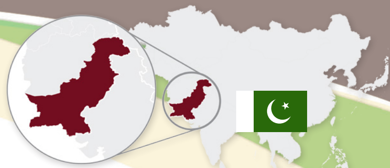

Climate-Smart Agriculture in Pakistan

Climate-smart agriculture (CSA) considerations

A M P $ Changes in monsoons and increased temperatures are likely to bring considerable challenges to the agricultural sector, particularly in northern Pakistan, where vulnerability to climate change is already high. Investment in CSA will be required to ensure a stable food supply in this dynamic economy in the face of climate change.

A M P Agriculture provides employment for roughly 25 million people in Pakistan and is the main income source for 34% and 74% of economically active men and women respectively in the country. Even though they make up the majority of the country's agricultural workforce, women are less likely to own income-generating assets and have inadequate access to education, latest technologies and farming techniques, and agricultural extension. CSA interventions targeting women will have disproportionally large impacts on Pakistan's agricultural sector.

A M P Pakistan often experiences periods of severe droughts, followed by devastating floods. In the aftermath of the 2010 floods, one fifth of the country's land area was submerged, damaging the economy, infrastructure and livelihoods, and leaving 90 million people food insecure. CSA strategies that help mitigate and adapt to extreme events are critical for food security in the country.

A P Three-fourths of the country receives less than 250 mm of rainfall annually. The country boasts a comprehensive network of irrigation infrastructure including canals and dams, yet water resources for agriculture are expected to decline in coming years. Critical investments in improved seeds, farming technology and techniques, and water infrastructure are needed to tackle the emerging challenges to the agricultural sector, especially in the context of declining water availability and climate change impacts.

M P Pakistan is the world's sixth most populous country and its population is growing at a rate of approximately 2% per year. Since most of the arable land is already in use, productivity gains to meet this growing and predominantly urban population will likely be achieved through sustainably increasing cropping intensity in the country, accompanied with increased fertilizer usage.

M Agriculture is responsible for approximately 41% of all GHG emissions in the country, mostly through livestock production. CSA technologies and practices that improve efficiency in livestock systems while simultaneously reducing emissions may include: improved animal feed and feeding techniques to reduce methane and nitrous oxide, improved breeding, adapted manure storage and management practices, and improved pastures and management of grazing lands to enhance productivity and create carbon sinks.

M Pakistan is making considerable efforts to incorporate renewable energy technologies into its agricultural production systems to overcome persistent and widespread energy shortages in the country. This includes windmills, solar panels and bio-energy production units that can be used for water supply and storage and other farm equipment.

I $ The level of climate-related expenditures has been low over the past years, yet the country's new Pakistan Climate Change Act (PCCA), 2017 sets the stage for the establishment of the Pakistan Climate Change Authority and Pakistan Climate Change Fund, which are expected to help mobilize domestic and international funds for mitigation and adaptation interventions in the country, including CSA.

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 [1]. 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 [2]. 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

The Pakistani economy has been growing steadily over the last 60 years at an average annual rate of 4.9% and has nearly doubled in size in only the last 10 years from GDP of US$ 137 billion in 2006 to over US$ 270 billion in 2015. The country's growth, however, has been inconsistent, with many cycles of booms and busts. Pakistan is considered an emerging market economy, but it lags on many development metrics, including being ranked 147th out of 188 countries on the 2016 Human Development Index.

Agriculture remains the second largest economic sector in Pakistan, contributing approximately 25% to the national Gross Domestic Product (GDP) [3][1] and absorbing roughly 42% of the labour force, mainly composed of women [4]. The sector is not only the largest employer in the country but generates over 75% of export revenue through agri-based textiles (cotton) and agri-food products [5]. The country is among the world's largest textile and rice exporters and imports significant quantities of palm oil used in cooking.

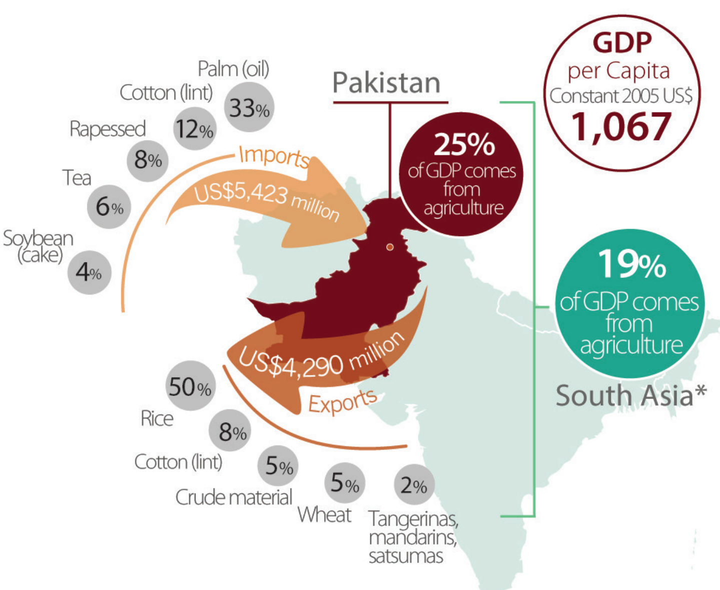
Despite its critical importance to food security, livelihoods, economic growth and export revenues, agricultural productivity remains low, with significant yield gaps compared to global averages in key crops like wheat, rice and sugarcane. The average farm size in Pakistan is 2.6 hectares (ha), with approximately 43% of the farmers categorized as smallholders with holdings of less than one ha, while only 22% own more than 3 ha of land [6][2]. In 2016, for first time in the past 15 years, the sector experienced a negative growth rate of 0.2%, primarily due to the impact of extreme events on key crops, a lack of access to key inputs, and a global downturn in commodity prices [4].

Critical investments in improved seeds, farming technology and techniques, and water infrastructure are needed to tackle the emerging challenges to the sector's development, especially in the context of declining water availability and climate change impacts.

Pakistan is the sixth most populous country in the world, with an estimated population of 190 million [3]. Over 60% of the population still resides in rural areas despite rapid urbanization in the past few decades[3]. Applying pro-poor strategies—including a focus on the development of smallholder farmers—the country has made significant progress in reducing the national poverty incidence, from 64% in 2001 to 29.5% in 2013. However, four in 10 people are still deprived of some of the basic necessities, a phenomenon known as multidimensional poverty [7]. This is predominantly a rural phenomenon with 55% of the rural population affected by multidimensional poverty.

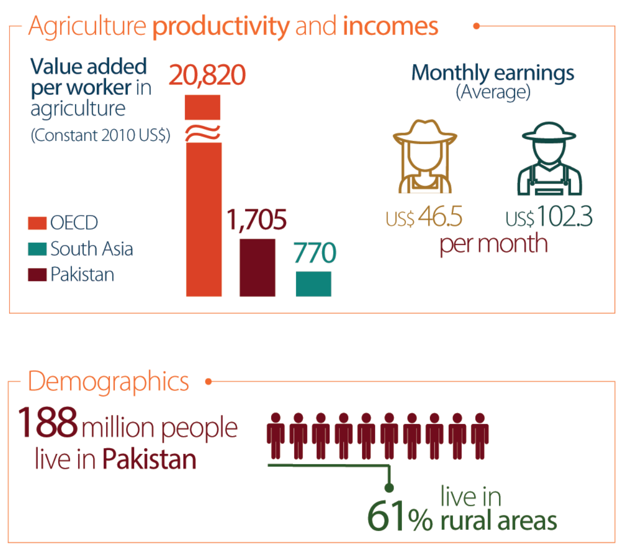
Agriculture provides employment for roughly 25 million people in Pakistan and is the main income source for 34% and 74% of economically active men and women respectively. Yet women have limited access and control over productive resources (e.g. land, irrigation infrastructure, and agricultural inputs), low awareness of improved technologies and skills for value addition and marketing, and limited access to extension and financial services. Their role in the household and in daily agricultural activities, however, varies across regions according to local customs and traditions [8].

Economic relevance of agriculture in Pakistan [3, 9]



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

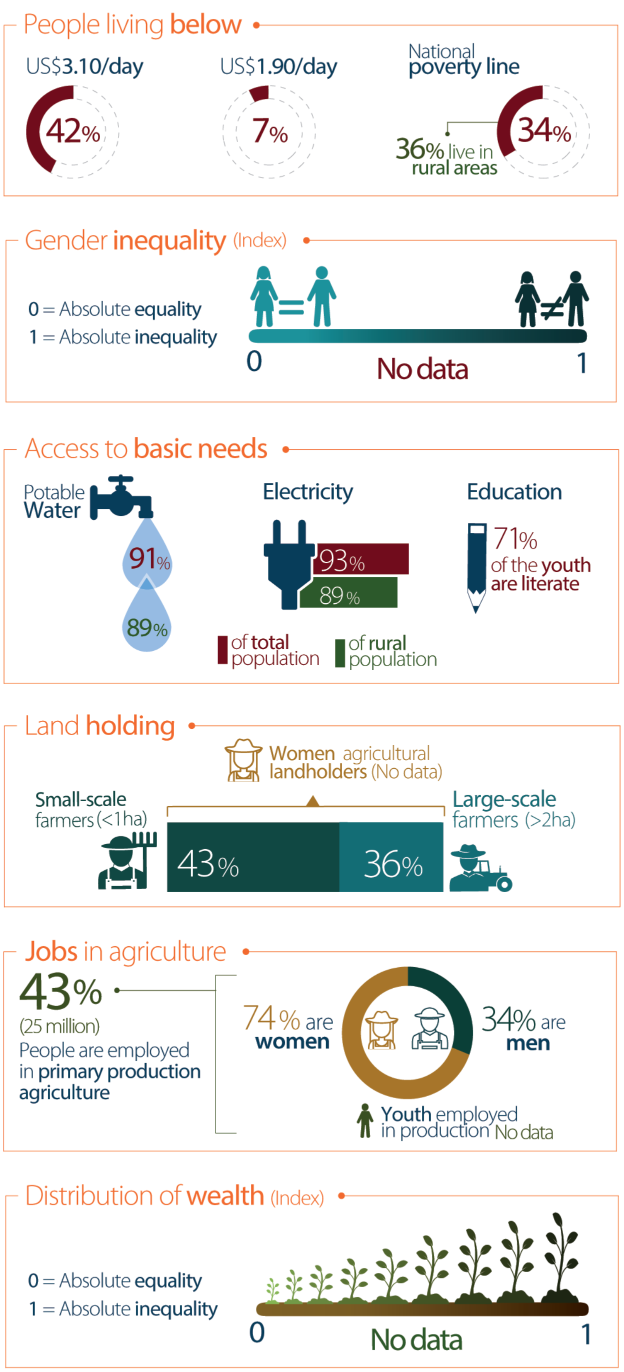
People, agriculture and livelihoods in Pakistan [3, 4, 9, 24, 25]



1 However, the sector's growth rate has been falling over the last three decades. As a result, its contribution to the national economy (GDP) has declined steadily from 46% in 1960 to 20% in 2015 [3].

2 The latest agriculture census in Pakistan was carried out in 2010.

3 Karachi and Lahore, Pakistan's two largest cities, are labelled as mega cities with population in excess of 10 million people.

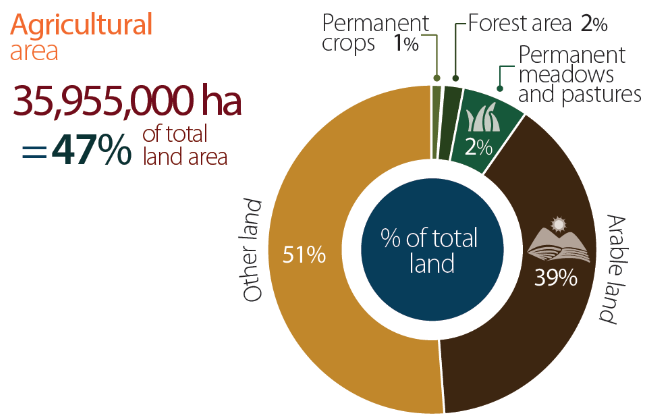


Land use

Pakistan is a natural resource–based economy, with almost half of its total land area (36 million ha) dedicated to agriculture [9]. Approximately 84% of land is classified as arable and 14% as permanent meadows or pastures. The country's forested area represents only 2% of total land—compared to the world average of over 30% [3] —and is declining at a rate of 0.2-0.5% per year [10]. Deforestation—driven by urbanization, a rural reliance on fuelwood, and poor land planning— has been linked with socioeconomic vulnerability and a lack of effective policy and monitoring mechanisms to protect forests.

The area of land under production has remained relatively stable over the last four decades at approximately 36 million ha. Since most of the arable land in Pakistan is already cultivated, productivity gains in the country are achieved through increased cropping intensity and the higher use of fertilizers. The average annual fertilizer use in Pakistan across all cropping systems is estimated at 159.9 kg/ha.

Land use in Pakistan [9]



Agricultural production systems

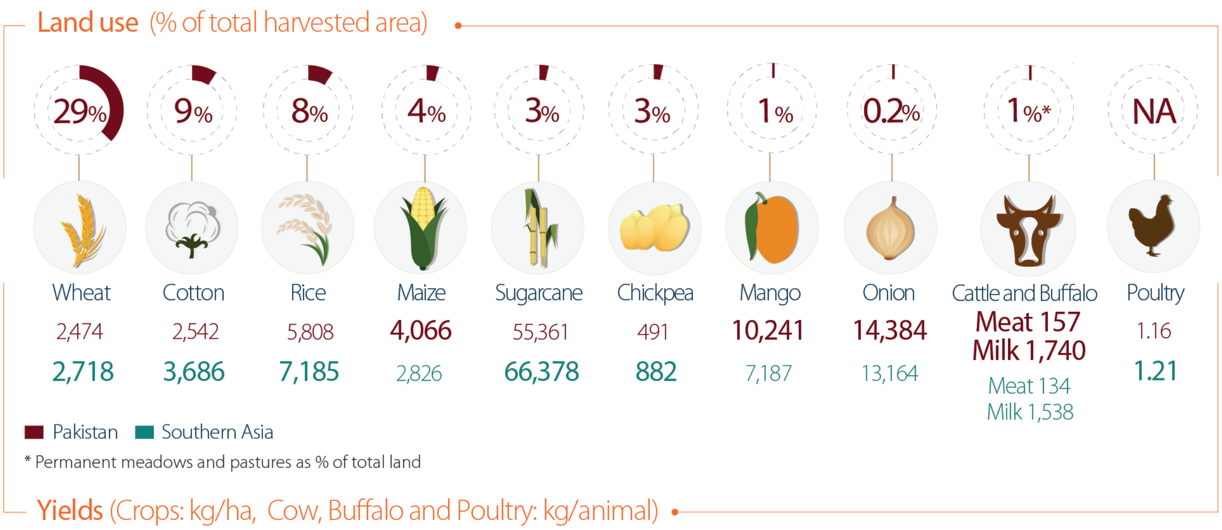
Pakistan is a country of diverse ecological zones with considerable variations in topography, altitude, climate, and seasons. Specifically, the country can be divided into ten distinct agro-ecological zones (AEZs) (Annex 1). The north has high mountains and valleys, while the Pothwar Plateau and the fertile Indus Plain lie immediately to the south. The western part of Pakistan is comprised of the Baluchistan Plateau, bordered by mountains to the northeast. There are two sandy deserts in the Indus Basin: the Thal desert in the upper region and the Thar desert in the south-east. The southernmost region of the country is characterized by marshy land.

Although most crops are grown across the country, some are more dominant in particular AEZs. It is in the AEZ along the Indus River, the Indus Basin and Delta, and northern and southern irrigated plains for example, where the main crops of cotton, sugar cane, rice and wheat are cultivated. Punjab province, Pakistan's most productive agricultural province, sits at the convergence of these highly productive ecological zones.

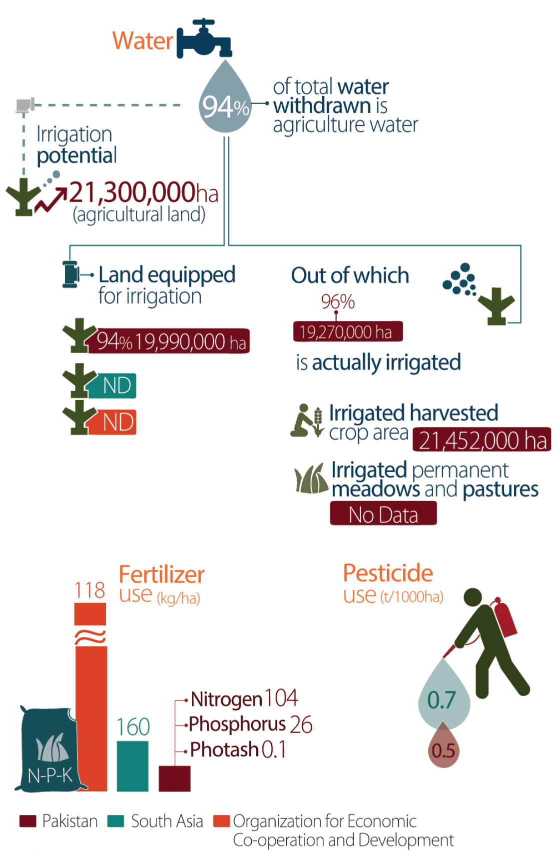
Pakistan receives monsoon rainfall in the summer, while in the winter it receives rainfall due to western systems (prevailing winds from the Mediterranean). These two forces broadly determine the two main cropping seasons in the country. These are 'Kharif' (April-June), suitable for summer crops cultivation (e.g. rice, sugarcane, cotton, maize, pulses), and 'Rabi' (October-December) when wheat, lentil, tobacco, rapeseed, barley and mustard are grown. The major crops are cotton, wheat, rice, sugar cane and maize that cover over 50% of the harvested area. Some crops such as pulses, onions, potatoes, chili, and tomatoes, have gained in economic importance in the country, given the consistently high prices of these essential commodities. Climate variability and change, pest infestation, and commodity price fluctuations are some of the challenges to crop productivity.

Livestock is the largest agriculture sub-sector in the country, representing more than half of Pakistan's agricultural GDP (55.4%) and is considered a key livelihood strategy for smallholder subsistence farmers, especially women and people lacking clear land ownership rights. Livestock activities are common across all AEZ areas in the country and are particularly important in predominantly rain-fed regions [8]. The following infographic shows a selection of agriculture production systems key for Pakistan's food security. The importance is based on the system's contribution to economic, productivity and nutrition quality indicators. For more information on the methodology for the production system selection, consult Annex 2

Production Systems Key for Food Security in Pakistan[9]



Agriculture input use in Pakistan (3.9.26)



Agriculture production is mostly irrigated, using both surface and groundwater. Roughly 94% of the agricultural area in Pakistan is equipped for irrigation. The country has an extensive irrigation system relying on rivers, dams, barrages and canals. However, erratic monsoons patterns, increased glacial melt, low water storage capacity and on-going cross boarder water disputes add uncertainty to the availability of water and affect production patterns.

Food security and nutrition

Natural disasters, economic instability, and militancy have challenged food security in Pakistan over the past years, despite significant increases in staple crop yields. Pakistan ranks 78th out of 113 countries in the Global Food Security Index [11], with more than half of the population (60%) experiencing food insecurity. The average food supply in the country is estimated at 2,440 kcal/person/day, yet this is rated insufficient to meet demand (the country boasts an index score of 39.7, where 100 indicates sufficiency of supply) given high geographical disparities in food production and supply. From a nutrition perspective, over one-fifth (22%) of the total population is undernourished, one-third (31%) of children are underweight for their age (15% are affected by wasting) and diets generally lack diversity (Pakistan scores a 53.60 on the food diversity index).

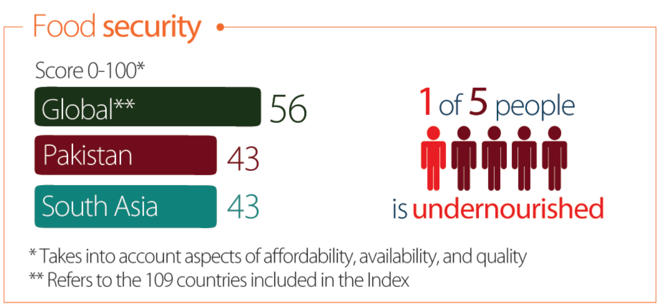
Low nutritional quality is associated with economic hardship, low literacy levels, poor sanitary conditions, and inadequate access to health services [9].

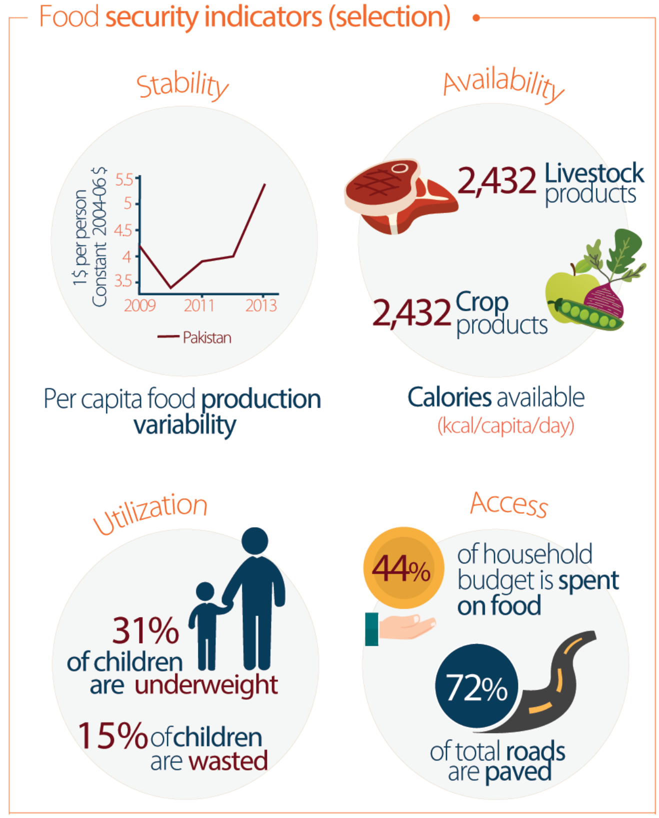
In the Pakistani diet, cereals (predominantly wheat) remain the main staple food, accounting for 62% of total energy. Wheat is followed by milk and vegetables in terms of calories consumed. On average, households in Pakistan spend 44% of their income on food, higher than any other commodity group [12]. The expenditure is higher in rural areas at 48%, where two-thirds of the population resides and 80% of the poor population is concentrated. Limited access to credit, markets and government services contribute to widespread chronic poverty and food insecurity among rural populations

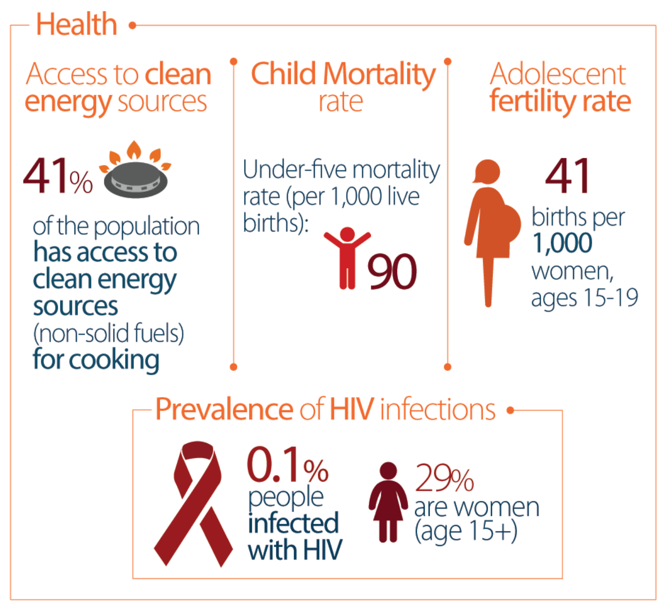
These conditions were amplified in the aftermath of the 2010 floods where 90 million people were considered food insecure in Pakistan. This situation had been deteriorating gradually since 2003[4] and worsening when the floods submerged one fifth of the country's land area, damaging infrastructure and limiting access to food and basic services. Socioeconomic factors also contributed to increased food insecurity in this period as on-going political instability and militancy gripped the country, leading to widespread unemployment and high inflation (16% in 2010, but has reduced to a 13 year low of under 3% in 2016).

In an effort to combat these long-term trends, Pakistan joined the Scaling-Up Nutrition initiative in 2013 and established a multi-sectoral committee to coordinate food policies and interventions at national and provincial levels. Additionally, Pakistan Vision 2025—the country's long term planning policy— puts food security of the population at the forefront of the political agenda in the country.

Food security, nutrition and health in Pakistan[3, 9,11,12,27,28,29]





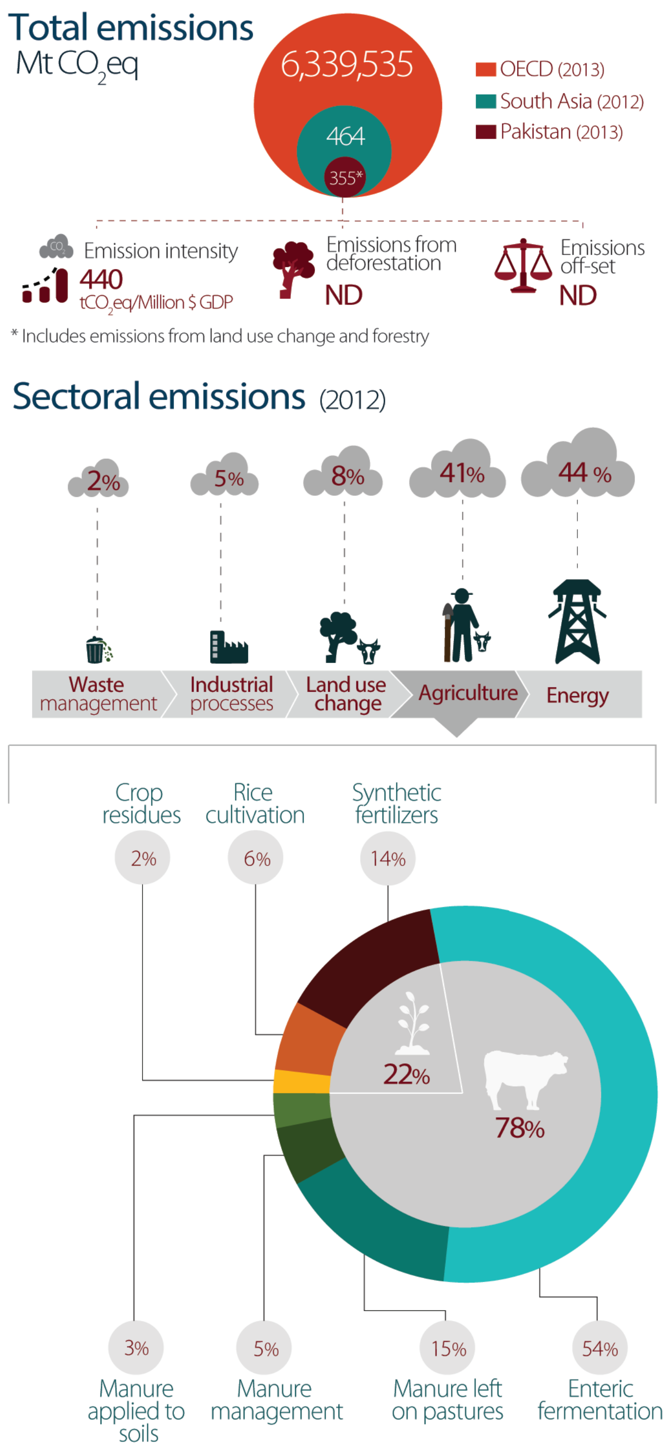


Agricultural greenhouse gas emissions

Pakistan's contribution to global greenhouse gas (GHG) emissions represent only 0.8 percent of global emissions, estimated at 355 megatons of CO2 equivalent annually, including emissions from the Land Use Change and Forestry (LUCF) sectors. Consequently, the country is ranked low at 148th in the world on the list of global emitters, based on a per capita GHG emission of 1.96 tons of CO2 equivalent [13].

4 The incidence of food insecurity rose from 38% in 2003 to 50% (equivalent to 83 million people) in 2009.

Greenhouse gas emissions in Pakistan [9,13,30]



Of the total GHG emissions in Pakistan, agriculture is the single largest contributor representing approximately 41% of the emissions, mainly through livestock rearing and cropland. These systems represent 78% and 22% of total agriculture emissions, respectively [3]. With a growing population and evolving dietary preferences, food demand is expected to increase significantly in to the future, driving commensurate increases in agricultural sector emissions.

Potential interventions to reduce livestock sector emissions are especially important in Pakistan. Technologies and practices that improve the production efficiency of livestock while simultaneously reducing emissions may include: improved animal feed and feeding techniques that can reduce methane and nitrous oxide generated during digestion and the decomposing of manure; improved breeding; adapted manure storage and management practices; and improved pastures and management of grazing lands which could improve productivity and create carbon sinks.

Meanwhile, for the cropping sector, improved irrigation and water management, particularly in rice cultivation, is needed to control the release of methane from paddy cropping systems. No-till farming and conservation agriculture may also be applied to reduce the use of chemical fertilizers and control weeds and pests for several cropping systems in Pakistan. Finally, agroforestry and large-scale tree plantation programs, such as the Billion Tree Tsunami Afforestation Project and the Green Pakistan Program, are necessary to counter emissions from rapid land use change and deforestation in the country.

Challenges for the agricultural sector

Despite significance of agriculture to the country's economy and its people, the sector currently faces a multitude of challenges including population growth, rapid urbanization, reduced water resource availability and gender inequality. Pakistan's population has more than doubled in the past two decades, growing at a rate of approximately 2% per year[6] and is expected to further increase to 244 million by 2030 and 300 million by 2050 [14]. At the same time, life expectancy in the country is projected to increase from 66 to 71 years by 2050. Such exponential growth will put significant strains on the already extended and vulnerable agriculture system, boosting demand for food. The current per capita caloric availability in Pakistan, 2,432 kcal/day is likely to fall unless food production keeps the pace with the projected population growth.

Population growth is likely to be accompanied by rapid urbanization and industrial expansion in Pakistan. Industrialization and urbanization exposes agricultural areas situated near these sites to harmful chemicals affecting both the quality and safety of food products. Crops in peri-urban areas are often irrigated with wastewater containing heavy metals, which are potentially absorbed by vegetables and other cash crops infiltrating the food chain. Urban agriculture has prominent effects on human health and water-borne diseases.

Deficiency in water availability, degradation of soil, and an increasingly animal-based diet are additional threats to food security in Pakistan. Changing climate conditions such as rainfall, temperature, and humidity multiply these threats, affecting the availability and quality of natural resources and increasing the vulnerability of the sector. Most of the country's territory is classified as arid to semi-arid. Three-fourths of the country receives less than 250 mm of rainfall

5 Based on 2013 data

6 The population increased from 92 million in 1985 to 188 million in 2015 [3].

annually, while about 20% of such area receives less than 120mm [15] Rainfall alone, then, is generally insufficient for growing agricultural crops, maintaining pastures, and growing fruit trees. Roughly 8 million ha of land in Pakistan is idle and unutilized due to unfavorable climatic conditions. Supplemental water is required for profitable agricultural production in Pakistan, either from irrigation or through water harvesting techniques.

An increase in the demand for water in agriculture poses a severe threat to water resources management in Pakistan. Droughts, floods, warming, and changes in precipitation can directly alter crop yields. Only some crops, such as wheat and barley, have higher resistance to changing climate conditions. A study conducted on wheat production in the mountainous areas of Swat and Chitral districts, for example, suggests that short duration and high yielding varieties that can withstand climate anomalies should be introduced in mountainous region [16].

Meanwhile, the rural population, which represents the backbone of the agricultural sector, is comprised mainly of small-scale, poor farmers who lack access to modern farming technologies, machinery, fertilizer inputs, as well as drought and other weather-tolerant seeds. The high price of seeds and a lack of support from government further restrict farmers from adopting improved techniques. Rural infrastructure lacks properly built roads, transport and storage facilities, electricity, education and health services. Each of these features is currently inadequate to meet the requirements of a growing agricultural sector. Small farm size and persistent poverty restricts the ability of farmers to take risks and diversify incomes, and minimal asset ownership and lack of collateral limits farmers' access to credit markets.

Finally, gender inequality and discrimination is another characteristic of the agricultural sector in Pakistan. While 74% of employed women depend on agriculture, compared to 34% of employed men, women are less likely to own income-generating assets such as land, machinery or equipment, nor do they have equal power in financial or economic decision making. The lack of access to the latest technologies and farming techniques, weak extension support, and high illiteracy among rural women creates further challenges for women in agriculture [8].

Agriculture and climate change

Agriculture in Pakistan is significantly affected by short-term climate variability and longer-term climate change. Pakistan is ranked among the top ten most climate vulnerable countries in the world in the Global Climate Risk Index [17][7]. The country has a diversified geography and climate. Broadly speaking, the country is situated on a steep incline, with altitudes varying from 8500 meters above sea level in the Himalayas to sea level at the country's coasts, all within a distance of less than 3,000 km. The marine tropical coastland, the subtropical continental lowlands and subtropical highlands, as well as the subtropical continental plateau constitute the main climatic regions of the country [18]. Climate change threats are exacerbated in the country due to the arid climate and reliance on water from the glacial melt in the north.

Periods of severe droughts, followed by devastating floods are common in the country and have contributed to low crop yields, loss of livestock, damage to irrigation infrastructure and food shortages in recent years. Economic losses associated to the 2010-2014 floods amounted to US$ 18 billion, affecting the livelihoods of 38 million people and causing damages to approximately 4.3 million ha of cropland [18]. Changes in climate have been manifested through long-term reduction in rainfall in the semi-arid regions of the country and higher glacial melts[8] that contribute to over 70% of river flows. Moreover, the mean temperature across the country has increased by 0.5°C in the past 30 years.

Projections indicate an increase in mean temperature of 1.4°C - 3.7°C by 2060 in Pakistan (higher than the expected global average), with the north potentially experiencing higher temperatures compared to the south of the country. Temperatures are also expected to increase more in winter than in summer in Pakistan. Projections for precipitation change are less clear, due to considerable model uncertainties for the region [31].

Changes in monsoons and increased temperatures are likely to bring considerable challenges to agriculture, particularly in northern Pakistan, where vulnerability to climate change is already high. Increases in temperature will likely speed up crop growth cycles and shorten the time between sowing and harvesting, affecting crop yields. According to the Climate Change Vulnerability Index, droughts are expected to increase in winter, affecting the yield of cash harvests. Meanwhile, increase in precipitation in the summer season may cause floods throughout different areas of Pakistan. Despite extensive irrigation infrastructure, gaps in water management infrastructure, such as dams, results in discharge of excess water into the sea, leaving the country in water-stressed situation for the large part of the year.

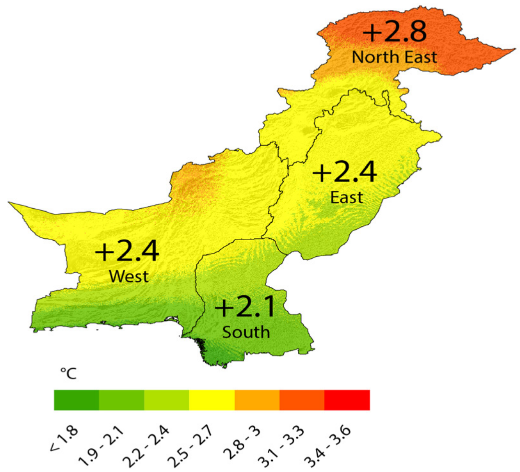
This will have considerable impacts on key crops in Pakistan. Wheat and rice yield, or example, are expected to decrease in all areas. Moreover, climate change impacts on water resources are unclear, due to the uncertain behavior of the northern glaciers. There is an increased risk of avalanches and glacial lake outburst floods (GLOFS) across the river systems of the country.

7 According to annual averages (1996 to 2015) of the Long-Term Climate Risk Index.

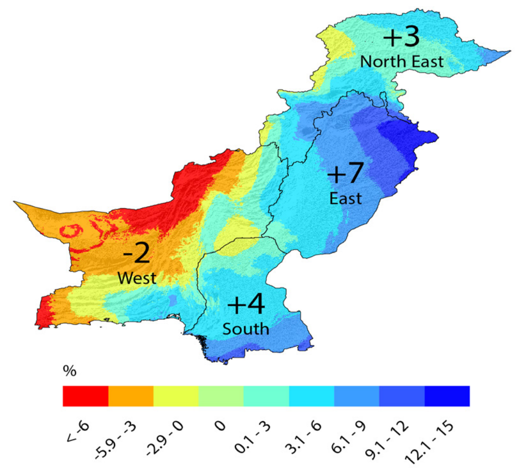
8 Annual glacial melting rates in Pakistan amount to 2.3%, representing one of the fastest melting rates in the world [18].

Projected change in Temperature and Precipitation in Pakistan by 2050 [31, 32, 33]

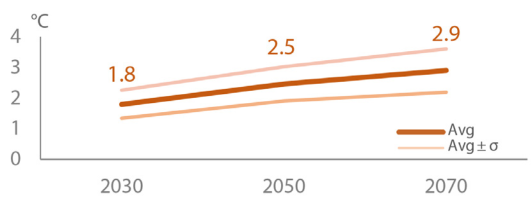
Changes in annual mean temperature (°C)



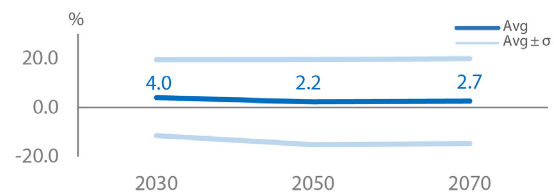
Changes in total precipitation (%)



Average temperature (°C)

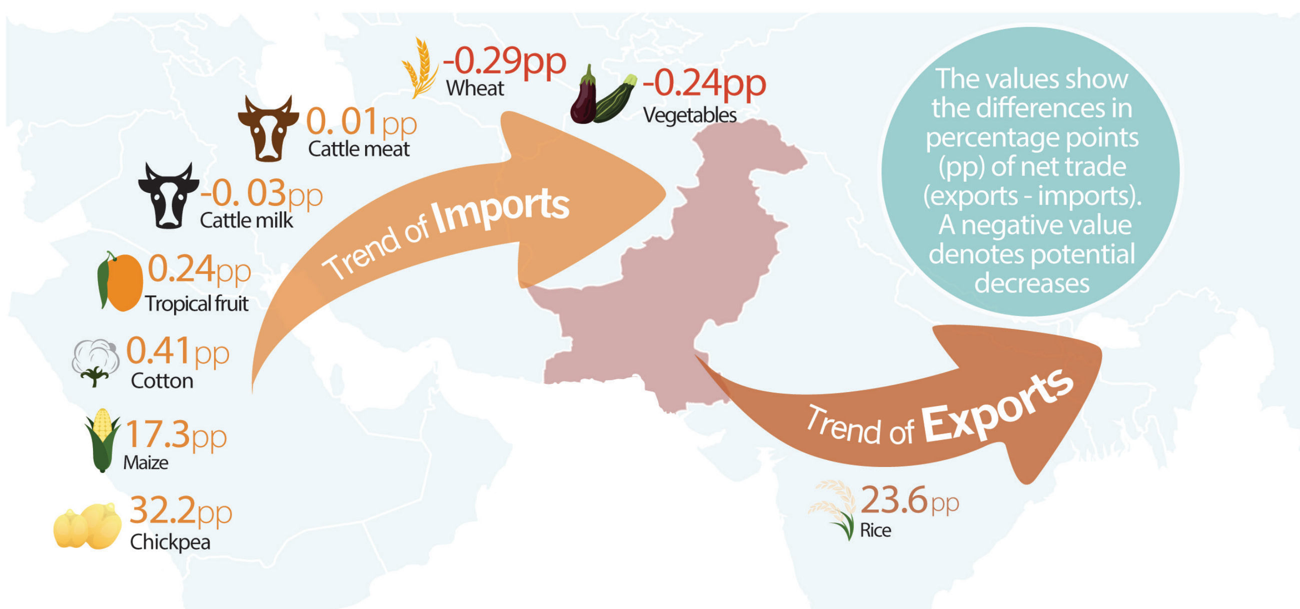


Average precipitation (%)



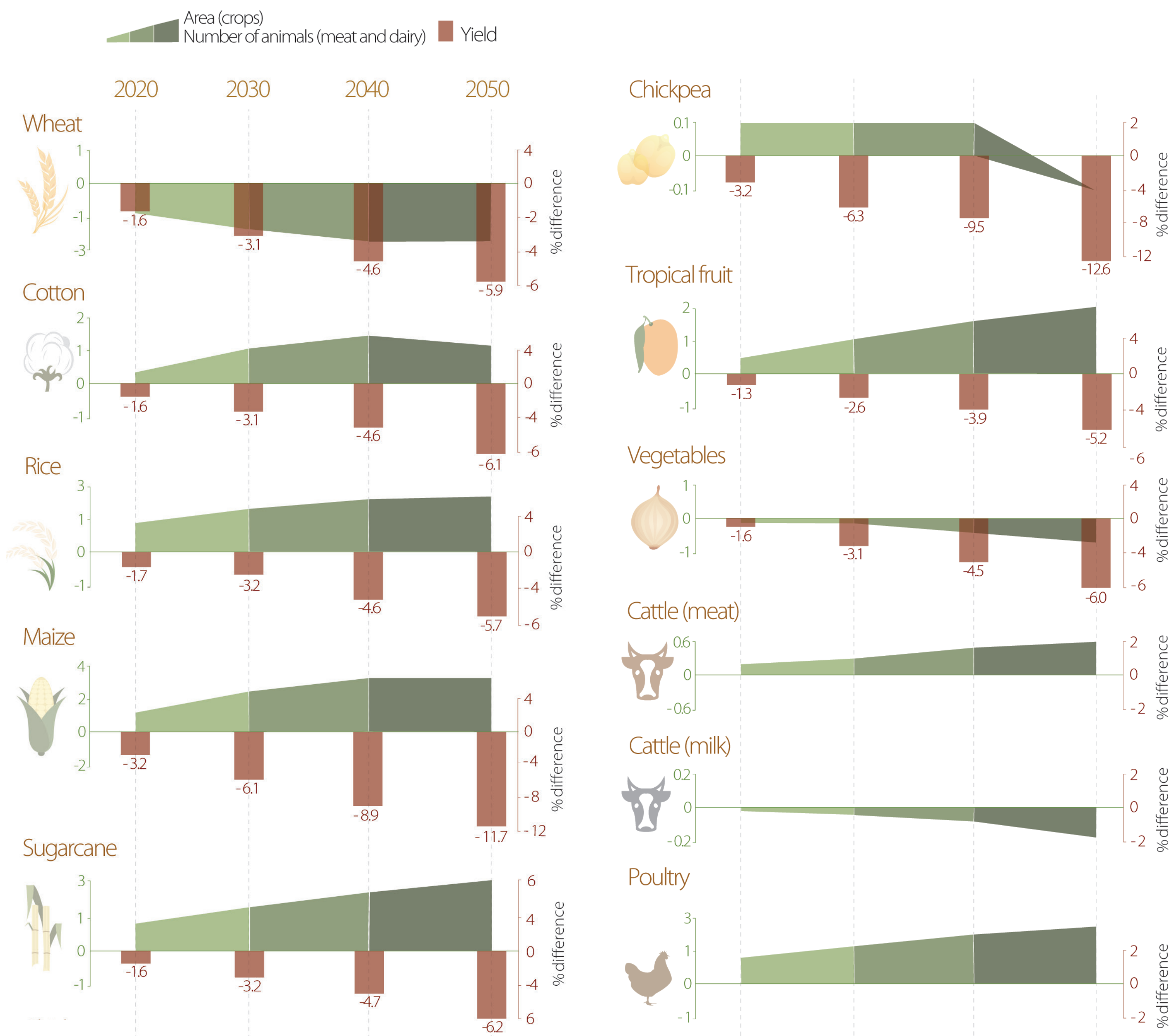
Potential economic impacts of climate change

The impact of climate change on net trade in Pakistan (2020-2050) [34]



An analysis using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)[9] [34] was carried out for the selected key production systems in Pakistan, analyzing impacts of climate change over the period of 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]. The specific impacts depend on the production system in question, with wheat, maize, sugarcane and chickpea facing the most negative impact.

Climate change impacts on yield, crop area and livestock numbers in Pakistan [34]



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

9 IMPACT, developed by the International Food Policy Research Institute [35], 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 [36, 37] 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) [19]. This study used SSP 2 and RCP 4.5 pathways.

Overall, the area under wheat cultivation is projected to decrease under both the CC and NoCC scenarios, while the area under cotton, maize, rice, sugarcane, tropical fruit cultivation are projected increase under both CC and NoCC scenarios. The 2050 wheat area under climate change is projected to be 2.5 % lower than the projected 2050 area if climate change had not occurred, followed by vegetable and chickpea with 0.7% and 0.1% respectively. Furthermore, harvested area of maize, sugarcane and rice cultivation under CC are projected to be larger than under NoCC, with 3.4%, 3.1% and 2.4% respectively.

Yields for some cultivations are projected to increase over the period 2020 to 2050 under both CC and NoCC, but this increase is projected to be less under CC in all productions systems. The 2050 chickpea yields under climate change are 12.6% lower than the projected 2050 value if climate change had not occurred, followed by maize, sugarcane and vegetable by 11.7%, 6.2% and 6.0%, respectively.

Likewise for 2050, the impact of climate change on animal numbers is anticipated to be partially negative and differentially distributed depending on the animal type. In the case of cattle for dairy, numbers are projected to be lower by 0.17% under CC than NoCC scenario, while poultry, eggs and cattle-meat might have positive differences under CC by 2.47%, 1% and 0.61% as compared to NoCC.

Independent of climate change, modeled results suggest that Pakistan may become more dependent on imports of the majority of production systems modeled, with exception of rice. However, the net impact of CC might be lower for eggs, vegetables and wheat by 0.53 percentage points (pp), 0.24pp and 0.29pp, respectively, as compared to NoCC. At the same time, the import levels for chickpea, tropical fruit and cotton are expected to increase under CC by 32.15pp, 0.24pp and 0.4pp, respectively.

Results also suggest that Pakistan will be able to increase exports of rice by 23.63pp under both CC and NoCC scenarios. On the other hand, maize will shift from being net exported to net imported in both CC and NoCC.

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 at least one of the other objectives of CSA (adaptation and/or mitigation). Hundreds of technologies and approaches around the world fall under the heading of CSA.

Most CSA practices identified in this study address chronic challenges to Pakistan's agricultural sector, namely drought, flood, and intense heat. Water management strategies, improved crop and livestock varieties, integrated pest management and manure management, and renewable energy technologies for the agricultural sector are among the most widely adopted strategies in Pakistan.

Water management strategies have grown in importance for agriculture in Pakistan in recent years given the increased intensity and unpredictability of both drought and flooding events in the country and the growing unreliability of glacier melt. One practice of particular importance to Pakistan rice production systems is alternate wet and drying (AWD) of paddies. AWD is a management strategy where close monitoring of soil saturation is used to reduce the need for constant submergence of rice paddies. Rice remains flooded during critical growing periods like flowering, but otherwise water levels can alternate between surface flooding and flooding up to 15cm above the soil surface. A simple "pani" pipe is used to determine flooding depth. AWD is moderately adopted in Punjab and Sindh provinces.

Another important water management technique in Pakistan is laser leveling. While irrigation is widespread in Pakistan, because of poor field design and surface unevenness, considerable agricultural water resources are lost due to water accumulation or dry pockets. As a result, germination is often inconsistent, and crops grow unevenly. The use of a laser beam (situated at a fixed point at the edge of the field with a receiver box on a plow) allows farmers to achieve uniformity in field preparation for uniform water and moisture distribution. This practice is promoted to farmers and service providers by the Directorate General Agriculture in the province of Punjab [20], although not yet widely adopted across the country due to differing provincial priorities and funding support.

Conservation agriculture and no-till practices are also on the rise in Pakistan. In Punjab and Sindh provinces, for example, no-till rice-wheat systems are increasingly being adopted (this is true across much of South Asia, more broadly). In this management system, wheat is planted immediately following the rice harvest without tilling the land. Only shallow channels sufficiently deep for seed germination are utilized, minimizing soil disturbance and maximizing soil carbon storage. Soil ripping, another minimal till practice, is currently widely adopted by sugarcane producers in

Pakistan, also in Punjab and Sindh provinces. Raised bed planting of maize is also a widely adopted management strategy in both KPK and Punjab provinces, contributing to considerable water use efficiency improvements.

The use of improved seed varieties and livestock breeds is a central CSA strategy being utilized in Pakistan, although limited in its current deployment given the reduced availability of breeding materials. Early maturing varieties of maize—a moderately adopted adaptation strategy— in KPK province is denoted as especially climate smart given its strong effect on productivity improvements. Meanwhile pest tolerant varieties of onion are also widely adopted in Punjab and Sindh provinces and considered moderately climate smart. Drought tolerant varieties of wheat and cotton, and heat tolerant varieties for cotton are utilized across Pakistan.

Other commonly adopted management practices in Pakistan include Integrated Pest Management (IPM), or a holistic view of pest management that aims to reduce environment and human impacts of pesticides and promotes natural pest control methods. To control white fly populations in chili crops in Pakistan, for example, natural predators like ladybugs, lacewings, or whitefly parasites can be released. This approach has been promoted by the Agribusiness Support Fund in Pakistan, with support from the U.S. Agency for International Development (USAID).

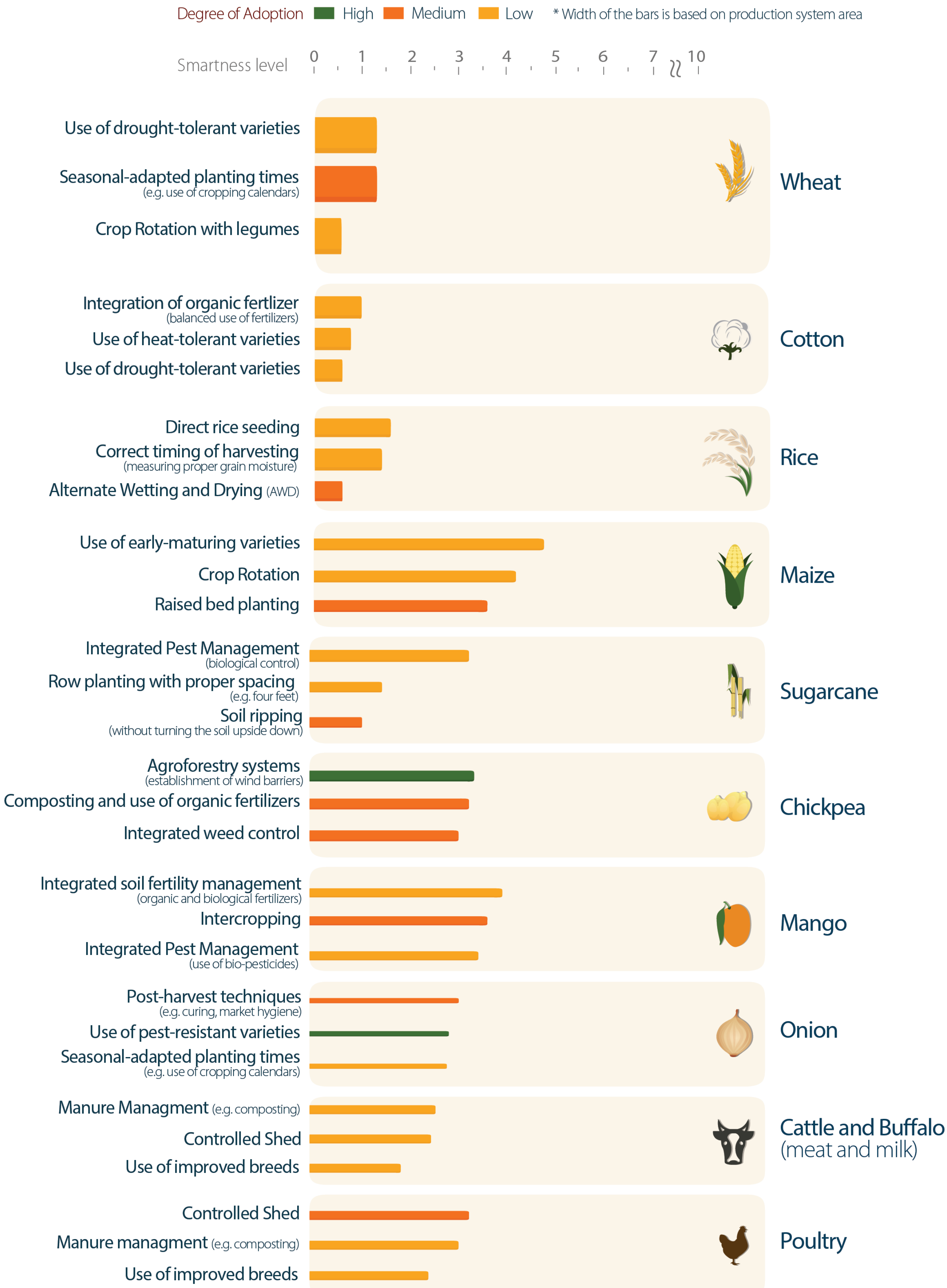
IPM strategies are determined to be highly climate smart in the context of sugarcane production in Sindh province, for example. Similarly, the use of bio-fertilizers, bio-pesticides and weed control practices are also widely adopted CSA practices that can reduce agricultural GHG emissions and solid waste pollution. This includes the application of bio-power fertilizer and Spinosad (bio-pesticide against fruit flies) in the case of mango and biological-controlled varieties of sugarcane. Generally speaking, across Pakistan a balanced used of chemical and biological fertilizers is maintained for the important cotton crop.

Through a focus on CSA, Pakistan has also sought to improve the dissemination of underutilized, low-barrier adaptation and mitigation strategies. In addition to adjusting crop calendars and planting dates, this includes the maintenance of proper row spacing, constructing agroforestry wind barriers, earthing-up during cropping of sugarcane, and crop rotations with legumes (wheat and maize), among other widely known practices.

Finally, Pakistan is making considerable efforts to incorporate renewable energy technologies into its agricultural production systems. This includes windmills, solar panels and bio-energy production units that can be used for water supply and storage and other farm equipment [21]. Under the "Better Use of Energy in Agriculture" project in Punjab province, solar powered High Efficiency Irrigation Systems (HEIS) are deployed for drip irrigation systems with storage ponds and submersible pumps to optimize use of water and supplement conventional high carbon energy sources that are limited and expensive [22]. The World Bank is supporting two HEIS projects in Punjab and Sindh provinces to improve productivity of water use in irrigated agriculture and to grow high value crops.

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 Pakistan



Case study: System of Rice Intensification (SRI)

Climate change risks and shocks to the agricultural sector are a growing challenge in Pakistan. Increasing temperatures and variations in monsoon systems disproportionally affect smallholder farmers that rely on rain fed agriculture and have low capacity to cope with climatic uncertainties.

The Food and Agriculture Organization (FAO) of the United Nations, under its "Livelihood Restoration, Protection and Sustainable Empowerment of Vulnerable Peasant Communities in Sindh Province" program, has helped smallholders in Sindh to adopt System of Rice Intensification (SRI) practices and technologies. SRI enables vulnerable farmers to combat the increasing water shortages at the tail end of canals through the application of a variety of technologies, including those related to water-efficient good agriculture practices, on-farm water management, integrated pest and disease management and integrated plant soil nutrient management.

Photo: FAO

The project has benefited over 80,000 peasant and smallholder farmers in 120 targeted villages in the Sindh province. SRI methods have improved efficiency of inputs, increased farm income, improved crop yields, protected and revitalized soils, biodiversity and the natural resource base, and contributing to climate-smart sustainable agriculture and rural development.

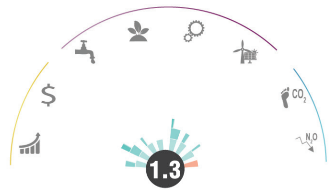
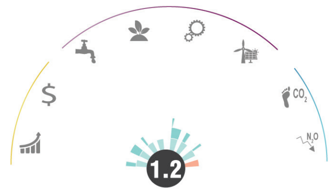
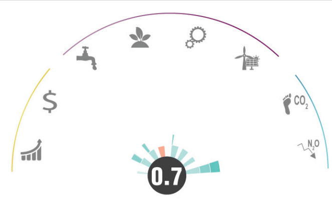
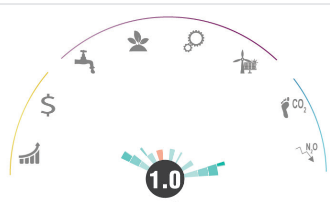
Ali Anwar, a 50-year-old small farmer from Loolja village, Dadu District in Sindh, along with his old parents and eight kids, was facing serious food and economic insecurity due to decreased farm production and health ailments. When FAO introduced the SRI intervention in his village, Ali Anwar was one of the first farmers to sign up for this support. He became an active member of the newly-established farmer field school from the project that trained farmers in water-efficient GAPs, post-harvest and vocational skills.

With training and input support from FAO, Ali Anwar applied the Direct Seeded Rice (DSR) method to directly sow rice in the fields. The DSR method helped him reduce 30% of water usage, reduce labor requirements and costs, and earn additional income through selling the extra seedlings to his neighboring famers. That way, he was able to acquire a good rice yield without nursery raising and transplantation.

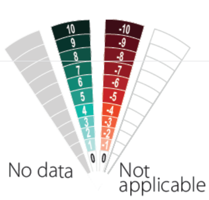
With the extra income, Ali Anwar, was able to invest in livestock to supplement his income, address the nutritional needs of his family, and pay for his daily expenses and his children's education.

(Information source and pictures courtesy of FAO Pakistan Office)

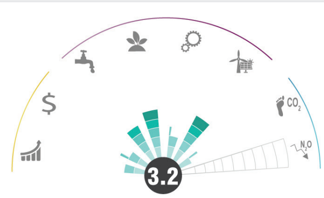
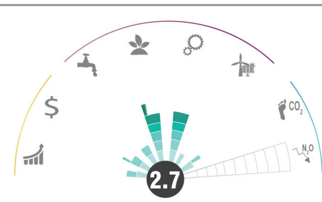
Table 1. Detailed smartness assessment for top ongoing CSA practices by production system as implemented in Pakistan.

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
Wheat (29% of total harvested area)				
Use of drought-tolerant varieties	Punjab <30%	S		**Productivity** Increases the yield per unit area, especially during dry periods, hence ensuring income for the farmers. **Adaptation** Enhances water use efficiency. Increases resilience to moisture stress and other climate shocks. **Mitigation** Provides moderate reduction in GHG emissions per unit of food produced.
	Sindh <30%	S		
Seasonal-adapted planting times (e.g. use of cropping calendars)	Sindh 30-60%	M		**Productivity** Increases land and crop productivity per unit of water. **Adaptation** Adjusting the cropping calendar by planting with the onset of rains reduces losses due to changing weather patterns. **Mitigation** Provides moderate reduction in GHG emissions per unit of food produced.
	Punjab 30-60%	M		
Cotton (9% of total harvested area)				
Integration of organic fertlizer (balanced use of fertilizers)	Sindh <30%	L		**Productivity** Enhances production and product quality, hence potential increases in income. **Adaptation** Enhances soil quality, water retention and soil functions, increasing the system's potential to overcome climate shocks. **Mitigation** Reduces use of nitrogen fertilizer, thus reducing related GHG emissions.
	Punjab <30%	L		
Use of heat-tolerant varieties	Sindh <30%	S		**Productivity** Increases the yield per unit area, especially during dry and hot periods, hence ensuring income for the farmers. **Adaptation** Enhances water use efficiency. Increases resilience to moisture stress and other climate shocks. **Mitigation** Provides moderate reduction in GHG emissions per unit of food produced.

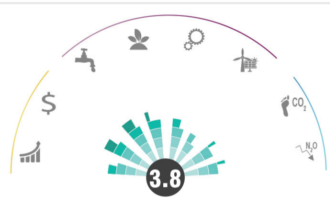
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Cotton (9% of total harvested area)				
Use of heat-tolerant varieties	Punjab <30%	S		**Productivity** Increases the yield per unit area, especially during dry and hot periods, hence ensuring income for the farmers. **Adaptation** Enhances water use efficiency. Increases resilience to moisture stress and other climate shocks. **Mitigation** Provides moderate reduction in GHG emissions per unit of food produced.
Rice (8% of total harvested area)				
Direct seeding	Punjab <30%	L		**Productivity** Increases yield by maintaining optimum conditions for plant development. **Adaptation** Promotes the efficient use of scarce resources such as water.. **Mitigation** The practice may contribute to reductions in GHG emissions by reduced use of fossil fuels..
	Sindh <30%	L		
Correct timing of harvesting (measuring proper grain moisture)	Punjab <30%	L		**Productivity** Increases in household income and profit due to greater yield. **Adaptation** Reduces the risk to extreme climate conditions, without compromising production and quality of produce. **Mitigation** Provides moderate reduction GHG emissions per unit of food produced.
	Sindh <30%	L		
Maize (4% of total harvested area)				
Use of early-maturing varieties	Khyber Pakhtunkhwa 30-60%	L		**Productivity** Promotes high yields per unit area hence an increase in income and profit due to reduced production costs **Adaptation** Optimizes the use of available soil moisture contributing to avoid crop loss. Increases water use efficiency. **Mitigation** Provides moderate reduction in GHG emissions per unit of food produced.

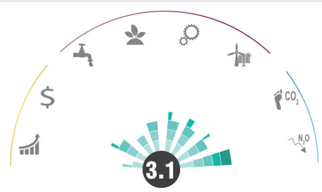
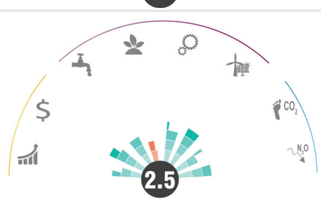


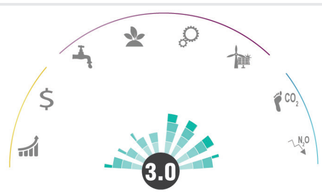
Yield Income Water Soil Risk/Information Energy CO_2 Carbon N_2O Nutrient

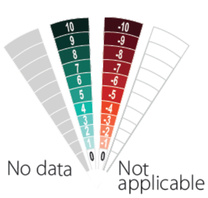
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Maize (4% of total harvested area)				
Use of early-maturing varieties	Punjab <30%	S		**Productivity** Promotes high yields per unit area hence an increase in income and profit due to reduced production costs **Adaptation** Optimizes the use of available soil moisture contributing to avoid crop loss. Increases water use efficiency. **Mitigation** Provides moderate reduction in GHG emissions per unit of food produced.
Crop Rotation	Punjab <30%	M		**Productivity** Increases total production and productivity per unit of land. Harvests of multiple crops increase income and food security. **Adaptation** Reduces the risk of total crop failure due to diversification of crops under unfavorable weather conditions **Mitigation** Protects soil structure and organic carbon reserves. Leguminous species integration reduces the need of nitrogen-based synthetic fertilizers.
	Khyber Pakhtunkhwa <30%	M		
Sugarcane (3% of total harvested area)				
Integrated Pest Management (Biological Control)	Sindh <30%	S		**Productivity** Ensures crop production and quality, hence potential increases in income. **Adaptation** Reduces crop losses even during moisture stress conditions. Represents an ecological alternative for pest control. **Mitigation** Reduces GHG emissions by reducing use of synthetic pesticides.
	Punjab <30%	S		
Row planting with proper spacing (e.g. four feet)	Sindh <30%	L		**Productivity** Increased crop productivity per unit of land **Adaptation** Improves soil's retention of nutrients. Reduces erosion and conserves soil moisture. **Mitigation** Promotes carbon storage in soil. Water retention increases, which in turn reduces energy needs for irrigation, therefore some reductions in related GHG emissions.
	Punjab <30%	L		

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
Chickpea (3% of total harvested area)				
Agroforestry systems (establishment of wind barriers)	Punjab <30%	S M L		**Productivity** Increases productivity and income through increased product quality. Reduces crop damage. **Adaptation** Increases productivity per unit area. Promotes soil and water conservation. **Mitigation** Increases above- and below-ground biomass. Increases in carbon capture.
	Khyber Pakhtunkhwa <30%	S M L		
Composting and use of organic fertilizers	Khyber Pakhtunkhwa 60%>	S M L		**Productivity** Higher profits due to increased yield and reduced cost. **Adaptation** Protects soil structure and organic carbon reserves. **Mitigation** Reduce requirement of synthetic Nitrogen-based fertilizers, hence reduce nitrous oxide emissions.
	Punjab 60%>	S M L		
Mango (1% of total harvested area)				
Integrated soil fertility management (organic and biological fertilizers)	Sindh <30%	S M L		**Productivity** Increases in yield. Reduces cost of production and hence increases profit from agriculture. **Adaptation** Improves soil health by increasing organic matter content and biological activities. Increases possibility of farming in degraded soils. **Mitigation** Reduces requirements of synthetic fertilizers use, thereby related GHG emissions during its production and use. Conserves Soil Organic Matter (SOM).
	Punjab <30%	S M L		
Intercropping	Sindh 30-60%	S M		**Productivity** Increases total production and productivity per unit area. Harvests of multiple crops increase income and food security. **Adaptation** Reduces the risk of total crop failure due to crop diversification under unfavorable climatic conditions. **Mitigation** Ensures soil coverage and increases in soil organic matter. Legume integration can reduce the use of synthetic Nitrogen-based fertilizers..

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
Mango (Tomato, aroid gouds etc.)(1% of total harvested area)				
Intercropping	Punjab 30-60%	S M		**Productivity** Increases total production and productivity per unit area. Harvests of multiple crops increase income and food security. **Adaptation** Reduces the risk of total crop failure due to crop diversification under unfavorable climatic conditions. **Mitigation** Ensures soil coverage and increases in soil organic matter. Legume integration can reduce the use of synthetic Nitrogen-based fertilizers..
Onions (5% of total harvested area)				
Post-harvest techniques (e.g. curing, market hygiene)	Sindh <30%	L		**Productivity** Reduces post-harvest lost by increasing shelf-life. Increases produce quality and income. **Adaptation** Reduces and prevents incidence of post-harvest diseases. Reduces dehydration of produce. **Mitigation** The practice may contribute to reductions in GHG emissions by reduced use energy for cooling during storage or transporting.
	Punjab 30-60%	M		
Use of pest-resistant varieties	Sindh 30-60%	S M L		**Productivity** Increases yield and quality of produce and reduce production costs. **Adaptation** Reduces environmental degradation due to reduced use of pesticides. Increases biodiversity on the farm as well as in the soil. **Mitigation** Reduces GHG emissions by reducing use of synthetic pesticides.
	Punjab 60%>	S M		
Cattle and Buffalo (meat and milk) (NA)				
Manure management (e.g. composting)	North Punjab <30%	S M L		**Productivity** Reduces cost of production and hence increases profit from agriculture. **Adaptation** Improves soil health by increasing organic matter content and microbial activities. Increases possibility of farming in degraded soils. **Mitigation** Improved soil characteristics (structure, bio-chemical), leads to a better soil capacity to sequester carbon. Reduces methane emissions, and can be integrated with other practices such us bio-digesters.
	South Punjab <30%	S M L		

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 and Buffalo (meat and milk) (NA)				
Controlled Shed	South Punjab <30%	M L		**Productivity** Faster growth and higher feed conversion ratio due to proper housing. **Adaptation** Reduces exposure to adverse climatic conditions, reducing animal's stresses. **Mitigation** Allows better manure management, thereby reducing the related GHG emissions.
	North Punjab <30%	M L		
Poultry (NA)				
Controlled Shed	North Punjab <30%	L		**Productivity** Faster growth and higher feed conversion ratio due to proper housing. **Adaptation** Reduces exposure to adverse climatic conditions, reducing animal's stresses (e.g. cold waves). **Mitigation** Allows better manure management, thereby reducing the related GHG emissions.
	South Punjab <30%	L		
Manure management (e.g. composting)	North Punjab <30%	M L		**Productivity** Represents alternative income sources. Reduces cost of production and hence increases profit from agriculture. **Adaptation** Improves soil health by increasing organic matter content and microbial activities. Increases possibility of farming in degraded soils. **Mitigation** Improved soil characteristics (structure, bio-chemical), leads to a better soil capacity to sequester carbon. Reduces methane emissions.
	South Punjab <30%	M L		



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

Institutions and policies for CSA

As part of its commitment to international climate action, Pakistan ratified the United Nations Convention on Climate Change (UNFCCC) in 1994 and the Kyoto Protocol in 2005 and submitted its First National Communication to the UNFCCC in 2003. Pakistan has remained an active participant in climate negotiations since ratification. The federal government engages in the UNFCCC through the Ministry of Climate Change, the focal institution for Pakistan internationally with regard to climate change. The Ministry oversees the activities of several other climate-related agencies, including the Global Change Impact Studies Centre (GCISC), the National Disaster Management Authority (NDMA), the Pakistan Environmental Protection Agency (Pak-EPA) and the Zoological Survey Department of Pakistan (ZSD) [18].

With leadership from the Ministry of Climate Change, several climate change policies of relevance to CSA practices have emerged in Pakistan in recent years:

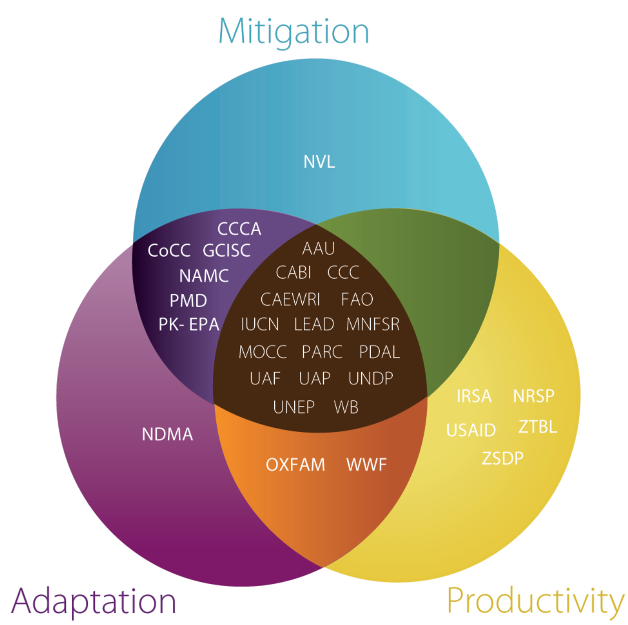
- National Climate Change Policy (NCCP), 2010.
- Framework for Implementation of the Climate Change Policy, 2014-2030
- Intended Nationally Determined Contribution (INDC), 2015
- Pakistan Climate Change Act (PCCA), 2017
- National Adaptation Plan (NAP), Forthcoming

In response to the disasters that ravaged the country in 2010 and 2011 (particularly floods), the government of Pakistan (GOP) developed the National Climate Change Policy, a multi-sectorial initiative that provides policy guidance on climate change mitigation and adaptation action in Pakistan. Through the NCCP, the GOP aims to provide a framework to build actions plans, projects and programs for reducing GHGs and increasing the country's resilience to present and future effects of climate change by enhancing infrastructure and knowledge, as well as reducing vulnerability in key areas, ecosystems, districts and regions. The NCCP is supported by a national implementing committee comprised of key government agencies in the country. The implementing committee aims to achieve improved coordination of climate-related efforts throughout the country in order to reduce duplication of efforts and competition for funds. The NCCP policy was followed by the Framework for Implementation of the Climate Change Policy (2014-2030), which identifies vulnerabilities to climate change and outlines potential avenues for adaptation and mitigation actions. However, implementation of the policy has been slow due to lack of resource commitment by the federal government. In 2015, the Lahore High Court in a landmark judgement, constituted a "Climate Change Commission" with representatives from key government agencies, NGOs, research institutes and legal sector, to expedite implementation of NCCP.

Meanwhile, in 2015, the GOP issued its Intended Nationally Determined Contribution and accompanying explanatory note under the Paris Agreement. Under the INDC, the country's long-term adaptation and mitigation goals are to increase climate resilience and reduce vulnerability through good governance, inter-sectoral coordination, capacity-building, investments in science, technology and innovation, provision of adequate finance from domestic and international sources, and effective communication and monitoring and evaluation. The expected annual costs for implementing climate adaptation actions, although difficult to estimate, amount to US$ 7-14 billion, while the 20% decrease in GHG emissions by 2030 (as committed in the INDC) will require an additional US$ 40 billion [18].

CSA has featured centrally in Pakistan's INDC, with the GOP targeting the implementation of a comprehensive CSA

Institutions for CSA in Pakistan



AAU Arid Agricultural University **CABI** Centre for Agricultural Bio-Sciences International **CAEWRI** Climate Change, Alternate Energy and Water Resources Institute **CCC** Climate Change Council **CCCA** Pakistan Climate Change Authority **CoCC** Commission on Climate Change **FAO** Food and Agriculture Organization of the United Nations **GCISC** Global Change Impact Studies Centre **IRSA** Indus River System Authority **IUCN** International Union for Conservation of Nature **LEAD** Leadership for Environment and Development **MNFSR** Ministry of National Food Security and Research **MoCC** Ministry of Climate Change **NAMC** National Agromet Center **NDMA** National Disaster Management Authority **NRSP** National Rural Support Programme **NVL** National Veterinary Laboratory **PARC** Pakistan Agricultural Research Council **PDAL** Provincial Departments of Agriculture and Livestock **PK- EPA** Pakistan Environmental Protection Agency **PMD** Pakistan Meteorological Department **UAF** University of Agriculture Faisalabad **UNDP** United Nations Development Programme **UNEP** United Nations Environment Programme **UAP** University of Agriculture, Peshawar **USAID** United States Agency for International Development **WB** The World Bank **WWF** World Wide Fund **ZSDP** Zoological Survey Department of Pakistan **ZTBL** Zarai Taraqiati Bank Ltd policy within the country's medium and long-term action plan. The country also plans to set-up training programs and field schools to promote CSA practices, as articulated in the INDC. The Pakistan INDC lists the following adaptation and mitigation priorities for the agricultural sector: water management in rice cultivation and improved rice varieties, agroforestry (fast growing tree species), manure management (e.g. use of green manure, improved manure storage), biogas and organic fertilizer production from animal waste, improved livestock feeding, efficient use of chemical fertilizers, and no-till farming.

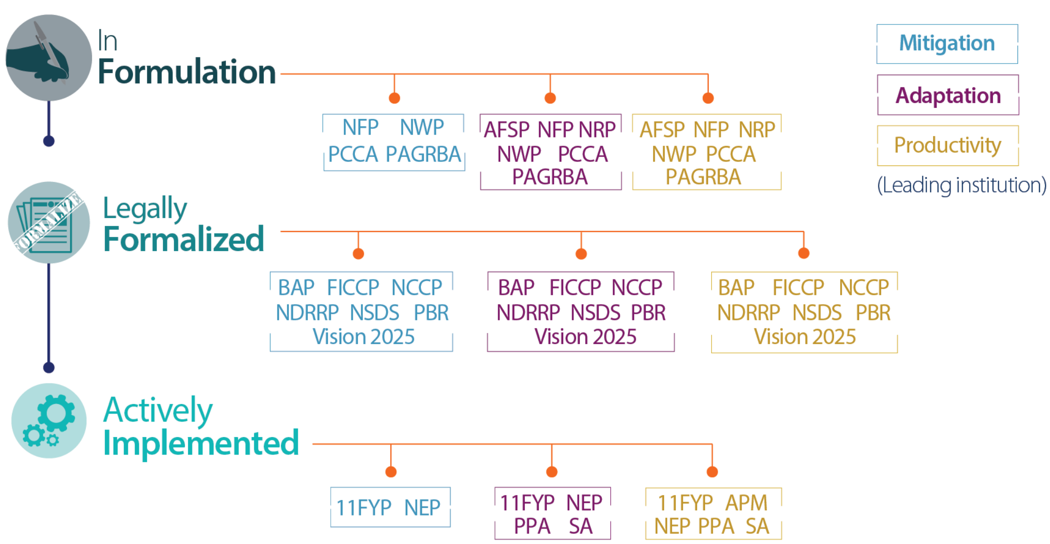
The GOP has also recently formulated the Pakistan Climate Change Act to expedite implementation of NCCP activities across sectors (including agriculture), by creating a Climate Change Council under the leadership of the Prime Minister and with representation of sub-national governments. Finally, Pakistan's most recent climate policy instrument, the National Adaptation Plan, is currently under formulation and identifies key investment priorities such as: enhancement of irrigation infrastructure, integrated water management and agriculture risk management, development of a national CSA programme, and the improvement of emergency response infrastructure.

These climate change policies have been developed in the context of agricultural development and national planning policies that shape the broader development trajectory of the country. Being a lower income agrarian economy, Pakistan has a host of institutions and polices focused on agriculture, food security and poverty alleviation, with climate change only recently gaining policy attention in this space.

The Ministry of National Food Security and Research (MNFSR) is the lead ministry responsible for national policy, planning and coordination of the agriculture sector. Several other ministries, departments and agencies, non-governmental organizations (NGOs), development agencies, international institutions, research institutions and private sector play an important role in the agricultural and climate change sectors. These include the Ministry of Climate Change (MoCC), Pakistan Meteorological Department (PMD), the Pakistan Agricultural Research Council (PARC), the Federal Flood Commission (FFC), the Indus River System Authority (IRSA), Provincial Agriculture and Livestock Department, Leadership for Environmental Development (LEAD), the World Wide Fund (WWF), Faisalabad Agriculture University (FAU), the Food and Agriculture Organization (FAO), The World Bank and Zarai Taraqiati Bank (ZTBL) to name a few. Strategies and programmes that target climate action in the agriculture sector include the Agricultural and Food Security Policy, the National Sustainable Development Strategy, and the National Disaster Risk Reduction Policy.

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 and results from interviews, surveys and expert consultations is available in Annex 4.

Policies for CSA in Pakistan



11FYP 11th Five Year Plan: Agriculture Strategy (2012) (MOPDR) **AFSP** Agricultural and Food Security Policy (2015) (MNFSR) **APM** Agricultural produce and Marketing Act (1939, 1978) (AGRI) **BAP** Biodiversity Action Plan (2000) (MNFSR) **FICCP** Framework for the Implementation of Climate Change Policy (2014–2030) (2013) (MOCC) **NCCP** National Climate Change Policy (2012) (MOCC) **NEP** National Environmental Policy (2005) (MOCC) **NDRRP** National Disaster Risk Reduction Policy (2013) (MOCC) **NFP** National Forest Policy (2015) (MOCC) **NRP** National Rangeland Policy (2010) (MOCC) **NSDS** National Sustainable Develoment Strategy (2012) (GOP) **NWP** National Water Policy (2017) (MOWP) **PAGBRA** Pakistan Access to Genetic Resources and Benefit-sharing Act (2012) (MOCC) **PBR** Plant Breeders Right Act (2016) (GOP) **PCCA** Pakistan Climate Change Act (2017) (MOCC) **PPA** Plant Protection Act (1976) (DDP) **SA** Seed (Amendment) Act (2015) (GOP) **Vision 2025** Vision 2025 (2014) (MOPDR)

Pakistan Vision 2025 specifically targets food security across the entire supply-chain (from production, processing, storage and distribution to consumption), whereby "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" [22]. Meanwhile, the Ministry of Planning Development and Reform, the country's apex planning body, has issued its 11th 5-year plan that prioritizes agriculture and food security as one the major economic goals to meet the rising food demand for a growing population.

There are several key institutional and policy challenges facing CSA implementation in Pakistan including longstanding tensions between federal and provincial governments, low implementation capacity of government, shortage of financing and the lack of mainstreaming of the CSA concept in to agricultural development strategies.

Regarding decentralized governance, the passing of the 18th amendment (Article 140A) to the Constitution of the Government of Pakistan (GOP) in 2010 significantly transformed the institutional and governance structure in the country, devolving legislative power over environmental issues to the provinces. Since this time, responsibility to implement agriculture policies and actions at local level rests with the provinces and are based on priorities that emerge from the sub-district authorities. However, devolution has been hampered by limited capacity for policy development and implementation at the provincial level, as well as fragmented coordination and shared learning across provinces.

Given the diversity of Pakistan's environment and weather, local planning offers the specific opportunities required to protect rural livelihoods successfully in the face of climate change. So while the NCCP represents an important step forward in addressing climate change impacts, the policy has yet to yield concrete results, due to limited resources and implementation capacity in provinces. Political tension from sectarian and religious conflicts has led to implementation and governance voids across national and sub-national levels, hindering progress and development. Focused efforts are needed to build sub-national capacity and institutional development, with support from the federal government and international NGOs and donors.

Finally, despite the increased interest in CSA practices by farmers and climate change institutions in Pakistan (most notably the INDC and NAP documents), the concept of CSA has not been formalized as a clear agricultural development objective in strategies and action plans of relevant institutions and policies. Some progress has been made on this front recently, with several efforts to merge climate change and agricultural development planning. This includes, most notably, the Agricultural Model Intercomparison and Improvement Project (AgMIP) in Pakistan, part of a larger global effort. AgMIP Pakistan, a collaboration between Pakistan's Agroclimatology Lab at the University of Agriculture in Faisalabad and UK AID, has developed climate change scenarios for the region, modelled climate impacts on key crops, and has aimed to determine the likely economic impacts of climate change on the agricultural sector in Pakistan.

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.

Financing CSA

Despite major economic threats from climatic change to the Pakistani economy, and the agriculture sector in particular, the current climate financing landscape has not kept pace. As articulated in the Vision 2025, agriculture is a key driver in Pakistan's envisioned growth rate of over 7% over the next decade. Yet climate change is generally not taken into consideration in the allocation of development expenditures at project and programmatic levels due to its low priority by the government over other competing development agendas such as health, security and education. Added to this challenge is the insufficient agriculture credit available to farmers for the purchase of inputs, weak extension support, and underinvestment in agriculture research at only 0.3% of GDP [23], all leading to inadequate growth in the sector.

Pakistan's Climate Public Expenditure and Institutional Review (CPEIR), undertaken by the United Nations Development Programme (UNDP), estimated national climate-related expenditure at 6-8% of the national budget between 2010 and 2014, mostly coming from the energy sector (57%), followed by agriculture (19%), health (9%), and water resources sector (7%) [14]. National finances for adaptation and mitigation actions have varied between 25-60% and 30-71%, respectively of the climate-related budget, and are expected to increase in importance in the coming fiscal years due to planned investments in the promotion of renewable energies and afforestation initiatives [18]. The recently promulgated PCCA envisions establishing the Pakistan Climate Change Fund that will mobilize resources from both domestic and international sources to support mitigation and adaptation initiatives in the country.

With the 18th Amendment coming into effect, the policy, implementation and financing responsibilities for CSA and other climate change interventions rests with the provinces.

In 2016, the provincial government of Punjab announced a finance package worth roughly US$ one billion for the promotion and prosperity of farmers, through investments in improved technology and inputs to enhance on-farm productivity. This transition is supported by larger allocations of federal budget to the provinces and fiscal incentives for climate related activities, such as interest-free loans to farmers for installation of solar powered water systems in the 2015-2016 federal budget.

Donor-funded projects focused on agriculture that support climate change also represent a considerable portion of the climate financing currently available in Pakistan. The Punjab and Sindh Irrigated Agriculture Productivity Enhancement Projects, for example are funded by US$ 665 million World Bank loans to improve irrigation practices and crop productivity. Similarly the Southern Punjab Poverty Alleviation Project is funded by a US$ 40 million International Fund for Agricultural Development loan on highly concessional terms. The project aims to increase the income of 80,000 poor households in Pakistan through enhancing employment potential and increasing agriculture productivity and production.

Potential Finance

Farmers in Pakistan lack access to agriculture credit, experience weak extension support and receive inadequate research knowledge to counter the threats of climate change. To promote and scale potential CSA activities across the country, new streams of public, private, and international finances need to be mobilized. Pakistan's Climate Change Act sets the stage for the establishment of the Pakistan Climate Change Authority and Pakistan Climate Change Fund, which are expected to help mobilize domestic and international funds for mitigation and adaptation interventions in the country [18 GOP, 2016b].

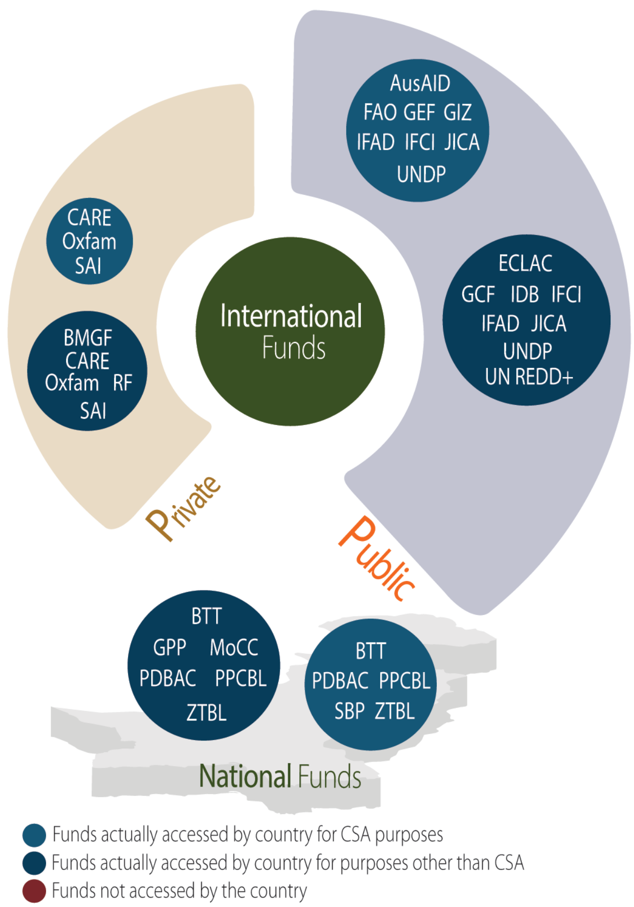
Extending agriculture credit to farmers is also critical for the widespread adoption of CSA activities. Despite dedicated agricultural credit limits by commercial and agriculture banks such as ZTBL, outreach of credit is available to less than 30% of the farmers. The majority of the smallholder farmers rely on informal credit—often at exorbitant rates—because of a lack of collateral.

Developing structures for group based lending, community based organizing or self-help groups and encouraging microfinance institutions through dedicated government credit lines to fund smallholders can help improve financial inclusion and offer new sources of financing for CSA activities. Private sector institutions, through innovative supply chain models, crop storage, crop collateral, insurance schemes and other financial instruments can also offer new and attractive sources of finance.

New international climate funds such as the Green Climate Fund (GCF) also offer opportunities to leverage funds for scaling-up CSA throughout the country. Dedicated agricultural finance organizations can be set-up to access direct financing from the GCF and other funds. This can be supplemented with local funds as envisioned under the Pakistan Climate Change Act.

The graphic highlights existing and potential financing opportunities for CSA in Pakistan. The methodology can be found in Annex 6.

Financing opportunities for CSA in Pakistan



AusAID Australian Agencyfor International Development **BMGF** Bill and Melinda Gates Foundation **BTT** Billion Tree Tsunami Afforestation Project - KPK **CARE** Cooperative for Assistance and Relief Everywhere **ECLAC** Economic Commission for Latin America and the Caribbean **FAO** Food and Agriculture Organization of the United Nations **GCF** Green Climate Fund **GEF** Global Environment Facility **GIZ** German Society for International Cooperation **GPP** Green Pakistan Programme **IDB** Inter-American Development Bank **IFAD** International Fund for Agricultural Development **IFCI** Australia's International Forest Carbon Initiative **JICA** Japan International Cooperation Agency **MoCC** Ministry of Climate Change **PDBAC** Private Domestic Banks Agriculture Credit **PPCBL** Punjab Provincial Cooperative Bank Ltd **RF** Rockefeller Foundation **SAI** Sustainable Agriculture Initiative Platform **SBP** State Bank of Pakistan **UNDP** United Nations Development Programme **UN REDD** United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation **ZTBL** Zarai Taraqiati Bank Ltd

Outlook

In Pakistan, where agriculture holds strong social, economic and cultural significance, CSA offers attractive opportunities for strengthening the sector in a changing climate reality. Climate change is an imminent threat to the livelihoods of millions of families in Pakistan that rely on agriculture.
Climate impacts may slow the economic progress of the country and roll-back development advances of the last several decades. Already, several CSA practices are being adopted across the country. By leveraging existing financing, unlocking new sources of financing, promoting pro-poor policies, and empowering institutions to take action, transformational change towards more sustainable and productive agricultural systems can be achieved in the country.

CSA can play a significant role in the Pakistani economy. Some measures that can be adopted range from innovative, technological practices like laser land leveling and solar powered irrigation systems to management changes like crop diversification, proper cropping patterns and optimized planting dates. Investing in research to develop high yielding heat resistant, drought tolerant, and pest resistant crop varieties and livestock breeds is especially critical.

Developing data driven models to simulate the likely impact of climate change on the different agricultural production systems across the AEZ will be critical to ensure the right adaptation and mitigation strategies are context appropriate. This may include the use of information technology, GIS techniques and remote sensing for precision farming that optimizes input use and generates quality data on crop, soil and climate related parameters to identify ideal cropping patterns for different AEZs.

Along with use of technology, offering financing through local and international sources especially to smallholders is important for widespread adoption of CSA. Developing climate conscious policy making and recognizing the threat of climate change in national planning agendas as well as training farmers in latest technologies and practices through farmer programs would further encourage CSA adoption in Pakistan.

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For further information and online versions of the Annexes

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

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