Climate-Smart Agriculture in Viet Nam

Climate-smart agriculture (CSA) considerations

P I Over the last 30 years, Viet Nam's rapid growth in agricultural production has transformed the country's socioeconomic status: alleviating national food insecurity, reducing poverty, fostering agricultural exports and providing livelihoods to nearly half of the labor force nationwide. Viet Nam outperforms its neighboring countries in Southeast Asia in its productivity for crops such as rice, maize, coffee, rubber, cashew, tea, and pepper.

M P But the substantial growth in agricultural production has come at significant environmental cost. Intensive use of chemical fertilizers, pesticides and water to boost productivity have made agriculture the second largest source of greenhouse gas (GHG) emissions after energy.

A M Increasing incidences of extreme weather events such as floods and cold spells in the north and north-central coast, saltwater intrusion in the Mekong River Delta, and droughts in the Central Highlands, have shown that climate change is becoming more apparent in Viet Nam. Changing business as usual (BAU) agricultural production practices to climate-smart and environmentally sustainable practices will overcome the challenges associated with climate change in the agricultural sector.

A P $ Given the diversity in typography, soil conditions, and climate characteristics within the country, the impacts of climate change vary by production systems and agro-ecological zones. Under climate change scenarios, Vietnam is projected to experience a reduction in net exports of rice, coffee and cassava as the productivity is affected more heavily.

A M To maintain agricultural production under increasing climate risk, various CSA practices have been identified. These include: smart water and irrigation management; adoption of improved crop varieties; agroforestry; intercropping trees with crops; sustainable land management; agricultural waste treatment such as integration of biogas technologies in livestock production; and improved agro-climate information services. Yet the majority of CSA technologies have a low to medium adoption rate. Low availability of required inputs, high costs of installation, financial constraints and limited access to tailored information and limited clear integration, guidance and support of CSA adoption in action plans and programs at the local levels (district, province), are all key barriers for the up-scaling of CSA measures.

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- A M I $ As rice production is the primary contributor of GHG emissions in the agricultural sector, improved practices for paddy cultivation are key to reducing agricultural emissions by 8–25% compared to the BAU scenario. Climate-smart options in rice involve practices such as system of rice intensification (SRI) with a component in alternative wetting-drying irrigation (AWD), and rice–shrimp or rice–fish diversified systems. However, the conventional habit of overusing inputs, uncontrolled irrigation practices, small and fragmented land, financial constraints and strict policy control are key challenges to the greater adoption of smart practices.

- I $ Creating an enabling environment for climate action in the agricultural sector is a priority in Viet Nam. However, lack of synergies in targets, and conflicts between the long-term interests of CSA and the immediate benefits of agricultural growth are key challenges to facilitating and scaling-out CSA in Viet Nam. Almost 90% of agricultural expenditure has been on adaptation, whereas mitigation efforts are largely neglected.

A Adaptation M Mitigation P Productivity I Institutions $ Finance

The concept of climate-smart agriculture (CSA) is to improve the integration of agricultural development and climate responsiveness. It aims to achieve food security and broader development goals under a changing climate and increasing food demands. CSA initiatives sustainably increase productivity, enhance resilience, and reduce net greenhouse gas emissions (GHGs), and require planning to address trade-offs and synergies between the three pillars of productivity, adaptation, and mitigation [1]. The priorities of different countries and stakeholders are to achieve more efficient, effective, and equitable food systems that address challenges in environmental, social, and economic dimensions across productive landscapes. While the CSA 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 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 Viet Nam and globally, about entry points for investing in CSA at scale.

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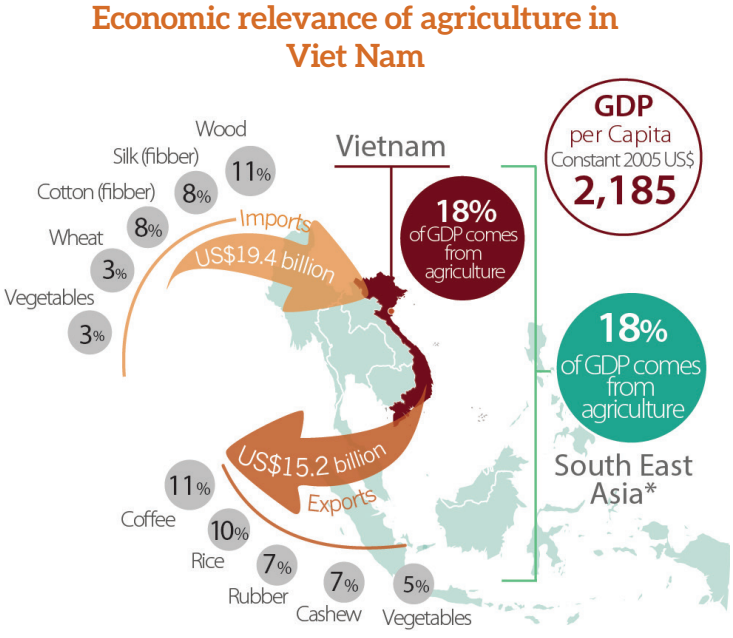
National context

Economic relevance of agriculture

After introducing a market-oriented or "Doi Moi" policy in 1986, Viet Nam experienced rapid economic growth, which allowed the transition to lower middle-income status. Now among the top emerging economies in the region, the country's gross domestic product (GDP) per capita reached US$2,185 in 2016 [3], with a GDP growth rate averaging 6% per annum in the last 5 years.

Spurring growth in agricultural productivity has been a key driver of GDP expansion in Viet Nam in the 1990s. Currently, the sector represents 15.2% of the national export value and contributes 18% to national GDP [4, 5]. Viet Nam recently became a leading global exporter of several important agricultural commodities such as rice, coffee, cashew nuts, vegetables, and rubber [6]. This has enabled agriculture, forestry and fisheries to become the only sector with a trade surplus, thereby helping to limit the country's trade deficit. Rice has also become a political commodity given its importance in ensuring food security [7]. In 2008, when Viet Nam banned rice exports, concerns over rice shortages in importing countries such as Bangladesh led to a world rice crisis. Although Viet Nam's export volume (4–5 million tonnes every year) is a small fraction of total rice consumed globally, abrupt changes in quantities supplied or in prices may affect the poor [7]. Viet Nam has joined the world economy and is becoming more interdependent on other countries through greater flows of agricultural imports, in particular non-food products. While food products represent a modest 6% of the total agricultural imports, the country is heavily reliant on manufacturing inputs such as wood, cotton, silk, and fiber [8].



*South East Asia: Brunei Darussalam, Indonesia, Cambodia, Lao PDR, Myanmar, Malaysia, Philippines, Singapore, Thailand, Timor-Leste, Vietnam

The World Bank Indicator. Mortality rate, under 5. Available at http://data.worldbank.org indicator/SH.DYN. MORT

Viet Nam has achieved significant advances in meeting the Millennium Development Goals and outperforms other countries at a similar per capita income on the provision of basic needs, such as access to improved water resources, access to electricity, and youth literacy [9]. The current population of Viet Nam benefits from higher incomes, better education and improved medical care than they did 20 years ago. The maternal mortality rate has fallen below the upper-middle-income country average [9] while that of infant and under-five-years' mortality ratios have reduced significantly by almost 50%, down to 19 and 25 deaths per 1,000 births, respectively, in the 2011–2015 period [10]. Important progress has also been made in improving access to sanitation facilities and non-solid fuel for cooking. The Human Development Index was 0.683 in 2015, positioning Viet Nam as 115th out of 188 countries and territories worldwide [11].

Control over land and assets has been traditionally dominated by men; women have not had rights to the assets, and have had no collateral to secure credit [12]. However, recently, significant efforts have been made to facilitate women's empowerment. Since the Land Law 2003, legal frameworks are increasingly supporting gender equality by including the name of women on land tenure certificates. As women and men are equally involved in agricultural production (51% of female versus 49% of male agricultural labor force) [13], more balanced rights over land may improve the role of women in decision-making on household investments and production systems, which are traditionally made by male household heads only.

The country has performed spectacularly in poverty reduction, moving more than 40 million people out of poverty over the course of the last two decades. During 2010–2014, the rate of people earning less than US$1.90 a day (2011 Purchase Power Parity – PPP) was on average 3.7% [14], compared to over half of the population who experienced such extreme poverty in 1993 [15]. However, poverty remains a considerable concern (14–17% of the population nationwide and nearly 25% of the rural population are still living under the poverty threshold[1]) [16]. Poverty is largely clustered in upland regions, particularly in the northern mountains and the Central Highlands where in 2015, 16% and 11.3% of the population, respectively, were living under the national poverty line [17]. Poverty is found to disproportionately impact those from ethnic minority groups, who account for only 15% of the population, but represent half of the poor and three-quarters of the extreme poor [9]. Such high poverty levels reflect a mix of constraints that ethnic minorities are facing, including geographical isolation, low access to education, and limited access to quality land. These groups are substantially vulnerable to shocks from climate change and natural disasters as well as economic and health shocks [18].

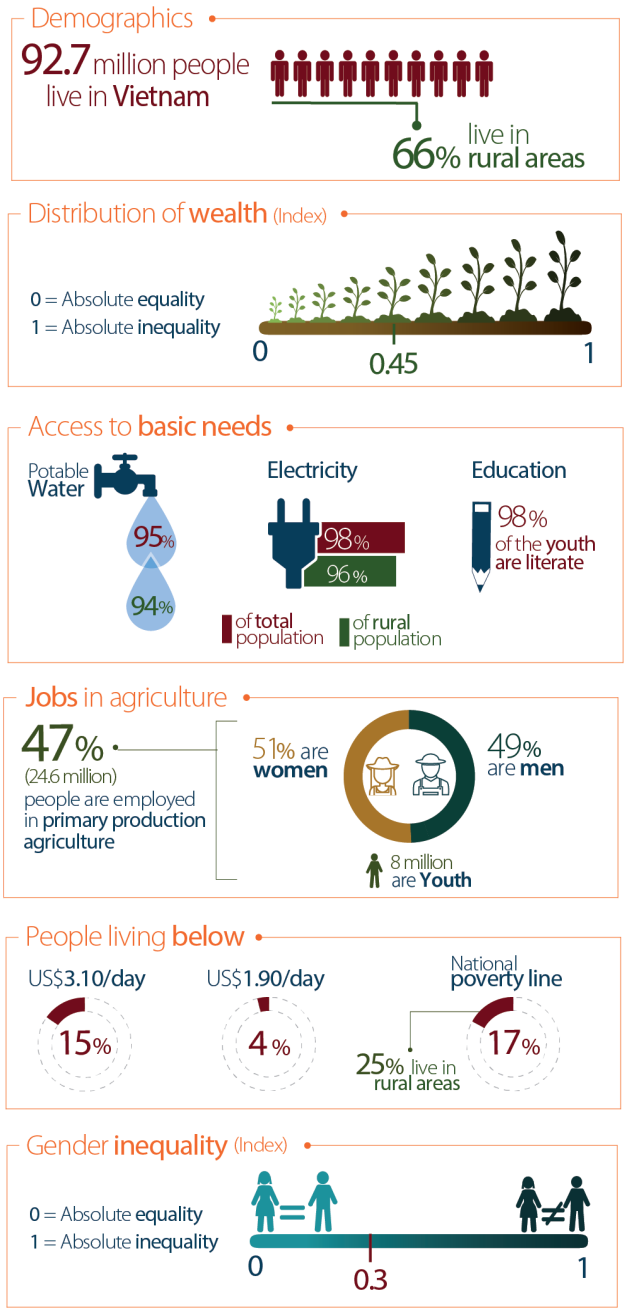
Viet Nam has benefited from a young and growing labor force [19]. The population grew at 1.1% every year over the 2011–2015 period, similar to the world average rate (1.2%)

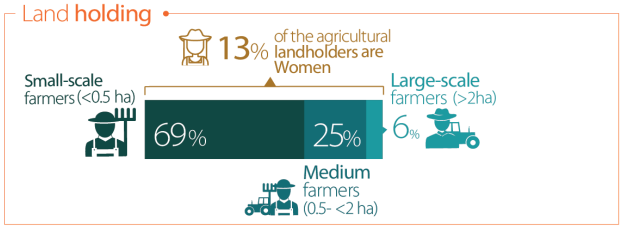
1 Rural poverty rate is 22% and 25% according to the 2011 PPP US$3.1/day poverty line and the national poverty line (GSO-WB poverty line), respectively.

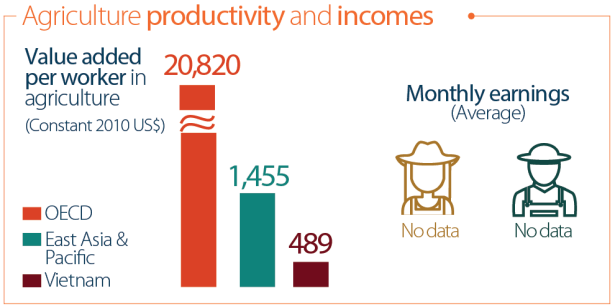
10 The boundaries and names shown and the designations used on the maps in this publication do not imply official endorsement or acceptance by CIAT, CCAFS, FAO, Winrock International, USAID.

and far above the regional rate (0.7% in East Asia and Pacific) [20]. Among its current 92.7 million inhabitants, about 66% live in the rural areas and 44.3% of the total population are reliant on agriculture, fisheries and forestry as their main livelihood [21, 22]. Substantial differences between employment share and GDP share of agriculture indicate a large gap in productivity between agricultural and non-agricultural sectors. This gap also explains the concentration of poverty in agricultural and rural areas [23]. Nevertheless, structural transformation is emerging in Viet Nam given the increasing trend in shifting the labor force and resources out of the agriculture, forestry and fishery (AFF) sector. From 2011 to 2016, the reduction in the number of AFF households is estimated to be about 1 million, nearly ten times higher than the rate in the previous 5 years [24].

People, agriculture and livelihoods in Viet Nam



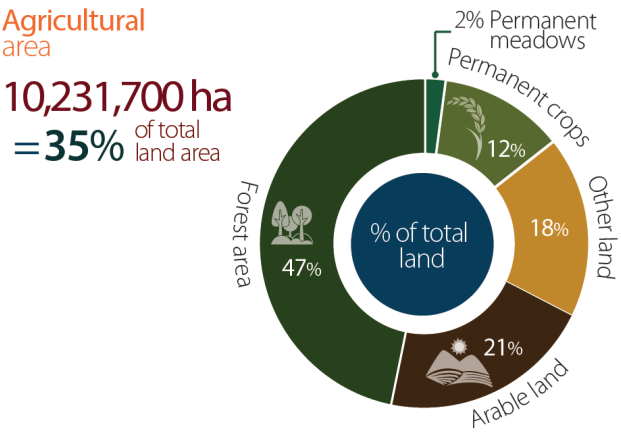




Land use

The total land area for agricultural production has remained stable since 2010, at 10.23 million ha, which accounts for almost 35% of the total national land area (including arable land, permanent crops land and permanent meadows land). Forests land accounted for 15.8 million ha in 2013, representing 46.8% of the total land area [25]. However, there are some areas classified as forest area without actual forests as the coverage rate is moderately 40% in the same period [26]. Forests in Viet Nam are classified into four main categories according to their designated purpose: (i) special-use forests (15% of the total forests); (ii) protection forests (33%); (iii) production forests (50%); (iv) other forested land (2%). Together with natural forest, forest plantations, which are not necessarily timber products are also classed as production forests. Therefore, a net increase in forest area has mainly been the result of significant expansion of plantations [26]. In fact, data from the Food and Agriculture Organization of the United Nations (FAO) revealed a negative trend in natural forest area between 2002–2013 [26].

Land use in Viet Nam



Agricultural production systems

Viet Nam stretches over 15 latitudes and has an extensive coastline of 3,260 km. A large part of the country is mountainous, particularly in north and central Viet Nam. There are large variations in the climate between the north which has four seasons and the south with only a wet and dry season. Based on the diverse topography, soil and climate characteristics, the country is divided into eight agro-ecological zones [27].

Production systems are specialized by agro-ecological zone. While rice and livestock production are concentrated in the two deltas (Red River Delta and Mekong River Delta), many other cash crops are produced in the Central Highlands and the southeast. The northeast and northwest are mountainous areas with deficient transportation facilities, poor market access, and limited irrigation systems. Agricultural production in these areas is mostly for food subsistence purposes, except where the conditions are advantageous for forestry plantations and industrial crops such as tea and rubber [27].

The Ministry of Agriculture and Rural Development (MARD) has identified 11 strategic agro-commodities with potential in improving trade integration and rural development up to 2030[2]. This country profile focuses on these 11 products as a result of the priorities defined by MARD and consultation with experts. These commodities are: rice, maize, coffee, rubber, cassava, cashew, tea, pepper, orange, pork and shrimp. The diagram below shows a selection of agricultural production systems that are key to food security in Viet Nam. It 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, see Annex 1, 2.

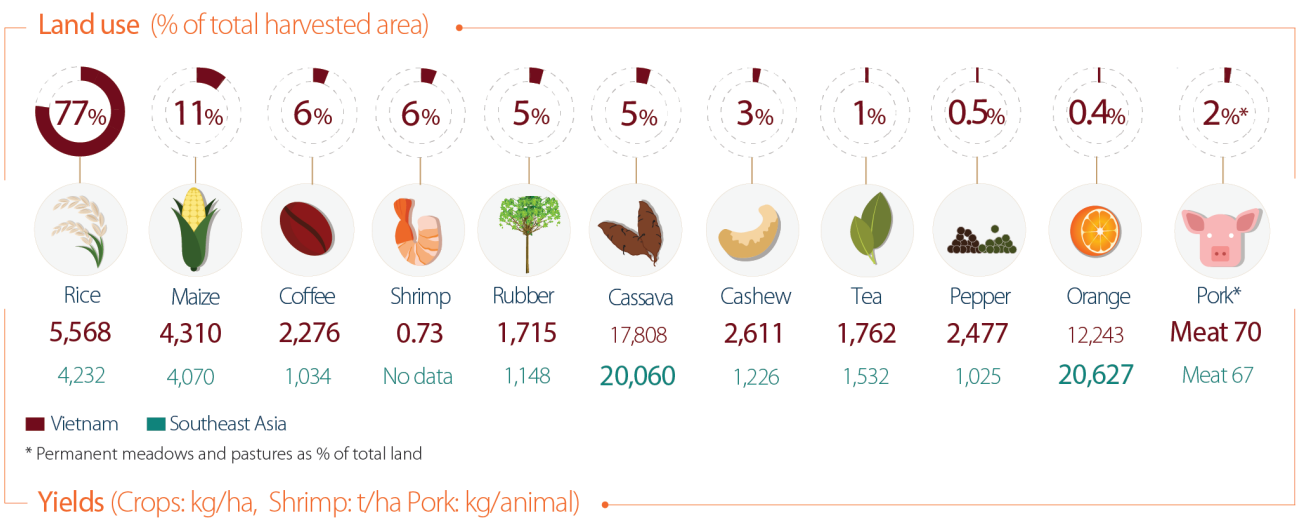
Rice is the dominant staple crop in Viet Nam, accounting for 77% of total harvested land area. Rice production is followed by maize (11%) and cassava (5%). Industrial crops such as coffee, rubber, cashew, and fruit trees occupy the remaining harvested area (15%) [28, 29, 30]. Pork and shrimp production are usually produced in intensive farming systems and do not require a large land area.

Average rice yields in Viet Nam reach some 5.5 tons per hectare, which is well beyond the regional average [28]. The country's rice yields rank only behind China, where high rice yields are the result of faster advances in science and technology as well as intensive use of hybrid varieties. Viet Nam also has the highest yields among global coffee producers. However, an aging coffee tree stock and the spread of plantations into less suitable or unsuitable land are hampering improvements in Viet Nam's coffee yields. More frequent exposure to droughts is resulting in declining coffee productivity in the Central Highlands.

Agricultural production accounts for up to 95% of total water withdrawals in Viet Nam [31]. Since the mid-1970s, it is estimated that about 80% of the government's capital investments in the agricultural sector have been allocated for irrigation. As a result, 49% of the total agricultural land is serviced by an irrigation scheme. Two-thirds of these schemes are found in the two delta areas as the irrigation systems were designed primarily for rice [18]. To further motivate agricultural production, the government provided an exemption or partially supported irrigation fees to reduce farmers' burden of production costs. However, water is becoming scarcer. About 60% of water availability in Viet Nam originates from upstream countries [18]. Reduced dry season river flow, sea-level rise and increased saline water intrusion impede the availability of freshwater in different zones. Furthermore, free irrigation is a major burden on the State budget. Applying water saving practices is therefore critical to increasing water shortages.

Agricultural input use in Viet Nam is relatively high compared to other Southeast Asian countries. This mainly results from farmers' efforts to sustain or to increase crops

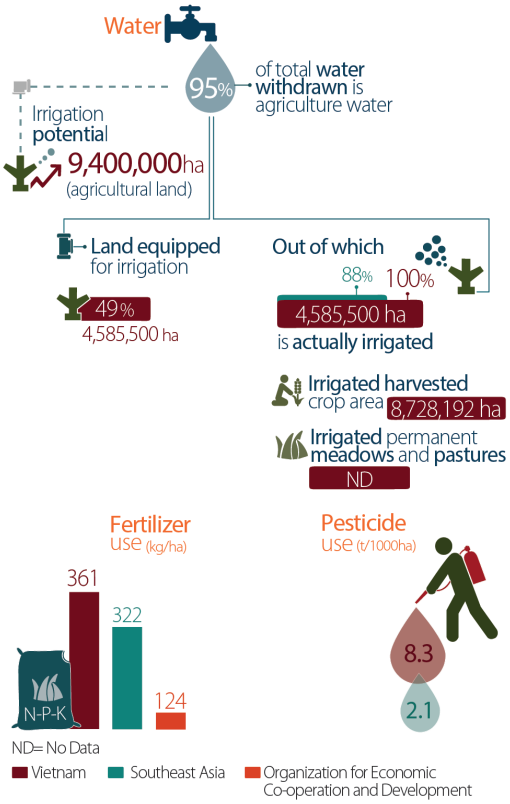
Production Systems Key for Food Security in Viet Nam



2 Decision 950/QD-TTg dated 2012 on the action program for implementation of the goods import and export strategy for the 2011–2020 period and towards 2030.

yield. Two-thirds of fertilizers sold in Viet Nam are applied for rice cultivation while 5-10% are used for maize, coffee and rubber. Although fertilizer accounts for the largest share of expenses in key grain crop production, it is estimated that crops fail to capture a half to two-thirds of fertilizer nutrients. Excess use of fertilizer is a large source of nitrous oxide emissions, and leads to serious land degradation [18].

Agriculture input use in Viet Nam



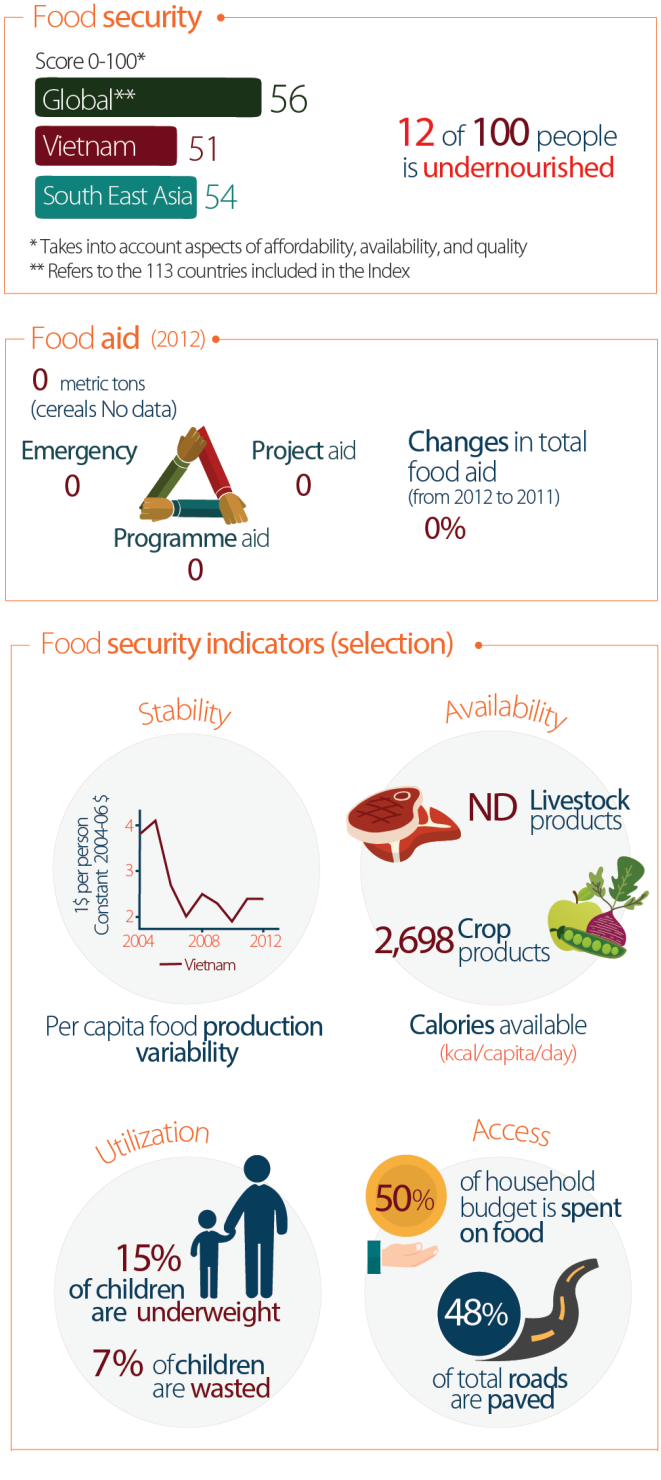
Food security and nutrition

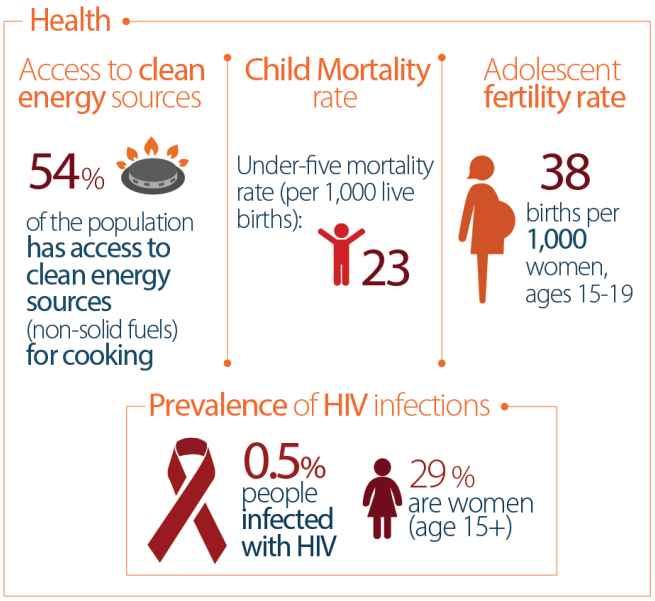
Sustained growth in agricultural output has helped improve food security in Viet Nam, thus contributing to economic and social stability. From the food shortages in the mid-1980s, Viet Nam has transformed into a food exporting country and ranks 57th out of 113 countries in the global food security index. The food security index valued at 51.04 over the 2012–2016 period is within the range of the average regional score (54.3 for Southeast Asia) [32]. Even under the most pessimistic scenario where paddy-land areas were predicted to decline by 20% to 25%, i.e. from 4.0 million ha to 3.0–3.2 million ha, or even as low as 2.5 million ha, Viet Nam would still generate a rice surplus [33].

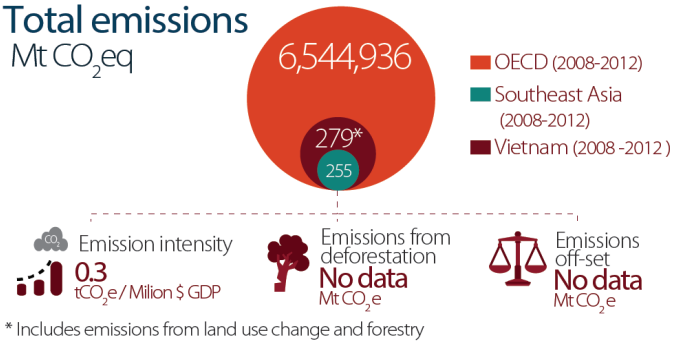
Nonetheless, food security remains a long-standing concern in Viet Nam, as food availability alone cannot fill the gap in food affordability and quality. Although the country is the second largest exporter of rice, many rural households remain net buyers of food and are vulnerable to food shortages and price volatility, as experienced during the rice crisis of 2008.

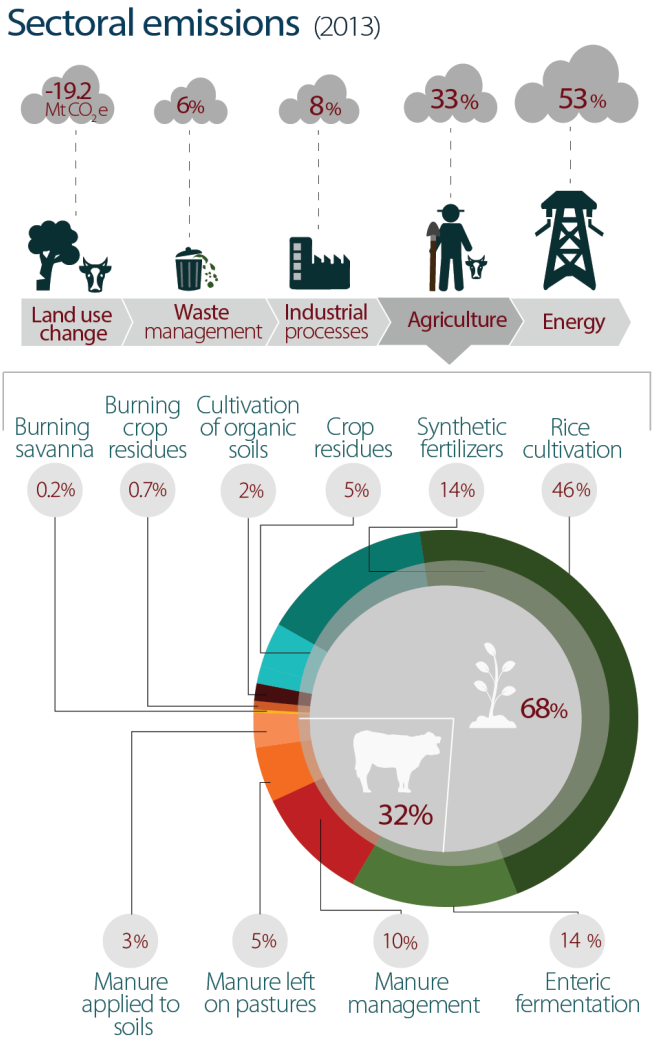
Per capita calorie intake at national level is estimated at 2,698 kcal per day during 2009–2013, well above the minimum requirement of 1,810 kcal/day [34, 35]. However, as food security has been reliant on rice as the dominant staple food for a long time, malnutrition has remained significant. In spite of a large portion of household budget spent on food (half of the total income) [36], around 15% of children were underweight and over 6% of children were emaciated during the 2008–2013 period [37, 38]. Child malnutrition is particularly worrying among ethnic minority communities where stagnant rates of malnutrition have been linked to a lack of improved sanitation facilities [9].

Food security, nutrition and health in Viet Nam









Agricultural greenhouse gas emissions

Viet Nam's economic growth is both energy and carbon intensive compared to its neighboring countries. While the country has historically been a minor emitter of greenhouse gases (GHGs), emissions grew at the fastest rate over the last decade and were higher than the average level in the Southeast Asian region [39]. Between 2010 and 2030, official projections of Viet Nam's energy emissions show a threefold increase in total net emissions [40]. These increases were driven by the projected growth in the use of coal for power generation. Viet Nam's carbon intensity of GDP, which is estimated at 0.3 tCo2eq per million US$ GDP, is now the second highest in Asia (after China) and is still increasing. The high carbon intensity in Viet Nam can be partly explained by the low cost of fossil fuels for power generation and transport, which is the result of a strict price control policy and indirect subsidies [41].

Agriculture is the second largest source of GHG emissions, contributing to about 33% of total GHG emissions in Viet Nam in 2010 [42]. So far, growing forestry plantations compensated for deforestation and land clearing in agriculture, and changed LULUCF (land use, land use changes and forestry) from net emitter to carbon sink. Within the agriculture sector, rice cultivation is responsible for the greatest GHG emissions, accounting for 46.3% of the sector's emissions. Other sources of agricultural emissions are derived from improper management of soils, fertilizer application, livestock manure, and the burning of biomass. To fulfill the Paris Agreement, Viet Nam has agreed to cut between 8% and 25% of total GHGs emissions from agriculture and increase forest coverage from 39.7% in 2011 to 45% by 2030 [43, 44]. Climate change mitigation is therefore becoming an urgent task for the agricultural sector.

Challenges for the agricultural sector

Shifting demographic, economic, and social trends are shaping a challenging context for agriculture. In the next decade, urbanization is forecast to reach 50% of the

population [9]. While food security has long been rice dominant, the burgeoning middle class is significantly shifting dietary patterns towards increased consumption of livestock products, vegetables and fruit [18]. The need for a more nutrient diverse strategy is also highlighted in the 2014 Agriculture Restructuring Plan (ARP) which outlines structural adjustment of the agricultural sector towards quality, efficiency and added value.

Modest land availability and fragmented land plots are barriers to the commercialization and improvement of agriculture profitability. Arable land is relatively scarce in Viet Nam, with just 0.34 ha per capita, which is about half to three-quarters the average size in Cambodia, Myanmar, and the Philippines [18]. Agriculture is dominated by small farms (0.6 ha per farm on average) and widespread subsistence farming is a result of the land distribution policy in the past [45]. Among 11.3 million agricultural land users, 69% are currently cultivating on less than 0.5 ha of land area, while only 6.2% of the households own 2 ha and above [45]. Stress over land is further exacerbated by low land quality; currently 5.1 million ha are seriously eroded and another 2 million have significantly reduced soil fertility [9]. In addition to small scale, fragmented land distribution (4.09 plots owned by a farm in the north and 3.09 plots per farm on national average) is another major constraint to achieving economies of scales and mechanization [45]. Land fragmentation is most serious in the Red River Delta and northern mountainous areas. In these areas, households resort to abandoning their fields or leasing out their land to large companies and go to work for them as permanent workers [46, 47].

The agricultural sector faces growing competition for land and water from the industry and services sectors and pressure from competing land uses within the AFF sector. As a result, achievements in agricultural growth come with environmental consequences [18]. Agricultural growth in recent years is largely derived from expansion of land areas, particularly coffee, rubber and cassava production in the upland areas. Natural forests were converted into plantation forests in recent years although expansion of plantations was only allowed on degraded forest lands, non-forested land and low productivity agricultural areas. In the Central Highlands, as much as 79% of new rubber plantations have been established on natural forest land which is not classified as poor (degraded) forests, as required. Expansion is one of the five main drivers of large-scale deforestation, biodiversity loss and land degradation in Viet Nam [48]. Likewise, a major expansion in shrimp aquaculture in the 1990s and early 2000s has caused a reduction in paddy production, polluted water, depleted biodiversity and destruction of nearly half of the Mekong Delta's mangrove forests [49]. Adding to land-use change, a rise in monoculture production has also made landscapes more vulnerable to climate change [50].

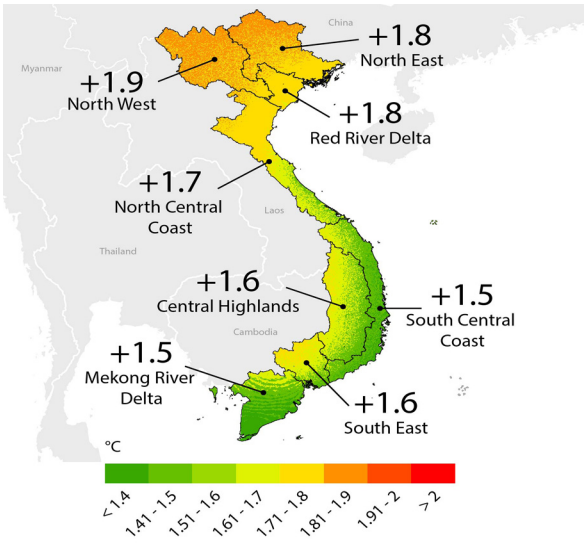
Agriculture and climate change

Climate change is becoming more and more apparent in Viet Nam. Temperature increases in Viet Nam have averaged about 0.26°C every decade since 1971, twice that of the global average [51, 52]. According to the initial biennial updated report of Viet Nam to the UNFCCC issued in 2014, the sea level along the coasts of Viet Nam has risen by more than 20 cm over the past 50 years. Annual rainfall decreased in the north and increased in the south, leading to different patterns of drought across climate regions (agro-ecological zones) [42]. Severe saltwater intrusion in the Mekong Delta and increasingly acute droughts in the Central Highlands provide clear examples of adverse impacts on agricultural production due to climate change. Predictions of climatic changes until the end of the 21st century draw a pessimistic perspective. According to the Climate change and sea level rise scenarios for Viet Nam published in 2016, under the medium emission scenario, annual mean temperature is projected to increase by 1.9–2.4°C in the north and 1.7–1.9°C in the south by the late 21st century. The average sea level is projected to rise by between 32 cm and 76 cm by 2100 around Viet Nam's shores [53].

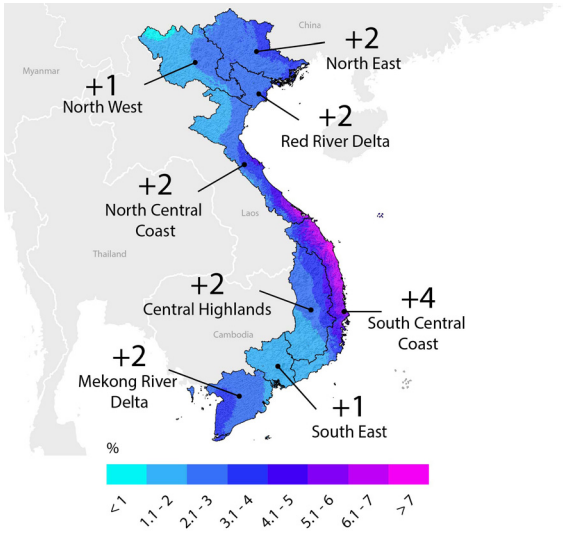
Climate change presents a big challenge for agriculture production. Warming, increased pest incidence, and droughts are expected to lower rice yields by 4.3% over the 2016–2045 period, below the level it would be in the absence of climate change. Sea level rise and salinity intrusion are expected to reshape the geography of rice production. The changing climate will probably drive rice production to areas that are especially suitable for multi-cropping. Coffee production, which is concentrated in the Central Highlands, could be hit hard by intense droughts, higher temperatures, more temperature extremes, and increasing frequency of heat waves that cause increased evapotranspiration, and increased pest incidence. Livestock systems are predicted to suffer not just from temperature change but from disease-related impacts of climate change [18]. However, aquaculture has a more promising outlook, with adapted species and innovative management systems. There is evidence that rising temperatures and increased inundation during the wet season, could improve aquaculture productivity [54].

Projected change in Temperature and Precipitation in Viet Nam by 2050 [55,56]

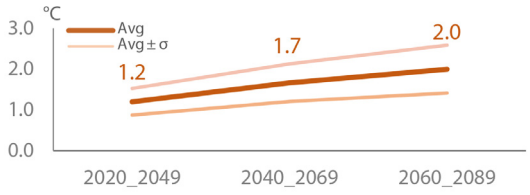
Changes in annual mean temperature (°C)



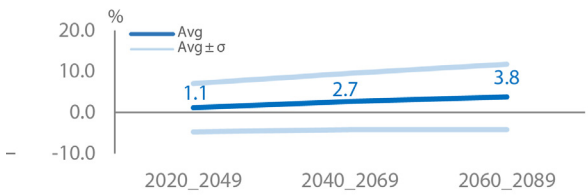
Changes in total precipitation (%)



Average temperature (°C)

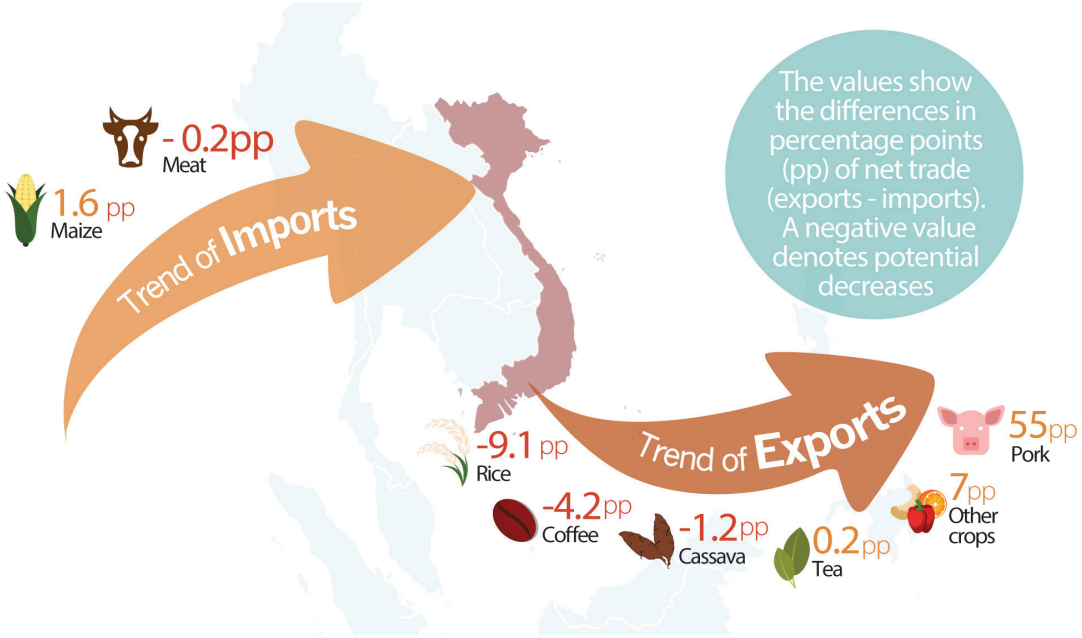


Average precipitation (%)



Potential economic impacts of climate change

The impact of climate change on net trade in Viet Nam (2020-2050)



Robinson S; Mason-D'Croz D; Islam S; Sulser T; Gueneau A; Pitois, G; Rosegrant MW. 2015. The international model for policy analysis of agricultural commodities and trade (IMPACT): Model description for version 3 IFPRI Discussion Paper 1483. International Food Policy Research Institute (IFPRI). Washington, DC. Available at http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/ id/129825

Viet Nam is among the most vulnerable countries to climate change. Among the 84 coastal developing countries heavily affected by sea-level rise, Viet Nam ranks first in terms of consequence to population and GDP performance, ranking second in terms of influence on land area and agricultural production [9]. Viet Nam is considered one of the 30 "extreme risk countries" in the world according to the 2014 Climate Change Vulnerability Index (CCVI) of Maplecroft [57].

Climate change is expected to reduce the agricultural production area by about 12% in the Red River Delta and 24% in the Mekong River Delta [58]. Climate change will likely affect not only the agricultural production area but also agriculture productivity. Indeed, if the sea level rises by 1 m, rice cultivation in the Mekong Delta is at risk of losing 40.5% of the region's total yield [58]. The productivity of crops such as rice and maize is forecast to decline whilst diseases are expected to increase due to the harsher climatic conditions [59]. The medium climate change scenario forecasts that the spring rice yield could decrease by 716.6 kg per ha by 2050, while summer-autumn rice production could decline by 795 kg per ha. This would cause a general decline in production of 1,475,000 tonnes. Maize yields could shrink by 781.9 kg per ha, resulting in a production decline of 880,000 tonnes [60]. Furthermore, rising sea levels will inundate most of the Mekong and Red River deltas by 2070 and cause adverse impacts on aquaculture. Inundated ponds and lakes could suffer from a complete loss of stock. Climate change will also reduce the variety of aquatic resources and degrade soil quality [60].

An analysis using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)[3] [41] was carried out for selected key production systems in Viet Nam, analyzing impacts of climate change in 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 would occur (CC) compared to a scenario with no climate change (NoCC). The results show that CC has mixed effects on agricultural production, potentially contributing to an increase in yields and land area for some crops, and decreases for others[4].

Modeled results suggest that Viet Nam may become more dependent on imports of maize and meat[5], regardless of climate change. However, reliance on import is projected to be less important under climate change scenarios for the group of meats (-0.2pp) while dependence is at greater extent for maize (1.6 pp above the NoCC scenario). Viet Nam will likely transition from being a net exporter to being an importer of tropical fruits, but climate change is expected to temper this transition somewhat, with a 4 pp lower dependence on imported tropical fruit under the climate change scenario.

The results also suggest that Viet Nam will increase its exports of coffee, pork, rice, tea, cassava and roots and tubers in general under both CC and NoCC scenarios. Comparatively, exports would be reduced under CC for coffee, rice, cassava, and slightly for root and tuber groups, by 4.2 pp, 9.1 pp, 1.2 pp, and 0.6 pp respectively. Notably, with climate change the net exports of pork and "other crops" would increase by 55 pp and 7 pp respectively, relative to the NoCC scenario. Ultimately, changes in demand are driven by relative commodity prices present in the global and national marketplace.

According to the IMPACT results, the area for maize and tea would be lower under CC by 1.6 pp and 0.05 pp, respectively. Area changes in the other crops analyzed do not reflect substantial changes. Yield is more heterogeneous and varies across the different crop categories:

- For maize and rice, yield decreases under CC and increases in the NoCC scenario.

- For other crops, yields are reduced under both CC and NoCC scenarios, but are more negatively affected under climate change by 2.8 pp.

- Although yield increases are foreseen in coffee, cassava, and tea, climate change is expected to lessen the amount of yield growth.

In terms of yields, the trends ending in 2050 show lower levels across most production systems as a result of climate change i.e. there is an overall negative effect associated with climate change. In 2050, for example, maize yields are expected to be 16% lower because of climate change. Indeed, in 2050, all other production systems are projected to have lower yields because of climate change, with percentage differences ranging from 3.6% (cassava) to 6.6% (coffee and rice).

Similar differences can be seen in the area under maize cultivation, with an expected difference of 1.6pp lower relative to the NoCC scenario. This is in contrast to coffee, cassava, and rice, which would have greater cultivated areas under the CC than under the NoCC scenario. In such cases, Viet Nam has a greater comparative advantage under CC than without CC. Where the difference is negative, Viet Nam would face negative impacts and lose competitive advantage.

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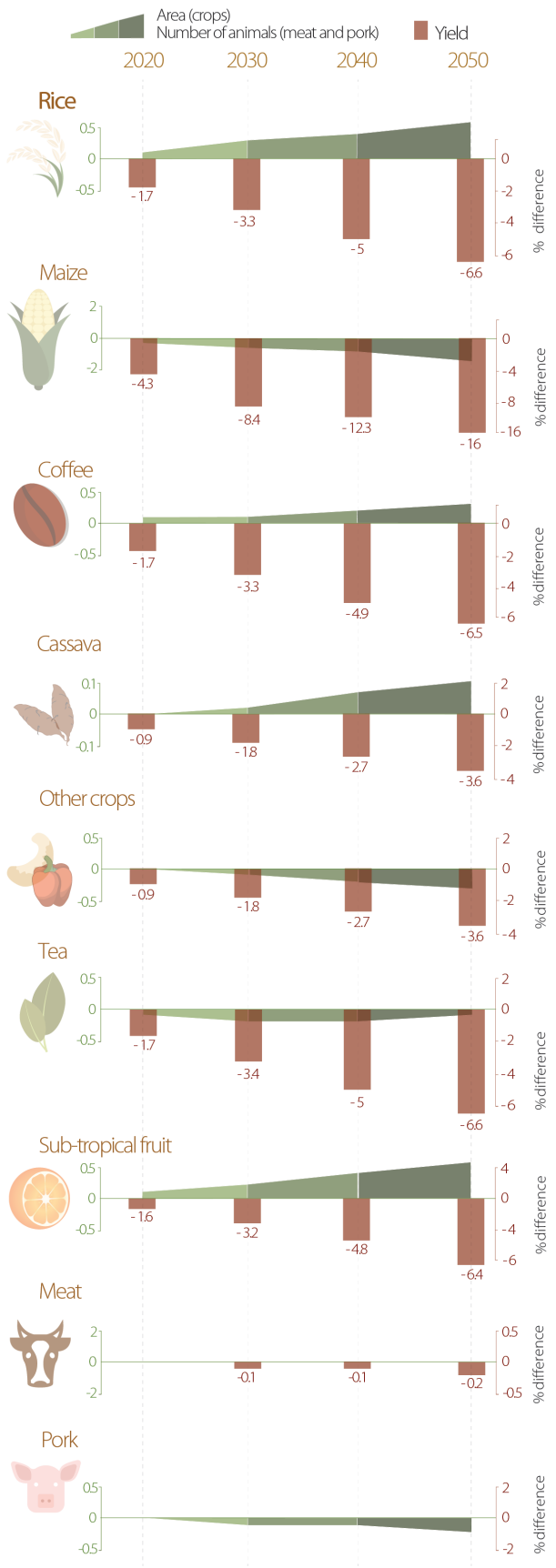
3 IMPACT, developed by the International Food Policy Research Institute [35], is a partial equilibrium model using a system of linear and non-linear equations designed to approximate supply and demand relationships at a global scale. This study used the standard IMPACT model version 3.2, less the IMPACT-Water 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.

4 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.

5 The meat group includes cattle, sheep, lamb and poultry

6 The availability crops modeled from IMPACT model are available in the document methodology or IMPACT MODEL description (Robinson et al., 2015)

Climate change impacts on yield, crop area and livestock numbers in Viet Nam



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

The impact of climate change on the number of animal is expected to be negative and differentiated per animal type. The impact of climate change is more pronounced on pig populations than on other livestock (including bovine, poultry, sheep, etc.). In the case of pigs, a 1.1 pp reduction in herd size is expected because of climate change. This reduction would be 8.2% without factoring in climate shocks. The impact on other animals is less substantial, with relatively stable projections for herd size despite climate change.

In general, climate change is projected to adversely affect productivity in all production systems in Viet Nam. The specific impacts depend on the production system, with maize showing the most negative potential impact.

CSA technologies and practices

CSA technologies and practices present opportunities for addressing climate change challenges, and for economic growth and development of the agricultural sector. Practices are considered climate smart 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 are classed as CSA.

The practices represent strategies or solutions for farmers to address some of the key challenges they face in responding to the impact of climate change in Viet Nam, such as higher frequency of droughts and water shortages, sea-level rise and salt intrusion, rising temperatures, rainfall intensity and floods, and increased pest or disease incidence.

Some of the most frequently suggested practices are those related to *smart water and irrigation management* in almost all crop systems, i.e. coffee, tea, citrus, cashew, maize, rice, and pepper. This refers to installing water-saving irrigation techniques such as drip or sprinkler irrigation, implementing moisture-preserving practices such as mulching (cassava), alternate wetting and drying (AWD) systems in rice (component of the System of Rice Intensification (SRI) technique), input-saving techniques in rice production (1M5R, 3R3G), integrating fishponds into citrus plantations, and use of humus storage pits in rubber.

Further practices *include the adoption of improved crop varieties* resistant to droughts, floods, or pests and diseases (e.g. in rubber, cashew, cereals, and pepper), which can also support *integrated pest management*. Integrating perennials such as orange, rubber, coffee, or cashew into *agroforestry systems* with other crops such as avocado, maize, guava, upland rice, or sesame will allow farmers to diversify their income, improve their productivity and resilience to climate change. Intercropping also allows for *heat stress management (microclimate regulation)* in coffee by planting shade trees such as durian fruit trees or cover crops to reduce direct soil moisture loss such as intercropping with leguminous plants (peanut, *Arachis pintoi*, etc).

Finally, *sustainable land management* reduces soil erosion in mountainous areas (e.g. via contour farming in maize, planting grass strips along contour lines (Mulato, Guinea) and improves soil fertility by intercropping with leguminous species e.g. in cassava or rubber.

For livestock, the practices suggest the integration of biogas technologies into pig production for *efficient manure management, and improved feed and fodder management* such as the use of local high-quality feeds that are more easily available and increase productivity. Shrimp production is practiced by farmers in coastal areas as a means to deal with saltwater intrusion, and can be integrated into shrimp–rice, shrimp–tilapia or shrimp–forest farming with mangrove systems for higher productivity.

Most CSA technologies have a low or medium adoption rate in Viet Nam (<30% or between 30–60% of farmers of a specific production system). Some rice technologies have high adoption rates (>60%), such as shrimp–rice farming in the Mekong River Delta (practiced by small-scale farmers) and use of flood resistant varieties in the Red River Delta and Northern Mountain region (practiced by small-, medium- and large-scale farmers). Among the few adopters, small- and medium-scale farmers are predominant in most technologies and regions, while some large-scale farmers can be found among the users of CSA technologies in pig production (in Midlands, Northern Mountains and Red River Delta), coffee (Central Highlands), rubber (Northwest, Central and Southeast Region) rice (Red River or Mekong Delta) and pepper (Central Highlands).

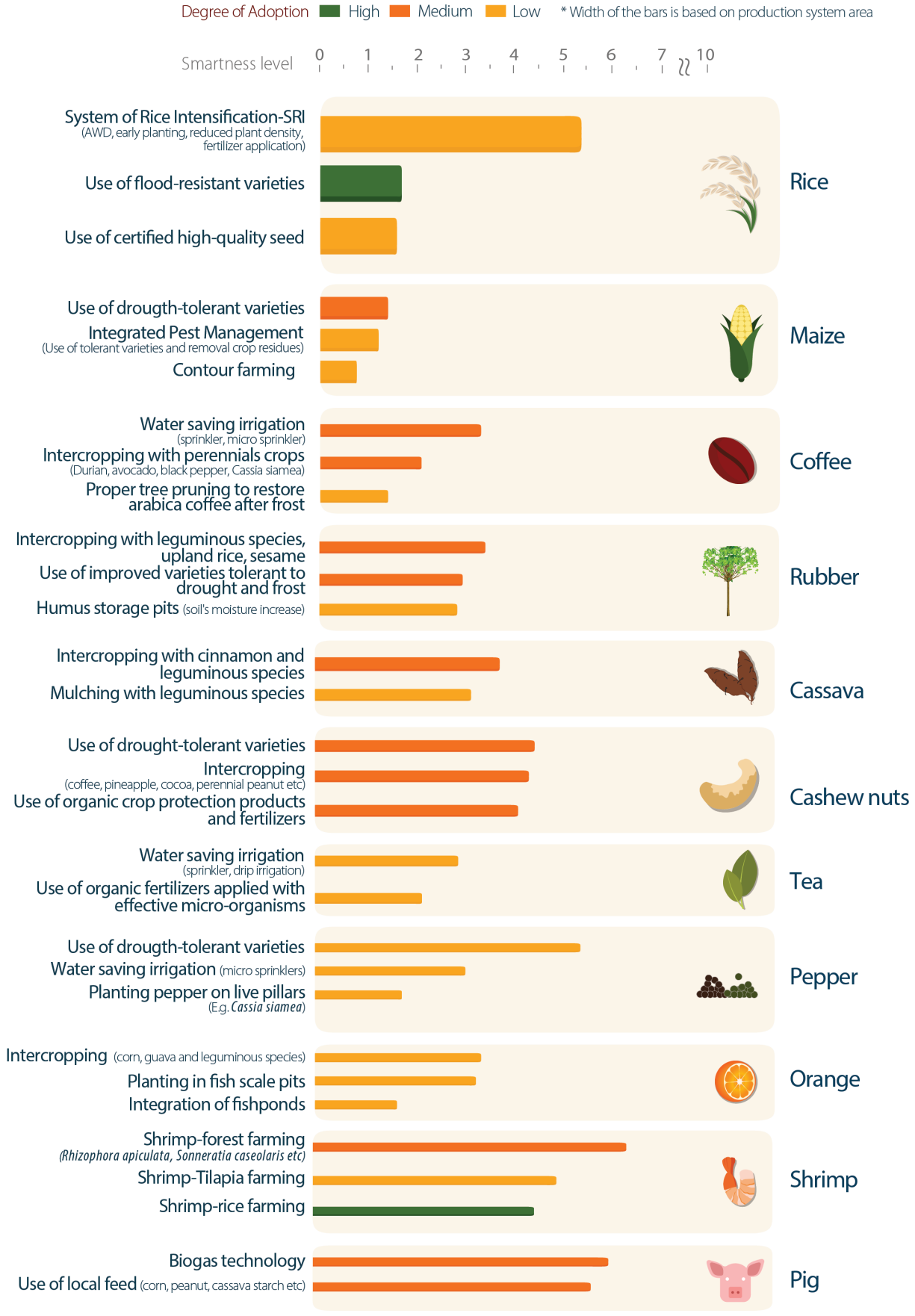
The relatively low level of technology use among farmers highlights that several challenges and barriers to adoption persist. Barriers often relate to low availability of required inputs (such as seeds for improved varieties, or water scarcity during droughts), high costs of installation (e.g. of improved irrigation facilities) with limited access to credit and markets, high labor costs and a limited level of technical knowledge and skills. Addressing those barriers will be a key requirement for successful out-scaling of CSA practices.

Although agricultural extension in Viet Nam is effective and well-equipped, the system still faces difficulties, for example a general inclination of extension staff to supply traditional 'top-down' instructions rather than promoting participatory approaches such as farmer-to-farmer extension and farmer field schools [62]. However, innovative methods in agro-advisory services can have significant impacts by tailoring information to farmers' needs. These also include the provision of weather and climate information services (CIS) to farmers. CIS pilot projects, such as the Agro-climate Information Systems for Women and Ethnic Minorities (ACIS) project in a climate-smart village in northern and coastal central Viet Nam[7], is improving farmers' ability to make informed decisions on farm production planning [63].

The diagrams below present a selection of CSA practices with high "climate smartness scores" according to expert evaluations. The average climate-smartness score is based on individual scores of a climate-smart practice on eight factors related 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 that is key to food security. A detailed explanation of the methodology can be found in Annexes 3.

7 ACIS is led by the World Agroforestry Centre and CARE International, and supported by CCAFS.

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



Climate-smart manure management for Ma village in Northern Vietnam

Animal production plays an important role in the livelihoods of farmers in Ma, a Climate-Smart Village (CSV) in Yen Bai province just 160 km north of Hanoi. Selected in 2016 by CIAT for the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) as a trial site to test various CSA practices directly on farms, Ma is characterized by high vulnerability to climate challenges such as prolonged droughts, bursts of heavy rain, and frequent cold snaps.

Raising animals like ruminants, pigs, poultry and fish are among the key sources of livelihoods for the farmers in Ma, yet improper management of animal waste has been a major drawback over past years. Often, farmers would dump untreated animal dung and droppings in a nearby locale, thereby wasting precious farm resources while neglecting the negative consequences on air and water pollution, spread of animal-related diseases, and increased emission of greenhouse gas (GHG) to the atmosphere.

Mr. Hoang Quoc Viet, Nguyen Duy Nhiem (from left to right) demonstrating the vermiculture model. Photo: Pham Nhu Trang/CIAT

The CSV team in Ma observed this lack of an effective waste management system and suggested to adopt a system of composting and vermiculture instead. Together with the Ma women's association, the CSV team designed and conducted hands-on trainings on composting and vermiculture among interested farmers in the village during two months in spring 2016.

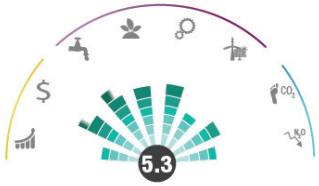
For the villagers, adopting these techniques offered relief and improvements on several levels of farm production. For example, composts made from animal manure, agriculture by-products (e.g. rice straw, weeds, sawdust), and household wastes now produce high-quality fertilizer for crops. While their application increases crop yields, use of compost also cuts down costs and use of chemical fertilizer and reduces overall GHG emissions. Furthermore, proper manure management increases animal production by improving the rearing environment and making the system more hygienic, thus, directly impacting on animal health and productivity. Finally, lower levels of waste also reduce the production system's ecological impacts and resource intensity, rendering it more eco-efficient.

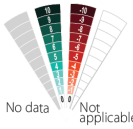
The trainings attracted many villagers. "*I wanted to make compost before but I did not know how. I really like this easy and cheap practice of waste treatment as after three days of implementing, I did not smell anything bad,*" said Mr. Hoang Van Toan, a farmer-trainee.

Mr. Hoang Quoc Viet was the first farmer to implement vermicomposting in Ma village. Since attending the training, he no longer burns manure to dispose of it, but treats it with effective microorganisms to increase its macro– and micronutrient contents. He raises earthworms in the dung, which represent nutritive feeds for his chickens, while the dung now serves as effective fertilizer for his rice and cassava. Thanks to vermicomposting, Mr. Hoang Quoc Viet now saves money on fertilizer and chicken feed, and the chickens, as well as the rice and cassava, grow very well.
Composting and vermiculture are just a few of several CSA practices implemented in the CSV. Further practices tested in Ma include intercropping cassava with legumes, grass strip plantations to prevent soil erosion and increase soil fertility, climate-smart rice production, integrated water management for rice production and cut-and-carry livestock systems.

This case study is adapted from a CCAFS blogpost entitled "Eco-efficient waste management in Ma Climate-Smart Village", authored by Nguyen Duy Nhiem (CIAT). [64]

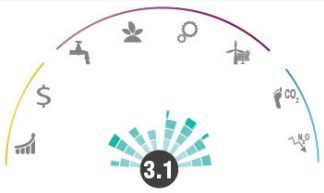
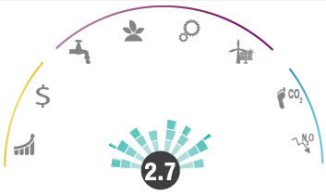
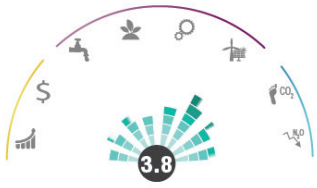
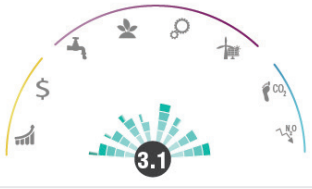
Table 1. Detailed smartness assessment for top ongoing CSA practices by production system as implemented in Viet Nam.

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 (77% of total harvested area)				
System of Rice Intensification-SRI (AWD, early planting, reduced plant density, fertilizer application)	Red river delta 30-60%	S		**Productivity** Increase yield. **Adaptation** Increase resistance to unfavorable condition: drought, flood, disease. **Mitigation** Mitigate GHG emissions.
	Mekong river delta 30-60%	S		
Use of flood-resistant varieties	Nothern mountain 60%>	M		**Productivity** Increase land and crop productivity per unit of water. **Adaptation** Increase resistance to heavy rains or flood. **Mitigation** Provide moderate reduction in GHG emissions per unit of food produced.
	Red river delta 60%>	S M L		
Maize (11% of total harvested area)				
Use of drougth-tolerant varieties	Central Highland 30-60%	M		**Productivity** Increase yield. **Adaptation** Maize varieties can adapt to local conditions given the water shortage. **Mitigation** NA.
	Northern midlands and mountainous 30-60%	M		
Integrated pest management (use of tolerant varieties and removal of crop residues)	Northern midlands and mountainous <30%	S		**Productivity** Increase yield. **Adaptation** Resistant to pests & diseases, increase/ improve biodiversity. **Mitigation** NA

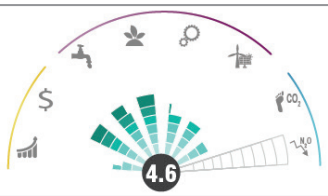


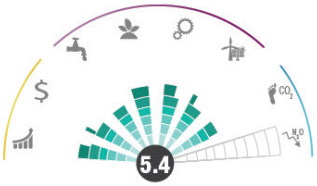
Yield Income Water Soil Risk/Information Energy CO_2 Carbon N_2O Nutrient

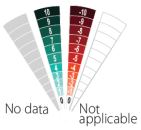
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Maize (11% of total harvested area)				
Integrated pest management (use of tolerant varieties and removal of crop residues)	Central Highland <30%	S		**Productivity** Increase yield. **Adaptation** Resistant to pests & diseases, increase/ improve biodiversity. **Mitigation** NA
Coffee (6% of total harvested area)				
Water saving irrigation (sprinkler, micro sprinkler)	South East 30-60%	S M L		**Productivity** Maintain yield. **Adaptation** Adapt to drought. **Mitigation** Reduce emissions from using machines.
	Central Highland 30-60%	S M L		
Intercropping with perennial crops (durian, avocado, black pepper, cassia siamea)	Central Highland 30-60%	S M L		**Productivity** Increase total yield per unit of area. **Adaptation** Resistant to salt intrusion and reduce impacts from storms.. **Mitigation** Increase carbon sequestration.
	South East 30-60%	S M L		
Shrimp (6% of total harvested area)				
Shrimp-forest farming (mangrove species: Rhizophora apiculata, Sonneratia caseolaris and others)	Mekong river delta 30-60%	L		**Productivity** Increase productivity of shirmp and forestry products. **Adaptation** Salinity resistant, reduce impacts from storms etc. **Mitigation** Increase carbon sequestration.
Shrimp-Tilapia farming	Mekong river delta <30%	S		**Productivity** Reduce production risks. **Adaptation** Reduce unfavorable conditions for shirmp or tilapia. **Mitigation** NA.

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
Rubber (5% of total harvested area)				
Agroforestry of rubber with with leguminous species, upland rice, sesame	Southeast region 30-60%	S M L		**Productivity** Increase yield. **Adaptation** Adapt well to market variation and cost. **Mitigation** Mitigate risk of climate change and price cost.
	Northwest 30-60%	S M L		
Use of improved varieties tolerant to drought and frost	Southeast region 30-60%	S M L		**Productivity** Increase 10-30%. **Adaptation** Suitable varieties grow well in drought, storm and cold. **Mitigation** Mitigate damages from drought, storms and improve carbon sequestration.
	Northwest 30-60%	S M L		
Cassava (5% of total harvested area)				
Intercropping with cinnamon and leguminous species (E.g. Acacia)	Central Highland 30-60%	S		**Productivity** Increase productivity. **Adaptation** Reduce erosion, increase soil fertility. **Mitigation** Increase carbon sequestration.
	Northern mountainous 30-60%	S		
Mulching with legomunious species	Northern mountainous <30%	S		**Productivity** Increase effectiveness of the production. **Adaptation** Reduce erosion, maintaining humidity. **Mitigation** NA
	Central Highland <30%	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
Cashew (3% of total harvested area)				
Use of drought-tolerant varieties	Southeast region 30-60%	M		**Productivity** Increase 10-30%. **Adaptation** Suitable varieties grow well in drought, storm and cold. **Mitigation** Mitigate damages from drought, storm and improve carbon sequestration..
	Central Highland 30-60%	M		
Intercropping with coffee, pineapple, cocoa, perennial peanut etc.	Southeast region 30-60%	M		**Productivity** Increase total yield per unit of area. **Adaptation** Adapt better to high temperature and lack of water. **Mitigation** Increase carbon sequestration.
	Central Highland 30-60%	M		
Tea (1% of total harvested area)				
Water saving irrigation (sprinkler, drip irrigation)	Midland and Northern mountain <30%	S		**Productivity** Maintain yield. **Adaptation** Adapt to drought. **Mitigation** Reduce emissions from using machines.
	Northwest <30%	S		
Use of organic fertilizers applied with effective micro-organisms	Midland and Northern mountain 30-60%	S		**Productivity** Increase productivity. **Adaptation** Maintain humidity to be resistant to drought. **Mitigation** Reduce NO_2 emission.
	Northwest 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
Pepper (0.5% of total harvested area)				
Use of drought-tolerant varieties	Central Highland <30%	L		**Productivity** Increase total yield per unit of area. **Adaptation** Adapt better to high temperature and lack of water. **Mitigation** Increase carbon sequestration.
	Central Highland <30%	L		
Water saving irrigation (micro sprinklers)	Central Highland <30%	S		**Productivity** Productivity is unchanged. **Adaptation** Adapt well to climate change; reduce volume of water. **Mitigation** Reduce emissions from using machines.
	Central Highland <30%	S		
Orange (0.4% of total harvested area)				
Planting in fish scale pits	Northeast <30%	M		**Productivity** Increase yield. **Adaptation** Effective use of water. **Mitigation** NA.
	Northwest <30%	M		
Agroforestry (intercropping with corn, guava and leguminous species)	Northeast <30%	M		**Productivity** increase effectiveness of the production, diversify income. **Adaptation** Drought resistant, reduce soil erosion. **Mitigation** Increase carbon sequestration.
	Northeast <30%	M		

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
Pork(NA)				
Biogas technology	Red River Delta 30-60%	M L		**Productivity** Increase the effectiveness in using pig waste. **Adaptation** NA. **Mitigation** Reduce GHG emissions.
	Midlands and northern mountains <30%	M L		
Use of local feed (corn, peanut, cassava starch, rice bran, groundnut meal)	Red River Delta 30-60%	M L		**Productivity** Increase pig yield. **Adaptation** Increase the resistance to unfavorable conditions. **Mitigation** Reduce waste from pig raising.
	Midlands and northern mountains 30-60%	M L		



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

Institutions and policies for CSA

The climate change policy-making processes in Viet Nam often involve a wide range of stakeholders. Like any other policy-making process in Viet Nam, the Central Committee of Party (CCP) is responsible for producing a framework for the response to climate change in the country. Through the issuance of relevant resolutions, the National Congress of the Communist Party sets out viewpoints and formulates overall directions that provide foundations for downstream climate policy, including national programs, strategies and action plans. In June 2013, the CCP adopted Resolution 24/NQ-TW which highlights the challenges of climate change and affirms the necessity of an active response to climate change and an improvement in natural resource management and environment protection in Viet Nam. The resolution has facilitated the approval of the Law on Environment Protection in 2014, with a separate chapter on climate change. However, while these bodies are at the top of the political hierarchy, the highest authority lies within the ministries and government, which are the key signatory in international treaties and commitments related to climate changes issues.

There is a range of ministries involved in the climate change policy formation and policy implementation[8]. These ministries include the Ministry of Agriculture and Rural Development (MARD), the Ministry of Environment and Natural Resources (MONRE), the Ministry of Planning and Investment (MPI), the Ministry of Finance (MOF), the Ministry of Industry and Trade (MOIT), the Ministry of Construction (MOC), the Ministry of Transportation (MOT), the Ministry of Science and Technology (MOST), the Ministry of National Defense (MND), the Ministry of Public Security (MPS) and the Ministry of Foreign Affairs. Among the ministries, MONRE and MPI lead in the policy-making process, while MARD leads the process for the agricultural sector. These ministries are drafting policies, coordinating and submitting these to the government and National Assembly for approval and to some extent, allocating financial resources to enable policy implementation. The National Committee on Climate Change (NCCC) coordinates these line ministries; it was established in 2012 and is chaired by the prime minister. The mission of the NCCC is to lead, coordinate, harmonize, and monitor the climate change and green growth policy formulation and program implementation. The NCCC also plays a key role in international cooperation for climate change related programs.

Provincial authorities can lead the mainstreaming of climate change as they lead local planning and implementation of national policies, investment in project formulation and budget allocation processes. Provincial People's Committees (PPC) are responsible for issuing action plans, programs, and projects to put national policies in practice. PPCs also establish Provincial Steering Committees (PSCs) to coordinate the implementation of the National Target Program to Respond to Climate Change. However, the operational mechanism of PSCs is not yet effective in every province. While a provincial Department of Natural Resources and Environment (DONRE) is in charge of climate policy implementation, the Department of Agriculture and Rural Development (DARD) controls agricultural policy implementation, which also covers climate change aspects. Furthermore, the functions of lower level authorities relative to the line ministries are often not clearly defined. Line ministries still maintain a significant portfolio of climate change related activities. The central government has not yet decentralized many of the key functions to the provinces or large cities [65].

Next to the government, other research, non-governmental or mass organizations play a key role in advising on and implementing climate policy in Viet Nam. National academic institutes (e.g. the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), Institute for Agricultural Environment (IAE); the Viet Nam Academy of Agricultural Sciences (VAAS); the National Institute of Animal Husbandry (NIAH); Can Tho University, and Thai Nguyen University) and international research institutes (such as the International Center for Tropical Agriculture (CIAT), the International Rice Research Institute (IRRI) and World Agroforestry Centre (ICRAF)) are providing significant technical assistance, scientific problem analysis and evidence-based solutions for the formulation of climate policy.

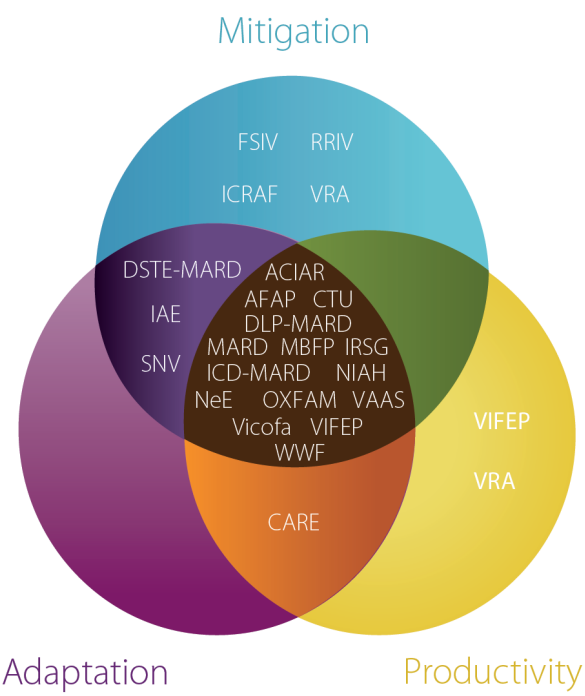
Furthermore, international development agencies such as the Australian Centre for International Agriculture Research (ACIAR), the German Agency for International Cooperation (GIZ), World Wide Fund for Nature (WWF) or UN-REDD are reinforcing their influence in both policy formulation and implementation, not only as the donors but also as kick-starters of policy debates. Nongovernmental organizations such as Oxfam, SNV, and CARE-International are providing growing support for development projects in the field (e.g. the Climate Smart Village projects piloted by CCAFS) and strongly advocating for changes in policies. The recent involvement of the private sector (including the Viet Nam Chamber of Commerce and Industry – VCCI and enterprises) through various policy discussions and policy dialogues is contributing positively to the policy-making process, given its status of not only being a beneficiary of policies but also as a source of substantial GHG emissions [66].

The diagram below highlights the 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.

The government of Viet Nam recognizes the challenges it faces with increasing climate change. The initial national response to climate change started in 1990 through Agenda 21, followed by the ratification of the Kyoto Protocol in 2002 and the official submission of Viet Nam's Initial Communication to the UNFCCC in 2003. Since then, there has been a strong response in pursuing the development of an enabling policy environment and institutional setting. Over the past decade, a climate change response has developed rapidly through the adoption of a number of agendas, policies and programs.

8 According to Decision 321/QĐ-TTg dated 13 March 2017.

Institutions for CSA in Viet Nam



ACIAR Australian Centre for international Agricultural Research **AFAP** Australian Foundation for the Peoples of Asia and the Pacific in Vietnam **CARE** Cooperative for Assistance and Relief Everywhere **CTU** Can Tho University **DLP-MARD** Department of livestock production **DSTE-MARD** Department of Science Technology and Environment **FSIV** Vietnammese Academy of Forest Sciences **IAE** The Institute for Agricultural Environment **CARE** CARE International **ICD-MARD** Department of International Cooperation **ICRAF** The World Agroforestry Centre **IRSG** International Rubber Study Group **MARD** Ministry of Agricuture and Rural Development **MBFP** Management board of forestry projects **NeE** Netherlands Embassy **NIAH** National Institute of Animal Husbandry **RRIV** Rubber research institute of Vietnam **SNV** Netherlands Development Organization **VAAS** Vietnam Academy of Agricultural Sciences **Vicofa** Coffee Cacao Association Vietnam **VIFEP** Vietnam Institute of Fisheries economic and Planning **VRA** Vietnam Rubber Association **WWF** World Wide Fund

The policy response aims to address the increasing climate vulnerability and to promote a low carbon, green growth development path.

Submission of the Intended Nationally Determined Contribution (INDC) to the UNFCCC in September 2015 and ratification of the Nationally Determined Contribution (NDC) in November 2016 reflected Viet Nam's efforts in climate change adaptation and GHG emission mitigation. In the NDC, Viet Nam commits to GHG reduction in the 2021–2030 period of 8% compared to the business as usual (BAU) scenario, increasing to 25% with international support, notably financial resources. To achieve the mitigation targets of the NDC, solutions are the reduction of GHG emissions through the development of sustainable agriculture, management and development of sustainable forests, and the enhancement of carbon sequestration and environmental services [67].

The earliest national policy on climate change is the National Target Program to Respond to Climate Change (NTP-RCC) issued by Decision 158/2008/QD-TTg in, 2008 and Decision 1183/QD-TTg in 2012. The NTP-RCC stresses the need for mainstreaming climate change responses in social and economic development planning (SEDP), disaster risk reduction (DRR), coastal zone management and energy use. The focus of the NTP-RCC is on adaptation rather than on mitigation (e.g. hydro-meteorological infrastructural and provincial climate change action plans).

The NTP-RCC was followed by the National Climate Change Strategy (NCCS: Decision 2139/QD-TTg, 2011) and the Viet Nam Green Growth Strategy (VGGS: Decision 1393/QD-TTg, 2012). The NCCS and VGGS have been strengthened through the National Action Plan on Climate Change (NAPCC) and the Green Growth Action Plan (GGAP), both for the period up to 2020. The latest effort in strengthening Viet Nam's commitment to responding to climate change was the issuance of the Decision 2053/QD-TTg on the approval of the Action Plan to Implement the Paris Agreement on Climate Change.

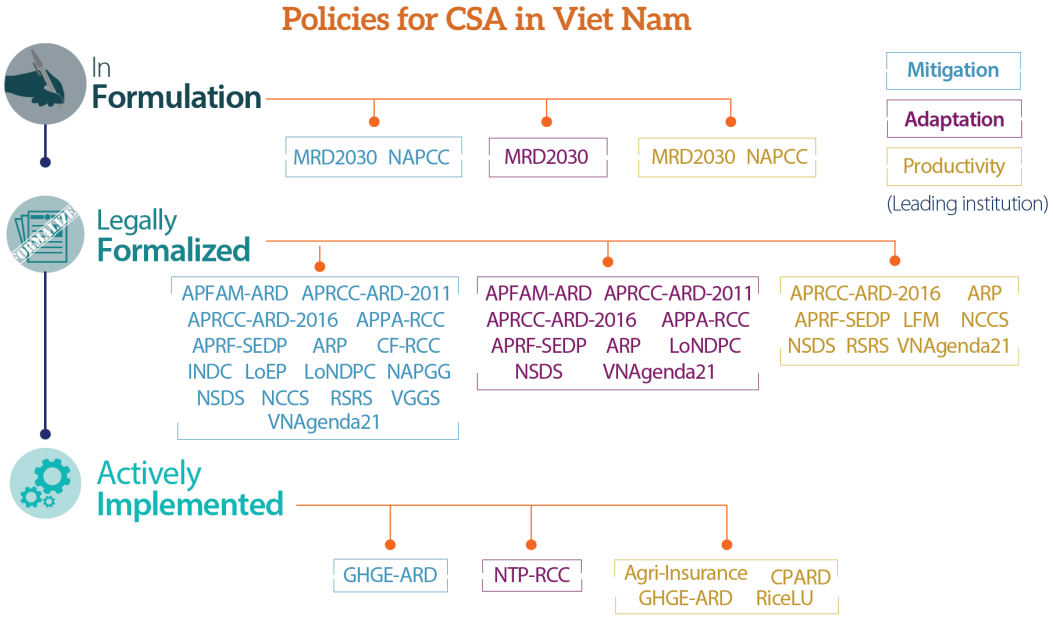
Important policies have been approved to address climate change at the sectoral level. These policies include the themes *natural disaster management* (Law on Natural Disaster Prevention and Control 2013, the National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020 (NSNDPRM) the national Community-Based Disaster Risk Management Program (CBDRM)) and *improvement of scientific and technological evidence for effective CC-responses* (the National Scientific and Technological Program on Climate Change). In the field of agriculture and forestry, important policies include the National Action Program on REDD+ for the period 2011–2020 (Decision 799/ QD-TTg, 2012), approval of the national program on REDD+ (Decision No. 419/QD-TTG, 2017), approval of the agriculture and rural development's action plan for responding to climate change for 2016 to 2020 with a vision for 2050 (Decision No. 819/QD-BNN-HCN, 2016) and approval of the Green Growth Action Plan of MARD up to 2020 (Decision 923/QD-BNN-KH, 2017). National Action Plan to implement the 2030 Agenda for Sustainable Development (Decision No. 622/QD-TTg, 2017).

Greater attention has been paid in mitigating emissions from energy use. The National Target Program on Energy Efficiency and Conservation (NTP-EE) was the first national energy saving and conservation effort. The Law on Environment Protection (2014) highlighted the creation and development of carbon credit markets and international emissions offsetting (Article 41). Renewable energy is also increasingly referred as an efficient pathway in targeting climate change mitigation (issuance of the Renewable Energy Development Strategy in 2015 and revision of the Power Development Plan in 2016). This is in line with the low-carbon green growth approach of the GGAP that emphasizes an increase in access to energy for the poor while also focusing on reducing GHG emissions. Such

development of renewable energy is particularly important in Viet Nam where energy development is reliant on fossil fuels.

National policies explicitly link climate change to green growth to promote sustainable development. However, some gaps and inconsistencies between documents are still evident and this may prove to be significant barriers for policy implementation. While the NCCS focuses on adaptation and includes mitigation, the VGGS emphasizes mitigation action, with a focus on low-carbon and green growth. Most climate actions in the Green Growth Action Plan (GGAP) are based on mitigation of GHG emissions, while climate change adaptation is not highlighted.

Significant barriers to scale-out CSA practices are also linked to policies on land management. Land tenure insecurity is a hindrance to large investment in agriculture. Under the Constitution, land is owned by the public and managed by the State. Land-use rights are issued to individuals for a specific period of time and may be subject to annulation under land acquisition projects [9]. In addition, strict control over the use of land is also an important constraint to crop diversification. Land-use policies were designed to protect paddy land areas. Since 2015, the government has allowed farmers and local authorities greater flexibility to convert paddy land to other agricultural uses or to introduce rotations between seasons[9]. However, the revised policy still restricts farmers from changing their land use to a more rewarding economic purpose, such as planting tree crops [9]. And most of the irrigated lowland areas are designed for rice cultivation with few opportunities for growing alternative crops [18]. According to a study by Markussen et al. (2009), 36% of the surveyed plots have cultivated rice year-round despite the users' preference for other crops [68]. While the country has thoroughly overshot its food production targets and nutrition-oriented food security now calls for crop diversification, its strict land-use policy has become a barrier rather than a tool for food security.



Agri-Insurance The pilot provision of agriculture during 2011-2013 (2011) (GOV) **APFAM-ARD** Action Plan Framework for Adaptation and Mitigation in the Agriculture and Rural Development sector for the period 2008-2020 (2008) (MARD) **APPA-RCC** Action Plan to Implement Paris Agreement in Response to Climate Change (2016) (GOV) **APRCC-ARD-2011** Action Plan on Response to CC in Agriculture and Rural Development period 2011-2015 and vision to 2050 (2011) (MARD) **APRCC-ARD-2016** Action Plan to Response to CC in Agriculture and Rural Development, period 2016-2020, vision 2050 (2016) (MARD) **APRF-SEDP** Adaptation prioritization Framework for Socio-Economic Development Planning (2013) (MPI) **ARP** Agricultural Restructring Plan towards raising added values and sustainable development (2013) (GOV) **CF-RCC** Proptection and Management of Coastal Forest in response to climate change for the period from 2015-2020 (2015) (GOV) **CPARD** Credit Policies for Agricultural and Rural Development (2010) (GOV) **GHGE-ARD** Reduction of GHG Emissions in Agriculture and Rural Areas by 2020 (2011) (MARD) **INDC** Intended Nationally Determined Contribution of Viet Nam (2015) (National Assembly) **LFM** Encouraging cooperation, development of Large-scale Fields Models and linkages between production and consumption of agricultural products (2013) (GOV) **LoEP** Law of Environment Protection (2014) (National Assembly) **LoNDPC** Law of Natural Disaster Prevention and Control (2013) (National Assembly) **MRD2030** Planning on Agriculture and Rural Areas in the Mekong River Delta to 2020, vision to 2030 in the context of climate change (2014) (MARD) **NAPCC** National Action Plan on Climate Change period 2012-2020 (2012) (GOV) **NAPGG** National Action Plan on Green Growth in Vietnam for the period 2014-2020 (2014) (GOV) **NCCS** National Climate Change Strategy (2011) (GOV) **NSDS** Vietnam Sustainable Development Strategy for 2011-2020 (2012) (GOV) **NTP-RCC** National Target Programe on Response to CC (2008) (GOV) **RiceLU** Management and Use of Rice-farming Land (2012) (GOV) **VGGS** Vietnam Green Growth Strategy (2012) (GOV) **RSRS** Restructuring Strategy for Vietnam's Rice Sector up to 2020 and vision to 2030 (2016) (MARD) **VNAgenda21** Promulgating the oriented strategy for sustainable development in Vietnam (2004) (GOV)

9 Through Decree 35/2015/ND-CP on management and use of paddy land.

The diagram shows a selection of policies, strategies, and programs that relate to agriculture and climate change 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 (i.e. a policy that is in an initial formulation stage or consultation process), policy formalization (i.e. the presence of mechanisms for the policy to process at national level) and policy in active implementation (i.e. visible progress or outcomes toward achieving larger policy goals through strategies and action plans). For more information on the methodology and results from interviews, surveys and expert consultations, see Annex 5.

Financing CSA

There is a crucial gap in climate finance in Viet Nam. Until 2020, the MPI estimates that financing climate change response activities will amount to approximately US$4.7 billion annually [69]. According to Viet Nam's NDC, the national budget can only meet one-third of its financial needs to implement adaptation measures in the 2021–2030 period [67]. Therefore, meeting a large share of the country's mitigation targets is conditional upon international financial aid, along with support through technology transfer and capacity building [67]. In order to fill these gaps in financial capacity, the Vietnamese government calls on the international community and the private sector to provide support.

In addition to the State budget, the major sources of climate funding are both bilateral and multilateral international donors. Since 1998, a significant part of the US$64 billion pledged in official development aid (ODA) to Viet Nam has been related to climate change adaptation and mitigation activities [68]. The Second National Communication has provided direct finance for climate change through a list of relevant climate change projects and donors. Among others, since 2000, eleven projects in the area of adaptation, eight relating to mitigation, nine in capacity building, and three in education and training have been implemented. The Support Program to Respond to Climate Change (SP-RCC) has committed a total of US$240 million [69] through various donors and funding agencies. Among development banks, the largest investment portfolios in Viet Nam are held by the World Bank and the Asian Development Bank (ADB), which have progressively integrated climate change into their lending policy with a strong focus on mitigation actions and to a lesser extent, on adaptation measures.

The share of government financing for climate change response (18%) was constant from 2010 to 2013, while the total amount has decreased slightly (by 11% in real terms). The decline in spending on climate change activities is largely attributed to the government's fiscal tightening. The total amount of expenditure from the line ministries (MONRE, MARD, MOT, MPI, MOC, MOIT) accounts for 0.1% of the country's GDP [70].

The allocation of climate change expenditure implies a strong focus on adaptation activities. The largest share (92%) of the climate change response expenditure in the 2010-2012 period has been spent on MARD and MOT projects. Most of these projects are large irrigation and road transport projects. However, there is a growing amount of financing directed towards mitigation. The share of the recurrent budget for mitigation activities increased from 2% in 2010–2012 to 3.9% in 2013, mainly due to increases in spending through the NTP-EE. There is only a small proportion of climate change response expenditure that has been allocated to scientific, technological, and societal capacity (9%) and policy and governance [70].

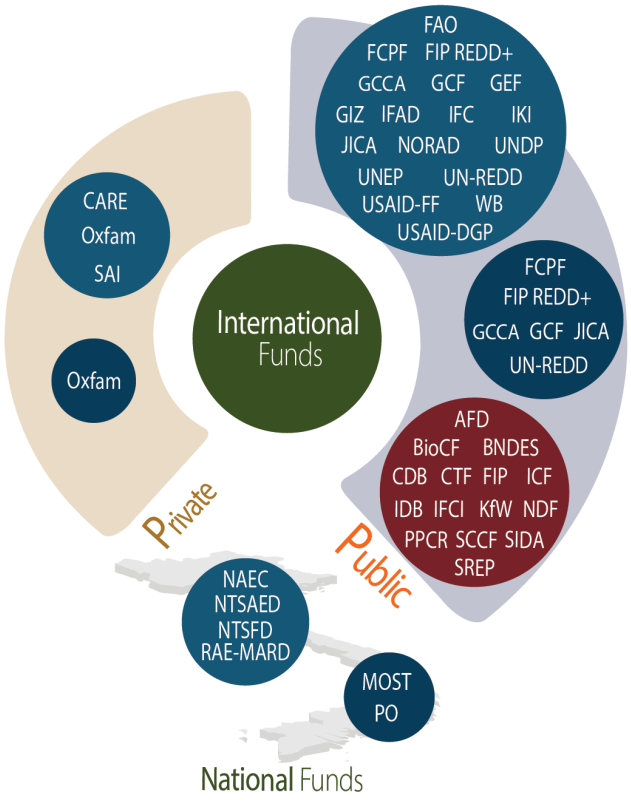
Climate funding collected from the State budget and international support has been distributed through the SP-RCC. The program assists the implementation of the NTP-RCC and enables the coordination of policy development and dialogue between the government and development partners. To be selected for SP-RCC funding, a climate change project must meet the priority criteria listed in Decision 1719/QD-TTg. Fund allocation involves various ministries; coordination and evaluation of project submission is led by MONRE, which submits the shortlist to MPI; which in turn submits proposed budget allocation to MOF, which finally passes along the funds to the local budget.

The basic source of domestic finance is the State budget. As climate change impacts cut across various sectors including energy, transport, industry, and agriculture, it is difficult to classify adaptation and mitigation activities in these sectors as separate budget lines in the State budget.

Potential Finance

While private sector engagement in climate action is still limited in Viet Nam, the Clean Development Mechanism (CDM) projects and Public-Private Partnerships (PPP) show potential for development. As of 2015, Viet Nam implemented 254 CDM projects and is ranked 4th internationally for the number of projects. This suggests clear potential for the development of financial mechanisms in this direction, providing the right kind of incentives and conditions, especially as Viet Nam is considering establishing a carbon market. Possible mechanisms are: an eco-tax on fossil fuel consumption, establishing an emissions trading system, or creating other tax incentives. There are also plans to establish an independent PPP unit in Viet Nam to address gaps in infrastructure financing. However, earlier efforts of ADB and Agence Francaise de Developement (AFD) to support PPP show interest in the fields of power, transport, and water rather than agriculture. The graphic below highlights existing and potential financing opportunities for CSA in Viet Nam. The methodology and a more detailed list of funds can be found in Annex 6.

Financing opportunities for CSA in Viet Nam



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

AFD French Development Agency **BioCF** Bio Carbon Fund of the World Bank **BNDES** Brazilian Development Bank **CARE** Cooperative for Assistance and Relief Everywhere **CDB** China Development Bank **CTF** Clean Technology Fund **FAO** Food and Agriculture Organization of the United Nations **FCPF** Forest Carbon Partnership Facility **FIP** Forest Investment Programme **FIP REDD+** Forest Investment Programme **GCCA** Global Climate Change Alliance **GCF** Green Climate Fund **GEF** Global Environment Facility **GIZ** German Society for International Cooperation **ICF** United Kingdom International Climate Fund **IDB** Inter-American Development Bank **IFAD** International Fund for Agricultural Development **IFC** International Finance Corporation **IFCI** Australia's International Forest Carbon Initiative **IKI** International Climate Initiative **JICA** Japan International Cooperation Agency **KfW** German Development Bank International Climate Initiative **MOST** Ministry of Science and Technology **NAEC** National Agricultural Extension Center **NDF** Nordic Development Fund **NORAD** Norwegian Agency for Development and Cooperation **NTSAED** National target on Sustainable Aquaculture Economic Development **NTSFD** National target on Sustainable Forestry Development **PO** Private Organisation (Honda, Sygenta, Loc Troi, Vinamilk) **PPCR** Pilot Program for Climate Resilience **RAE-MARD** National target on Restructuring Agricultural Economics, Disaster Risk Reduction, Stablize Living Conditions **SAI** Sustainable Agriculture Initiative Platform **SCCF** Special Climate Change Fund **SIDA** Swedish International Development Cooperation Agency **SREP** Scaling Up Renewable Energy in Low Income Countries Program **UNDP** United Nations Development Programme **UNEP** United Nations Environmental Programme **UN-REDD** United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation **USAID-FF** United States Agency for International Development – Feed the Future **USAID-DGP** United States Agency for International Development – Development Grants Program **WB** The World Bank Group

Outlook

Viet Nam has made great advances in terms of poverty reduction and food security status. However, it is also among the most vulnerable countries in the world due to the impacts of climate change, environmental degradation, a growing population, rapid urbanization, and shifting dietary patterns that require targeted action to maintain the positive outlook of recent years.

Much has been achieved in terms of policy response to climate change. However, implementation of these policies remains a challenge, and efficient solutions for identifying and overcoming many barriers have yet to be found. While adaptation and mitigation targets exist for the country, the agricultural sector strategy makes no explicit reference to CSA. Yet, defining a CSA strategy following a landscape approach would ensure consistency within the agricultural sector and across the region. These efforts would be aided if the government dedicated a percentage share of its financial budget line explicitly for climate change policy and implementation. Linking up with the ongoing out-scaling work of the CCAFS-funded CSV projects in northern, central and southern Vietnam at provincial scale will better help the government develop a good and suitable national CSA-strategy across the country.

Further efforts in reaching mitigation and adaptation targets would require the government to remove barriers in land policy (e.g. land consolidation or accumulation and land-use changes) and input uses (e.g. water pricing). Establishing market-based management mechanisms such as building a carbon market could be important drivers of moving CC policy implementation forward in Viet Nam.

Apart from the policy level, the private sector plays an important role in scaling-out CSA. Currently, much of the potential of private sector engagement for CSA remains untapped. Increased investments in innovative technologies for agriculture (such as for data collection, processing, and dissemination of information) will also enhance the institutional capacity for monitoring, reporting and verification.

Overall, it becomes evident that for successful out-scaling of CSA, integration is needed among the activities of all relevant stakeholders in the country.

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For further information and online versions of the Annexes

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

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