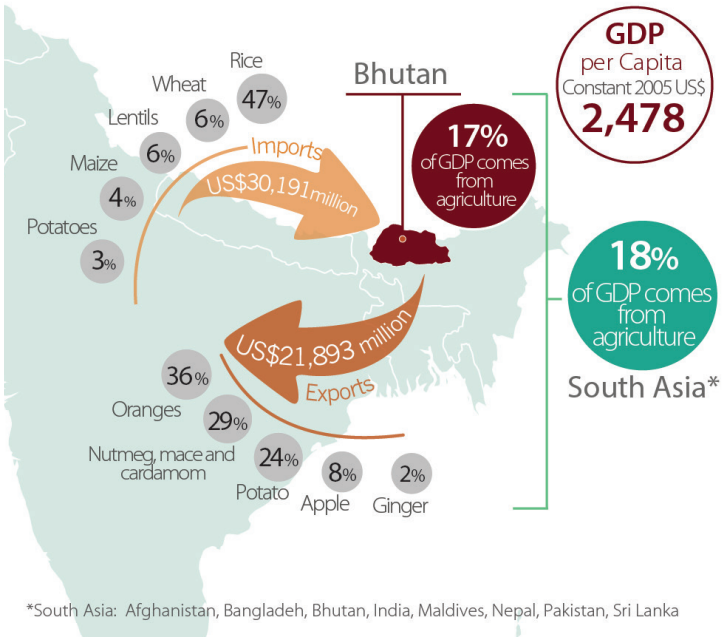
National context

Economic relevance of agriculture

Bhutan is one of the world's smallest and least developed countries, with an economy based primarily on agriculture, livestock and forestry (also known as the Renewable Natural Resource (RNR) sectors). These provide livelihoods for approximately 57% of the population. Although GDP from RNR has increased in absolute terms over the years, the contribution to national GDP has declined significantly, from 23% in 2005 to 16% in 2013[1]. This is mainly due to booming developments in secondary and tertiary sectors. Nevertheless, the RNR sector continues to be the third largest contributor to national GDP after the industries and services sectors [16]. On average, agriculture value added has been at 17.2% over the past five years.

In 2014, the country earned BTN 2,542 million (USD 39.53 million) from agricultural exports, including cash crops such as oranges, cardamom, apple, potato, and vegetables. In the same year, imported agricultural products were worth BTN 6,777 million (USD 71.86 million).While food self-sufficiency and food security are the underlying strategies of the Ministry of Agriculture and Forests (MAF), imports of major commodities (rice, potato, vegetables and dairy products) have been increasing steadily over the years[2] [16]. This has been associated with a decrease in agriculture activities due to a number of challenges persisting in agricultural production, associated with limited availability of farm inputs, rural infrastructure (including for irrigation) and labor availability in rural areas, among others.

Economic relevance of agriculture in Bhutan [5, 46]

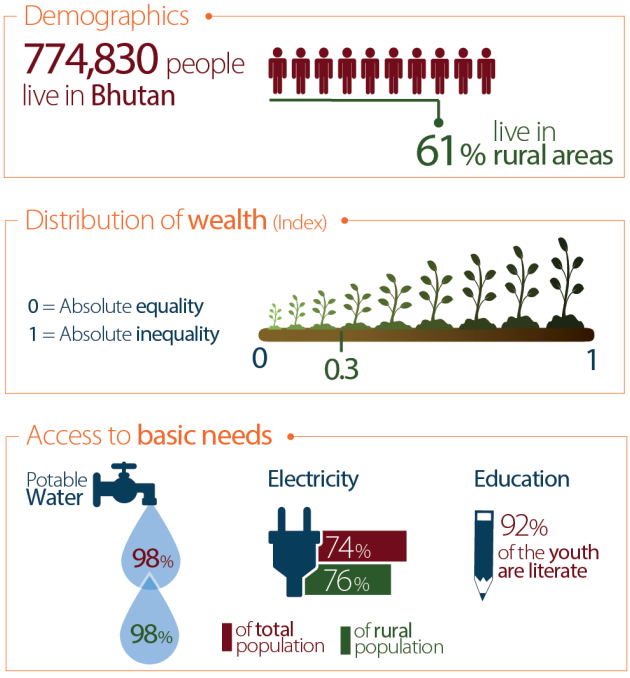


*South Asia: Afghanistan, Bangladeh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

Bhutan has a population of approximately 635,000 inhabitants, with more than two-thirds living in rural areas [29]. A 40% increase of the population is expected within the next 25 years. The unemployment rate stands at 3.1%. Crop farming, livestock and forest sectors provide employment to about 58% of the people in the country. Agricultural production in Bhutan is predominantly small-scale and subsistence-oriented. Approximately 94% of farms cultivate on 2 hectares of land or less, whereas the average farm size lies at approximately 1 hectare [18].

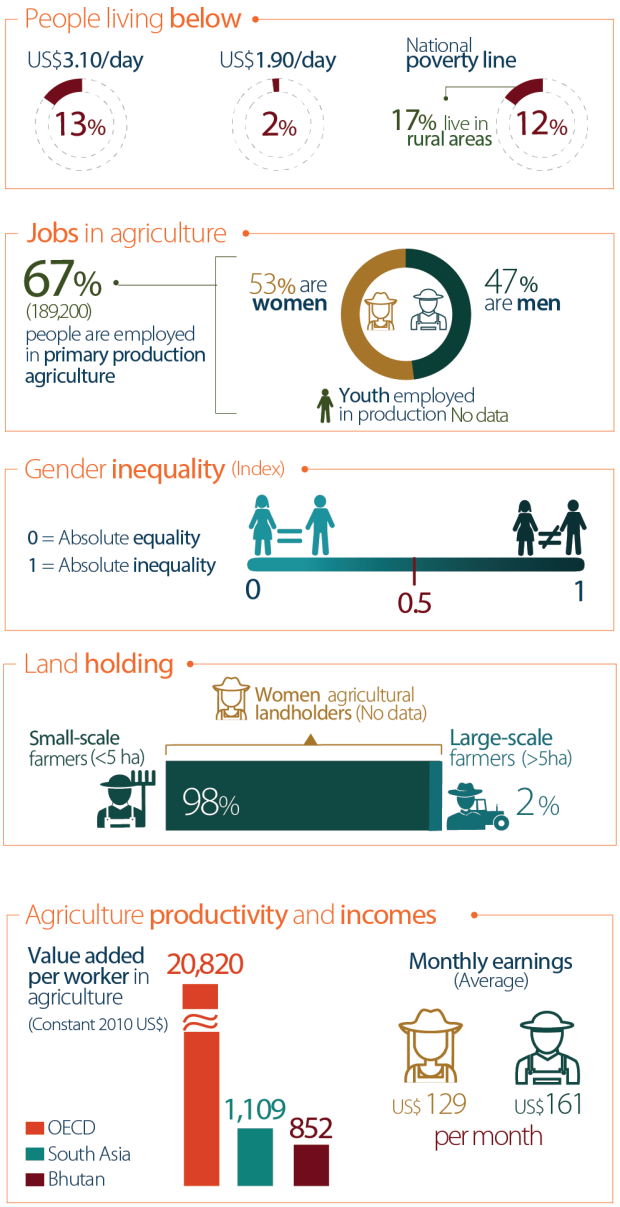
With a steadily growing GDP per capita (estimated at US$ 2,584 in 2012 [30] and a proven, internationally acclaimed track record of reducing poverty rates, Bhutan aims to achieve Middle Income Country (MIC) status in few years (though have no specific target year). Approximately 2% of the total populations live with less than US$ 1.90 per day, 98% have access to improved drinking water resources, 74% have access to electricity, and 66% to improved sanitation facilities [22]. The country scores fairly low in income and gender equality (with a gender inequality index of 0.5 and rural GINI index of 0.38) [30]. Multidimensional poverty indicators show relatively low rates of deprivation in education (both formal and non-formal) and health (food security and child mortality), at 2.5% and less than 1% of the population, respectively [30]. In the most recent five-year period (2007-12), per-capita consumption increased by roughly 5.5% in real terms as compared to 2007 [30]).

People, agriculture and livelihoods in Bhutan [5, 16, 18, 30, 31, 42, 45, 47]



1 Between 2005 and 2013, the RNR sector contribution to GDP (in constant prices) decreased from 9.8%to 6.5% in agriculture, from 6.8% to 3.8% in livestock and 4.9% to 3.1% in forestry sub-sector.

2 The value of rice imports increased from BTN 1,202 million in 2012 to 1,788million in 2014 and for potato from BTN 61 million to BTN 81million. Vegetables and dairy products imports also boosted over the same period, from BTN 127 million to 411 in 2014 (vegetables) BTN 603 million to 1,246 million (dairy) [15].



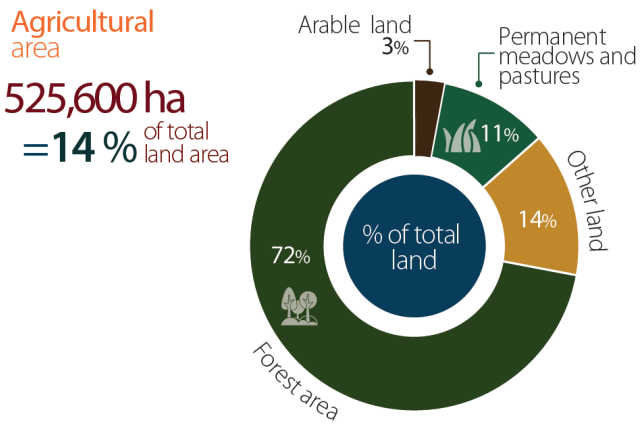
Land use

Bhutan's Constitution requires 60% of its land area to be covered by forests. Currently, approximately 71% of the country is covered by trees such as blue pine, broadleaf, conifer, Chir pine, fir, and fixed conifer forest. Of the remaining area, agricultural land area is very low at 2.93% of total land area. The rest of the land is made up of marshy, meadows, shrubs, bare land, snow cover, water bodies, and built and non-built up areas (waste dump sites, mines, stone quarries and other).

Agriculture land cover includes: drylands (68,255 ha, equivalent of 61% of agricultural land), wetlands (31,911 hectares [ha], representing 29% of agricultural land), apple orchards (2,081 ha), citrus orchards (5,488 ha), cardamom plantations (3,600 ha), arecanut plantations (1,199 ha), and other horticulture (16 ha) [16].

Despite the limited land available for cultivation, land productivity in value terms has been increasing. A shift to high-value commercial crops such as kiwi, hazelnuts, shiitake mushroom, cardamom, orange and apples[3] has contributed to a rise in production value per acre. FAO estimated 8% annual growth in crop production per hectare over 2006 to 2011, on top of 7% annual increase over the preceding five year period [30][4]. At the same time, the area under cereals has been declining, being substituted by fruit and vegetable crops, largely for import substitutions [30].

Land use in Bhutan [5]



Agricultural production systems

Bhutan is a land-locked country in the eastern Himalayas with elevation that ranges from 100 meters above sea level (m.a.s.l.) in the southern foothills to around 7,500 meters in the northern peaks. The country's picturesque topography consists of tall mountains, thick forests and tumultuous rivers with five Agro-Ecological Zones (AEZs): wet-subtropical, humid-subtropical, dry-subtropical, warm temperate, cool temperate and alpine (see Annex 1 for map and more details).

The wet subtropical (100-600 m.a.s.l.), humid subtropical (600-1200 m.a.s.l.), and dry subtropical (1200-1800 m.a.s.l.) zones are located in the Himalayan foothills in the southern belt and are characterized by high humidity and heavy rainfall, with temperatures ranging from 15°C to 30°C all year round [13]. The dry-subtropical AEZ (13% of the country's area) is dominated by maize, paddy, millet, pulses, fruit trees, wild lemon grass, cattle, pigs, poultry, and vegetables farming. In the humid sub-tropical areas and wet subtropical zones - making up 10% and 6% of the country's area, respectively - farmers most commonly cultivate paddy, mustard, wheat, pulses, tropical fruit trees and vegetables.

3 Spurred by trade agreements with India and Bangladesh, Bhutan has been shifting to crops more suited to its comparative advantage.

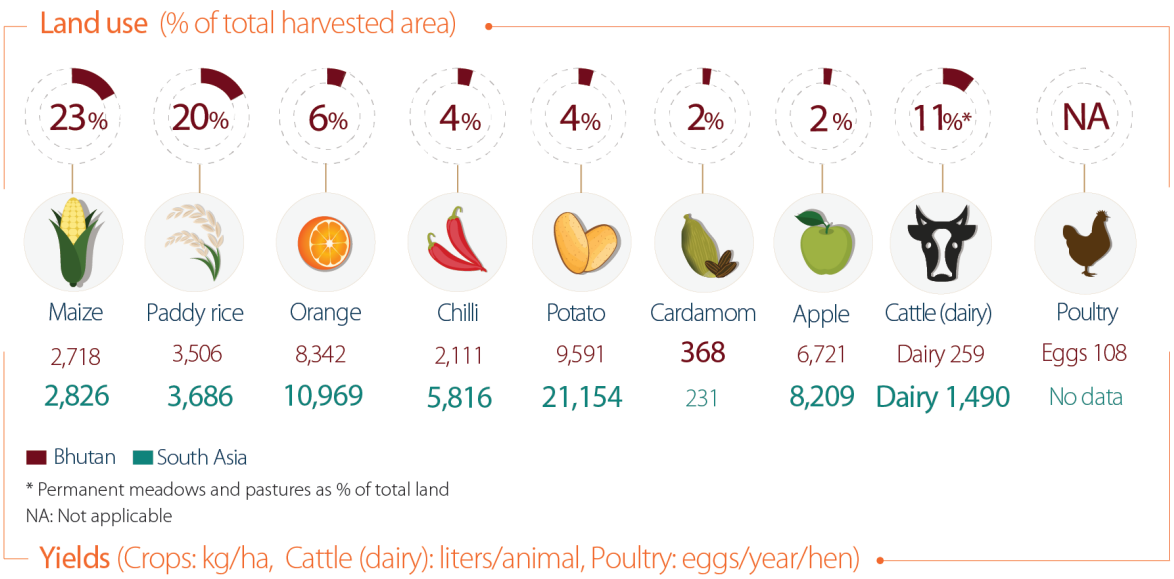
4 Real GDP from agriculture (adjusted for price changes) shows lackluster growth over the same period. With production shifting fast to high-value crops, the GDP for agriculture, which is based on 2000 figures, is likely to underestimate the real GDP from agriculture.

Warm temperate (1800-2600 m.a.s.l.) and cool temperate (2600-3600 m.a.s.l.) zones are found in the main central valleys, characterized by cool winters and hot summers with moderate rainfall. Summer temperatures usually range from 15°C to 26°C, while winter temperatures range from -4°C to 15°C. In the cool temperate zone, extending over almost a quarter of the area, farmers are in charge of yaks, cattle, sheep, and horses rearing, as well as of crop production (barley, wheat, potatoes, buckwheat, mustard, temperate fruits and vegetables). The warm temperate zone, covering 19% of the area, is suitable for paddy, wheat, mustard, barley, potato, temperate fruits, vegetables and dairy cattle production.

Finally, the alpine (3600-7500 m.a.s.l.) zone is composed of snow-capped peaks and alpine meadows with very cold winters and cool summers, covering around 29% of the area. Predominant agricultural activities include yak herding for dairy products (semi-nomadic farmers) and cultivation of barley, buckwheat, mustard, and vegetables.

The following infographic shows a selection of nine agriculture production systems important for Bhutan's food security. This importance is based on the system's contribution to economic, productivity and nutrition indicators. For more information on the methodology for the production system selection, see Annex 2.

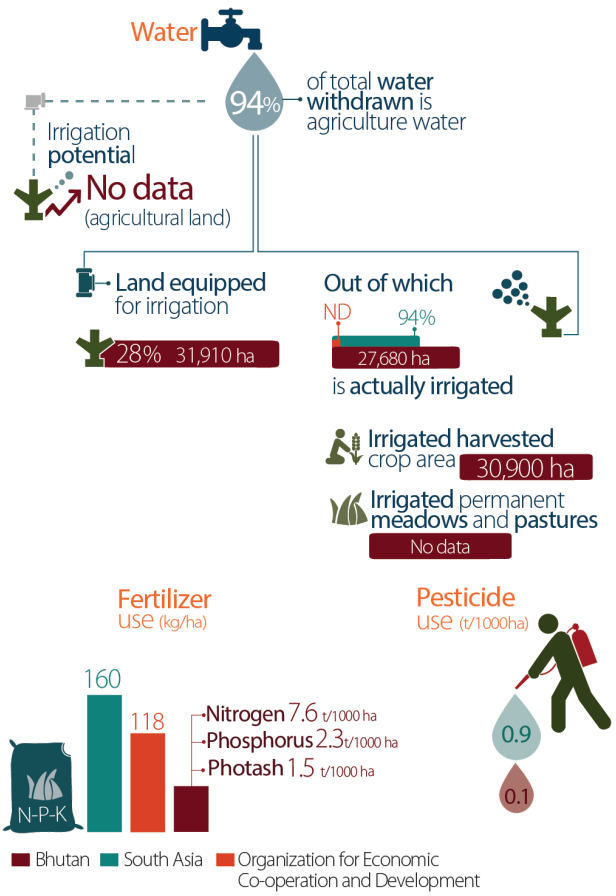
Production systems key for food security in Bhutan[2, 3, 5]



Agricultural input use in Bhutan remains very low, as access to fertilizers and chemicals for pest and weed control is strictly limited. In total only 24,567 kg of plant protection chemicals were distributed to farmers between 2010 and 2014 even though food production can be accelerated with their use. The use of fertilizer and chemicals remains a contested issue, with the government currently exploring the possibility of transforming the entire agricultural production system along organic guidelines. The low input use means that approx. 95% of agricultural production is already organic given that most farmers lack the financial means and access to synthetic fertilizers and pesticides. Instead, most farmers rely on traditional inputs such as manure, leaf litter collected from forests, and crop residues left in the fields for soil fertility management.

Shortage of irrigation water and related infrastructure is another common challenge for many farm households, and often rice fields remain uncultivated due to insufficient water supply. Increasing irrigation and water supply to rural farm households is therefore a key priority for the government during the current (11th) Five-Year-Plan with heavy investments towards providing and improving available irrigation and water harvesting facilities.

Agriculture input use in Bhutan [5, 6, 47]

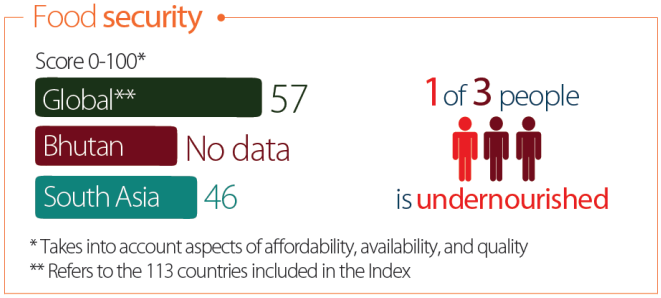


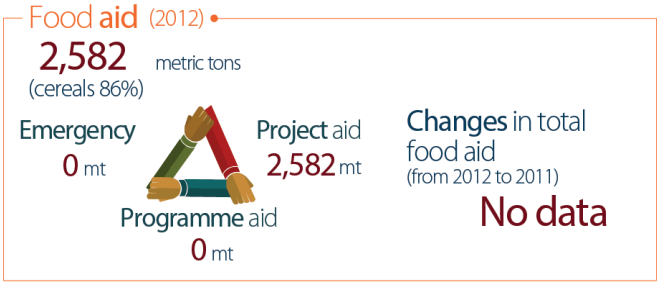
Food security and nutrition

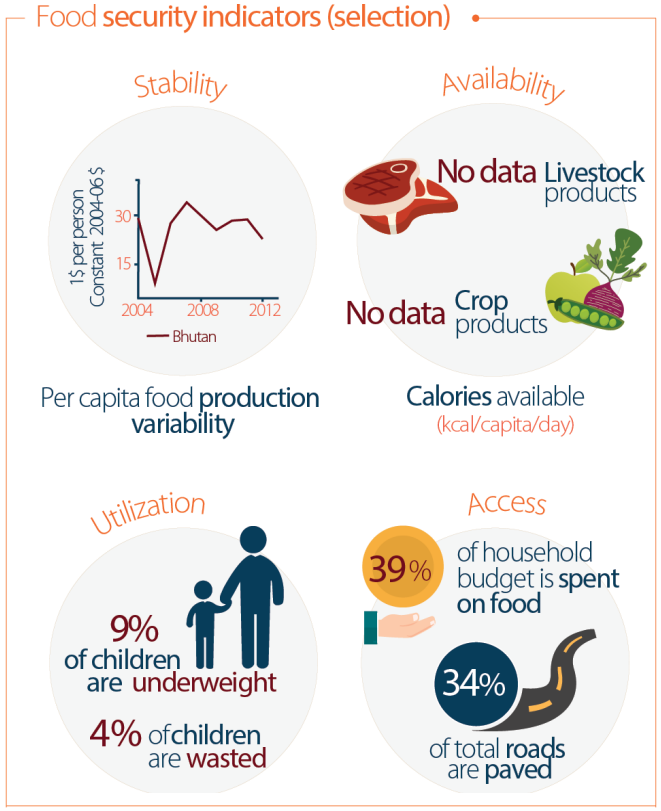
In early 2015, 48% of the population was self-sufficient in relation to rice, 39% to beef, 40% to pork, 76%to chicken and 63% to eggs, 56% to vegetables and 2% to fish [12, 15]. Food insecurity prevails among a third of the population. With limited, continuously fragmented land holdings and rural-to-urban migration of working age adults, labor-intensive agriculture is becoming increasingly difficult. The remote rural areas are inhabited primarily by the most socio-economically vulnerable people. Children and youth usually start working at an early age in order to prevent greater food insecurity. Moreover, the country's topography presents a number of challenges for roads and infrastructure development, worsening national food insecurity.

Although the majority (98%) of the households in Bhutan have access to food, 88% of children aged 6-23 months do not receive the nutrition that they need. Throughout South Asia, an estimated 38% of children under the age of five are affected by stunted growth, which leads to cognitive and physical limitations. In Bhutan, around a fifth of the children under 5 years are stunted, 9% underweight and 4.3% are wasted. Anemia prevails among 44% of the children under five and among more than a third (35%) of the women of reproductive age [21]. Inadequate food (both quality and quantity) is reported by 10% of poor households (which is more than double than the non-poor's, at 4%). Nearly all households in Bhutan consume cereals, milk and milk products, and vegetables. The Household Dietary Diversity Score (HDDS) increased slightly, from 6.6 in 2007 to 9.6 in 2012 [30][5].

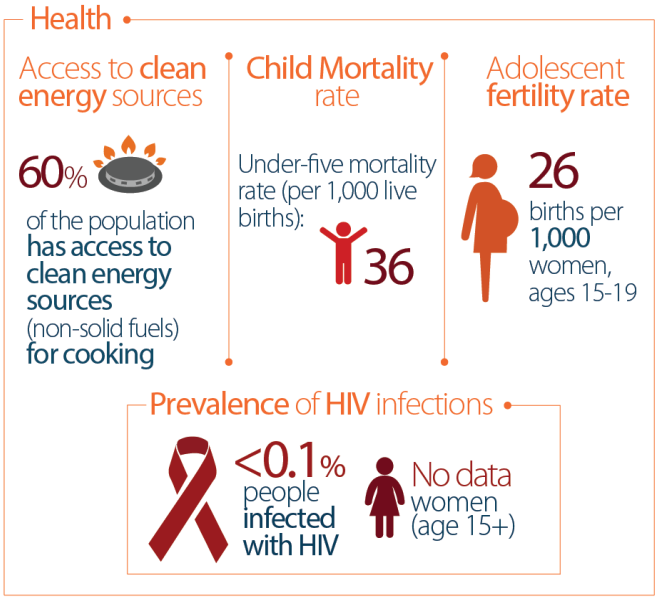
Food security, nutrition, and health in Bhutan [4, 5, 29, 31, 45, 47, 48, 49, 50]

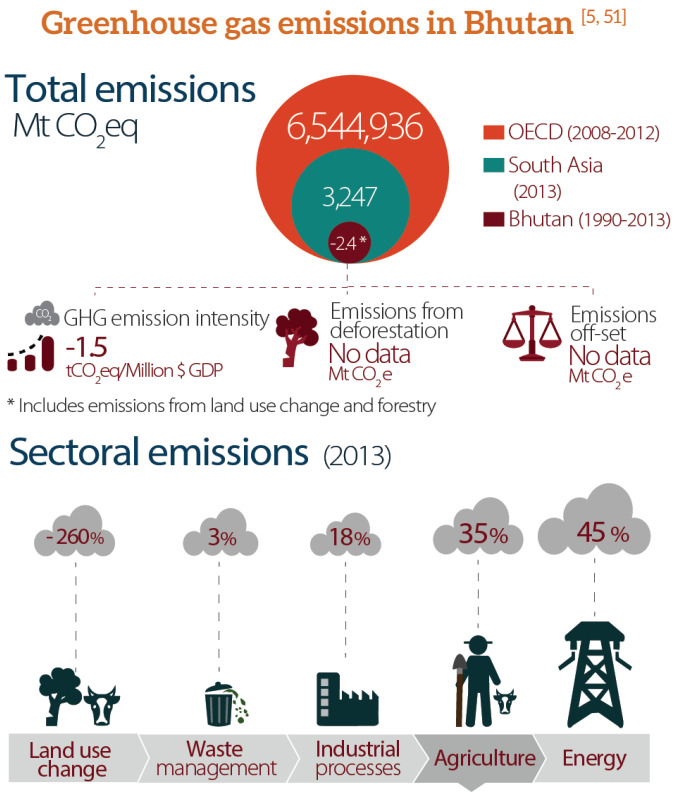


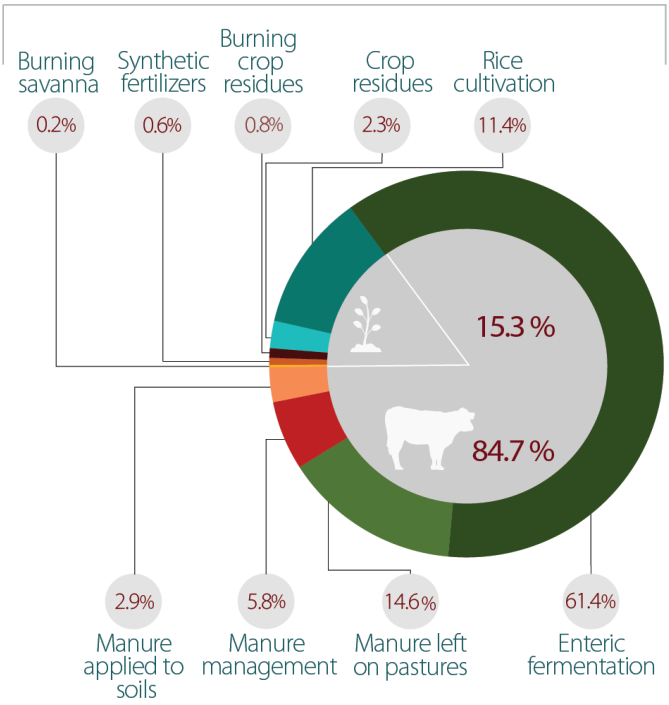




5 In Nepal and Pakistan, the score is currently at 8.8 and 9, respectively.







Agricultural greenhouse gas emissions

Bhutan Greenhouse Gas Emissions (GHGs) are estimated at 1.559 megatons (Mt) Carbon Dioxide equivalent (CO_2eq), excluding land use change and forestry (LUCF). The CO_2 sequestration capacity (including LUCF) is estimated at 6.3 Mt, and hence net emissions are negative (estimated at -4.7 Mt) [25, 26]. While the constitutional requirement of maintaining 60% forest cover will help preserve Bhutan's status as carbon sink, sectoral emissions have been increasing in recent years in the transport and industry (hydropower) sectors, whose management will become significant in the future [9].

Agricultural sector emissions, which constitute almost two-thirds of total emissions, are associated with enteric fermentation (61%), crop residues (2.3%), rice cultivation (11.4%), burning of crop resides (1%), manure left on pastures (14.6%), manure management (5.8%), and synthetic fertilizers (0.6%). Since agricultural emissions make up the dominant share of overall emissions and as the emergent pressure on forests is likely to increase , diminishing agriculture's contribution to total emissions through climate-smart practices is needed. The degradation of forests (as a result of roads, power transmission lines and grids, unsustainable mining, excessive use of forest through timber and fuel wood extraction, over grazing) and increasing urbanization and industrial activities also increase pressure on the agriculture sector to lower its emissions.

6 Forest fires are considered to be one of the key threats to coniferous forests in the country. Around 526 incidents of forest fire affected over 70,000 ha of forest between 1999 and 2008. Most of the forest fires in Bhutan are caused by human activity, rising temperatures, and long dry spells due to climate change. These are likely to increase the risk of forest fires, resulting in further reduction and degradation of forest resources.

Challenges for the agricultural sector

The main challenges for food security and food self-sufficiency in Bhutan are linked with the loss of agriculture and productive land owing to rapid development and urbanization, and other agricultural constraints such as labor shortage (reported by 53% of households); crop damage by wild animals (43%); insufficient irrigation supply (28%); crop damage by pests and diseases (16%); having unproductive land (15%); limited access to markets (15%); shortage of land (14%); hail storms (4%); drought (2%); excessive rainfall (1%) and landslide/ soil erosion (1%) [16]. Poor road connectivity to remote villages limits access to seeds and inputs. Moreover, production costs are high given high input prices and input transportation costs.

Agriculture remains dominated by rain fed dryland and wet land farming as most of the water sources are dependent on monsoon rainfalls. Water shortage is expected to impact feed resources, decreasing fodder production and contributing to the degradation of pasture and rangelands. This would further lead to lower livestock productivity and carrying capacity of rangelands. The shortage of agricultural land also means that potential for livestock production is often limited, as most poor farm households have insufficient space for cultivating fodder crops or keeping pasturelands. Fodder needs to be collected from nearby forests and cattle are often found roaming in open grazing areas and forests during the day. During the winter, farmers seek income from off-farm employment, creating a labor shortage as a result of which domestic cattle may stray. As agricultural fields are usually not fenced, these stray animals are likely to invade crop fields and feed crop residues. This is also one of the leading factors discouraging farmers from growing winter and spring crops such as wheat, barley and buckwheat, in turn affecting cropping intensity and overall production potential [16].

The productivity of crops, forage, and rangelands could change depending on location, system and species though there is no existing evidence demonstrating similar changes in the past. Lack of water could lead to degradation of nutrients of different plant species, which would then influence consumption and digestibility [17].Crop diseases such as Gray leaf spot and Turcicum leaf in maize (northern corn leaf blight), greening in Citrus, or Phytophthora blight (wilt) in chili and potatoes cause further damage to crops. Moreover, the incidence of vector-borne diseases such aspiroplasmosis and helminthes infections in domestic animals have increased; and are expanding into cooler areas as temperature and rainfall patterns change.

Bhutan's Constitution's strict guidelines on environmental protection have vast implications for the Renewable Natural Resources (RNR) sector and the path of agricultural development in the country. For example, the majority of farmers experience significant crop losses from wild animals[7] yet the constitution forbids the killing of wild animals under all circumstances except self-defense in case of a serious attack [40]. This no-kill policy is based on Buddhist beliefs that value all forms of life as inherently sacred and according to which the Bhutanese pursue a peaceful lifestyle in harmony with nature and all its living creatures. Accordingly, most farm households are forced to spend several weeks per year crop-guarding[8], a time-consuming necessity that puts additional pressure on the already prevalent labor scarcity in rural areas. Recent projects are promoting electric fencing to address this problem, yet this is usually too expensive for the majority of poor farm households. Furthermore, most farmers not only abstain from slaughtering livestock for meat production but also avoid chemical pesticides that may kill both insects and plants.

Most Bhutanese also firmly believe in natural spirits and demons that should not be angered by disrupting the lifecycle of natural habitats (Caspari 2004). While the existing rigid forest conservation rules have preserved most of Bhutan's forests, they have created challenges such as the high demand and corresponding low supply for fuel-wood (which accounts for 90% of energy use in rural areas),

As agriculture is practiced mainly on steep slopes, the climate change impacts on farming systems will be felt even more strongly as changes in temperature and precipitation affect the frequency and intensity of soil drainage (leading to nitrogen leaching), and cause soil erosion and crop diversity loss.

Agriculture and climate change

Bhutan's climate is influenced by the monsoon and is mainly characterized by dry winters and high precipitations during June-September. Climatic conditions are determined by topography, elevation, and rainfall patterns. The great variation in rainfall within a relatively short distance is due to rain shadow effects due to the country's mountainous terrain. Precipitation generally diminishes significantly from south to north.

Over the past years, the country has experienced rapid changes in average temperatures, precipitation patterns, and increased risks of climate hazards, including excessive rains, flash floods, windstorms, hailstorms, and droughts, causing massive losses and damage to farming households [42, 52]. Most farmers are entirely dependent on the monsoons for irrigation. The late arrival of the monsoon can lead to drought, while excessive monsoon rains cause natural disasters, such as landslides and floods. Such climatic events also put rural communities at higher risks, as many remain isolated due to inadequate and damaged infrastructure.

7 In 2015, wild animals caused damage to 4,608 acres of cultivated land and a total crop loss of 4,305 metric tons (paddy, maize, wheat, vegetables and potato) [15].

8 Crop-guarding means farmers spend days and nights in their fields over several weeks prior to harvesting to watch their crops and scare away wild animals, usually by making loud noise.

Analysis of historical data for Bhutan (2005–2014) shows a steady increase in summer mean temperatures in temperate and subtropical regions and a decline in winter mean temperatures in temperate regions. However, annual mean temperatures in both temperate and subtropical regions have been gradually rising.

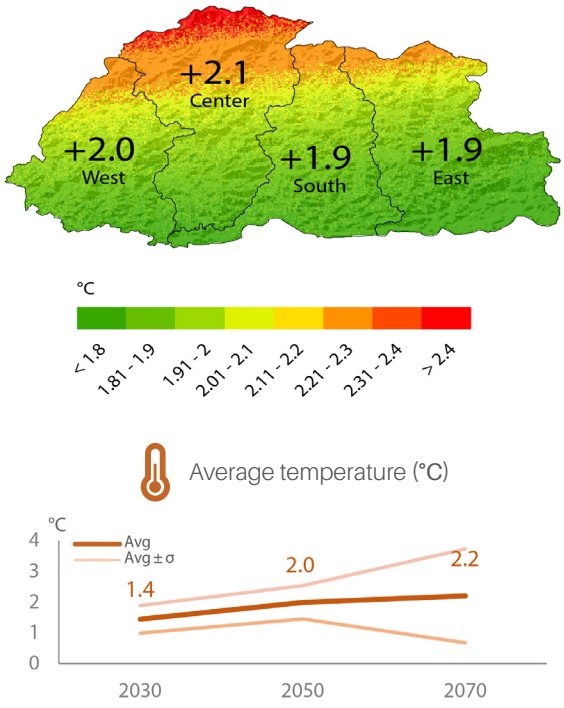
Some of the implications of rising temperatures to the Renewable Natural Resource (RNR) sector include [15]:

- Higher threat of glacier lake outburst floods
- Reduction in agricultural water availability (increasing fallow land in rice cultivation due to lack of irrigation water)
- Reduction in crop yield due to inadequate rainfall during the growing season
- Erratic and excessive rainfall patterns leading to extreme events like flash floods, and reducing availability of arable land
- Shift in vegetation and phenology due to increased heat stress. Crop varieties and animal breeds will shift towards more favorable zones. For example, cardamom and citrus are increasingly grown in warm temperate zones, which were unsuitable ten years ago
- Gradual shift in the geographical location of insects. For instance, leeches that previously predominated in warmer areas are now found in cooler regions; potato tuber moths, a common pest for the lower subtropical region, are increasingly found in higher elevations; and the caterpillar fungus (*Ophiocordyceps sinensis*) is disappearing at elevations below 3000 m.
- Loss of habitat for important faunal diversity, such as black necked cranes.

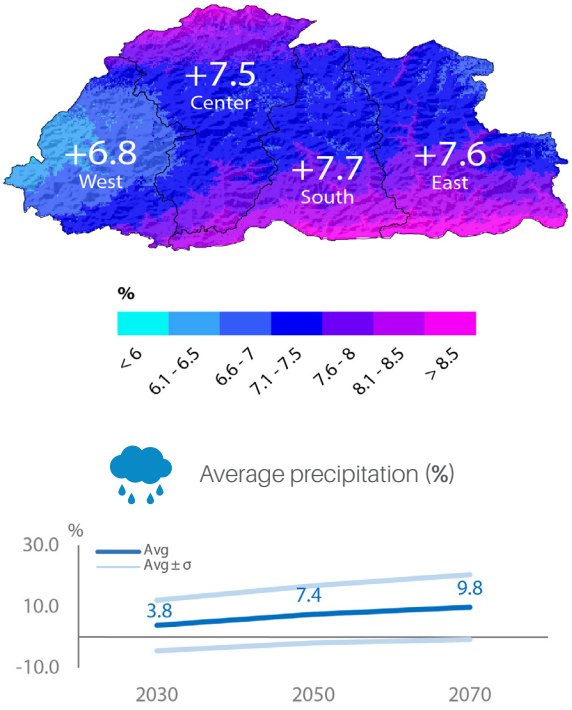
In 1996, farmers in the high altitude areas lost between 80 and 90% of rice harvest due to a rice blast epidemic. Likewise, the northern corn blight disease outbreak from 2007 caused maize harvest losses of more than 50% at altitudes above 1800 m.a.s.l.

Projected changes in temperature and precipitation in Bhutan by 2050 [1, 36, 37]

Changes in annual mean temperature (°C)

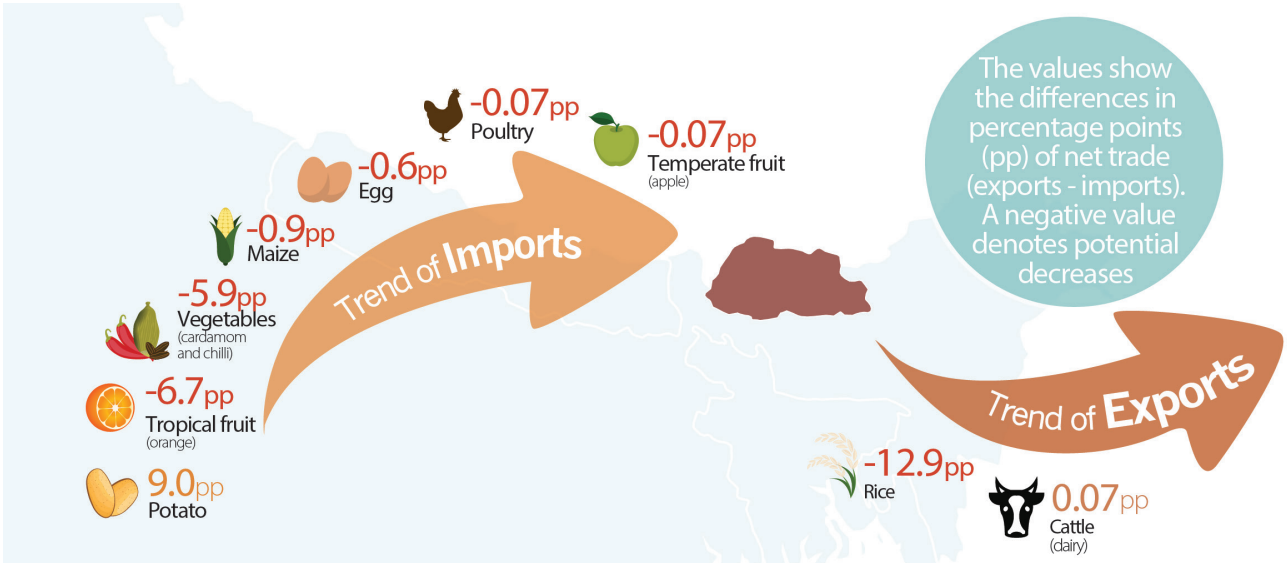


Changes in total precipitation (%)



Potential economic impacts of climate change

The impact of climate change on net trade in Bhutan (2020-2050) [41]



An analysis using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)[9][41] was carried out for selected key production systems in Bhutan, analyzing impacts of climate change over the period 2020 – 2050, on net trade, yield and area (for crops), and animal numbers (for livestock products). The results are presented as the percentage differences between a scenario where climate change occurs (CC) compared to a scenario without climate change (NoCC). The results show that CC has mixed effects on agricultural production, potentially contributing to the increase in yields and land area for some crops, and decreases for others[10]. For example, under CC the land area dedicated to agricultural production is projected to increase more than under NoCC, especially for potato and tropical fruits (orange), while for temperate fruits (apple), CC will likely decrease the cultivated land area.

While almost all crop yields are expected to increase over the period of 2020 – 2050 regardless of the scenario, results suggest that yield increases under CC are likely to be higher than under NoCC, with greater increases under CC in temperate fruits (apple), tropical fruits (orange), rice, vegetables (cardamom and chili), and potato by 0.8%, 6.2%, 0.9%, 4.9% and 5.0%, respectively. Only maize yield increases are expected to be lower under CC compared to a NoCC scenario in 2050, by about -10.3%.

For livestock, the expected changes in egg and cow milk production and other dairy products present a potential tendency to increase in a range of above 100% and 60%, respectively, under both scenarios. The impact of CC is thus only marginal on these production systems, with a difference of 0.1% between both scenarios. Similarly, poultry meat production could increase under both CC and NoCC scenario just by about 4%, yet this increase is expected to be by 0.1% lower under CC.

Regarding net trade, projections suggest a potential increase in import activities for all production systems with and without climate change. However, under the CC scenario results indicate a slight reduction in imports mainly in eggs, vegetables, maize and tropical fruits in a range between a 0.61 pp to 6.7 pp difference compared to NoCC. By contrast, in the potato, climate change could further expand negative trade by 9 pp.

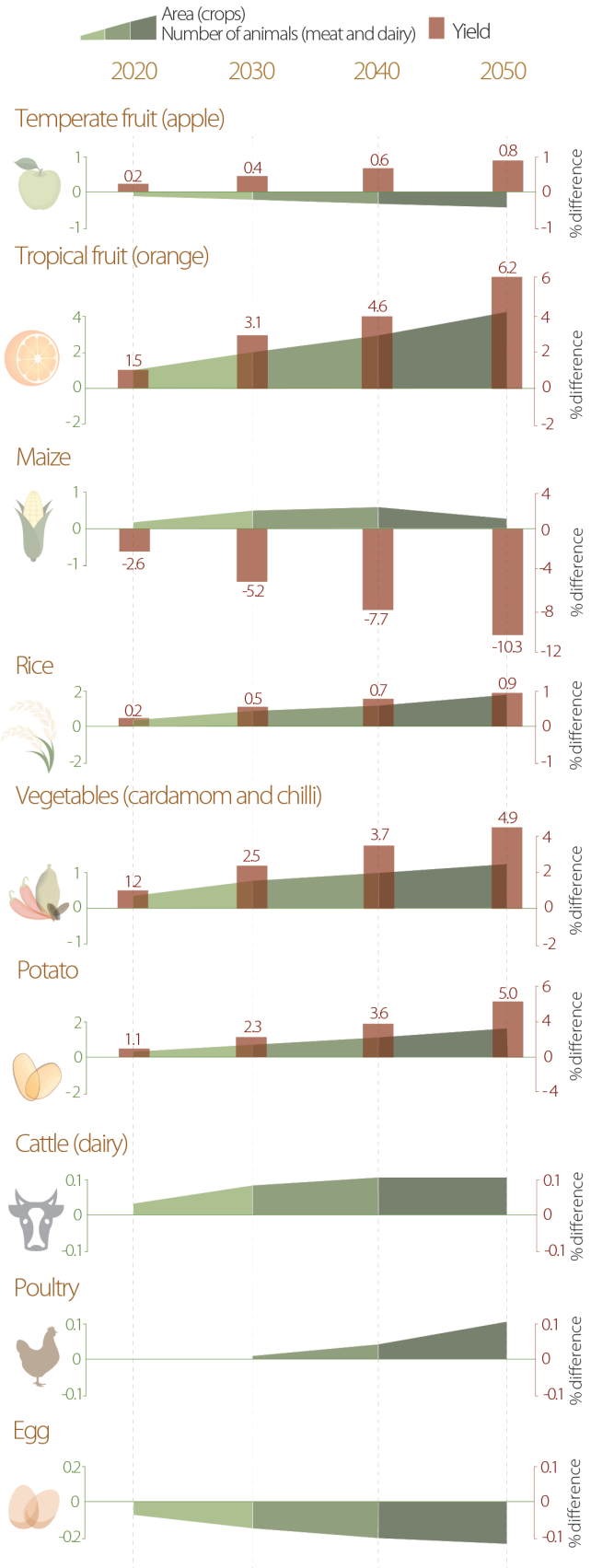
Exports, on the other side, show potential increases under both scenarios (with and without climate change) of dairy products and rice commodities. Nevertheless, modelling suggests that CC could cause rice exports to increase less (by -12.9 pp) compared to the NoCC scenario. This could cause Bhutan to lose presence in international agricultural trade, affecting the rice production system and related incomes for farmers. As Bhutan seeks to achieve food security as a long-term goal, and rice being a key staple crop in the country, lower rice exports under CC compared to NoCC suggest that per-capita rice production in general, and production of high-quality rice for export in particular, is likely to decrease under CC. This is an undesirable scenario for Bhutan and highlights the need to attract more research and development activities towards the rice sector.

As for dairy, despite projected export increases, the difference between both scenarios is likely to be marginal (0.07 pp).

9 IMPACT, developed by the International Food Policy Research Institute [41], is a partial equilibrium model using a system of linear and non-linear equations designed to approximate supply and demand relationships at a global scale. This study used the standard IMPACT model version 3.2, less the IMPACT-Water module. The tool uses the GAMS program (General Algebraic Modeling System) to solve a system of supply and demand equations for equilibrium world prices for commodities. The tool generates results for agricultural yields, area, production, consumption, prices and trade, as well as indicators of food security.

10 The IMPACT model scenarios are defined by two major components: (i) the Shared Socioeconomic Pathways (SSPs), which are global pathways that represent alternative futures of societal evolution [32, 33] and (ii) the Representative Concentration Pathways (RCPs), which represent potential greenhouse gas emission levels in the atmosphere and the subsequent increase in solar energy that would be absorbed (radiative forcing) [44]. This study used SSP 2 and RCP 4.5 pathways.

Climate change impacts on yield, crop area and livestock numbers in Bhutan [41]



*A negative value denotes potential decreases in area and yield expressed as percentage change in a climate change scenario vs. non climate change

CSA technologies and practices

CSA technologies and practices present opportunities for addressing climate change challenges, as well as for economic growth and development of the agriculture sector. For this profile, practices are considered CSA if they enhance food security as well as fulfilling at least one of the other objectives of CSA (adaptation and/or mitigation). Hundreds of technologies and approaches around the world fall under CSA.

Most CSA practices identified in the study address some of the key challenges to the agricultural sector in the country, such as shortage of irrigation water, reduced soil fertility, higher incidence of pests and diseases due to climate change. For crop cultivation, CSA practices include: improved planting and crop management (e.g. use of drought-tolerant, pest- and disease-resistant as well as early-maturing seed varieties for cereals and vegetables), crop intensification techniques (e.g. maize intercropping with legumes, or agroforestry in cardamom using shade trees), soil conservation and nutrient management (use of manure and bio-gas slurry, terracing and no-till/direct sowing), improved water and irrigation management (via use of water efficient technologies such as sprinkler and drip irrigation in green houses for vegetables and in fruit orchards for apples and oranges; ridge system planting for potatoes; alternate wetting and drying for paddy and upland rice cultivation).

Practices for livestock farming are mostly adopted to address shortage of feed and fodder, to reduce disease susceptibility, and to improve manure and nutrient management. CSA practices for livestock include: cross breeding for improved climate resilience (in cattle and poultry), promotion of biogas (installation of biogas digester and integration with stall feeding), support for feed mills to produce high quality feed (high protein, low fibre and easily digestible), pasture and fodder production integration into existing farming using leguminous shrubs, and product diversification using energy-efficient technologies associated with dairy and poultry farming.

However, several challenges and barriers to adoption and up-scaling of the CSA technologies prevail. For example, the ridge system for planting (potato) is challenged by the sloppy terrain that inhibits mechanization; the cattle population on a typical farm is often too small to produce sufficient organic manure; sustainable land management practices such as constructing terraces and contour hedgerows on sloped land are labor intensive and have high costs with no immediate benefits to farmers; there is low cultural acceptance of intercropping with legumes; and despite contributing to household food security, the adoption of upland rice cultivation remains low.

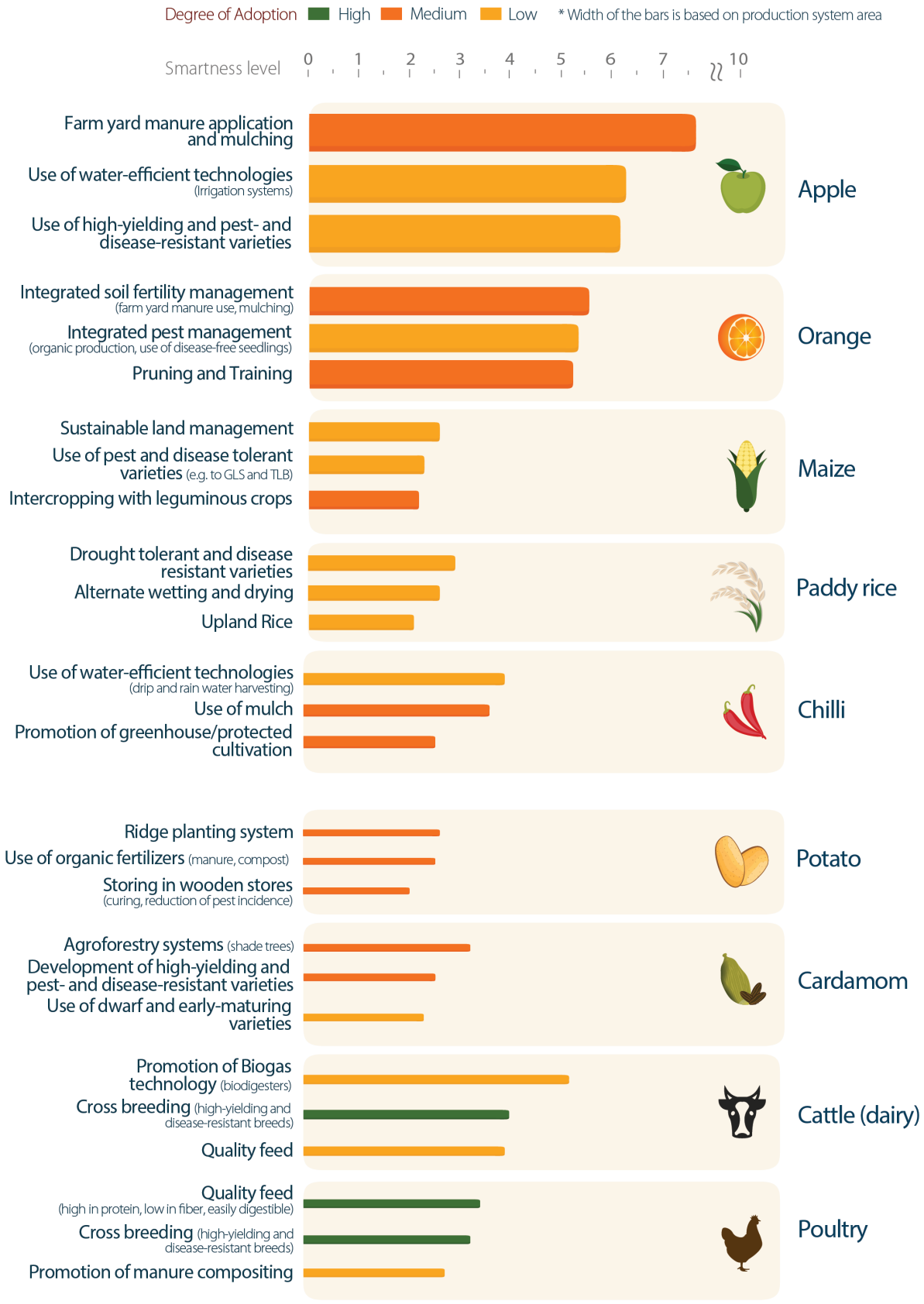
Furthermore, in orange and apple cultivation, pruning for high productivity is often carried out according to traditional knowledge, disregarding more effective professional

techniques; practices associated with integrated pest and soil fertility management are costly and face considerable technical, cultural and social barriers; land holdings are small and fragmented and a general scarcity of irrigation water inhibits intensive cultivation of cash crops such as cardamom and vegetables; farmers often have limited access to financial means and credits, reducing their ability to invest in modern technologies such as greenhouses for improved vegetable cultivation, or improved irrigation technologies (such as drip irrigation, use of pipes, sprinklers, water harvesting technologies).

Finally, farmers have limited knowledge about good practices for cattle and poultry cross breeding for the promotion of high yielding and disease resilient breeds. The cost of high quality dairy and poultry feed (high protein, low fibre, easily digestible, and thus reducing GHG emissions from livestock) is high and may not be affordable for small scale farmers.

The following graphics present a selection of CSA practices with high climate smartness scores according to expert evaluations. The average climate smartness score is calculated based on the practice's individual scores on eight climate smartness dimensions that relate to the CSA pillars: yield (productivity); income, water, soil, risks (adaptation); energy, carbon and nitrogen (mitigation). A practice can have a negative/ positive/ zero impact on a selected CSA indicator, with 10 (+/-) indicating a 100% change (positive/ negative) and 0 indicating no change. Practices in the graphics have been selected for each production system key for food security identified in the study. A detailed explanation of the methodology can be found in Annex 3.

Selected CSA practices and technologies for production systems key for food security in Bhutan



Case study: Efficient Irrigation Systems for Horticulture Cash Cropping Established

The Ministry of Agriculture and Forests, through its Council for Renewable Natural Resources (RNR) Research, in 2013 launched a comprehensive Climate Change Adaptation Program (CCAP).The goal of the program was to support farming communities in coping with challenges associated with changing climate and weather patterns in order to enhance productivity and improve food security. The project focus area, the Kurichu River Basin, was selected based on the level of poverty, status of community resilience, and local need for climate change adaptation initiatives in the dzongkhags[11] across all major watersheds of Bhutan. Accordingly, some 16,047 households of 44 gewogs under Pemagatshel, Mongar, Lhuentse and Zhemgang dzongkhags have been selected as beneficiaries. Amongst its other achievement, CCAP has been successful in promoting efficient irrigation systems for horticulture production. This includes activities like water harvesting, efficient conveyance systems, water storage structures, use of groundwater, and modern irrigation technologies such as drip and sprinkler irrigation. Often, these are combined with the adoption of poly-tunnels and greenhouses. In 2015 – 2016 alone, the project procured and supplied 467 sets of irrigation equipment to the project area. Sprinkler irrigation for vegetables and fruit crops was highly demanded in the project dzongkhags. A total of 730 households adopted this activity, with Zhemgang having the highest adopters (360 households), followed by Mongar (207) and Pemagatshel (163). By 2016, 375 households in Zhemgang, Pemagatshel and Lhuentse have also set up poly-tunnels and greenhouses together with water harvesting structures for improved vegetable gardening.


Photo: MoAF

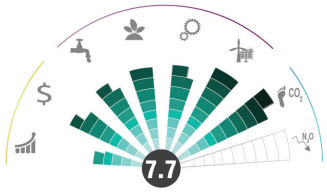
As a result of training, provision and installation of technical equipment, several villages in Mongar and Pemagatshel dzongkhags are now harnessing water from the creeks below the villages for drinking and vegetable gardening. Electricity is used to pump water uphill into reservoirs and the water is later supplied for drinking and home gardening. An electric water pump set is installed at the water source in the creeks, connected by pipes to a series of tanks uphill for a distance of 150 feet, leading to big reservoirs above the villages. Water from the reservoirs is then distributed through pipes to individual homes both for drinking and kitchen gardens via sprinkler irrigation and drips.

In some villages, such as Chongshing Gonpa, the project made a big difference for households that had previously suffered from severe water shortages. A village of only nine households had no near-by water source (the nearest located 3 kmaway – on foot) and struggled with an unreliable and outdated water-pump. The CCAP project has initiated the construction of a rain water harvesting system for the village, which has a water holding capacity of 1500 liters. With the newly-installed rain water harvesting technique, people can now store rainwater and have access to a regular water supply. Each of the household level rain water harvesting units cost Nu. 8000 (approx. 130 USD), excluding labour costs. The initiative also encouraged kitchen gardening amongst farmers. The activity has been so successful that similar water harvesting systems have been promoted in other villages in the project area. Overall, this has helped farmers increase production and enabled them to cultivate vegetables year-round, significantly improving their food self-sufficiency and food security.

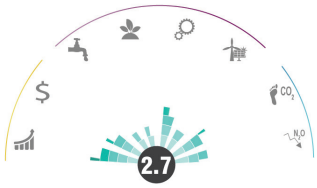
Case Study adapted from "State of Climate Change Report for RNR Sector, May 2016" by Ministry of Agriculture and Forests, Royal Government of Bhutan

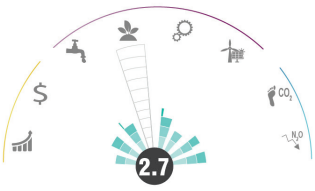
11 Dzongkhag is the Bhutanese term for political district comparable to national province or state. Bhutan consists of twenty Dzongkhags, which are further divided into 205 Gewogs (sub-districts).

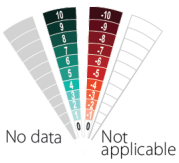
Table 1. Detailed smartness assessment for top ongoing CSA practices by production system as implemented in Bhutan.

CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Apple (77% of total harvested area)				
Farm Yard Manure application and mulching	Western Bhutan 30-60%	M		**Productivity** Increases in productivity per unit of area and produce quality. Promotes food security and income. **Adaptation** Contributes to soil health and fertility by improving physical, chemical and biological characteristics. Reduces soil erosion. **Mitigation** Increases carbon storage in soils. Reduces use of synthetic fertilizers and related GHG emissions.
Use of water-efficient technologies (Irrigation systems	Western Bhutan <30%	L		**Productivity** Increases yield per unit area, especially during the dry season. Ensures income and agricultural diversification. **Adaptation** Minimizes water use per unit of product, increasing water use efficiency and resilience to climate shocks. **Mitigation** Reduces GHG emissions due to reduced fuel/energy required for pumping and/or carrying water for irrigation.
Orange (51% of total harvested area)				
Integrated soil fertility management (Farm Yard Manure use, mulching)	South Bhutan 30-60%	S M L		**Productivity** Increases crop yields and income. **Adaptation** Builds soil fertility by improving physical and biochemical characteristics. Improves moisture content avoiding water stress during dry seasons. **Mitigation** Increases carbon storage in soils. Reduces the need of synthetic fertilizers and related GHG emissions.
	South and East Bhutan 30-60%	M L		
Integrated Pest Management (organic production, use of disease-free seedlings)	South Bhutan 30-60%	M		**Productivity** Reduces production losses and in certain cases costs. Enhances in crop quality, hence potential increases in income. **Adaptation** Increases farmers' capacity to limit the crop exposure to crop damage or loss. Reduces the need for water and external inputs for crop protection. **Mitigation** Reduces carbon footprint per unit of food produced by reducing the use of synthetic pesticides (insecticides etc.).

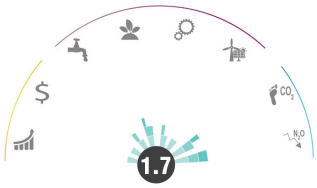
Yield Income Water Soil Risk/Information Energy CO_2 Carbon N_2O Nutrient

CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Orange (51% of total harvested area)				
Integrated Pest Management (organic production, use of disease-free seedlings)	South and East Bhutan <30%	S L		**Productivity** Reduces production losses and in certain cases costs. Enhances in crop quality, hence potential increases in income. **Adaptation** Increases farmers' capacity to limit the crop exposure to crop damage or loss. Reduces the need for water and external inputs for crop protection. **Mitigation** Reduces carbon footprint per unit of food produced by reducing the use of synthetic pesticides (insecticides etc.).
Maize (46% of total harvested area)				
Sustainable land management	Eastern Bhutan <30%	S		**Productivity** Increases crop yields and income. **Adaptation** Reduces soil erosion and builds soil fertility by improving physical and biochemical characteristics. Contributes to soil moisture conservation. **Mitigation** Maintains or improves soil carbon stock and/or soil organic matter content.
Use of pest and disease tolerant varieties (e.g. to GLS and TLB)	Eastern Bhutan <30%	S		**Productivity** Reduces production losses and costs. Enhances crop quality, hence potential increases in income. **Adaptation** Increases farmers' capacity to limit the crop exposure to crop damage or loss. Reduces the need for water and external inputs for crop protection. Reduces environmental pollution. **Mitigation** Reduces carbon footprint per unit of food produced by reducing the use of synthetic pesticides (insecticides, fungicides etc.).
Rice (39% of total harvested area)				
Drought tolerant and disease resistan varieties	South, Low altitude; foothills and rainfe ecosystem <30%	S		**Productivity** Increases the yield per unit area, especially during dry periods, hence income for the farmers. **Adaptation** Enhances water use efficiency. Increases resilience to moisture stress and other climate shocks. **Mitigation** Leads to reduction in emissions due to lower energy consumption for irrigation, and reductions in agro-chemical inputs..
	West, High altitude; Temperate zone 30-60%	S		

CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Rice (39% of total harvested area)				
Alternate wetting and drying	South, Low altitude; foothills and rainfe ecosystem <30%	S		**Productivity** Potential increases in yield due to the higher number of tillers and better grain quality. **Adaptation** Minimizes water use for irrigation hence increase water use efficiency. Enables larger area for cultivation with limited water availability. **Mitigation** Reduces GHG emissions, especially methane emission from rice fields.
	West, High altitude; Temperate zone <30%	S		
Chilli (20% of total harvested area)				
Use of water-efficient technologies (drip and rain water harvesting)	Southern belts (Samtse, Sarpang) <30%	L		**Productivity** Increases in yield due to appropriate water management. **Adaptation** Increases availability of water. Minimizes water use per unit of product. Reduces run-off and water waste. **Mitigation** Reduces energy required for irrigation.
	West-central (Paro, Punakha, Wangdue) <30%	L		
Use of mulch	Southern belts (Samtse, Sarpang) 30-60%	S M		**Productivity** Increases productivity by contributing to build long- term soil health and fertility. **Adaptation** Promotes soil structure and moisture conservation. Reduces erosion. **Mitigation** Maintains or improves soil carbon stocks and organic matter content. Long-term reductions in nitrogen- based fertilizers.
	West-central (Paro, Punakha Wangdue) 30-60%	M		



Yield Income Water Soil Risk/Information Energy CO_2 Carbon N_2O Nutrient

CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Potato (10% of total harvested area)				
Ridge planting system	West (Chukha, Haa, Paro 30-60%	S M L		**Productivity** Increases productivity through improved soil quality and water availability. **Adaptation** Promotes in-situ soil moisture retention. Prevents erosion when are contour line oriented. **Mitigation** Promotes carbon sinks through increased accumulation of organic matter.
	Central (Wangdi, Bumthang) >60%	S M L		
Use of organic fertilizers (manure, compost)	West (Chukha, Haa, Paro) 30-60%	S M		**Productivity** Increases in productivity per unit of area and produce quality. Promotes income. **Adaptation** Contributes to soil health and fertility by improving physical, chemical and biological characteristics. Reduces soil erosion **Mitigation** Increases carbon storage in soils. Reduces use of synthetic fertilizers and carbon foot print related to production, transport and application of inorganic fertilizers.
	Central (Wangdi, Bumthang >60%	S M		
Cardamom (5% of total harvested area)				
Agroforestry trees	South-wester Bhutan 30-60%	S M		**Productivity** Can lead to increases in yield and quality, with potential benefits for food and nutrition security and income diversification. **Adaptation** The inclusion of tree crops for shade reduces heat stress on cardamom crop and implies progressive increase of soil fertility. **Mitigation** Increases in carbon capture and storage. Gradual increases in soil organic matter.
Development of high-yielding and pest- and disease resistant varietie	South-western Bhutan 30-60%	S M L		**Productivity** Promotes high yields per unit area, hence potential increase in income. **Adaptation** Reduces the risk of crop losses caused by pest or diseases incidence. Reduces the need for external inputs for crop protection. **Mitigation** Promotes above- and below-ground carbon sinks through increased accumulation of dry mater.

CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Cattle (dairy) (NA)				
Promotion of Biogas technology (biodigesters)	Southern belts (Sub tropical) 30-60%	S		**Productivity** Increases land productivity, and income. By-products such as organic fertilizers can be used on forages to enhance productivity. **Adaptation** Promotes the use of organic waste and eliminates pathogens. Contributes to cover heating needs, reduces pressure on local resources such as timber. **Mitigation** Reduces the use of nitrogen-based fertilizers, thus reducing nitrous oxide emissions. Reduces methane emissions from manure, and promotes on- farm energy generation.
Cross breeding (High-yielding and disease-resistant breeds)	Southern belts (Sub tropical) >60%	S M		**Productivity** Increases quality and stability of the food production. Reduces production costs per unit of area. **Adaptation** Local and exotic breeds can present greater resistance to diseases and various abiotic stress conditions, hence reducing animal mortality. **Mitigation** Reduced inputs (e.g. veterinary drugs) could reduce related GHG emissions per unit of produce.
Poultry (NA)				
Quality feed (high in protein, low in fiber, easily digestible)	Southern belts (Sub tropical) >60%	M L		**Productivity** Promotes animal health and productivity due to balanced/optimum nutrition. Reduces production costs, hence potential increases in income. **Adaptation** On-farm feed preparation and conservation from natural and local resources available reduces the need for external inputs. Increases in women empowerment. **Mitigation** Reduced input requirements, leads to reductions in carbon footprint related to production and transport of concentrates and other products.
Cross breeding (High-yielding and disease resistant breeds)	Southern belts (Sub tropical) >60%	M L		**Productivity** Increased stability in productivity given increased resilience to diseases incidence and climate shocks. **Adaptation** Local and exotic breeds can present greater resistance to diseases and various abiotic stress conditions, hence reducing animal mortality. **Mitigation** Contributes to reductions in GHG emissions and energy when the practice is integrated with feeding and manure management techniques.

Institutions and policies for CSA

Bhutan has several institutions promoting climate change adaptation and mitigation activities. These institutions aim at enhancing food security and production and promoting sustainable rural development and farming practices in the face of climate change.

The key government organization coordinating climate and environmental policy is the National Environment Commission (NEC), a high-level autonomous government agency and the highest decision-making and coordinating body on all matters relating to the protection, conservation and improvement of the natural environment. It is mandated to review, revise and promote the implementation of environmental policies and legislation and is the national focal agency for the UNFCCC.

The NEC is furthermore leading the Climate Change Coordination Committee, which was established in 2016 as a forum to discuss and coordinate matters related to climate change in Bhutan. To achieve the national goals in environmental protection and climate change, the NEC is led by the various government ministers and representatives of key environmental organizations. It engages with the various sectors of economic development, such as hydropower, infrastructure and agriculture, in order to align the respective policies and private sector development efforts to the national principles of environmental conservation [53].

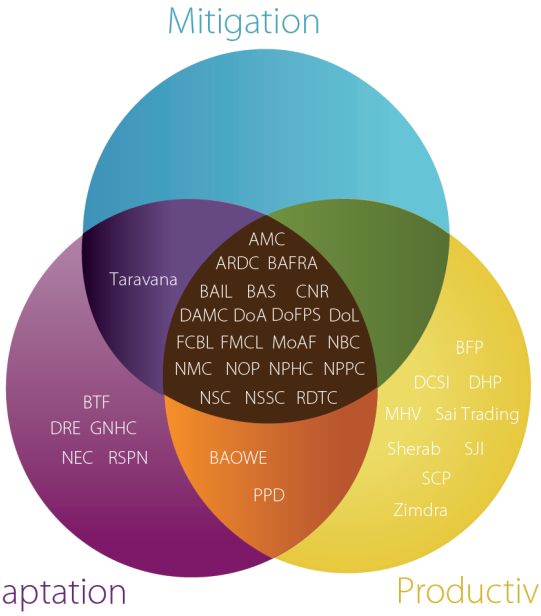
Although the focus lies in environmental conservation, there is a growing recognition on the side of the Bhutanese government of the role of the agriculture, livestock and the forestry (RNR) sectors as they work towards climate change mitigation and adaptation.

Next to the NEC, the Ministry of Agriculture and Forests (MoAF) is the key organization implementing climate change adaptation initiatives in the RNR sector, and climate change related institutions are mostly based within this ministry in various departments and tertiary organizations, such as: Department of Agriculture; Department of Livestock; Department of Forest and Park Services; National Biodiversity Centre; Bhutan Agriculture and Food Regulatory Authority; and Department of Agriculture Marketing and Cooperatives.

Several international organizations, NGOs and other organizations are also actively working on climate smart approaches by implementing programs and projects and funding initiatives targeting agricultural sector development, adaptation and mitigation efforts. These organizations include, among others, the World Bank, International Fund for Agricultural Development (IFAD), United Nations Development Programme (UNDP), Food and Agriculture Organization of the United Nations (FAO), World Food Programme (WFP), Asian Development Bank (ADB), World Wildlife Fund (WWF), Netherlands Development Organisation (SNV), and local organizations like Tarayana Foundation and Samdrupjongkhar initiative.

Several national and international research organizations have actively been supporting studies and carrying out research activities focused on enhanced agricultural productivity, assessing vulnerabilities and increasing agricultural resilience to climate change. These include the Bhutanese College of Natural Resources (CNR) in Lobesa, as well as the International Rice Research Institute (IRRI), the International Potato Centre (CIP), the International Centre for Tropical Agriculture (CIAT) or the Australian Centre for Agricultural Research (ACIAR).

Institutions for CSA in Bhutan



AMC Agriculture Machinery Center **ARDC** Agriculture Research and Development Centre **BAFRA** Bhutan Agriculture Food & Regulatory Authority **BAIL** Bhutan Agro Industry Limited **BAOWE** Bhutan Association for Women Enterpreneurs **BAS** Bhutan Alpine Seeds **BFP** Bhutan Fruit Production Ltd **BTF** Bhutan Thrust Fund **CNR** College of Natural Resources **DoA** Department of Agriculture **DAMC** Department of Agriculture Marketing & Cooperatives **DCSI** Department of Cottage and Small Industries **DoFPS** Department of Forest and Park Services **DHP** Druk Horticulture Private Ltd **DoL** Department of Livestock **DRE** Department of Renewable Energy **FMCL** Farm Machinery Cooperation ltd **FCBL** Food Corporation of Bhutan LTD **GNHC** Gross National Hapiness Commission **ICS** Information and Communication Services **MoAF** Ministry of Agriculture and Forests **MHV** Mountain Hazelnut Venture **NBC** National Biodiversity Centre **NEC** National Environment Commission **NMC** National Mushroom Center **NOP** National Organic Programme **NPPC** National Plant Protection Centre **NPHC** National post harvest center **NSC** National Seed Centre **NSSC** National Soil Service Centre **PPD** Policy and Planning Division **RSPN** Royal Society for Protection of nature **RDTC** Rural Development Training Centre **SCP** Samden Coffee Production **Sherab** Sherab Enterprises **SJI** Samdrup Jongkhar Inititative

While the NGOs and international donors and organizations manage the programs related to climate change, it is usually the local government at the gewog level (sub-district) through extension agents that implement the activities, imparted through the dzongkhag (district) administration. Coordination of all above institutions is necessary to streamline and strengthen support of climate smart practices.

The following graphic highlights key institutions whose main activities relate to one, two or three CSA pillars (adaptation, productivity and mitigation). More information on the methodology is available in Annex 4.

Bhutan signed and ratified several international climate policy commitments, such as the Kyoto Protocol in 1997, Doha Amendments to the Kyoto Protocol in 2015, and the Paris Agreement for Climate Change in 2016. As a signatory to the UNFCCC, Bhutan submitted its second national communication in 2011, which outlines several measure for climate change adaptation and mitigation measures to help reduce future impacts of climate change in Bhutan. In that framework, the government submitted a new Climate Action Plan and Bhutan's Intended Nationally Determined Contributions (INDCs) to the UN Framework Convention for Climate Change (UNFCCC) in 2015.

In its INDCs, Bhutan commits to remaining carbon neutral, as it is currently a net sink for GHG with an estimated sequestration capacity of 6.3 million tons of CO2, due to its large forest cover. The INDCs closely follow Bhutan's Strategy for Low GHG Emission Development. For the RNR sector, the strategy envisions ensuring sustainable forest management, promoting a green and self-reliant economy, investing in clean renewable energy, and promoting climate smart livestock farming and agriculture practices. These practices include organic livestock and crop production, improvement of livestock breeds, expansion of biogas production with stall feeding, agro-forestry practices for fodder production and promotion of sustainable soil and land management practices.

Bhutan's Gross National Happiness (GNH) index requires that all national and institutional activities are aligned to the concept's four key principles, namely sustainable and equitable socio-economic development, preservation and promotion of culture, conservation and sustainable utilization and management of the environment, and promotion of good governance [39]. These four pillars enable a framework for the development of sustainable environmental and climate policies. Accordingly, the Constitution of Bhutan safeguards the "protection of the natural environment, conservation of the rich biodiversity of Bhutan and prevention of all forms of ecological degradation including noise, visual and physical pollution through the adoption and support of environment friendly practices and policies."

This is also reflected in a rigid National Environmental Strategy, formulated in 1997, that "seeks to find a development path that will meet the food, health care, employment, and education needs of Bhutan's populace without sacrificing the quality of the natural environment or depleting the natural resource base" [53, p.664 cited in]. Several legal documents, such as the Forest and Nature Conservation Act from 1995 and the Biodiversity Action Plan from 1998 anchor the principles of environmental conservation in the Constitution and remain valid guidelines. They are complemented by several legal acts touching upon and offering guidance to the sustainable management of the agricultural sector, such as the Pesticides Act or the Livestock Act from 2000, or the National Irrigation Policy from 2012 [9].

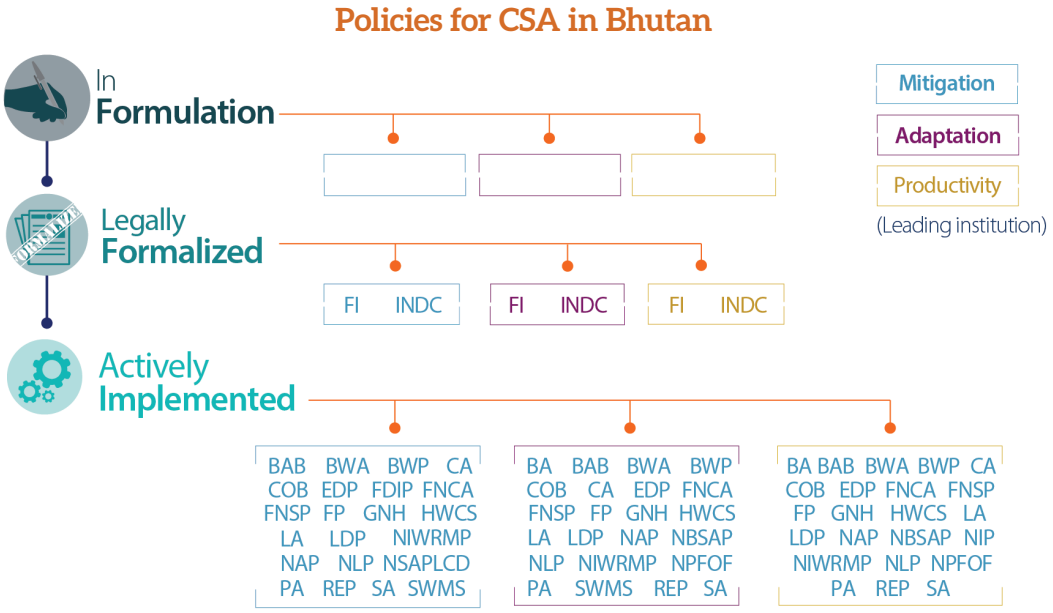
Though no major program is explicitly targeted towards CSA, there are numerous practices being incentivized to Bhutanese farmers that align with the core principles of CSA, i.e. promoting higher productivity, adaptation and mitigation of climate change. This becomes evident in the current (11th) Five Year Plan, which focuses on strengthening commercial farming by investing in infrastructure, facilitating domestic and international market access in order to incentivize higher productivity, as well as promoting cultivation of cash crops such as spices, fruits and vegetables, among others [10, 16].

Further policies under MoAF that are relevant to the promotion of CSA by prioritizing innovative agricultural technologies and promoting improved practices are the National Policy Framework for Organic Farming (documenting the aspiration of turning agriculture in Bhutan completely organic), National Seed Act, Livestock Development Act, National Irrigation Policy and the National Action Plan to Combat Land Degradation and Desertification. Given the variation dictated by climate and other environmental factors, the government recognizes the need to broaden the scope for biodiversity in agricultural systems.

The Water Act, Bhutan Water Policy and National Integrated Water Resource Management Plan have been framed to ensure the sustainable availability and use of water. Bhutan's Economic Development policy focuses on low carbon development, thus prioritizes organic farming, bio-technology, agro-processing and promotion of green and climate smart agriculture practices [38].

The Foreign Direct Investment (FDI) policy encourages FDI in green and sustainable technologies, and the promotion of socially responsible and ecologically sound industries. Agricultural businesses, for example, enjoy a 10-year tax holiday to support their development [19]. The Renewable Energy (RE) Policy, amongst other objectives, aims at protecting the environment and reducing GHG emissions by generating 20 MW of RE by 2020. In agriculture, this is addressed by promoting the adoption of small-scale biogas plants and improved livestock and manure management practices at rural households and community-level. The bio-safety act of Bhutan, furthermore, was adopted to protect the rich domestic and wild biodiversity of Bhutan, promote the nation's food and nutrition security and safeguard the animals and human health.

The graphic shows a selection of policies, strategies and programs that relate to agriculture and climate change topics and are considered key enablers of CSA in the country. The policy cycle classification aims to show gaps and opportunities in policy-making, referring to the three main stages: policy formulation (referring to a policy that is in an initial formulation stage/consultation process), policy formalization (to indicate the presence of mechanisms for the policy to process at national level) and policy in active implementation (to indicate visible progress/outcomes toward achieving larger policy goals, through concrete strategies and action plans). For more information on the methodology see Annex 5.



BA Biodiversity Act (2003) (BNBC) **BAB** Biosafety Act of Bhutan (2015) (BAFRA) **BWA** The Water Act (2011) (NEC) **BWP** Bhutan Water Policy (2014) (NEC) **CA** Cooperatives Act (2009) (DAMC) **COB** Constitution of Bhutan (2008) (People of Bhutan) **EDP** Economic Development Policy (2016) (MoEA) **FDIP** Foreign Direct Investment Policy (2014) (MoEA) **FI** Fiscal Incentives (2010) (MoEA) **FNCA** Forest and Nature Comservation Act (1995) (DoFPS) **FNSP** Food and Nutrition SecurityPolicy (2014) (MoAF) **FP** Forest Policy (2014) (DoFPS) **GNH** Gross National Happiness (1990) (Gross National Happiness Commission) **HWCS** Human Wildlife Conflict Strategy (2007) (DoFPS) **INDC** Intended National Determined Contribution (2015) (NEC) **LA** Land Act (2007) (NLCS) **LDP** Livestock Development Policy (2016) (DoA) **NAP** National Actin Plan to Combact Land degredation and Desertification (2017) (MoAF) **NBSAP** National Biodiversity Strategy Action Plan (2015) (NBC) **NIP** National Irrigation Policy (2010) (DoA) **NIWRMP** National Intergated Water Resource Management Plan (2016) (NEC) **NPFOF** National Policy Framework for Organic Farming (2007) (DoA) **NSAPLCD** National Strategy and Action Plan for Low Carbon Development (2012) (NEC) **PA** Pesticide Act (2000) (DoA) **REP** Renewable Energy Policy (2013) (MoEA) **SA** Seed Act (2000) (DoA) **SWMS** Solid Waste Management Strategy (2012) (MoWHS)

Financing CSA

Despite the emerging challenges and impacts of climate change and agriculture, so far only limited funding has been dedicated explicitly to CSA in Bhutan. The major shares of investors are the international donors, from which the country availed financing for CSA from organizations such as the International Fund for Agricultural Development (IFAD), the FAO, the Japan International Cooperation Agency (JICA) and Global Climate Change Alliance. One example of successful funding is the ongoing Commercial Agriculture and Resilient Livelihoods Enhancement Programme (CARLEP) in Eastern Bhutan, which has received an investment of approximately US$ 32 million over seven years (starting in 2016) by a consortium of IFAD, the Bhutanese government, and the private sector represented by the Food Corporation of Bhutan (FCBL), among others. It focuses on market-led sustainable agriculture by promoting climate resilient agricultural production, value chain development and marketing. Similarly, the World Bank-funded Global Agriculture Food Security Program (GAFSP), with a grant of USD 8 million (signed in May 2017), is aimed at increasing agricultural productivity and enhancing access to markets for farmers in selected Gewogs in Southwest Bhutan.

From national lending institutions, several financing opportunities exist for the agricultural sector, although these are not explicitly targeting CSA. They include: 1) the Bhutan Development Bank, providing credits to farmers that are applicable for rural development, agriculture development and renewable energy programs; 2) the Rural Enterprise Development Corporation, providing credits for starting up cottage and small industries in rural areas; 3) the Bhutan Trust fund for Environmental Conservation; 4) Druk Holding and Investment, which has a fund for promoting entrepreneurship; 5) the Loden Foundation, supporting and financing education, learning and entrepreneurship among the young Bhutanese; 6) Tarayana Foundation, an

NGO funding economic development programs and green technologies for communities; and 7) the Singye Group, a private company that is involved, among others, in financing horticulture programs.

The Netherlands Development Organisation (SNV) has made significant efforts in promoting climate smart agriculture in Bhutan. Their CSA initiative was launched with the objective to benefit over 1800 farmers covering 14 sites in six districts. In a similar line, UNDP SGP has invested to support the human wildlife conflicts. The solar electric fence invention supported by UNDP has increased productivity of agricultural crops by reducing and eliminating wildlife damages to crops. The United Nation Environmental Programme (UNEP) has also supported the water sector in reducing the threat for national water resources (implemented by the Department of Forest and Park Services).

In addition, other international donor programs include the Forest Carbon Partnership Facility (FCPF), the Pilot Program for Climate Resilience (PPCR) for water source protection, Japan International Cooperation Agency (JICA) supporting farm mechanization and other relevant infrastructures, ADB supporting bio-gas and renewable energy, Global Climate Change Alliance (GCCA+) supporting CSA and non-CSA programs in eastern Bhutan, Bill and Melinda Gates Foundation (Gates Foundation) supporting programs for wheat improvement. The Government of India, the Netherlands Enterprise Agency (RVO) and the International Centre for Integrated Mountain Development (ICIMOD, Nepal) are supporting research activities of academic institutions like CNR. Furthermore, the EU supports the agricultural sector via projects that help creating income-generating activities at the rural level and improve farm-to-market access. Finally, the SAARC Development Fund (SDF), the Least Developed Country Fund (LDCF) of the UNFCCC, and the MAVA Foundation are supporting national NGOs involved in agricultural activities.

Potential Finance

Apart from existing financing opportunities from international donors, several other potential sources of CSA funding exist, which so far have been accessed only for matters unrelated to CSA, yet represent potential funding sources for future CSA activities. Among others, these include the Austrian Cooperation Bureau, Bhutan Foundation, UNDP on Reducing Emission from Deforestation and Forest Degradation (UN-REDD), United Nations Environment Programme (UNEP), FAO, Oxfam International, and Conservation International. Limited domestic capacity in terms of CSA technical know-how and human resources were cited as main challenges in tapping more finances for CSA.

The graphic highlights existing and potential financing opportunities for CSA in [Country]. The methodology and a more detailed list of funds can be found in Annex 6.

Financing opportunities for CSA in Bhutan

- Funds actually accessed by country for CSA purposes
- Funds actually accessed by country for purposes other than CSA
- Funds not accessed by the country

ACP-EU African, Caribbean and Pacific-European Union Energy Facility **AECID** Spanish Agency for International Development **AFD** French Development Agency **AFD-WS** French Development Agency-Water and Sanitation **AusAID** Australian Agency for International Development **BDBL** Bhutan Development Bank Limited **BioCF** World Bank BioCarbon Fund **BMGF** Bill and Melinda Gates Foundation **BTFEC** Bhutan Trust Fund for Environmental Conservation **CARE** Cooperative for Assistance and Relief Everywhere **CDB** China Development Bank **CDCF** Community Development Carbon Fund **CDM** The Netherlands Clean Development Mechanism **CEPF** Critical Ecosystem Partnership Fund **CF** The Clinton Foundation **CI** Conservation International **CLUA** Climate and Land Use Alliance **DCI** Development Cooperation Instrument **DCF** Danish Carbon Fund **DHI** Druk Holding & Investments **ENRTP** Environment and Sustainable Management of Natural Resources Thematic Programme **EU ETS** European Emissions Trading System **FAO** Food and Agriculture Organization of the United Nations **FCPF** Forest Carbon Facility **FIP** Forest Investment Program **FSF** Japan's Fast-Start Financing **GCCA+** Global Climate Change Alliance **GEF** Global Environment Facility **GIZ** German Society for International Cooperation **ICF** United Kingdom International Climate Fund **ItCF** Italian Carbon Fund **IFAD** International Fund for Agricultural Development **IFCI** Australia's International Forest Carbon Initiative **IKI** International Climate Initiative **JICA** Japan International Cooperation Agency **KfW** German Development Bank International Climate Initiative **LF** Loden Foundation **NC** The Nature Conservancy **NCDM** The Netherlands Clean Development Mechanism **NDF** Nordic Development Fund **NORAD** Norwegian Agency for Development and Cooperation **PCF** Prototype Carbon Fund **PMI** Partnership for Market Initiatives **PPCR** Pilot Program for Climate Resilience **RA** AXA IM - Real Assets Forest Investment **REDCL** Rural Enterprise Development Corporation Limited **RF** Rockefeller Foundation **RFRL** Rabobank Farm and Rural Lending **SAI** Sustainable Agriculture Initiative Platform **SCCF** Special Climate Change Fund **SCF** Spanish Carbon Fund **SG** Singye Group **SHARE** Sending Help and Resources Everywhere **SIDA** Swedish International Development Cooperation Agency **SREP** Scaling Up Renewable Energy in Low Income Countries Program **TG** Tashi Group **UBSDGF** Union Bank of Switzerland Dutch Green Fund **UNDP** United Nations Development Programme **UNEP** United Nations Environmental Programme **UN REDD** United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation **USAID-DGP** United States Agency for International Development – Development Grants Program **VCS** Verified Carbon Standard

Outlook

- Bhutan is facing growing challenges in agriculture from the increasing impacts of climate change. There is a lack of national capacity in terms of institutional, infrastructure, human, and technical capacity across the board in dealing with climate change and its effects on agriculture and biological diversity, food security and water resources.

- In general, there is limited understanding and awareness of impacts of climate change on agriculture and food security, water resources, forests and biodiversity at all levels (central, regional, Dzongkhags and Gewogs including the extension institutions at Gewog levels). The specific areas of capacity that need to be addressed include research and assessment, monitoring, extension and training, and policy development.

- Despite agriculture being the primary occupation of the rural population and the Ministry of Agriculture and Forests' goal of food security and self-sufficiency, the country is experiencing decreasing trends in agriculture production, especially cereals. This is not only caused by climate change related difficulties, but also because of the shortage of farm manpower (rural-urban migration).

- Along with the implementers of agriculture programs at central, regional, dzongkhags and gewogs levels, farmers' awareness of CSA and its practices is limited. The government and relevant stakeholders have to undertake key actions to minimize the impacts of climate change and to contribute to the overall goals of food security and self-sufficiency. These steps include the collection of appropriate data on climate smart practices, attracting donors for projects and programs on CSA, aligning CSA goals with national goals and enhancing technical skills and knowledge of implementers at all levels.

- Concerted efforts must be made to educate people on the impacts of climate change on agriculture and food security, water resources, and forests and biodiversity. This will help support Bhutan's preparedness in reducing vulnerability against the impacts of climate change through improved awareness and strengthened capacities of all stakeholders.

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For further information and online versions of the Annexes

Annex 1: Map of agro-ecological zones in Bhutan
Annex 2: Selection of agricultural production systems key for food security in Bhutan (methodology)
Annex 3: Methodology for assessing climate-smartness of ongoing practices
Annex 4: Institutions for CSA in Bhutan (methodology)
Annex 5: Policies for CSA in Bhutan (methodology)
Annex 6: Assessing CSA finances in Bhutan (methodology)

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