Climate-Smart Agriculture in Sri Lanka

Supplementary Material

This publication is a product of the collaborative effort between the International Center or Tropical Agriculture (CIAT) – lead Center of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) – and the World Bank to identify country-specific baselines on CSA in Africa (Kenya and Rwanda), Asia (Sri Lanka), and Latin America and the Caribbean (Nicaragua and Uruguay).

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ANNEX I: Acronyms

CIAT	International Center for Tropical Agriculture
CRS	Catholic Relief Services
CSA	Climate Smart Agriculture
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank

ANNEX II: Agro-ecological map of Sri Lanka

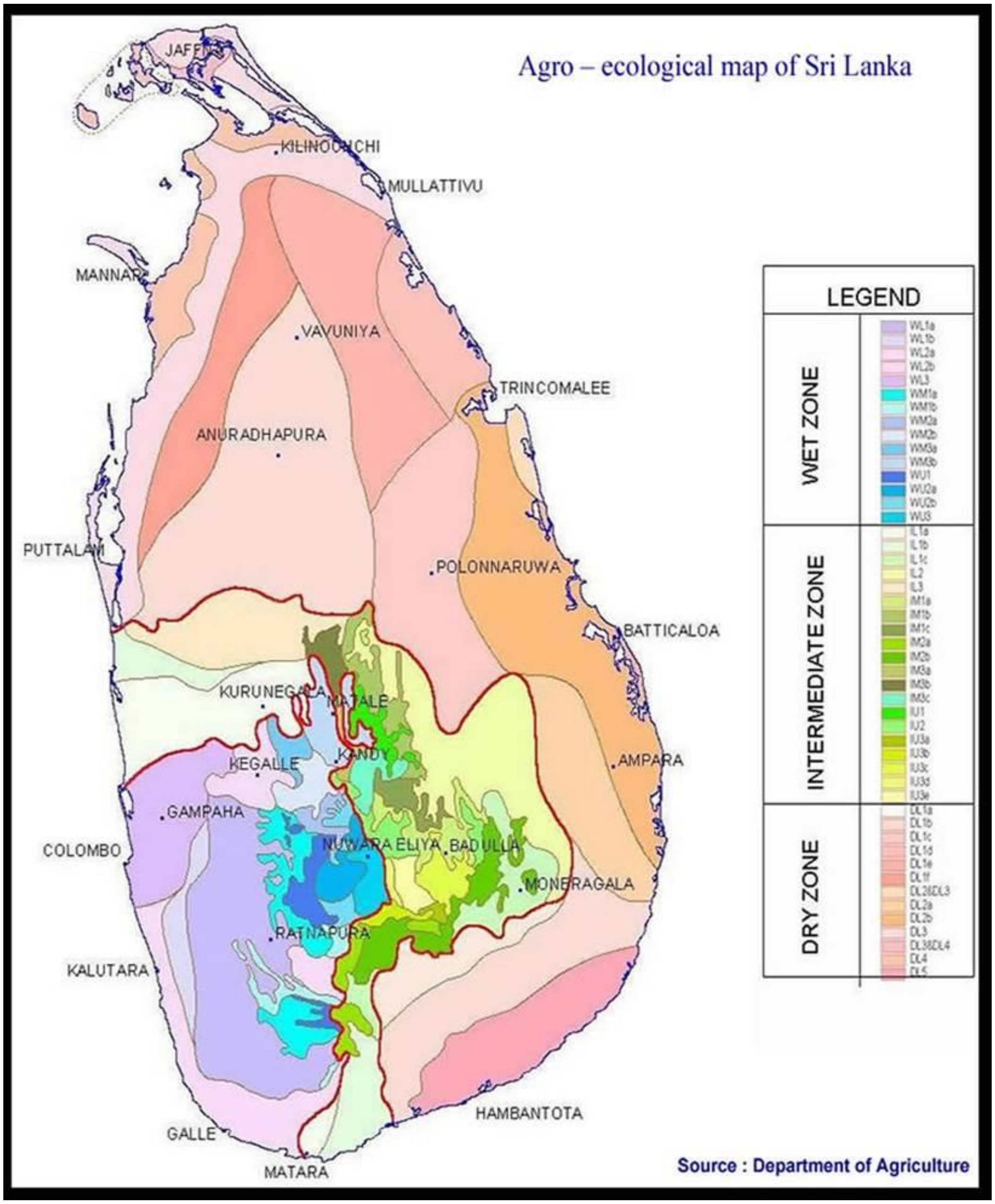

Figure 1: Agroecological zones in Sri Lanka. Source: *Department of Agriculture (DA)*

ANNEX III: Land-use map of Sri Lanka

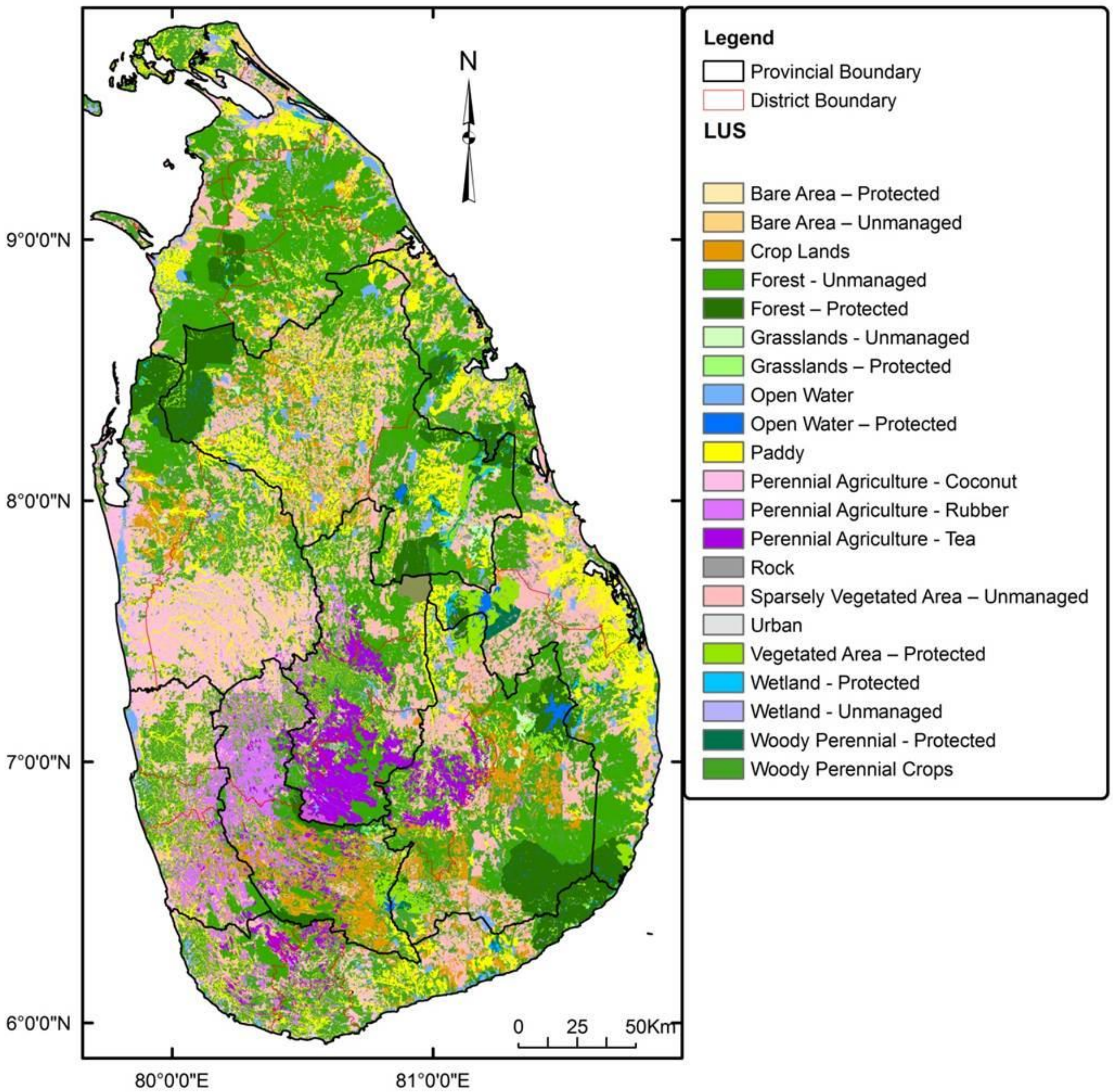

Figure 2: Land use in Sri Lanka. Source: *Department of Agriculture (DA)*

ANNEX IV: Selection of important production systems in Sri Lanka

Identifying the main production systems key for food security in the country requires an understanding of the complex interaction between social, economic and environmental factors at national and subnational levels, apart from the spatial and agro-ecological heterogeneity that can be found regionally. This means that the importance of a production system varies both within a country and between countries. In order to account for this variability, the study departed from a methodology developed by CIAT (2014) to identify and prioritize productions systems key for food security in a given country, based on a set of indicators such as: harvested area, variation in production, net production value (NPV), contribution to agricultural gross domestic product (AgGDP), contribution to national gross domestic product (GDP), and calories intake. These indicators help establish the relevance of the production system for the country's economy and food security. Below we discuss more in detail these sub-indicators.

Harvested area (ha): indicates the total cultivated area for the production system. For livestock systems look at pastures. The indicator is calculated as a five-year average and provides information on which production system is the most prevalent per area and can be interpreted as harvested or simple crop area. Knowledge of harvested area also constitutes an indirect source of information regarding land use for agriculture.

Variation in production: this indicator was added to the CIAT (2014) methodology, in order to offer more insights on how the production has varied in the past five years, and the implications this may have on the evaluation of the production systems' relevance for national economy and food security. The variation in production for each production system was calculated as follows:

(Variation in production) = (Standard deviation) / Average for 5 years in production)

Contribution to the agricultural GDP (%) illustrates the importance of the production system in the agricultural sector in each country, and becomes a benchmarking parameter that allows it to be compared against other production systems. To calculate the economic contribution of each production system we used the five-year averages (2005-2009; or the most recent years for which data was available for all the indicators) of the *g ross production value (GPV)* (constant 2004-2006 USD), the total gross national agricultural output (agricultural GDP) and gross national GDP (National GDP) data for each country. The contribution of each crop to Agricultural GDP (%) was calculated as follows:

*(Contribution to Ag. GDP) = (gross production value of crop) / (total gross national Ag. GDP) * 100*

Contribution to national GDP (%) allows for a benchmark comparison with the rest of the sectors of the national economy. For this indicator, we took into account the five-year average (most recent years). The contribution of each production system to national GDP was calculated as follows:

*(Contribution to national GDP) = (gross production value of crop) / (total gross national GDP) * 100*

Net production value (USD 2004–2006 USD constant) reflects the importance of each production system in currency value to the economies of the region. For this indicator, we took into account the five-year average (most recent years). Using the following equation, it also becomes an indicator of the volume of production, which can be linked to food security for the case of crops that are considered staple foods or that account for a substantial fraction of the consumption of calories.

(Production in tons) = (Net value of production in US$) / (Unit price of tons in US$/ton)

Calorie intake (food supply) (kcal/capita/day) was chosen as the primary indicator of food security as it reflects which production systems are sustaining the population and reducing hunger (food supply). For this indicator, we took into account the five-year average (most recent years). Calorie intake is measured by the FAO at the country level, and is based on national food balance sheets (Headey and Ecker, 2012).

In order to then identify the production systems most important for national economy and food security, we then calculated the total score of the production system, based on the average value of each indicator mentioned above. These indicators were weighted, assigning for each a percentage (17%). The production system with the highest score indicated highest importance. Formula:

*Total score = (NPV * 0.017) + (Contribution to AgGDP * 0.017) + (Contribution to GDP * 0.017) + (Calorie intake* 0.017) + (Harvested area * 0.017) + (Variation in production * 0.017)*

Since monocultures may present high values in the indicators and skew the results, each indicator was weighted in order to ensure the meaning was not lost. It is important to note that the contribution of a production system to food supply and livelihoods may not be reflected in the specific crop's regional economic contribution to agricultural production. The following table (Table 1) is an illustration of the selection of the production systems in Sri Lanka.

Table 1: Indicators for selecting production systems key for food security in Sri Lanka

Year	**NPV** (Constant 2004-2006 USD)	**GPV** (Constant 2004-2006 USD)	**Total gross National Ag GDP**	**Contribution to Ag GDP** (%)	**Total Gross National GDP**	**Contribution to national GDP** (%)	**Food supply** (Kcal/ capita/ day)	**Harvested area** (ha)	**Production** (t)	**Coefficient of variation**	**Total score**
Rice (paddy)											
2013	1,262,198,830	1,287,612,620	7,255,657,656	0.18	67,182,015,336	0.02	1062	1188230	4620730	*0.09*	18,790,172
2012	1,046,242,900	1,071,712,430	6,533,236,207	0.16	59,393,056,426	0.02	1048	989950	3845950		
2011	1,055,589,160	1,085,350,050	7,160,539,685	0.15	59,178,013,928	0.02	1052	1091050	3894890		
2010	1,167,772,100	1,198,410,770	6,344,642,774	0.19	49,567,521,670	0.02	1082	1060360	4300620		
2009	989,440,850	1,017,574,360	5,342,632,774	0.19	42,067,974,595	0.02	1052	942410	3651670		
Average	*1,104,248,768*	*1,132,132,046*	*6,527,341,819*	*0.17*	*55477716391*	0.02	*1059.2*	*1054400*	*4062772*		
Coconut											
2013	277,869,950	277,869,950	7,255,657,656	0.04	67,182,015,336	0.00	1062	394840	2513000	*0.08*	4,124,769
2012	245,969,640	245,969,640	6,533,236,207	0.04	59,393,056,426	0.00	1048	417000	2224500		
2011	227,484,040	227,484,040	7,160,539,685	0.03	59,178,013,928	0.00	1052	394840	2057320		
2010	220,088,920	220,088,920	6,344,642,774	0.03	49,567,521,670	0.00	1082	394840	1990440		
2009	239,753,220	239,753,220	5,342,632,774	0.04	42,067,974,595	0.01	1052	394840	2168280		
Average	*242,233,154*	*242,233,154*	*6,527,341,819*	*0.04*	*55,477,716,391*	*0.00*	*1059*	*399272*	*2190708*		
Tea											
2013	361,826,780	361,826,780	7,255,657,656	0.05	67,182,015,336	0.01	1.00	221969	340230	*0.05*	5,858,259
2012	350,947,410	350,947,410	6,533,236,207	0.05	59,393,056,426	0.01	1.00	221969	330000		
2011	348,288,720	348,288,720	7,160,539,685	0.05	59,178,013,928	0.01	1.00	221969	327500		
2010	352,436,280	352,436,280	6,344,642,774	0.06	49,567,521,670	0.01	2.00	221969	331400		
2009	308,408,330	308,408,330	5,342,632,774	0.06	42,067,974,595	0.01	1.00	221969	290000		
Average	*344,381,504*	*344,381,504*	*6,527,341,819*	*0.05*	*55,477,716,391*	*0.01*	*1.2*	*221969*	*323826*		
Maize											
2013	13818000	29613650	7,255,657,656	0.00	67,182,015,336	0.00	45	67720	209,040	*0.19*	181,787
2012	14305330	28637580	6,533,236,207	0.00	59,393,056,426	0.00	47	59130	202,150		
2011	6912830	19521010	7,160,539,685	0.00	59,178,013,928	0.00	23	50545	137,797		
2010	10338710	22905810	6,344,642,774	0.00	49,567,521,670	0.00	34	57620	161,690		
2009	7805740	18383870	5,342,632,774	0.00	42,067,974,595	0.00	34	50860	129,770		
Average	*10,636,122*	*23812384*	*6,527,341,819*	*0.00*	*55,477,716,391*	*0.00*	36.60	*57175*	*168,089*		

	NPV (Constant 2004-2006 USD)	**GPV** (Constant 2004-2006 USD)	**Total gross National Ag GDP**	**Contribution to Ag GDP** (%)	**Total Gross National GDP**	**Contribution to national GDP** (%)	**Food supply** (Kcal/ capita/ day)	**Harvested area** (ha)	**Production** (t)	**Coefficient of variation**	**Total score**
Cattle (milk, meat)											
2013	144727710	144727710	7,255,657,656	0.02	67,182,015,335.80	0.00	86.95	589500	415,274	*0.161337819*	2,173,397
2012	138797280	138797280	6,533,236,207	0.02	59,393,056,426.30	0.00	98.16	589500	370,107		
2011	114930500	114930500	7,160,539,685	0.02	59,178,013,927.80	0.00	100.46	589500	322,632		
2010	127552110	127552110	6,344,642,774	0.02	49,567,521,669.90	0.00	92.99	589500	286,254		
2009	110278690	110278690	5,342,632,774	0.02	42,067,974,595.40	0.00	80.53	589500	269,916		
Average	*127,257,258*	*127257258*	*6,527,341,819*	*0.02*	*55477716391*	*0.00*	*91.818*	*589500*	*332,836*		
Chicken											
2013	151029140	151029140	7,255,657,656	0.02	67,182,015,336	0.00	26	196500	144540	*0.15*	2,482,632
2012	146443490	146443490	6,533,236,207	0.02	59,393,056,426	0.00	21	196500	137390		
2011	145407410	145407410	7,160,539,685	0.02	59,178,013,928	0.00	21	196500	116760		
2010	145296910	145296910	6,344,642,774	0.02	49,567,521,670	0.00	21	196500	104160		
2009	141026350	141026350	5,342,632,774	0.03	42,067,974,595	0.00	21	196500	99280		
Average	*145,840,660*	*145840660*	*6,527,341,819*	*0.02*	*55,477,716,391*	*0.00*	*22*	*196500*	*120426*		
Vegetables											
2013	12,248,670	12,248,670	7,255,657,656	0.00	67,182,015,336	0.00	45	79405	910065	*0.09*	205,526
2012	12,342,890	12,342,890	6,533,236,207	0.00	59,393,056,426	0.00	41	81900	818840		
2011	11,871,780	11,871,780	7,160,539,685	0.00	59,178,013,928	0.00	40	78150	758690		
2010	11,721,030	11,721,030	6,344,642,774	0.00	49,567,521,670	0.00	39	75954	733400		
2009	11,871,780	11,871,780	5,342,632,774	0.00	42,067,974,595	0.00	39	77020	732240		
Average	*12,011,230*	*12,011,230*	*6,527,341,819*	*0.00*	*55,477,716,391*	*0.00*	*40.8*	*78485.8*	*790647*		

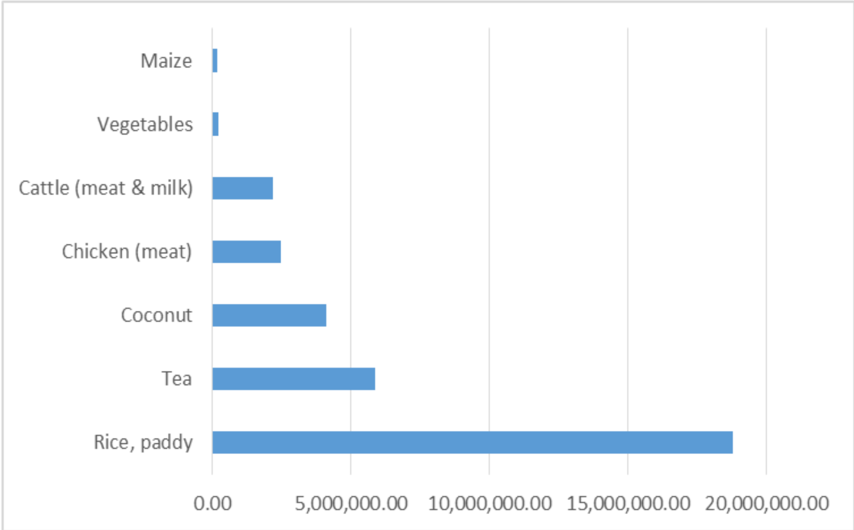

Figure 3: Production system ranking based on total score in Table 1. Source: compiled from FAOSTAT

ANNEX V: CSA Practices in Sri Lanka

For collecting data on CSA practices in the country (types of practices, levels of adoption, climate-smartness scores, etc.) we used several processes and methods described below.

Step 1: A first identification and initial listing of practices was carried out through a *literature review* and consultation of the CSA Compendium (CCAFS and ICRAF, forthcoming), and were determined based on the feasibility of implementing them in the important production systems of the country. The list of practices was then confirmed with criteria from in-country experts (mainly agronomists with experience in the selected production systems or agricultural regions of interest in the country).

Step 2: After a first validation of the list of CSA practices identified in the country (and related to the main production systems), experts were then asked to provide, via semi-structured interviews, surveys or focus group discussions, information on where, how, and to what extent the practice is adopted in the country and the production system it is associated with.

Step 3: Moreover, experts were also asked to give qualitative evaluations of different components of the 'climate smartness' concept for each of the identified practices.

For assessing climate-smartness levels of a practice we used categories of indicators (and sub-indicators) related to the management and use of *carbon*, *nitrogen*, *energy*, *weather*, *water* and *knowledge*, using a set of proxies for each to evaluate climate-smartness. We recognize that there are many possible angles to look at when assessing the smartness of a production system, and that this list of categories is not exhaustive. However, we considered them as important entry points for adaptation and mitigation of climate change in the agricultural sector, based on previous work undertaken by Aggarwal et al (2013) as part of CCAFS' initiative on "Climate-Smart Villages", a community approach to sustainable agricultural development. We argue that a combination of efficient use and management of water, energy, carbon and nitrogen, combined with efforts to reduce climate risks and to promote local knowledge and social capital when implementing the practice, increase the practice's likelihood to contribute to goals related to adaptation, mitigation and improved productivity.

In order to operationalize the analysis of the practice's performance in the six categories of interest, we asked experts specific questions that offer insights into the proxies used for carbon-, nitrogen-, energy-, weather-, water-, and knowledge- smartness. On a scale from 0 to 5, experts indicated the level of change that the implementation of each practice would bring about, based on knowledge and previous 5 experience with implementing the practice. It is important to note that these indicators and associated questions should not be taken as absolute metrics for assessment, but they should just guide the qualitative assessment of the practice and be adapted to the context of the analysis.

Table 2: Valuation of potential positive impact of CSA practices

Value	Potential impact
5	Very high positive change
4	High positive change
3	Moderate positive change
2	Low positive change
1	Very low positive change
0	No change; Not applicable; No data

The smartness level of a category is an average of the scores (0-5) obtained in each sub-indicator of the respective category. The climate-smartness dimensions and respective sub-indicators are outlined in the table below.

Table 3: Smartness dimensions and anticipated change

Smartness category	Anticipated change (sub-indicator)
1. Water smartness	1.1. Allows reduction in the volume of water consumption per unit of product (food) (l/kg/ha, l/ha etc.)
	1.2. Enhances water quality available for agricultural production (by reducing chemicals, sediments, metals in the water bodies)
	1.3. Enhances water and moisture retention in soils (mm/m, %)
	1.4. Promotes protection/ conservation of hydric sources (especially headwaters)
	1.5. Promotes water capture/ use of rainwater for agricultural production
2. Energy smartness	2.1. Allows for reduced consumption of fossil energy (reflected by savings in fossil fuel combustion, or electric energy consumption [J/kg, J/h, etc.])
	2.2. Promotes the use of renewable energy sources (e.g. wind and/or solar energy, biogas, etc.)
3. Carbon smartness	3.1. Increases above- and below-ground biomass (ton/ha; kg/m2 etc.), This is related to the mitigation pillar in terms of carbon dioxide (CO2) capture (plant biomass, wood etc.).
	3.2. Enhances the accumulation of organic matter in soils (soil carbon stock) (Soil Organic Carbon (SOC) or Soil Organic Matter [SOM]: %; kg/ha; g/m3; kg/m3). Refers to the mitigation pillar in terms of CO2 capture (increases in soil Carbon and indirectly improvement of biological and physical soils conditions that impact the greenhouse gas [GHG] emissions.)
	3.3. Reduces soil disturbance (reflected in number of hours of tractor labor, application of alternative soil management techniques, etc.). Refers to the mitigation

	pillar in terms of CO_2, reducing carbon emissions (mainly emissions associated with tillage process)
	3.4. Promotes techniques to better manage the quality of animal diet and/or manure in livestock systems (manure management and animal husbandry mitigation practices, etc.)
4. Nitrogen smartness	4.1. Reduces the need of synthetic nitrogen-based fertilizers (e.g. kg/ha/year)
	4.2. Reduces nitrous oxide (N_2O) emissions (by adopting better techniques of fertilizers use and soil management practices). Reflected in, for instance, reductions in number of grams of $N_2O/m^2/year$.
5. Weather smartness	5.1. Minimizes negative impacts of climate hazards (such as soil degradation, effects of flood or prolonged drought events among others).
	5.2. Helps prevent climatic risks (refers to practices that allow farmers be more prepared to mitigate climate risks, such as water reservoirs, early warning systems, heat/, water stress- pests- and diseases- tolerant/ resistant varieties, etc.)
6. Knowledge smartness	6.1. Allows rescuing or validates local knowledge or traditional techniques.

Step 4: Experts were then asked to provide qualitative evaluations of the impacts of each practice on the CSA pillars - adaptation, mitigation and productivity. This was complemented with information from a literature review.

Step 5: Then we identified high-interest practices, based on total climate-smartness score and adoption level of the practice, as following:

1. A detailed list of all practices identified in the country was compiled. The practices were ordered by value obtained in the climate-smartness assessment (highest values first);
2. The first quintile of the list, (the 20% highest values of the list) was identified. For instance, if the list includes 50 practices, identify the top 10 with highest smartness score.
3. Practices in the first quintile with low adoption level were then highlighted.
4. The high-interest practices will then be those practices with high smartness values and low adoption rates.

Step 6: From the literature review and expert consultations we also identified challenges and barriers to adoption and/or scaling out of the identified CSA practices, related to policies, institutions, finances, etc.

Step 7: We then studied the implementation of a CSA practice into more detail, by means of a case study.

Table 4: Detailed list of practices identified in Sri Lanka.

Production System associated with the practice	**CSA Practice** * indicates high-interest practice	**Geographical location**	**Farm scale**	**Adoption rate of the practice** (out of country's agricultural area) Orange: <30%; Yellow: 30-60%; Green: >60%	**Smartness levels** (by climate smartness dimension)						**Climate-smartness average**
					Water	**Energy**	**Carbon**	**Nitrogen**	**Weather**	**Knowledge**	
Cattle	**Rearing and conservation of indigenous cattle**	Northern province, Dry zone	Small		2	3	2	3	5	4.3	**3.2**
Cattle	**Providing shelters for animals**	Mostly wet and intermediate zones, and in farms with improved breeds in the dry zone	Small, medium and large		2	2	2	2	5	3.7	**2.6**
Cattle	**Silage preparation**	In farms with Improved breeds and their crosses	Large		1	3	3	3	5	4.0	**3.0**
Cattle	**Biogas production**	Scattered	Small, medium and large		0	5	3	3	5	3.7	**3.2**
Cattle	**Efficient feeding system (Total Mixed Ration - TMR)**	In farms with Improved breeds and their crosses	Small, medium and large		1	2	2	1	5	3.3	**2.4**
Cattle	**Rearing adaptive breeds/types (based on agro-climatic zones)**	Wet, dry and intermediate zones	Small, medium and large		3	3	1	1	5	5	**3**
Cattle	**Composting and biogas production**	Up country and mid Country	Medium and large		0	3	3	3	5	5.0	**3.1**
Cattle	**Fodder banks for intensive rearing system**	Scattered	Small, medium and large		0	3	3	2	4	4.0	**2.7**

Production System associated with the practice	CSA Practice * indicates high-interest practice	Geographical location	Farm scale		Smartness levels (by climate smartness dimension)						Climate-smartness average
					Water	Energy	Carbon	Nitrogen	Weather	Knowledge	
Chicken	**Rearing indigenous chicken in backyard with shelter only for nights**	Wet, dry and intermediate zones	Small and medium		1	3	2	2	5	4.7	**2.8**
Chicken	**Providing permanent shelters (intensive system)**	Wet, dry and intermediate zones	Small, medium and large		1	2	2	2	4	4.3	**2.5**
Chicken	**Rearing adaptive breeds (based on agro-climatic zones)**	Wet, dry and intermediate zones	Small, medium and large		3	3	1	1	5	5.0	**3.1**
Chicken	**Waste management (compost production)**	Intermediate zone (North Western Province)	Large		0	4	4	3	5	5.0	**3.4**
Coconut	**Micro-irrigation ***	Wet, dry and intermediate zones	Small and medium		5	2	3	4	5	3.0	**3.5**
Coconut	**Crop-livestock integration**	Intermediate zone	Small and medium		2	2	3	3	5	5.0	**3.2**
Coconut	**Intercropping with fruit crops**	Intermediate zone	Small and medium		1	1	3	2	5	3.7	**2.5**
Coconut	**Cover crops (live mulches)***	Intermediate zone	Small, medium and large		3	2	4	4	5	4.3	**3.7**
Homegardens	**Agroforestry (crops-livestock integration) ***	Dry and intermediate zones	Small		2	4	4	4	5	5.0	**3.9**
Homegardens	**Rearing backyard poultry**	Scattered	Small		3	3	2	2	5	5.0	**3.2**
Homegardens	**Mulching and thatching**	Scattered	Small		3	2	5	3	5	4.7	**3.7**
Homegardens	**Precise fertilizers application (timing)**	Scattered	Small		2	2	2	2	4	5	**3**
Homegardens	**Agroforestry**	Scattered	Small		4	3	5	5	5	5.0	**4.4**
Homegardens	**Livestock integration**	Scattered	No data	No data	1	4	3	3	5	5.0	**3.5**
Homegardens	**Crop diversification**	Scattered	Small		4	1	4	3	5	5.0	**3.6**
Homegardens	**Micro-irrigation ***	Scattered	Small		5	2	4	3	5	3.7	**3.7**

Production System associated with the practice	CSA Practice * indicates high-interest practice	Geographical location	Farm scale		**Smartness levels** (by climate smartness dimension)						Climate-smartness average
					Water	Energy	Carbon	Nitrogen	Weather	Knowledge	
Homegardens	**New crop varieties**	Scattered	Small		3	2	3	1	5	3.7	**2.9**
Homegardens	**Rainwater harvesting ***	Scattered	Small		5	3	4	0	5	4.0	**3.5**
Maize	**Planting with onset of rains**	Dry and intermediate zones	Small		3	3	1	2	5	5.0	**3.2**
Maize	**Use of high quality seeds**	Dry and intermediate zones	Small and medium		2	2	2	1	5	5.0	**2.8**
Maize	**Growing in selected agro-ecological regions with long rainy seasons**	Dry and intermediate zones	Small and medium		3	2	2	2	5	5.0	**3.0**
Rice	**High quality seeds**	Wet, dry and intermediate zones	Small		4.0	1.0	1.3	1.0	5.0	3.0	**2.5**
Rice	**Short-duration variety**	Dry and intermediate zones	Small		4	4	3	4	5	4	**4**
Rice	**Pest- and disease-resistant varieties**	Wet, dry and intermediate zones	Small		2.0	5.0	2.8	2.0	5.0	4.0	**3.5**
Rice	**Seasonal-adapted planting times ***	Wet, dry and intermediate zones	Small		5	4	3	4	5	5.0	**4.2**
Rice	**Use of traditional varieties ***	Dry and intermediate	Small		4	5	2	3	5	5.0	**3.9**
Rice	**Crop diversification ***	Dry and intermediate zones	Small		4	4	3	3	5	4.0	**3.9**
Rice	**Shared cultivation (Bethma)**	Dry and Intermediate zone	Small		4	2	1	2	5	5.0	**3.2**
Rice	**Changing crop establishment techniques ***	Dry and intermediate zones	Small		3	5	3	3	5	5.0	**4.0**
Rice	**Precise fertilizers application (timing)**	Wet, dry and intermediate zones	Small		2	2	2	3	5	4.7	**3.0**

Production System associated with the practice	CSA Practice * indicates high-interest practice	Geographical location	Farm scale		Smartness levels (by climate smartness dimension)						Climate-smartness average
					Water	Energy	Carbon	Nitrogen	Weather	Knowledge	
Tea	**Agroforestry systems with scattered trees for shade**	Wet, dry and intermediate zones	Small, medium and large		2	2	3	2	5	3.0	**2.7**
Tea	**Mulching and thatching**	Wet, dry and intermediate zones	Small, medium and large		3	2	3	3	5	3.7	**3.3**
Tea	**Drought-tolerant cultivars**	Uva and Southern Provinces	Small, medium and large		4	2	2	1	5	4.0	**3.0**
Tea	**Organic fertilizers**	Wet, dry and intermediate zones	No data		3	3	3	4	5	5.0	**3.6**
Tea	**Grafting of tea**	Uva Province	Small, medium and large		4	2	1	1	4	2.0	**2.4**
Tea	**Rainwater harvesting (deep lock and spills)**	Wet, dry and intermediate zones	Small, medium and large		4	3	1	0	5	4.3	**2.7**
Vegetables	**Micro-irrigation ***	Wet, dry and intermediate zones	Small and medium		5	2	4	3	5	3.7	**3.7**
Vegetables	**Controlled environment agriculture/ rain shelters**	Wet, dry and intermediate zones	Small and medium		4	1	3	3	5	3.7	**3.1**
Vegetables	**Use of high quality seeds**	Wet, dry and intermediate zones	Small, medium and large		2	2	1	2	5	4.3	**2.7**
Vegetables	**Mixed cropping system**	Wet and Intermediate zones	Small and medium		2	2	2	3	5	5.0	**3.1**

Identified benefits of selected CSA practices:

Animal production:

- *Breeding for adaptability of different AERs* can help enhance the productivity of the systems.
- *The sustainable utilization of indigenous animals* specifically identified in the animal breeding guidelines of the Ministry of Livestock and Rural Community Development (2010) can increase productivity, due to their resistance and or tolerance to a wide range of environmental conditions (e.g. CPRS poultry breed developed for local climatic conditions and feeding regimes), resistance to diseases, and their multipurpose character (e.g. Kottukachchiya goat breed [23] developed as a dual purpose breed suitable for DZ of Sri Lanka).
- *Introducing high yielding exotic breeds, and crossbreeds* can help achieve country's goal to reach 50 % self-sufficiency in milk production by 2015 [23] under a variable climate. Lack of pasture development strategies for improving feed under climate change is a major challenge. Selection of animals should be done with attention for their suitability to different AERs.

Coconut:

- *Grow drought resistant varieties* (e.g. Tall x Tall and Tall x San Ramon crosses) to meet the challenges of climate change in drought-prone areas. Non-availability of adequate quantity of planting materials may be a challenge.
- *Grow varieties tolerant to water stress*: (e.g. Dwarf Brown variety) to help solve challenges related to water. Non-availability of adequate quantity of planting materials may be a challenge. *The use of Gliricidia as an energy source for coconut mills* can also be taken as fuel wood in the agro-based energy sector, mitigate the impacts of fossil fuels, and meet the overall energy security for the country.

Homegardens:

- Changing planting date: to suit the rainfall pattern. Need proper climate forecasts.
- Changing agronomic practices: to suit the rainfall regimes and the type of crops (e.g. incorporation of tree crops - Agroforestry)
- Changing technology: e.g. use of new varieties and irrigation equipment to enhance productivity and irrigation water use efficiency. The capital cost may be more.
- Use of rain water harvesting techniques: to make maximum use of rainwater during drought conditions
- Incorporation of livestock: enhance land productivity and income, and serves as an insurance under variable or drastic climates. Capital cost may be high. Need more labour.

- Use of soil and water conservation measures: to increase the use of residual moisture and avoid soil erosion under water limited and extreme rainfall situations, respectively.

Maize, vegetables and other food crops:

- *The use of hybrid varieties* can help increase yields under different climates. The cost of seeds is a challenge.
- *The use of mulches* can help conserve soil moisture.
- *Constructing ditches and contour planting* can help minimize surface runoff under intensive rainy conditions and improve water retention capacity of soil.
- *Growing less water-demanding crops*, such as mung bean (green gram), finger millet and sesame, can help increase productivity under low moisture stress conditions.
- *Using short-age crops for inter-seasons cultivation*, such as mung bean, with appropriate agronomic management practices can facilitate the utilization of residual soil moisture
- *Adjusting the cropping calendar* according to changes in the rainfall pattern can enhance productivity and income.

Rice:

- *Aligning planting and farming practices with the recognized pattern of rainfall*: carrying out planting/farming with the onset of rainfall to make the maximum use of rainwater and efficient management of rainwater harvested in the village tanks. Absence of a seasonal climate forecast is an issue.
- *Use of short duration rice varieties*: suitable for short and low rainfall seasons (especially the *Yala* cultivating season; March-August). An ultra-short duration variety (Bg250: maturing in 75-80 days) have also being developed to evade the impact of drought. Non-availability of adequate quantities of seed paddy is a limitation
- *Crop establishment techniques:* Grow rice under aerobic conditions (D sowing) to minimize the water use [20]. *Kekulama* or *Manawari* system and *Nava Kekulama* (D sowing systems) [21] and System of Rice Intensification (SRI) [22] to minimize water use and to conserve soil moisture: Need more labour for operations. Lack of appropriate aerobic rice varies is an issue. Weed competition and weed control is a major challenge
- *Zero tillage in the DZ and IZ (this practice in most cases is coupled with crop establishment technique):* to reduce cost of production and enhance water conservation without significantly affecting the yield. Weed competition and weed control may be a major issue
- *Cultivation of traditional varieties*: e.g. traditional rice varieties such as '*Hata da vee*' survives long D spells in the DZ and IZ of the country; the yield may be low.
- *Informed choices in species selection*: combining local knowledge in species and varieties to fit into AERs
- *Use of salt-tolerant varieties*: e.g. At354 - three and half month age class for saline soils. Non-availability of adequate quantum of seed paddy may an issue

- *Agronomic measures such as improved field drainage, application of organic manure, rice straw and burnt paddy husk, and transplanting instead of direct seeding*: to overcome salinity.
- *Shared cultivation* (*Bethma* System): sharing paddy land closer to water outlets when water is limited. Decision-making should be done with the Farmer Organizations to avoid conflicts.

Tea:

- *Identification of high productive areas for expansion*: Nuwera Eliya, Ratnapura, Deniyaya and Kalawana are the most suitable areas with favorable climate for growing and expanding tea
- *Use of hardy or drought-tolerant cultivars*: (e.g. clones DN, DG 7, DG 39, TRI 2025, TRI 4042, TRI 4052, S 106, CY 9, KP 204, CH 13 and KEN 16/3) to avert the impact of drought together with high temperature. Non-availability of the planting materials may be a challenge.
- *Use of biclonal and polyclonal seed stocks* can help tackle variable climates. Non-availability of planting materials may be a challenge.
- *Use grafted tea combinations* for drought tolerance: e.g. clones TRI 4054/DG 7, TRI 4053/DG 39. Non-availability of planting materials may be a challenge.
- *Growing shade trees* can help reduce the impact of heat stress and has a major contribution to carbon sequestration particularly in low-grown tea.
- *Rainwater harvesting,* by constructing ponds and lakes, enhances the collection and efficient utilization of rainwater. It requires more labor for construction.
- *Establishment of green manure crops, mulching, contour planting, establishment of cover crops, proper bush management and Infilling* are CSA practices that can effectively conserve soil moisture.
- *Application of Kaolin* can help reduce transpiration losses and leaf surface heat to avoid drought stress.