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Best Practices Report

Applied Water Resources Management in the Lake Chad Basin, Transboundary Water Management:

Climate change adaptation and resource conservation in the Waza-Logone wetlands.

Chad

Table of contents **Page**

List of tables

List of figures

Abbreviations and acronyms

AfDB/BAD	African Development Bank/*Banque Africaine de Développement*
ANADER	National Support Agency for Rural Development (*Agence Nationale d'Appui au Développement Rural*), Tchad
BGR	Federal Institute for Geosciences and Natural Resources (*Bundesanstalt für Geowissenschaften und Rohstoffe*), Germany
CC	Climate Change
CCA/ACC	Climate Change Adaptation/*Adaptation au Changement Climatique*
CEMAC	Economic and Monetary Community of Central Africa (*Communauté Économique et Monétaire de l'Afrique Centrale*)
CIRAD	The French Agricultural Research Centre for International Development (*Centre de coopération internationale en recherche agronomique pour le développement*), France
FAO	Food and Agriculture Organisation of the United Nations
FFS	Farmer Field School
GIZ	German Federal Enterprise for International Cooperation (*Deutsche Gesellschaft für Internationale Zusammenarbeit*), Germany
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
IRAD	Agricultural Research Institute for Development (*Institut de Recherche Agricole pour le Développement*), Cameroon
ITRAD	Chadian institute of Agricultural Research for Development (*Institut Tchadien de Recherche Agronomique pour le Développement*), Chad
LCB	Lake Chad Basin
LCBC/CBLT	Lake Chad Basin Commission/Commission du Bassin du Lac Tchad
LIS	Lake Chad Information System
MINADER	Ministry of Agriculture and Rural Development (*Ministère de l'Agriculture et du Développement Rural*), Cameroon
NGO	Non-Governmental Organisation
ONDR	National Office for Rural Development (*Office Nationale du Développement Rural*), Chad
PD	Person-Day
PRASAC	Regional Centre for Applied Research for the Development of Agricultural Systems in Central Africa (*Pôle régional de Recherche Appliquée au Développement des Systèmes agricoles d'Afrique Centrale*), CEMAC
PRODEBALT	Lake Chad Basin Sustainable Development Programme (*Programme de Développement Durable du Bassin du Lac Tchad*), LCBC
RNT	Chadian National Radio (*Radiodiffusion Nationale Tchadienne*)
RTN	Radio Terre Nouvelle
USAID	United States Agency for International Development, USA

1 Introduction

This report is a result of the work on the component “Adaptation to Climate Change (ACC) through agriculture” within the scope of the GIZ/BGR programme “Sustainable Water Management in The Lake Chad Basin” in collaboration with the Lake Chad Basin Commission (LCBC). The aforementioned component will henceforth be referred to as “the project”. The Project was initially implemented from 09/2013 to 05/2018. Specific project activities were extended until 06/2019 through integration into the programme “Organisational Advisory Services for the Lake Chad Basin Commission”.

The report provides an overview of the agricultural climate change adaptation measures implemented during this period, as well as a summary of the best practices with respect to the selection, implementation, and upscaling of these measures.

1.1 Project context and the need for adaptation

1.1.1 The need for adaptation

In the Lake Chad Basin, increasing climate variability and long-term climate are manifested in rising temperatures and increasingly erratic rainfall. The rainy season is getting shorter and more irregular. This has serious repercussions for the main agricultural production systems in the basin on which most people depend for their livelihoods. The most important impacts are:

- Decreased crop yields and arable farmland, which are largely dependent on the rainy season.
- Increased food insecurity for both humans and livestock.
- Increased farmer-herder conflicts because of increasing scarcity of natural resources and land.

Consequently, the vulnerability of farmers and herders to climate variability and change is rising!

1.1.2 Adaptation hypothesis

The adaptation measures presented in this report, were selected, and implemented based on the following adaptation hypothesis:

“Carrying out adaptation measures contributes to increasing the resilience of communities to deal with climate change. Testing, evaluating and demonstrating the results of these projects enrich the overall adaptation knowledge which leads to replication at a larger scale.”

1.2 Project objectives and indicators

The objective for the activities of the ACC-component was formulated as follows:

"In the transboundary area of the project, beneficiaries have improved their capacities and have more effective adaptation techniques to climate change at their disposal".

The indicators of the project were formulated as follows:

1. **Adaptation measures to climate change are tested and the results are documented for four production systems / sectors (with at least one system dominated by women).**
2. **60% of participants in pilot activities apply two adaptation measures adopted by the project.**
3. **300 people (farmers, technicians, extension workers, etc.) have participated in cross-border exchanges.**

1.3 Methodology

1.3.1 Core processes

At a project, level three core processes were implemented to achieve the project objectives and indicators:

1. **Preparation of a study on climate change and an inventory of the production systems in the Lake Chad Basin.**
2. **Selection and implementation of adaptation measures to climate change for the main production systems in the pilot zone.**
3. **Dissemination of adaptation experiences and networking of stakeholders.**

The sequence of the core process and their main activities are shown in Figure 1.

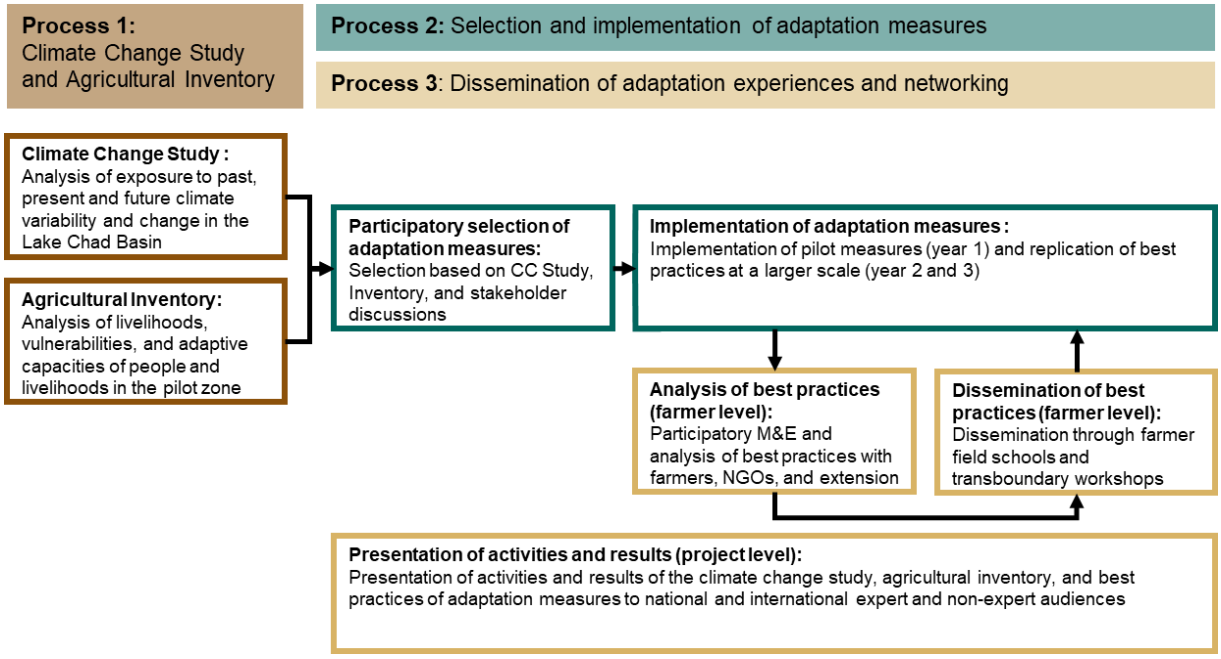

Figure 1: Sequence and main activities of core processes

Process 1: Preparation of a study on CC and an inventory of the production systems used in the Lake Chad Basin

Climate Change Study

A climate change study was developed for the entire Lake Chad Basin. It analyses past climate variability and change in the period 1900-2013, predicted climate variability and change in the period 2000-2013, and the impacts of climate variability and change on relevant natural resources.

For more information on the climate study, please see chapter 2.1 of this report and the report of the study (GIZ, 2015).

Agricultural Inventory

The inventory, which also provided the baseline data for the project, analysed the following (agricultural) production systems: rainfed farming, flood recession farming, off-season farming (market gardening and irrigated agriculture), fisheries, and livestock production. The field work, primary and secondary data collection and analysis of the study was done in collaboration with three NGOs from Chad and three NGOs from Cameroon. Each NGO carried out their work in the parts of the study zone that they were already active in. The study zone covered around 858 villages and an area of around 40,000 km² (see Figure 2).

The inventory provided information on the sensitivity, impacts, adaptive capacities, and vulnerability of agricultural production systems and people's livelihoods to climate variability and change.

For more information on the inventory, please see chapter 2.2 of this report and the report of the inventory (GIZ, 2017).

Process 2: Selection, development implementation of adaptation measures to climate change for the main production systems in the pilot area

Selection and planning of adaptation measures

The adaptation measures were selected based on results of the climate study and the agricultural inventory, as well as a series of workshops and exchanges with LCBC experts, Chadian and Cameroonian extension services and NGOs (see chapter 2.3.1). A longlist of potential adaptation measures and selection criteria was developed in 2014. During further discussions and workshops and with LCBC experts, a final shortlist of selection criteria was developed in early 2015 (see chapter 2.3.2).

Sites for the implementation of the measures were chosen to be representative for their particular agro-ecological conditions (see chapter 2.3.3). Pilot famers at the pilot sites were identified from the respondents of the agricultural inventory (see chapter 2.3.4).

Finally, the last step in the development of the adaptation measures, adaptation hypotheses were defined for each of the planned adaptation measures. The adaptation hypotheses described the main characteristics of the adaptation measure and the measures' contribution to adaptation (see chapter 2.3.5).

The adaptation measures were implemented by the participating farmers and agro-pastoralists supported by local NGOs and regional extension services. The implementation was supervised and guided by GIZ and its international consultant and the LCBC (chapter 2.3.6)

Implementation of adaptation measures

The adaptation measures were implemented in close collaboration with local NGOs and the regional extension services responsible for the regions in which the measures were implemented. Adaptation measures were implemented in the following four production systems:

- Rainfed agriculture (see chapter 2.4)
- Recession agriculture (see chapter 2.5)
- Livestock (see chapter 2.6)
- Market gardening (not part of this report as measure was only tested in one year)

An overview of the sites at which sites the measures were implemented is presented in Table 1. A map of the pilot zone, indicating where the measures were implemented, is presented in Figure 3.

Table 1: Overview of sites at which adaptation measures were implemented

NGO	**Region**	**Department**	**Municipality**	**Production system**	**Year**		
					2015	2016	2018
ESPOIR	Chari-Baguirmi	Baguirmi	Dourbali	rainfed		x	x
				recession	x	x	x
				livestock		x	x
			Mai Ache	rainfed		x	x
				recession	x	x	
				livestock		x	x
		Chari	Linia	rainfed		x	x
				recession	x	x	x
				livestock			x
APR			Mandelia	rainfed	x		
				recession	x	x	x
	Mayo-Kebbi Est	Mayo-Boneye	Moulkou	rainfed	x	x	
		Mayo-Lémié	Guelendeng	rainfed	x	x	
Sana Logone	Extrême-Nord	Mayo-Danay	Yagoua	rainfed	x	x	

Process 3: Dissemination of adaptation experiences and networking of stakeholders

Information about climate change in general, climate change impacts in the Lake Chad Basin, and best practices of agricultural climate change adaptation were disseminated to different audiences. The objectives, target groups, and contents of the dissemination activities varied (see chapter 2.7.1).

Analysis and dissemination of best practices (farmer level)

At farmer level, the best practices of adaptation were disseminated via the farmer field school (FFS) approach. As part of this approach, NGOs and extension services trained pilot farmers in the first year of implementation. In subsequent years, the pilot farmers went on to train student farmers thereby increasing the total number of farmers reached by the project (see chapter 2.7.2).

Furthermore, exchange workshops were organised by the project to provide farmers from Chad

and Cameroon with the opportunity to exchange their experiences and document best practices of adaptation (see chapter 2.7.3).

The support of the project beneficiaries eventually led to un-guided dissemination of best practices in the pilot zone (see chapter 2.7.7).

Presentation of activities and results (project level)

Apart from the exchange workshops organised for the participating farmers and agro-pastoralists, a number of workshops and meetings were organised to present the project results and plan the implementation of the project (see chapter 2.7.3).

Radio programs produced and broadcast by a regional radio station from Chad, Radio Terre Nouvelle (RTN), and the Chadian National Radio, helped to spread the knowledge about climate change, adaptation, best practices, and the project to a wider audience in the pilot zone (see chapter 2.7.4). With the same objective, a video was produced by the project (see chapter 2.7.5).

Information materials, i.e. fact sheets, posters, online content, and a photo exhibition were developed to document and disseminate information about the project and the best practices of adaptation to a wide array of target audiences (see chapter 2.7.6).

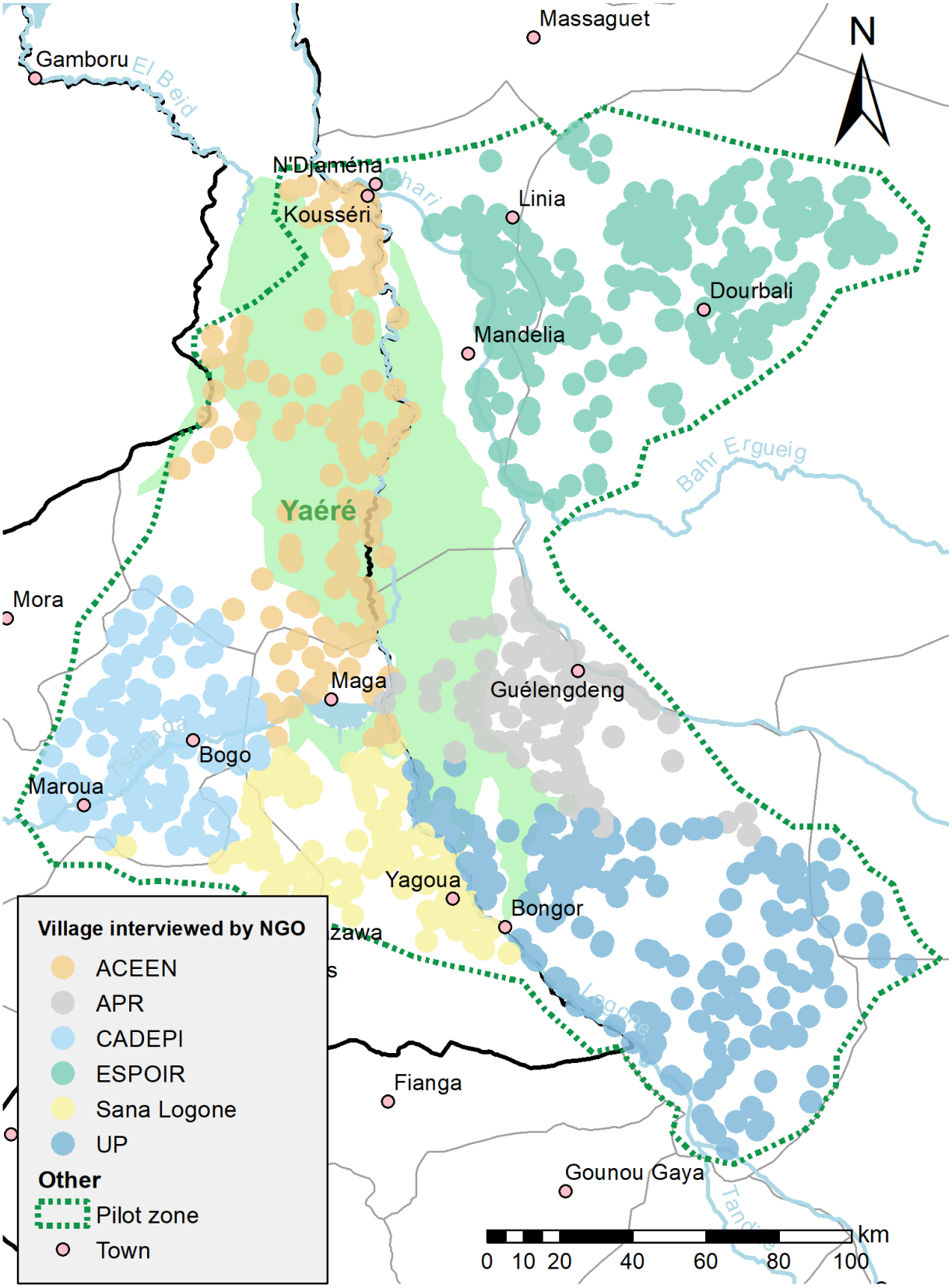

Figure 2: Map of pilot zone and location of interviewed villages and settlements by NGO

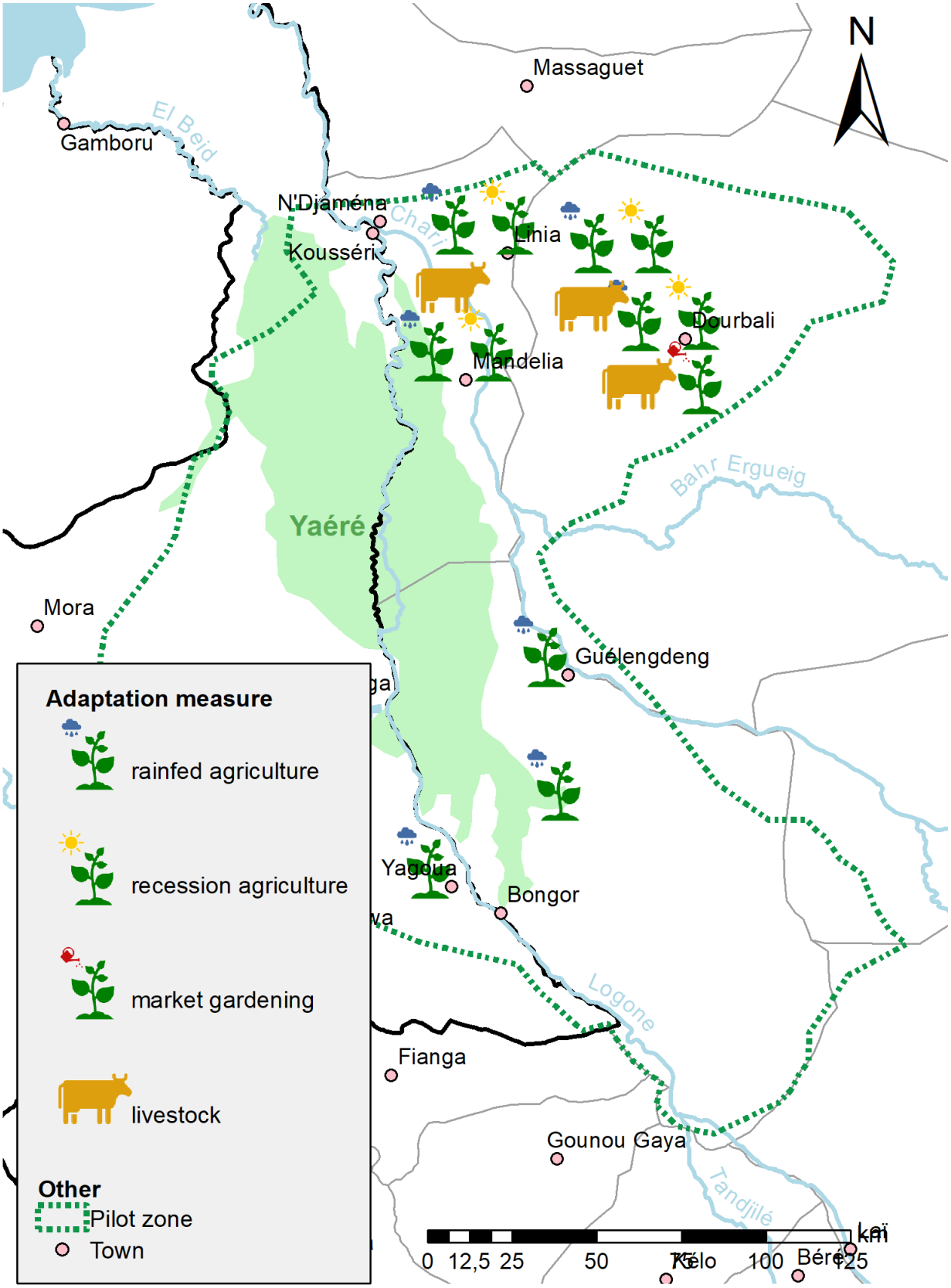

Figure 3: Map of implementation sites of adaptation measures

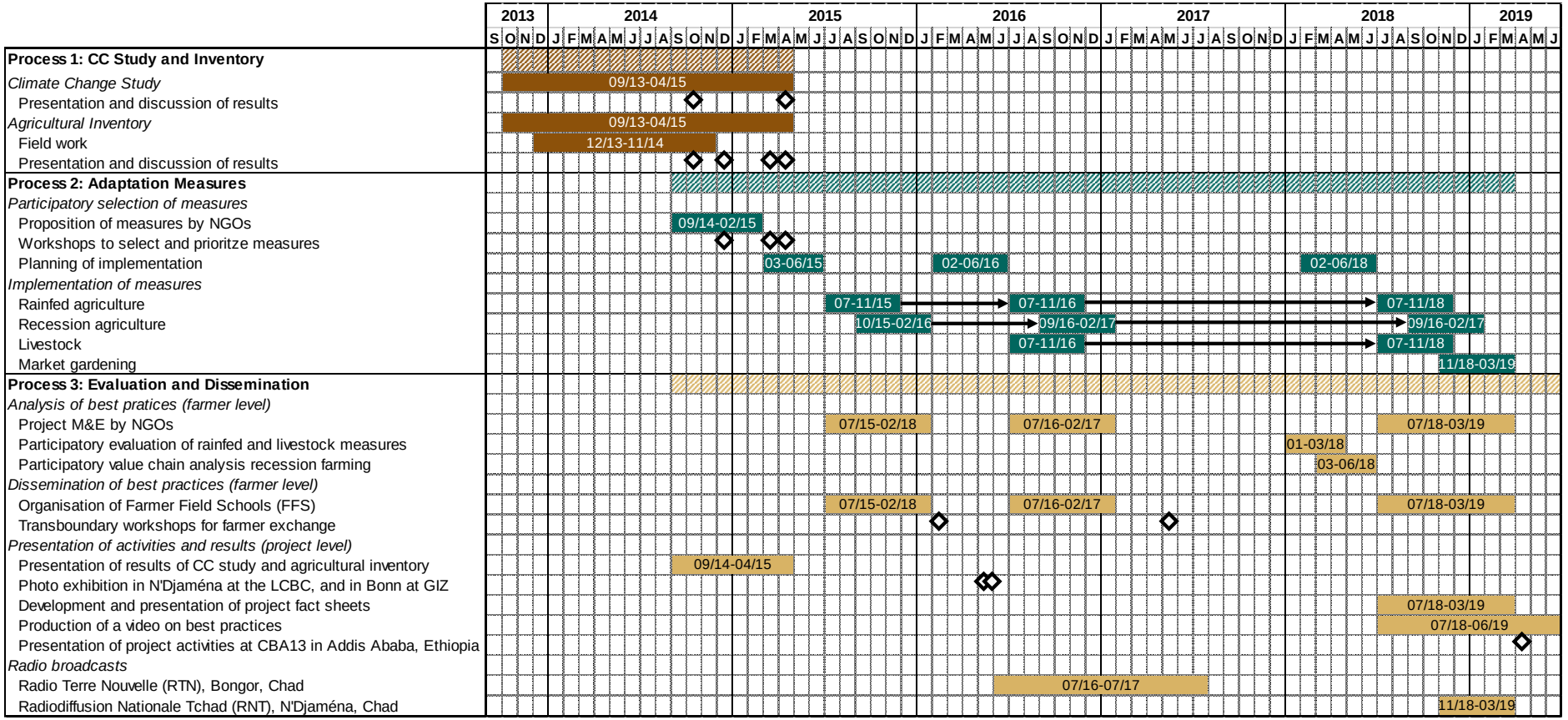

Figure 4: Calendar of implemented activities

1.4 Best practices – concept and definition

The selection criteria for the adaptation measures (see chapter 2.3.2) were the basis for the evaluation of best practices. These criteria are:

- **Relevance**: Measures that contribute to adaptation by building adaptive capacity and/or reducing vulnerability to climate variability and change.
- **Profitability**: Measures that increase yields and measures with little or no regret.
- **Scalability**: Measures that can be rapidly implemented in the field and that have a potential of being implemented on a larger scale (development of procedures for future dissemination of best practices).
- **Multiple benefits**: Focus on measures that improve multiple value chain aspects (production, storage, transformation, and marketing).

These criteria were considered in the formulation of the adaptation hypotheses. Best practices can be described as those activities that lead to achieving the objectives as described in the adaptation hypothesis.

2 Synthesis of project activities and achievements

2.1 Climate Change Study

To establish a scientific basis for the analysis of past, present and future climate variability and change in the Lake Chad Basin (LCB), a climate study was developed in 2013/14 (GIZ, 2015). The key results are presented below. For more details, please refer to the climate study.

2.1.1 Past climate variability and change (1900-2013):

Rainfall: The last century was marked by a strong variation of rainfall within and between years. It has seen decades with serious rainfall deficits and droughts (1900s, 1910s, 1970s, and 1980s) as well as decades with a stable rainfall surplus (1940s and 1950s). Rainfall levels show a recovery since the but have not gone back to the level of the mid-20th century.

Temperature: Between 1973 and 2013, temperatures in the LCB have increased significantly. Increases in average temperatures range from 1.4°C in the West, to 1.9°C in the East. At the same time, minimum temperatures in summer and winter increased by between 3°C and 4°C.

Impact: Past climate variability and change have led to a loss of available water resources with severe impacts for the lives and livelihoods of people in the LCB.

2.1.2 Predicted climate variability and change (2000-2099):

Rainfall: Climate models generally underestimate inter-annual rainfall variability. However, based on observations of actual climate data, according to the climate study, most studies agree that inter-annual variability is likely to increase rather than decrease in the future.

Temperature: Depending on the applied climate change scenario, temperatures in the LCB will increase by around 2°C (scenario B1), 3°C (scenario A1b), or even up to 4°C (scenario A2) by 2099.

Impact: For the livelihoods of people in LCB, the change in agricultural potential is expected to be the most important impact of climate change. The change in the average position of the 120-day line can be used as an indicator for the impact of climate change on agricultural potential. The 120-day-line is based on temperature, rainfall, and evapotranspiration. It indicates the boundary of regions in which crops with a growing period of 120 days can be grown. It determines whether a region is intensely farmed of marked by only scattered agricultural activity. Under the B1 and A2 scenarios, the average position of the 120-day-line will move southwards leading to a considerable loss of arable land in the central part of the LCB. It has been estimated that by 2099, between 70,960 km² (scenario B1) and 135,150 km² (scenario A2) of currently arable land could become unfit for arable farming (see Figure 5).

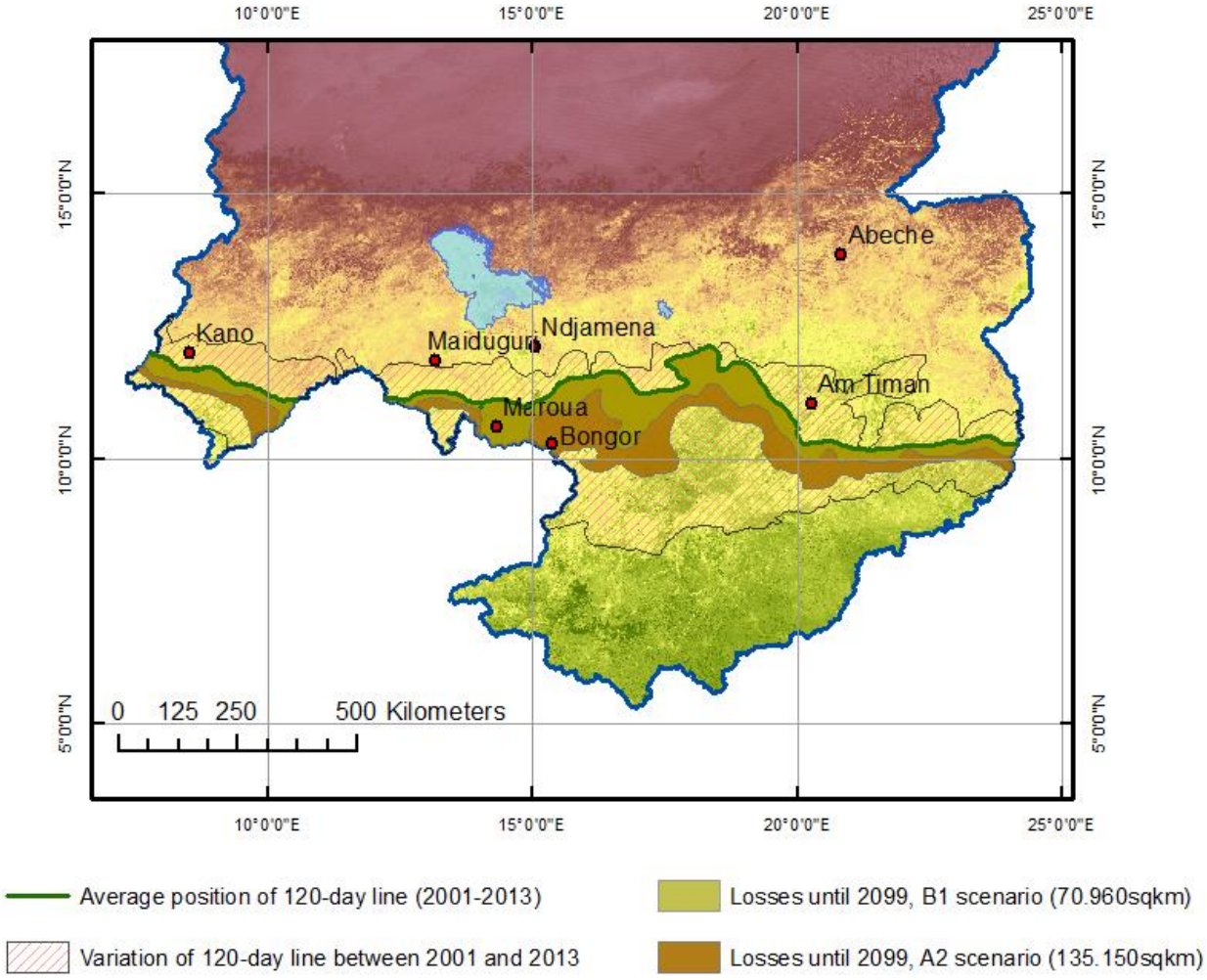

Figure 5: Retreat of the 120-day line under a B1 (green) and an A2 (brown) climate change scenarios

2.2 Agricultural inventory

An agricultural inventory, or baseline study, was carried out in 2014/15 to gain an overview of existing agricultural production systems in the transboundary pilot zone in the LCB (GIZ, 2017). The study served as a basis to plan, implement, monitor, and evaluate gender-sensitive climate change adaptation measures. The key results are presented below. For more details, please refer to the report of the agricultural inventory.

2.2.1 Main production systems

The most important agricultural production systems in the pilot zone area are: rainfed arable farming, recession agriculture, irrigated agriculture and market gardening, and livestock production in the form of nomadic, semi-nomadic and sedentary pastoralism, and fisheries. All five systems are described in the following paragraphs.

Figure 6 shows and indicative livelihood calendar for the main production systems in the pilot zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Season	dry season				rainy season							
Rainfed farming		land preparation										
					sowing							
											harvest	
Flood recession farming						preparation/sowing						
								transplanting				
	harvest											
Off-season farming	irrigated off-season farming											
Livestock migration/ pastoralism			Northern Nigeria									
				Chad, Cameroon, Niger								
Fisheries							Peak period along the Logone					
									Floodplains			
										Permanent ponds		

Figure 6: Indicative livelihood calendar in the study zone (compiled from expert interviews and FAO, 2004, 2017; IRD, 2000)¶

The **agricultural calendar** in the pilot zone follows rainfall availability but rainfall irregularities make it difficult for farmers to adhere to the calendar. Generally, the following pattern is followed:

- **Rainfed crops** are grown during the rainy season from May to October. Farmers sow their crops at the expected onset of the rainy season and harvest their crops at the end of the rainy season. In the south of the pilot zone crops are sown earlier because of an earlier arrival of the rainy season.
- In **recession farming**, sorghum is grown in nurseries during the rainy season and transplanted onto recessional lands along rivers and streams and in depressions in October. It is harvested in February/March.
- **Irrigated agriculture and market gardening** take place throughout out the year where irrigation water is available. During the rainy season, famers use supplementary irrigation to compensate water deficits.

In recent years, the diversity of cultivated crops has increased. The choice of crop depends on different soil types (ranging from sand to clay), water availability (rainfed, on recessional land, and irrigated), and socio-economic factors, such as labour availability and farm size. This panoply of factors, has resulted in a mosaic of traditional and new farming methods and cropping calendars (FAO, 2004).

Figure 7: Rainfed maize and sorghum (left), recessional sorghum (centre) and market gardening (right)

Fertile pastures surrounding Lake Chad and the floodplains along rivers, have attracted herders and pastoralists for a long time. Today, there are different types of **livestock production and pastoralism** in the LCB (CBLT, 2016; IOM, 2014):

- **Transhumance**: Transhumant pastoralists migrate seasonally with their animals between fixed dry and wet season pastures. Many of these pastoralists migrate across country borders and move with their entire families.
- **Semi-transhumance**: Pastoralists that practice semi-transhumance stay in one area in which they practice agriculture during parts of the year.
- **Sedentary animal husbandry**: The animals of this group of herders roam within a radius of around 20 km of their settlements. Sedentary livestock farmers usually have other sources of income, mostly agriculture, alongside their livestock.

In recent years, conflicts between farmers and pastoralists have increased because they are competing for the same natural resources, mainly land and water.

Figure 8: Cattle at a watering point (left) and transhumant pastoralists (right)

The baseline study found that today most farmers in the transboundary largely practice **extensive low-input agriculture**. Cereals, mostly sorghum, maize, rice, and pearl millet, but also legume crops such as cowpea and peanut dominate **rainfed agricultural production**. Most farmers grow rainfed crops to ensure household food security and, in some cases, earn an income. The practice of planting sorghum on recessional lands after the rainy season (**recession agriculture** is known as *Muskuwaari* in Cameroon and *Berbéré* in Chad) is continuously spreading and now practiced by more than half of interviewed farmers (57.1%). It provides farmers with a source of household nutrition and means of earning an extra income during the otherwise lean dry season. Finally, **irrigated agriculture and market gardening** are practiced along rivers and streams where water for irrigation is available. Farmers grow irrigated crops mainly to earn an extra income.

2.2.2 Crop yields

Crop yields in all three farming systems relatively low with some variation between resource-rich southern part of the pilot zone and the drier northern regions. Most farmers make very little use of high quality production inputs, e.g. fertilizers and pesticides, and rely on few external inputs and manual methods of weed and pest control. The degree of agricultural mechanization remains low.

Rainfed sorghum yields, range from 600-700 kg/ha in the north of the pilot zone which is part of the Sahelian-Sudanese climate zone (corresponding to the departments of Baguirmi and Chari in Chad and Logone-et-Chari in Cameroon) to around 1,100 kg in the regions in the Sudanese-

Guinean climate zone in the south of the pilot zone (corresponding to the departments of Mayo-Boneye, and Mayo Lémié in Chad, and Diamaré, Mayo-Danay, and Mayo-Kani in Cameroon).

The same is true for recession agriculture, where yields range between 500-600 kg/ha in the northern part (Baguirmi and Chari) to 1,000-1,300 kg/ha in the Diamaré region.

Irrigated rice yields, on the other hand, are substantially higher and reach an average of around 3,500 kg/ha.

2.2.3 Crop varieties used

Throughout the pilot zone, farmers mostly use **traditional varieties** with relatively long growing seasons (an average of 125 days for rainfed and recession sorghum). Improved short varieties with better resistance to the most common pests and diseases have been introduced to the pilot region over the years but are not widely used by famers interviewed for this inventory. With a few exceptions, most farmers' **re-use part of their harvest as seeds** for the following year.

2.2.4 Perception of climate variability and change

Perception of climate change is a prerequisite for climate change adaptation (Reid et al., 2009). As water is one of the main limiting factors in agricultural production in the pilot zone, farmers mainly perceive near-, medium- and long-term impacts of climatic change in form of trends in the duration, inter-annual variability/regularity and intensity of the rainy season. Another indicator is the associated frequency of flooding events. Farmers perceive climate change through the following phenomena:

- **Rainfall:**
  - The rainy season is getting shorter (89.4% of respondents);
  - Rainfall intensity is decreasing in many parts of the pilot zone (66%);
  - Inter-annual rainfall variability is increasing (97.5%);
  - In most regions, farmers perceive a decrease in flooding, which provides the necessary soil moisture for rainfed and recessional agriculture (79.8%). However, along the southern reaches of the Logone and Chari, farmers perceive flooding to have become more frequent (13.1% of all interviewees). Intense rains in August and September can lead to flooding destroying fields and inundating fertile grazing areas.
- **Temperature:** According to the interviewed farmers and pastoralists, the dry season is getting hotter (79.2%) and longer (68.8%), and stronger winds occur more often (61.8%).

Figure 9: Approaching rain near Bongor (left) and dried up sorghum field in Dourbali (right)

2.2.5 Vulnerability of livelihoods

Farmers are faced with several non-climate- and climate-related challenges. A lack of water caused by low rainfall, soil degradation, pests and diseases, and a generally low level of maintenance as well as a lack of inputs hamper agricultural productivity. The effects of climate change are already being felt by farmers in a real and devastating way. Each year, farmers live with the uncertainty whether the rainy season will arrive as expected and bring sufficient amounts of rainfall for their crops to grow.

The rainy season in the pilot zone is becoming increasingly irregular and the amount of rainfall is not well-distributed within the season. Farmers are trying to adapt to changing rainfall conditions by changing the composition of crops and varieties they are cultivating. Whenever they perceive a variety to be resistant to the prevailing climatic conditions, they will re-sow it in the following year. However, due to increasing rainfall irregularities, this strategy does not always provide the desired results

The delayed start of the rainy season leads to a delay in sowing at the beginning of the rainy season. Since the rainy season is also becoming shorter and the amount of rainfall is decreasing, some farmers delay harvesting their crops at the end of the rainy season in the hopes of seeing them mature. Along the Logone River, this effect is less pronounced, and farmers are not changing their harvest dates. The same phenomenon can be observed during the dry season.

Since the rainy season is getting shorter, transhumant pastoralists leave earlier for their dry season pastures in the Yaéré-Naga Wetlands and along the Chari River. During their migration, the herders' animals cross agricultural fields thereby destroying plants that are still developing. Since the rainy season tends to begin later in the year, the same pastoralists return later from their dry season pastures to their rainy season pastures. At this point, many farmers have already sown crop for the new year, and their fields may be destroyed by crossing animals, too. This effect is particularly pronounced in the departments that lie within the traditional transhumance corridors on the Chadian side of the border, namely Chari, Baguirmi, and Mayo-Lémié.

2.3 Selection and planning of adaptation measures

2.3.1 Selection process for adaptation measures

The selection of adaptation measures was based on the following steps:

1. **An analysis of past, present, and predicted climate variability and change as well as their impacts on natural resources** through the development of a climate study and analysis of the perception of climate variability and change by the target population (see chapters 2.1 and 2.2.4).
2. **An analysis of the most important agricultural production systems and livelihoods** of the people living in the project area. The analysis included an assessment of the vulnerability of people and their livelihoods to climate variability and change (see chapter 2.2).
3. **The identification of potential adaptation measures** through focus groups discussions (FGDs) in the project area to discuss people's development and adaptation priorities, expert interviews, and workshops with representatives of the LCBC and NGOs, as well as with regional and national technical services.
4. **Development of criteria for the selection and hierarchisation of adaptation measures** resulting a final list of adaptation measures approved by the LCBC in cooperation with the project PRODEBALT (Development Program for the Lake Chad Basin).

An overview of the workshops' and key meetings' dates, locations, topics, and participants can be found in Table 15 in chapter 2.7.3.

Figure 10: Focus group discussion as part of the agricultural inventory (left) and selected results of workshop at LCBC to develop adaptation measures (right)

2.3.2 Selection criteria for adaptation measures

At an internal workshop held in N'Djaména with GIZ, AHT and representatives of the participating NGOs in N'Djaména in December 2014, a following longlist of aspects relevant for the selection of adaptation was developed. The development of the list was based under the precondition of being coherent with the project indicators (see chapter 1.2).

At the final validation workshop at the LCBC in March 2015, the longlist was shortened to four main criteria to consider while selecting and prioritizing adaptation measures. In addition to these four criteria, the selected measures had to be coherent with the project indicators and build on experiences by LCBC's PRODEBALT programme

- **Relevance**: Measures that contribute to adaptation by building adaptive capacity and/or reducing vulnerability to climate variability and change.
- **Profitability**: Measures that increase yields and measures with little or no regret.
- **Scalability**: Measures that can be rapidly implemented in the field and that have a potential of being implemented on a larger scale (development of procedures for future dissemination of best practices).
- **Multiple benefits**: Measures that improve multiple value chain aspects (production, storage, transformation, and marketing).

2.3.3 Selection of sites for the implementation of adaptation measures

As the project aimed at testing the feasibility and analysing best practices of adaptation, the sites for the implementation of the pilot measures had to be carefully chosen. The selection was based on the following criteria:

- **Representative conditions**: The sites should be representative for certain agro-ecological conditions (the relatively dry Sahelian-Sudanese climate zone in the north and the relatively wet Sudanese-Guinean zone in the south of the pilot zone).
- **Motivation and absence of conflict**: The population at the selected sites should be motivated and no major social conflicts should exist.
- **Availability of natural resources**: Sufficient natural resources should be available for agricultural production.

Information on sites that fit these criteria were collected during the field work for the Agricultural Inventory (see chapter 2.2). The verification of the proposed sites was done in collaboration between GIZ and LCBC experts, NGO representatives who had conducted the inventory at the given site and AHT technical experts. On the Cameroonian site of the border the selection of sites for implementation was restricted by the security concerns.

2.3.4 Selection of pilot farmers

The pilot farmers were identified during the field work for the Agricultural Inventory. After the selection of sites for implementation, the NGOs who had conducted the surveys in the respective region identified farmers from the surveyed population that met the following criteria:

- **Perception** of past and present climatic variability and climate change.
- **Motivation to participate** in the project and test new agricultural practices.
- **Motivation to train** other farmers and disseminate best practices.

2.3.5 Adaptation hypothesis and characteristics of the adaptation measures

Adaptation hypothesis

Generally speaking, measures to adapt to climate change can be categorised into the three dimensions of adaptation (GIZ, 2013):

1. **Building adaptive capacity:** Measures that develop people's problem-solving abilities to respond better to climate variability and change and to extreme weather conditions. This includes, for example, capacity building measures or the provision of locally relevant data on climate change.
2. **Reducing identified risks/vulnerabilities (adaptation actions):** Unlike capacity-building measures, the aim of these measures is directly to reduce specific risks or vulnerabilities. Examples include the introduction of drought-resistant crops in regions that experiences longer dry periods due to climate change.
3. **Successful development despite climate change (sustained development):** This dimension focuses primarily on achieving development goals and/or securing the progress already made despite the adverse effects of climate change. It may include both capacity-building and direct measures to reduce identified risks. In contrast to the first two dimensions, however, greater focus is placed here on securing development goals.

The selected measures contribute to all three dimensions to some degree. To determine their contribution to adaptation, an adaptation hypothesis was drawn up for each of the measures. The resulting adaptation hypotheses are presented in Table 2.

Table 2: Adaptation hypotheses at project level and for each of the agricultural production systems

Intervention	**Adaptation hypothesis**
Project level	The participatory planning and implementation of adaptation measures contributes to increasing the resilience of communities to deal with climate change. Testing, evaluating, and demonstrating the results of these measures enriches the overall adaptation knowledge which leads to replication at a larger scale.
Rainfed farming	The introduction of early-maturing, more drought-resistant varieties with better yield characteristics reduces farmers' vulnerability to droughts and climatic variability while improving their livelihood base.
Flood recession farming	The cultivation of cereals and horticultural crops on recessional land during the dry season reduces farmers' vulnerability towards rainfall variability and improves their livelihood base by providing additional sources of food and income during the dry season thus making them less dependent on rainfed production. In addition, the introduction of early maturing, more drought-resistant varieties with better yield characteristics reduces farmers' vulnerability to droughts and climatic variability.
Animal husbandry	Animal fodder production increases fodder availability during the rainy season and the dry season thereby reducing the vulnerability of animal herders to climatic variability, improving the livelihood base of herders and farmers alike and reducing the potential for herder-farmer conflicts.
Market gardening	Irrigated horticultural production using solar pumps reduces farmers' vulnerability to rainfall variability and improves their livelihood base by providing them with additional sources of food, nutrients, and income during the dry season.

Main characteristics of the adaptation measures

All of the tested adaptation measures had three main characteristics in common:

- **The introduction of new seed varieties:** The new seed varieties have shorter growing period (90 days instead of 120 days of traditional varieties) and exhibit better yield characteristics: Short-season varieties allow for later planting dates, earlier harvest dates, and for re-sowing in the event of failed rains. In the south of the pilot zone, seeds were obtained from the Cameroonian Agricultural Research Institute for Development (IRAD). The varieties used were developed by IRAD in collaboration with various international partners (ICRISAT, IITA, CIRAD, USAID, BAD, PRASAC, and others). In the north of the pilot zone, seeds were obtained from the Chadian Institute of Agricultural Research for Development (ITRAD).
- **Trainings and supervision of good agricultural practices by local NGOs and regional extension services**: This includes the practice of line sowing instead of broadcasting, the correct timing of agricultural management activities (application of animal manure, fertilizer and pesticides, weeding, harvesting, storage, and post-harvest treatment), and the production of biopesticides. Farmers were sensitized to the effects of climate change. In addition to trainings and technical support, farmers received basic agricultural equipment from the project (ploughs and yokes, hoes, axes, machetes, rakes, pulverisers, and pushcarts).
- **Farmer field schools (FFS):** All of the tested adaptation measures were disseminated using the FFS approach. Pilot farmers who were trained in the first year, trained between three and four other farmers in the following year (average 3.6 student farmers per each trainer farmer).

2.3.6 Implementation arrangements

The arrangements for the implementation of the adaptation measures are depicted in Figure 11 and described in the paragraphs below.

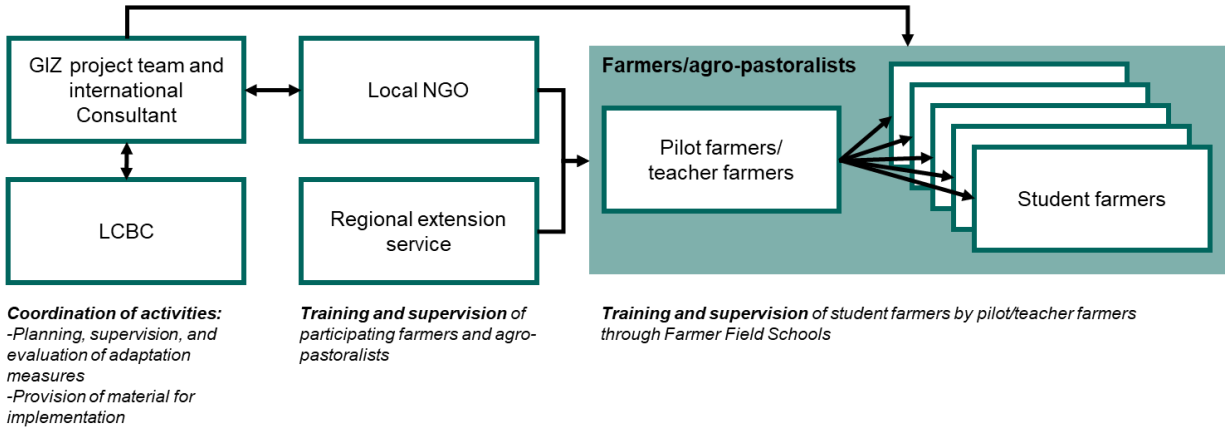

Figure 11: Implementation arrangements for the adaptation measures

Local NGOs

The role of the local NGOs was to train and supervise the participating farmers in the implementation of the agricultural adaptation measures. To this end, each of the participating NGOs hired dedicated agricultural experts who organised trainings in collaboration with the regional

extension services. After the first year of implementation, the NGOs supervised the teacher farmers in the training of their respective student farmers.

In addition, the NGOs regularly monitored and evaluated the project results in the field and reported back to GIZ and the international consultant. Finally, the NGOs assisted in the organisation and the implementation of the farmer exchange workshops.

Regional technical services

The role of the regional extension services was to conduct trainings on improved seed varieties and good agricultural practice in collaboration with the local NGOs.

In Chad, the project cooperated with the national extension agency ONDR which was later renamed to ANADER. The heads of the sub-sector offices of the ONDR in Linia, Dourbali, Mandelia, and Guelendeng accompanied the trainings and supervised the implementation of the adaptation measures. In Cameroon, the project was accompanied by the extension agents from department of agricultural development at the departmental delegation of the Cameroonian agricultural ministry MINADER.

LCBC

The directors and technical experts of the LCBC accompanied the development of the climate change study and the agricultural inventory. Based on the results of the studies, LCBC, GIZ, regional extension services and local NGOs jointly developed and selected the adaptation measures which were, to a large degree, based development priorities by the LCBC.

During the implementation of the adaptation measures, LCBC experts conducted supervisory missions to the implementation sites of the project. Furthermore, LCBC experts reviewed the project results and participated in the workshops to disseminate and exchange information on best practices of climate change adaptation in the LCB.

GIZ and international consultant

GIZ and the international consultant were responsible the development of the climate change study and the agricultural inventory. Based on the results of the two studies, GIZ and the international consultant planned and guided the selection process of the adaptation measures in collaboration with the technical experts of the LCBC.

After the selection of the adaptation measures, GIZ and the international consultant developed the implementation concept and the ToR for the local NGOs that implemented the adaptation measures. The NGOs contracted by GIZ received agricultural equipment and inputs from GIZ which they in turn distributed to the participating farmers.

GIZ and the international consultant supervised and accompanied the NGOs and participating farmers during the implementation of the adaptation measures. This included the review of project reports and results as well as regular monitoring missions to the field. Finally, GIZ and the international consultant organised and held workshops at which participating farmers from Cameroon and Chad as well as representatives of all of the participating NGOs could share their experiences and knowledge about best practices of climate change adaptation.

2.4 Adaptation measures: Rainfed agriculture

2.4.1 Characteristics of the production system

The following are the most important characteristics of rainfed agriculture in the pilot zone:

- **Main production system:** Rainfed agriculture is the main production system in the pilot zone.
- **Main crops grown:** Main crops are sorghum, cowpeas, maize and millets.
- **Crop yields:** Crop yields are generally low with strong regional differences (average sorghum yields in the departments in the pilot zone range between 638 and 1,137 kg/ha; the average yield for the pilot zone is 833 kg/ha).
- **Climate:** The success of rainfed agriculture is dependent on the performance of the rainy season between May and October.
- **Resources**: External production inputs, i.e. fertilizer and pesticides, are not widely available and their level of use is low. Farmers mostly grow traditional varieties with a growing period of 120 days or more.

2.4.2 The need for adaptation

There need for adaptation is manifested in the following aspects:

- **The duration of rainy season is decreasing.**
- **The rainy season becomes more erratic.** Dry periods during the rainy season, also known as drought pockets, occur more often. These drought pockets often occur at the end of June or early July and towards the end of September and early October.
- **The length of growing period is decreasing** in large parts of the basin and becoming shorter than 120 days.

→ As a result, rainfed agriculture is vulnerable to short and irregular rains.

2.4.3 Adaptation hypothesis

The following adaptation hypothesis was defined for the adaptation measure in the in the rainfed agriculture system:

"The introduction of early-maturing, more drought-resistant varieties with better yield characteristics reduces farmers' vulnerability to droughts and climatic variability while improving their livelihood base."

2.4.4 Characteristics of the adaptation measure

The main features of the adaptation measure are presented below:

- **The introduction of new seed varieties:** Varieties of sorghum, cowpeas and maize with improved yield characteristics, a resistance to drought and certain pests, incl. striga, and a shorter growth cycle (90 days compared to 120 days of traditional varieties) are sown at a later date than the traditional varieties. The following varieties were tested (see the annex for the technical data sheets):
  - **Sorghum:** CS54, CS61, Damougari, S35, and Zouaye
  - **Maize:** CMS9015, EVDT-99, and Tze-Comp
  - **Cowpea:** Fekem and TN5-78

- **Trainings and supervision of good agricultural practices by local NGOs and regional extension services**: Participating farmers are supported through the provision of production inputs (seeds, manure, and agricultural tools) and trainings on good agricultural practices.
- **Farmer field schools:** Through the implementation of the farmer field school approach, farmers who have successfully used the improved varieties in one year, go on to train other farmers in the following years.

2.4.5 Best practices of the adaptation measure

The best practices of the adaptation measure are summarised below:

- **Use of drought-resistant short-season varieties of sorghum, maize, and cowpea with better yield characteristics:** The use of short-season sorghum, maize and cowpea varieties with an average growing period of 75-90 day–as opposed to 120 days or more–responds to a shorter and more variable rainy season.
- **Postponement of the sowing date:** The new short-season varieties allow for a sowing date in mid-July when rainfall is more regular as opposed to mid-June, when drought pockets can still occur. Moreover, in case of a low germination rates due to erratic rainfall at the onset of the rainy season (in June and July), it is possible to sow a second time (in August) and still have a harvest at the end of the rainy season (in October).
- **Line sowing instead of broadcasting**: Line sowing ensures homogeneity of plants, improves plant growth, and facilitates weeding. This increases yields and makes production less variable.
- **Better knowledge of the agricultural calendar:** Including the management practices to carry out (sowing, fertilisation, pest management, weeding, harvest, post-harvest treatment) and their correct timing. Good management practices vary slightly between the varieties and are detailed in the technical data sheets in the annex. Figure 16 shows a comparison of the agricultural calendars for traditional and improved varieties of sorghum and cowpea in the pilot zone.
- **Soil management practices:** Knowledge about which crops and varieties are best suited to which type of soil, helps to improve yields without external inputs. In addition, following crop rotations and fallow periods reduces pressure from pests.
- **Use of bio-pesticides and manure:** The use of bio-pesticides and manure minimises costs and the dependence on external production inputs while at the same reducing the risk of pollution and adverse effects on human health.


Figure 12: Line sowing of cowpea (left) and ridging of sorghum field after fertilizer application (right)


Figure 13: Sorghum field (variety CS-61) 29 days (left) and 64 days (right) after sowing


Figure 14: Sorghum field infested with *Striga hermonthica* (left) and Striga flowers (right)


Figure 15: Group of farmers weeding a cowpea field

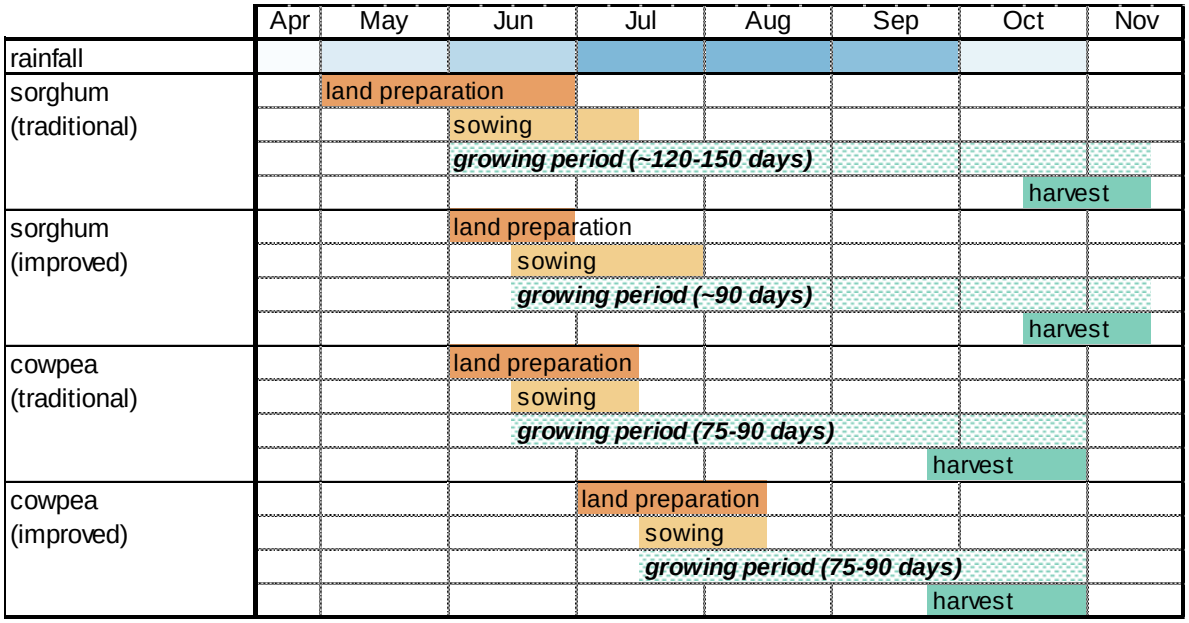

Figure 16: Agricultural calendar of traditional and improved sorghum and cowpea varieties in the pilot zone under rainfed production (baseline vs. adaptation measure)

2.4.6 Challenges and solutions

The following challenges were encountered in the implementation of the adaptation measure:

- **Pest attacks**: Pest attacks, during all stages of plant development, remain a major challenge. If chemical pesticides are used, they are often purchased from vendors in local markets who also provide technical advice and guidance on pesticide use. Buying pesticides represents a high investment for farmers. Their incorrect application can cause harm to people and the environment and damage plants. Pesticide vendors in local markets often do not have the necessary knowledge to advise farmers on the safe and efficient use of pesticides. In addition, many farmers do not have the proper equipment and use other materials for spraying, normally plastic bottles with pierced caps.
  - ➔ **Use of biopesticides:** The neem tree (*Azadirachta indica*) grows naturally in Chad and Cameroun. Its seeds and/or leaves are collected, peeled, and immersed in water. The exudate is then filtered and put into a sprayer (or a perforated plastic bottle). The manufacture of solutions based on neem is time and labour intensive.

Figure 17: Preparation of neem-based biopesticides against stemborers (left) and adult form of African sugarcane stalkborer (*Eldana saccharina*), a common sorghum pest in Chad

2.4.7 Results of the adaptation measure

The main results of the adaptation measure are mentioned below.

- **Higher and less variable crop yields**: Crop yields have increased and are less influenced by rainfall variability, droughts, pests, and other circumstances (***relevance, profitability***).
- **Reduced vulnerability of rainfed production to rainfall variability:** Due to a shorter growing period, better drought resistance and yield characteristics (***relevance, profitability***).
- **Replication and dissemination in the pilot zone:** In addition to the project-supported activities (trainings, field visits, and farmer fields schools), farmers have continued using the adaption measures in years without project support. Participating farmers have shared seeds of the new varieties with their neighbours and people from other villages thereby increasing the dissemination of the varieties in the pilot zone. Finally, neighbours of participating farmers have also adopted the adaptation measures and learned from the project experiences (***relevance, scalability***).

Higher and less variable crop yields

Table 3 below shows rainfed crop yields for sorghum, maize, and cowpea from the agricultural inventory as well as the results of the adaptation measures. Except in the case of sorghum in the Sudanese-Guinean climate zone, crop yields have increased considerably under all circumstances. The apparent decrease of sorghum yields of the improved varieties under rainfed conditions in the Sudanese-Guinean zone, can be attributed to severe drought pockets in August and September 2016 which resulted in the sorghum plants not reaching maturity. The harvested plants were used exclusively as animal fodder.

Table 3: Crop yields of sorghum, maize, and cowpea under rainfed conditions (baseline and adaptation measure)

climate zone	**sorghum**		**maize**		**cowpea**	
	N	*kg/ha*	*N*	*kg/ha*	*N*	*kg/ha*
Baseline						
Sahelian-Sudanese	410	737	105	631	4	369
Sudanese-Guinean	461	929	85	966	51	742
pilot zone	871	833	190	777	55	714
Adaptation measure						
Sahelian-Sudanese	43	2,519	1	1,000	54	1,891
Sudanese-Guinean	16	893	10	1,443	15	1,747
pilot zone	59	2,238	11	1,399	69	1,873

Reduced vulnerability of rainfed production to rainfall variability

Table 4 shows the growing periods for sorghum, maize, and cowpea from the agricultural inventory as well as the results of the adaptation measures. The actually realised growing periods are in line with the recommendations from the technical data sheets and considerably shorter than under the baseline conditions.

The apparently short growing period of sorghum in the Sahelian-Sudanese climate zone under baseline conditions can be attributed to pastoral migration patterns. Since the rainy season is getting shorter, transhumant pastoralists leave earlier for their dry season pastures in the Yaéré-Naga Wetlands and along the Chari River. During their migration, the herders' animals cross agricultural fields thereby destroying plants that are still developing. Since the rainy season tends to begin later in the year, the same pastoralists return later from their dry season to their rainy season pastures. At this point, many farmers have already sown crops for the new season, and their fields may be destroyed by crossing animals, too. The shorter growing period of the improved varieties allows farmers to have a secure yield despite a shorter time window in which to grow their crops.

Table 4: Growing periods of sorghum, maize, and cowpea under rainfed conditions (baseline and adaptation measure)

climate zone	**sorghum**		**maize**		**cowpea**	
	N	days	N	days	N	days
Baseline						
Sahelian-Sudanese	410	106	105	135	4	92
Sudanese-Guinean	461	141	85	153	51	92
pilot zone	871	125	190	143	55	93
Adaptation measure						
Sahelian-Sudanese	43	104	1	107	54	72
Sudanese-Guinean	16	100	10	91	15	83
pilot zone	59	103	11	92	69	74

Replication and dissemination in the pilot zone

The best practices of adaptation were disseminated through farmer field school approach. In total, 72 farmers were supported by the project in adapting their rainfed agricultural production. Out of the 72 farmers, 19 were pilot farmers. Out of these 19 pilot farmers, 12 acted as trainer farmers in the following years. Each of the 12 trainer farmers taught between three and five student farmers resulting in a total of 54 student farmers (see Table 5).

Participating farmers disseminated the best practices and new seed varieties beyond the scope of the project. Over the course of the project, the 72 participating farmers shared the new seed varieties with a total of 232 people, who were not directly supported by the project.

Finally, funding issues prevented the project from supporting farmers during the rainy season in 2017. A subsequent assessment in early 2018 found, that all farmers who had been supported in 2016 had continued applying the practices in 2017.

Table 5: Number of individual pilot, teacher and student farmers (male, female, and total) for the rainfed adaptation measure from 2015 to 2018

year	**pilot farmers**			**teacher farmers**			**student farmers**			**total**		
	M	W	total	M	W	total	M	W	total	M	W	total
2015	5	6	11	0	0	0	0	0	0	5	6	11
2016	4	4	8	4	2	6	21	6	27	29	12	41
2018	0	0	0	2	4	6	18	9	27	20	13	33
total	9	10	19	6	6	12	39	15	54	47	25	72

2.5 Adaptation measures: Recession agriculture

2.5.1 Characteristics of the production system

The following are the most important characteristics of recession agriculture in the pilot zone:

- **Important production system:** Recession farming is the second most important agricultural system in the pilot zone.
- **Main crops grown**: Main crops are sorghum, locally known as *berbéré*, *muskuwaari*, *masakwa*, and *karal.*
- **Crop yields:** Generally low crop yields with regional differences (average sorghum yields in the departments in the pilot zone range between 581 and 1,298 kg/ha; the average yield for the pilot zone is 884 kg/ha).
- **Climate:** Traditional adaptation measure to rainfall variability and drought condition and an important buffer crop in the dry season.
- **Resources:** Practiced on land flooded during rainy season (along rivers and streams and in depressions) on sandy clay soils. Mostly traditional varieties are used.

2.5.2 The need for adaptation

There need for adaptation is manifested in the following aspects:

- **The duration of rainy season is decreasing**.
- **The rainy season becomes more erratic**. Dry periods during the rainy season, also known as drought pockets, occur more often. These drought pockets often occur at the end of June or early July and towards the end of September and early October.
- **The length of growing period is decreasing** in large parts of the basin and becoming shorter than 120 days.

→ The increasing vulnerability of rainfed production, increases the importance of recession agriculture as an adaptation measure.

2.5.3 Adaptation hypothesis

The following adaptation hypothesis was defined for the adaptation measure in recession farming:

"The cultivation of cereals and horticultural crops on recessional land during the dry season reduces farmers' vulnerability towards rainfall variability and improves their livelihood base by providing additional sources of food and income during the dry season thus making them less dependent on rainfed production. In addition, the introduction of early maturing, more drought-resistant varieties with better yield characteristics reduces farmers' vulnerability to droughts and climatic variability."

2.5.4 Characteristics of the adaptation measure

The main features of the adaptation measure are presented below:

- **The introduction of new seed varieties:** Varieties of sorghum with improved yield characteristics, a resistance to drought and certain pests, incl. striga, are grown in nurseries during the rainy season and transplanted at the onset of the dry season. The following varieties were tested (see the annex for the technical data sheets):
    - **Sorghum:** Red Djiresse, White Djiresse, and Yellow Djiresse

- **The introduction of new crops:** In addition, watermelons and honeydew melons (also known as musk melons) are grown on recessional land to diversify production in a system heavily dominated by the sorghum and provide additional sources of income and nutrition. The following varieties were tested (see the annex for the technical data sheets):
    - **Watermelon:** Crimson Sweet
    - **Honeydew melon:** Charentais
- **Trainings and supervision of good agricultural practices by local NGOs and regional extension services**: Participating farmers are supported through the provision of production inputs (seeds, manure, and agricultural tools) and trainings on good agricultural practices.
- **Farmer field schools:** Through the implementation of the farmer field school approach, farmers who have successfully used the improved varieties in one year, go on to train other farmers in the following years.

2.5.5 Best practices of the adaptation measure

- **Use of residual soil moisture to ensure crop production during the dry season:** The practice of recession agriculture is a traditional adaptation to rainfall variability in the Lake Chad Basin. Sorghum plants are sown in small nurseries towards the end of the rainy season (around the end of September) over the course of two weeks. The aim is to have two to three generations of plants in the same nursery. This allows for a staggered transplanting as progressively more recessional lands become available towards the end of the rainy season. If transplanted at the end of the rainy season at the right time on the right soil, no additional irrigation is necessary. Musk melons and watermelons, on the other hand, are sown directly in the plots with residual soil moisture. The following types of soils are suited for recession farming:
    - Natural depressions (sandy clay soils), that retain residual moisture.
    - Recessional lands along the rivers Chari and Logone, retaining residual moisture.
    - Other types of land which may retain some residual soil moisture will have to be irrigated using jerry cans.
- **Use of drought-resistant varieties of sorghum with better yield characteristics:** Seeds of improved sorghum varieties were obtained from ITRAD's experimental farm in Amtiman. The varieties (Red, White, and Yellow Djiresse) are crossbreeds between various traditional varieties.
- **Cultivation of watermelon and honeydew melon on recession land during the dry season:** The cultivation of high value crops on recessional land using the residual soil moisture during the dry season. The watermelon and honeydew melon seeds were bought a commercial seed store in N'Djaména.
- **Better knowledge of the agricultural calendar:** Including the management practices to carry out (sowing, fertilisation, pest management, weeding, harvest, post-harvest treatment) and their correct timing. Good management practices vary slightly between the varieties and are detailed in the technical data sheets.
- **Soil management practices:** Knowledge about which soils are suitable for recession farming, helps to improve yields without external inputs. Best suited are natural depressions with sandy clay soils, that retain residual moisture after the rainy season, and recessional lands along rivers that are inundated during the rainy season.
- **Use of bio-pesticides and manure:** The use of bio-pesticides and manure minimises costs and the dependence on external production inputs while at the same reducing the risk of pollution and adverse effects on human health.

Figure 18: Sorghum nursery (left), preparation of sorghum plants for transplanting (right)

Figure 19: Traditional method of transplanting sorghum on recessional land

Figure 20: Sorghum plants ca. 60 days after transplanting (left) and women preparing flour and weaving baskets from sorghum grain and leaves (right)

Figure 21: Farmer with harvested watermelons (left) and watermelons at a market (right)

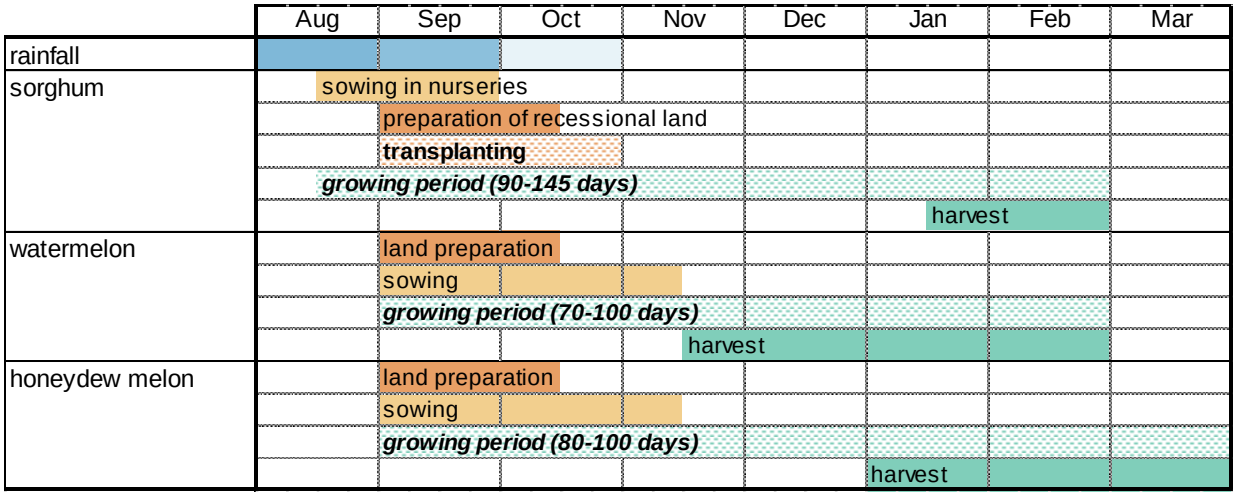

Figure 22: Agricultural calendar of sorghum (*berbéré*), watermelon, and honeydew melon on recessional land during the dry season

2.5.6 Challenges of the adaptation measure

The following challenges were encountered in the implementation of the adaptation measure:

- **Pest attacks**: Pest attacks, during all stages of plant development, remain a major challenge. If chemical pesticides are used, they are often purchased from vendors in local markets who also provide technical advice and guidance on pesticide use. Buying pesticides represents a high investment for farmers. Their incorrect application can cause harm to people and the environment and damage plants. Pesticide vendors in local markets often do not have the necessary knowledge to advise farmers on the safe and efficient use of pesticides. In addition, many farmers do not have the proper equipment and use other materials for spraying, normally plastic bottles with pierced caps.
  - ➔ **Use of biopesticides:** The neem tree (*Azadirachta indica*) grows naturally in Chad and Cameroun. Its seeds and/or leaves are collected, peeled, and immersed in water. The exudate is then filtered and put into a sprayer (or a perforated plastic bottle). The manufacture of solutions based on neem is time and labour intensive.
- **Damages caused by animals:** In addition to plant diseases and insects, watermelons and honeydew melons are often eaten by various mammals, incl. mice and jackals.
  - ➔ **Guarding fields:** To prevent mammals from eating the watermelons and honeydew melons, famers assign family members or hire day labourers to guard the fields for several weeks. This practice is, of course, very costly but can considerably reduce the losses incurred by animal damages.

Figure 23: Watermelon damaged by mammals (left) and guard tower in a sorghum field (right)

2.5.7 Results of the adaptation measure

The main results of the adaptation measure are mentioned below.

- **Higher and less variable crop yields**: Crop yields of sorghum have increased and are less influenced by droughts, pests, and other circumstances (***relevance, profitability***).
- **Reduced vulnerability of rainfed production to rainfall variability:** The cultivation of sorghum, watermelons, and musk melons in the dry season on land with residual moisture, has reduced people's vulnerability to rainfall variability of their rainfed production (***relevance, profitability***).
- **Replication and dissemination in the pilot zone:** In addition to the project-supported activities (trainings, field visits, and farmer fields schools), farmers have continued using the adaption measures in years without project support. In the year without project support, farmers from Dourbali bought watermelon seeds from stores in N'Djamena. Farmers growing Sorghum have shared seeds of the new varieties with their neighbours and people from other villages thereby increasing the dissemination of the varieties in the pilot zone. Finally, neighbours of participating farmers have also adopted the adaptation measures and learned from the project experiences (***relevance, scalability***).
- **Livelihood diversification and additional source of income:** The measures strengthened the beneficiaries' knowledge about best practices of sorghum cultivation on recessional land. It thus provided them the opportunity two diversify their livelihood base in addition to rainfed agricultural production. In addition, the introduction of new crops (musk melons and watermelons) provided an additional source of income during the dry season (***relevance, profitability, multiple benefits***).

Higher and less variable crop yields

Table 6 shows crop yields for sorghum on recessional land under baseline conditions and the results of the adaptation measure. In addition, it shows the yields of watermelons and musk melons realised as part of the project. Baseline data for musk melons and watermelons were not available as the practice is not yet widespread in the pilot zone.

The data show, that sorghum yields in the Sahelian-Sudanese zone have increased from 701 kg/ha under baseline conditions to 1,693 kg/ha under the conditions of the adaptation measure. The yield data

Table 6: Crop yields of sorghum, musk melon, and watermelon under recession agriculture (baseline and adaptation measure)

climate zone	**sorghum**		**watermelon**		**musk melon**	
	N	*kg/ha*	*N*	*kg/ha*	*N*	*kg/ha*
Baseline						
Sahelian-Sudanese	187	701	-	-	-	-
Sudanese-Guinean	282	1,015	-	-	-	-
pilot zone	469	884	-	-	-	-
Adaptation measure						
Sahelian-Sudanese	36	1,693	48	12,885	50	12,351
Sudanese-Guinean	-	-	-	-	-	-
pilot zone	36	1,693	48	12,885	50	12,351

Reduced vulnerability of rainfed production to rainfall variability

The rainy season is the most important agricultural season in the pilot zone. A lack of water is the main limiting factor to crop production during the dry season. A common way to adapt to a lack of water is to irrigate crops. The initial investment in irrigation equipment is prohibitively high for most people in the pilot zone. The Agricultural Inventory found, that about 5% of farmers in the pilot zone grow irrigated rice, most of whom grow their crops in a large irrigation perimeter in the Cameroun part of the intervention zone. Another way to adapt to a lack of water, is to grow crops on land with residual soil moisture. Apart from higher labour demands, this technique does not entail any investment costs that go beyond those of the regular rainfed production.

Given that rainfall variability and thus vulnerability of rainfed production are increasing, production of crops on land with residual moisture during the dry season, provides an important buffer. Growing sorghum (*bérbéré*) ensures the household food supply during the dry season and can provide an extra source of income. The cultivation of other crops, such as musk melon and watermelon, diversifies household nutrition and provides an additional source of income at the same time.

Replication and dissemination in the pilot zone

The best practices of adaptation were disseminated through farmer field school approach. In total, 74 farmers were supported by the project in adapting their recession agricultural production. Out of the 74 farmers, 14 were pilot farmers. All of the 14 pilot farmers acted as trainer farmers in the following years. Each of the 14 trainer farmers taught between three and five student farmers resulting in a total of 63 student farmers.

Table 7: Number of individual pilot, teacher, and student farmers (male, female, and total) for the recession agriculture adaptation measure from 2015 to 2018

year	pilot farmers			teacher farmers			student farmers			total		
	M	W	total	M	W	total	M	W	total	M	W	total
2015	10	4	14	0	0	0	0	0	0	10	4	14
2016	0	0	0	4	1	5	17	4	21	21	5	26
2018	0	0	0	10	3	13	41	6	47	51	9	60
total	10	4	14	11	3	14	54	9	63	61	13	74

Livelihood diversification and additional source of income

A value chain analysis carried out in 2018, found that transport costs were an important factor determining the gross margins of watermelon and musk melon production. In general, gross margins decreased the further away the fields were from the main market centres. An updated value chain analysis in 2019 including the M&E data for the entire project duration, found that average gross margins for musk melons and watermelons were respectively 2.2 and 10.2 times higher than those for sorghum grown on recessional land. At the same time returns on family labour were 3.4 and 19.7 times higher, respectively (see Table 8 and Table 9).

Table 8: Gross margins of selected agricultural crops in Chad

	unit	sorghum	*berbère*	peanut	tomato	gombo	vegetables
yield	*kg/ha*	800	700	500	8,500	5,500	7,000
costs	*FCFA/ha*	40,500	44,580	102,600	687,500	413,100	550,300
revenues	*FCFA/ha*	154,000	176,750	262,500	1,870,000	1,100,000	1,485,000
gross margin*	*FCFA/ha*	113,500	132,170	159,900	1,182,500	686,900	934,700
return on family labour	*FCFA/PD*	1,261	1,469	1,523	8,155	4,906	6,531

*gross margin at field level, i.e. without transport cost
Source: FIDA (2013), « République du Tchad : Projet d'amélioration de la résilience des systèmes agricoles au Tchad (PARSAT) - Rapport principal et appendices », 61 pages.

Table 9: Average gross margins of musk melon and watermelon in the pilot zone

	unit	watermelon	musk melon
yield	*kg/ha*	12,351	12,885
costs	*FCFA/ha*	51,500	51,500
revenues	*FCFA/ha*	1,399,780	337,464
gross margin*	*FCFA/ha*	1,348,280	285,964
return on family labour	*FCFA/PD*	28,933	5,719

gross margin at field level, i.e. without transport cost

2.6 Adaptation measures: Livestock

2.6.1 Characteristics of the production system

- **Important production system:** Animal husbandry, or livestock production, is an important production system in the pilot zone. Generally speaking, there are three types of animal husbandry:
    - **Transhumance:** Transhumant pastoralists migrate seasonally with their animals between fixed dry and wet season pastures.
    - **Semi-transhumance:** Pastoralists practicing semi-transhumance migrate seasonally (usually during the dry season) and farm the rest of the time.
    - **Sedentary animal husbandry:** The animals of this group of herders roam within a radius of around 20 km of their settlements. Sedentary pastoralists usually have other sources of income, mostly agriculture, alongside their livestock.
- **Main species raised:** The most important animal species raised are cattle, sheep, and goats.
- **Seasonal movements:** Pastoralists in the LCB move from south to north in the period from April to October. During the dry season from November to April, pastoralists migrate southwards (or east-west) in search of water points, rivers, and dry season grazing areas. To buy and sell goods on markets, they normally spend two to three months close to settlements before moving on.

2.6.2 The need for adaptation

There need for adaptation is manifested in the following aspects:

- **The duration of rainy season is decreasing.**
- **The rainy season becomes more erratic.** Dry periods during the rainy season, also known as drought pockets, occur more often. These drought pockets often occur at the end of June or early July and towards the end of September and early October.
- **The length of growing period is decreasing** in large parts of the basin and becoming shorter than 120 days.
- **The availability of water and pastures is decreasing** due to a mix of climatic (rainfall and temperature) and other factors, incl. land use change, expansion of crop land on transhumance corridors, overgrazing.
- **The conflict potential between herders and farmers increases** because of climate-induced changes in seasonal migration patterns (early departure to–and later departure from–dry season pastures) and competition for land and water resources.

→ As a result, livestock productivity decreases and is vulnerable to short and irregular rains.

2.6.3 Adaptation hypothesis

The following adaptation hypothesis was defined for the adaptation measure in the in livestock production system:

"Animal fodder production increases fodder availability during the rainy season and the dry season thereby reducing the vulnerability of animal herders to climatic variability, improving the livelihood base of herders and farmers alike and reducing the potential for herder-farmer conflicts."

2.6.4 Characteristics of the adaptation measure

The main features of the adaptation measure are presented below:

- **The introduction of new seed varieties:** Varieties of sorghum and cowpeas for human consumption and as fodder with improved yield characteristics, a resistance to drought and certain pests, incl. striga, and a shorter growth cycle (90 days compared to 120 days of traditional varieties) are sown at a later date than the traditional varieties. The following varieties were tested (see the annex for the technical data sheets):
  - **Sorghum:** CS61 and S35
  - **Cowpea:** TN5-78
- **Trainings and supervision of good agricultural practices by local NGOs and regional extension services**: Participating agro-pastoralists are supported through the provision of production inputs (seeds, manure, and agricultural tools) and trainings on good agricultural practices.
- **Training preparation of animal fodder:** Participating agro-pastoralists are trained in the processing and storage of crop residues as animal fodder (see the annex for the technical data sheet for hay production).
- **Farmer field schools:** Through the implementation of the farmer field school approach, farmers who have successfully used the improved varieties in one year, go on to train other farmers in the following years.

2.6.5 Best practices of the adaptation measure

The best practices of the adaptation measure are summarised below:

- **Use of drought-resistant short-season varieties of sorghum and cowpea for human and animal consumption with better yield characteristics:** The use of short-season sorghum and cowpea varieties with an average growing period of 75-90 day–as opposed to 120 days or more–responds to a shorter and more variable rainy season and provides nutrition for humans and livestock alike.
- **Production and storage of animal fodder from crop residues:** Production of hay from sorghum stalks and spikes that are usually left on the field after harvest. Production of hay from cowpea leaves and vines. Cowpea crop residues are collected in a green state instead of waiting for the leaves to dry completely before the harvest. The crop residues/hay are stored on sheds and/or trees to avoid them being eaten by livestock prematurely.
- **Postponement of the sowing date:** The new short-season varieties allow for a sowing date in mid-July when rainfall is more regular as opposed to mid-June, when the occurrence of drought pockets is still possible. Moreover, in case of a low germination rates due erratic rainfall at the onset of the rainy season (in June and July), it is possible to

sow a second time (in August) and still have a harvest at the end of the rainy season (in October).

- **Line sowing instead of broadcasting**: Line sowing ensures homogeneity of plants, improves plant growth, and facilitates weeding. This increases yields and makes production less variable.
- **Better knowledge of the agricultural calendar:** Including the management practices to carry out (sowing, fertilisation, pest management, weeding, harvest, post-harvest treatment) and their correct timing. Good management practices vary slightly between the varieties and are detailed in the technical data sheets in the annex. Figure 16 shows a comparison of the agricultural calendars for traditional and improved varieties of sorghum and cowpea in the pilot zone.
- **Soil management practices:** Knowledge about which crops and varieties are best suited to which type of soil, helps to improve yields without external inputs. In addition, following crop rotations and fallow periods reduces pressure from pests.
- **Use of bio-pesticides and manure:** The use of bio-pesticides and manure minimises costs and the dependence on external production inputs while at the same reducing the risk of pollution and adverse effects on human health.

Figure 24: Cattle grazing on cropland before ploughing to enhance soil fertility (left) and direct distribution of dried cow manure (right)

Figure 25: Land preparation with ox-drawn (left) and horse-drawn ploughs (right)

Figure 26: Harvest of cowpea (left) and transport of crop residues of cowpea (right)

2.6.6 Challenges and solutions

The following challenges were encountered in the implementation of the adaptation measure:

- **Pest attacks**: Pest attacks, during all stages of plant development, remain a major challenge. If chemical pesticides are used, they are often purchased from vendors in local markets who also provide technical advice and guidance on pesticide use. Buying pesticides represents a high investment for farmers. Their incorrect application can cause harm to people and the environment and damage plants. Pesticide vendors in local markets often do not have the necessary knowledge to advise farmers on the safe and

efficient use of pesticides. In addition, many farmers do not have the proper equipment and use other materials for spraying, normally plastic bottles with pierced caps.

➔ **Use of biopesticides:** The neem tree (*Azadirachta indica*) grows naturally in Chad and Cameroun. Its seeds and/or leaves are collected, peeled, and immersed in water. The exudate is then filtered and put into a sprayer (or a perforated plastic bottle). The manufacture of solutions based on neem is time and labour intensive.

2.6.7 Results of the adaptation measure

The main results of the adaptation measure are mentioned below.

- **Higher and less variable crop yields**: Crop yields have increased and are less influenced by rainfall variability, droughts, pests, and other circumstances (***relevance, profitability***).
- **Reduced vulnerability of rainfed production to rainfall variability:** Due to a shorter growing period, better drought resistance and yield characteristics (***relevance, profitability***).
- **Improved fodder availability and additional source of income:** The agro-pastoralists supported by the project used the animal fodder from crop residues to feed their own animals during the dry season and sold it to other pastoralists. This reduced the agro-pastoralists' vulnerability to climatic variability and increased their adaptive capacities (***relevance, profitability, multiple benefits*****)**
- **Replication and dissemination in the pilot zone:** In addition to the project-supported activities (trainings, field visits, and farmer fields schools), farmers have continued using the adaption measures in years without project support. Participating farmers have shared seeds of the new varieties with their neighbours and people from other villages thereby increasing the dissemination of the varieties in the pilot zone. Finally, neighbours of participating farmers have also adopted the adaptation measures and learned from the project experiences (***relevance, scalability***).

Higher and less variable crop yields

Table 10 below shows rainfed crop yields for sorghum and cowpea from the agricultural inventory as well as the results of the adaptation measures. The yields of the sorghum and cowpea varieties chosen for human and livestock consumption are considerably higher than under baseline conditions.

Table 10: Crop yields of sorghum and cowpea under rainfed conditions (baseline for all rainfed production and adaptation measure for multi-purpose varieties)

climate zone	**sorghum**		**cowpea**	
	N	*kg/ha*	*N*	*kg/ha*
Baseline				
Sahelian-Sudanese	410	737	4	369
Sudanese-Guinean	461	929	51	742
pilot zone	871	833	55	714
Adaptation measure				
Sahelian-Sudanese	22	2,612	21	1,963
Sudanese-Guinean	-	-	-	-
pilot zone	22	2,612	21	1,963

Reduced vulnerability of rainfed production to rainfall variability

Table 11 shows the growing periods for sorghum and cowpea from the agricultural inventory as well as the results of the adaptation measures. The actually realised growing periods are in line with the recommendations from the technical data sheets and considerably shorter than under the baseline conditions.

Table 11: Growing periods of sorghum and cowpea under rainfed conditions (baseline for all rainfed production and adaptation measure for multi-purpose varieties)

climate zone	**sorghum**		**cowpea**	
	N	days	N	days
Baseline				
Sahelian-Sudanese	410	106	4	92
Sudanese-Guinean	461	141	51	92
pilot zone	871	125	55	93
Adaptation measure				
Sahelian-Sudanese	22	106	21	68.3
Sudanese-Guinean	-	-	-	-
pilot zone	22	106	21	68.3

Improved fodder availability and additional source of income

Participating farmers' hay yields for sorghum of ranged between 80 and 200 bales/ha with an average of 120 bales/ha. Average hay yields for cowpea ranged between 80 and 300 bales/ha with an average of 208 bales/ha. As the weight of a bale of hay is not standardized, it is difficult to estimate the amount of hay produced per hectare. However, the average weight of a bale of sorghum hay is estimated between 20 and 30 kg/bale resulting in average yield of 2,400 kg/ha for sorghum and 4,160 kg/ha for cowpea. See also Table 12.

Although quantitative data for this aspect were not recorded, participating farmers reported that they have sold the produced hay to migrating pastoralists and gained an additional income during the dry season.

Table 12: Straw yield of multi-purpose sorghum and cowpea under rainfed conditions based on different assumptions (20kg/bale, 25 kg/bale, and 30 kg/bale)

crop		**straw yield**		
	straw yield	20 kg/bale	25 kg/bale	30 kg/bale
	bale/ha	*kg/ha*	*kg/ha*	*kg/ha*
sorghum	120	1,800	2,400	3,000
cowpea	208	3,120	4,160	5,200

Replication and dissemination in the pilot zone

The best practices of adaptation were disseminated through farmer field school approach. In total, 28 farmers were supported by the project in adapting their animal fodder production practices. Out of the 28 farmers, seven were pilot farmers. Out of these seven pilot farmers, five acted as trainer farmers in the following years. Each of the five trainer farmers taught between three and five student farmers resulting in a total of 26 student farmers (see Table 13).

Participating farmers disseminated the best practices and new seed varieties beyond the scope of the project. Over the course of the project, the 28 participating farmers shared the new seed varieties with a total of 62 people, who were not directly supported by the project.

Finally, funding issues prevented the project from supporting farmers during the rainy season in 2017. A subsequent assessment in early 2018 found, that all farmers who had been supported in 2016 had continued applying the practices in 2017.

Table 13: Number of individual pilot, teacher and student farmers (male, female, and total) for the livestock adaptation measure from 2015 to 2018

year	**pilot farmers**			**teacher farmers**			**student farmers**			**total**		
	M	W	total	M	W	total	M	W	total	M	W	total
2016	7	0	7	0	0	0	0	0	0	7	0	7
2018	0	0	0	5	0	5	25	1	26	26	1	27
total	7	0	7	5	0	5	25	1	26	27	1	28

2.7 Dissemination of experiences and best practices

2.7.1 Introduction

Information from the climate study and the agricultural inventory were disseminated from the beginning of the project. A comprehensive dissemination strategy was developed in 2016 to ensure a broad dissemination of the knowledge on best practices for climate change adaptation.

The dissemination activities were designed and carried out to promote best practices of climate change adaptation within the pilot zone (micro level) as well as within the wider Lake Chad Basin (meso level). Dissemination measures and the establishment of networks among different actors are a continuous process. Different activities were designed to establish appropriate and efficient tools and messages to accommodate and reach different target groups. Individual measures were selected in consultation with LCBC staff and GIZ based on the dissemination concept.

Objectives

The dissemination measures had the following **objectives**:

- **To raise awareness** among farmers, technicians, representatives of the LCBC and other state representatives, on the impacts of climate change and thus the importance of climate change adaptation. Climate Change may be taken even more seriously if its cross-cutting impact can be clearly illustrated and understood (e.g. the impacts on health, agriculture, infrastructure etc.). The hypothesis is that a better understanding will increase the motivation and commitment to implement the adaptation measures.
- **To strengthen technical knowledge** to promote the implementation of agricultural adaptation measures, and the adoption of best practices.
- **To increase the number of people implementing adaptation measures:** In this context, it will be important to highlight and communicate that each individual can act and adapt to the effects of climate change without having to invest large sums of money and large amounts of labour.
- **To increase the number of women implementing adaptation measures:** Women shall be particularly targeted by the dissemination measures.

Content

In order to attain these goals, the following **content** was disseminated:

- Dissemination of experiences made during implementation of the adaptation measures, the best practices.
- Dissemination of results of the climate study and the Agricultural Inventory.

The content was disseminated through the following **strategic activities**:

- **Workshops/Meetings:** Promotion of exchanges and networking between actors to facilitate the exchange of knowledge and mutual learning.
- **Capacity development:** Building capacities for dissemination of best practices by training of change agents, or farmer teachers. The institutionalization of “best practices” was achieved by training of farmer teachers in the application of the new practices, with them acting subsequently as multiplying agents.
- **Provision of didactic material and information material** (audio and written) on the best practices as well as the impacts of climate change.

2.7.2 Farmer field schools

Introduction

In the second year of implementation of the agricultural adaptation measures, the farmer field school (FFS) approach was introduced. The FFS approach is widely known and applied in the context of rural development. The method is particularly well adapted to rural conditions and can be considered a highly cost-efficient tool for dissemination.

FFS allows for direct and reciprocal communication and exchange between students and trainers. The trainers themselves are members of the respective communities. The proximity of farmer trainers as well as their knowledge of local conditions and languages helps to create confidence and acceptance of adaptation measures within the communities, particularly when neighbouring farmers can directly witness the impact of the adopted measures and help to

ensure the respect of local traditions and practices. Further, the geographic proximity- between teachers and students facilitates exchange and allows for continues dialogue.

Objective and target audience

Objectives: The aim of the FFS approach was to disseminate the best practices within communities the pilot zone. More specifically, the FFS activities had the following objectives:

- **Replication:** To replicate successful adaptation measures in consecutive years.
- **Consolidation:** To consolidate and enhance adaptive capacities.
- **Increase in application:** To increase the number of participating farmers implementing the adaptation measures.
- **Sustainability:** To ensure the sustainability of best practices by broadening the base of people who know how to apply these practices. The practical trainings aimed at enabling the farmer students to apply the adaptation measures independently after completion of the trainings.

Target audience: The FFS approach was directly targeted at smallholder farmers and agro-pastoralists living and working in the pilot one.

Concept

An FFS is a regular exchange and training fora which takes place throughout one growing season. It brings together pilot farmers, who have previously participated in the project for at least one growing season and who will be trained to disseminate their experiences and knowledge with the adaptation measures as farmer trainers, and student farmers which have not yet participated in the project. See Figure 27 for a graphic representation of the FFS approach.

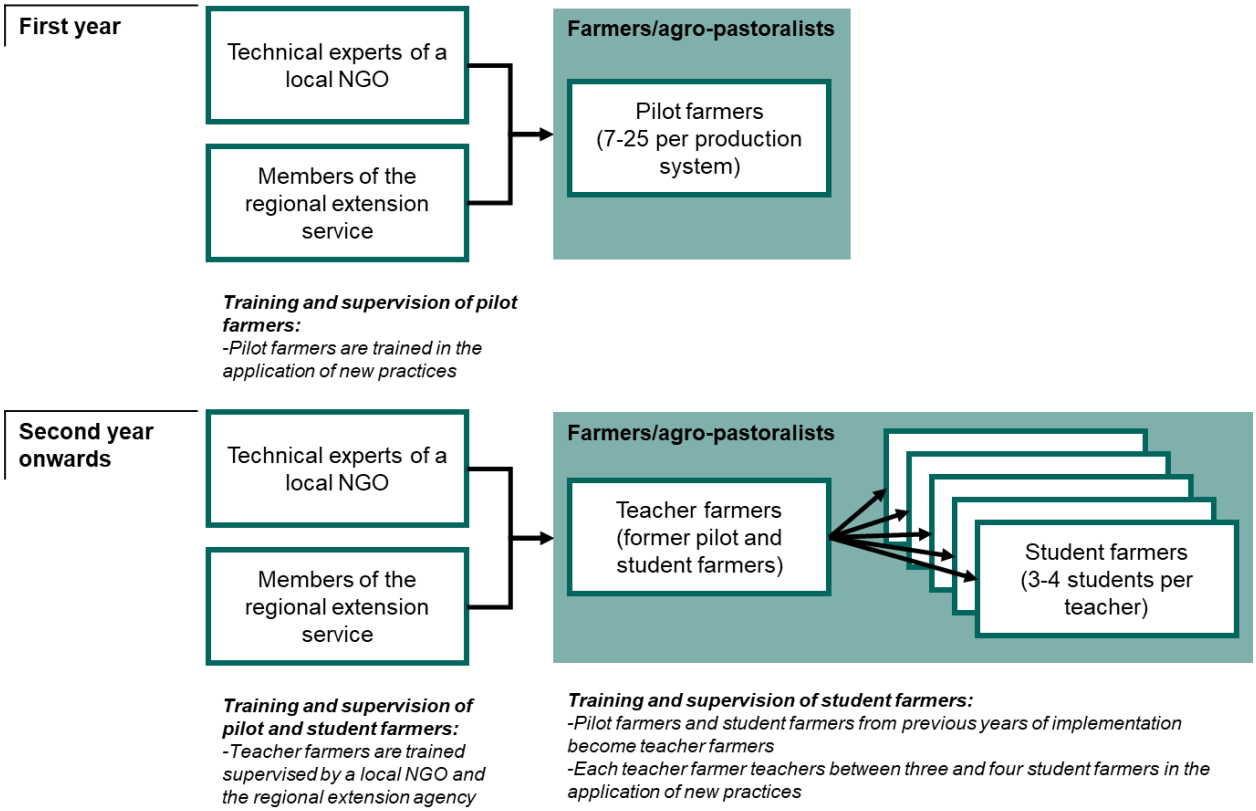

Figure 27: Farmer field school approach

Trainer farmers: The trainer farmers were trained by the extension services and NGOs contracted by the project . The aim of the trainings was to strengthen the participating farmers' knowledge of the agricultural calendar of the respective crop as well as to familiarize them with their role and responsibilities as farmer trainers. Farmer trainers were selected, according to the following selection criteria:

- Motivation of pilot farmers to act as farmer trainers: Farmer trainers were selected first on a voluntary basis to ensure commitment throughout the training period.
- The respective farmer's performance during implementation of the adaptation measure (adherence to the agricultural calendar etc.) during the first year.
- Dynamic attitude and communication and presentation skills.
- Their standing in the respective communities, based on the assumption that a well-known and respected farmer, for example a head of a farmer group, will increase confidence and commitment by the student farmers.

Student farmers: The trainings took place on a specifically selected test field of the trainer farmer at specific stages of the seasonal calendar. The acquired knowledge was then simultaneously implemented by the students on their own fields. The trainers conducted monitoring visits on the fields of their respective students to monitor implementation. The trainings were by agricultural extension staff.

The student farmers were proposed by the farmer trainers and selected by the project, based on an evaluation of their ability to participate. Proximity of student's fields to the test field of the farmer was equally considered to allow for regular exchange and facilitate movement.

Content

The content of trainings was based on the technical data sheets of the crop varieties provided by ITRAD and IRAD as well as on the experiences from the first year of implementation of the adaptation measures. In line with the information provided in the technical data sheets, the cropping calendar was divided into the following strategic steps to organise the training:

1. Sowing
2. Fertilizer application
3. Weeding
4. Pest management
5. Selection of plants for seed production
6. Harvest and post-harvest treatment, i.e. preparation of animal fodder

Figure 28: Training on preparation of biopesticides (left) and selection of plants for seed production (right)

The FFS was implemented in the following steps:

1. **Preliminary training of farmer trainers**, conducted by NGOs to:
    - Explain and familiarize themselves with their role as trainers.
    - Explain and prepare individual training sessions.
    - Revision of technical training received by ITRAD to consolidate knowledge of farmer trainers on the technical itinerary for the agricultural growing season regarding their crop type.
    - Identification and selection of test fields for implementation of trainings.
2. **Practical training of farmer students**, conducted by farmer trainers with support from NGOs, and extension staff:
    - Training was carried out on a designated test field of the farmer trainer at strategic moments of the cropping calendar. The strategic visits and trainings were conducted during: Sowing, utilization of fertilizer, weeding, crop selection for seed production, pest management, harvest.
    - Subsequently, visits to the farmer students were organized by the farmer trainer to monitor the implementation of activities on their respective fields and provide assistance, if necessary.

The total number of pilot, teacher and student farmers who participated in project, is shown in Table 14

Table 14: Number of individual* pilot, teacher, and student farmers from 2015 to 2018

System	Year	Pilot farmers	Teacher farmers	Student farmers	Total
rainfed	2015	11	0	0	11
	2016	8	6	27	41
	2018	0	6	27	33
	total	19	12	54	72
recession	2015	14	0	0	14
	2016	0	5	21	26
	2018	0	13	47	60
	total	14	14	63	74
livestock	2016	7	0	0	7
	2018	0	5	26	27
	total	7	5	26	28
total	2015	25	0	0	25
	2016	15	11	48	73
	2018	0	24	97	117
	total	40	31	140	170

*some farmers participated in multiple measures in a given year

2.7.3 Workshops

Introduction

A central aim of project interventions was to promote networking of actors within the project's pilot zone to facilitate the exchange of information and experiences between the different actors (producers) in Cameroon and Chad who have implemented the adaptation measure (test), research institutions (IRAD and ITRAD) as seed suppliers, as well as other actors involved during implementation of the adaptation measures, such as government technical services, the National Office for Rural Development (ONDR) and NGOs .In this context, indicator 3 specifies that '300 people (producers, technicians, extension agents, etc.) have participated in cross-border exchanges' (see chapter 1.2).

Different workshops were organised to present the results of the climate change study for the Lake Chad Basin and to present and validate the results of the inventory of agricultural production systems in the transboundary pilot zone. Other workshops were organized to bring together farmers from Chad and Cameroon and give them the opportunity to exchange their experiences with the application of best practices of agricultural adaptation.

Objective and target audience

The objectives and target groups of the workshops differed. Broadly speaking, the project organised two types of workshops with different objectives and target groups.

- **Workshops and presentation of the climate change study and agricultural inventory**
    - **Objective:** The main aim of these workshops was to present the results of the climate change study and inventory in order to identify and select potential

adaptation measures for the different production systems in the Lake Chad Basin.

- **Target audience:** The main findings of the study and inventory were presented and discussed during the workshops. The workshops brought together decision maker and technical experts from GIZ, the CBLT, and regional NGOs.

- **Farmer exchange workshops**
  - **Objective:** The two workshops held in Bongor were organized after the first and second year of implementation of the agricultural adaptation measures with the objective to:
    - Present the results of the adaptation measures in terms of harvest and yields
    - Assess and evaluate the technical details and implementation methodology of the adaptation measures.
    - Collect testimonies from different actors involved in the implementation of measures, results obtained, and differences observed compared to traditional methods.
    - Identify good practices and inform other local actors of the results of these measures.
    - Learn from these tests of improved varieties in the rainfed system and recession agriculture,
    - To disseminate locally and on a larger scale (Lake Chad Basin), effective measures and approaches that can contribute to local adaptation to climate change.
  - **Target audience:** The workshops brought together farmers, extension staff as well as technical extension staff of the government and the NGOs as implementing partners of the project to allow for an exchange of experiences and formulate recommendations for a continuation of the project measures.

Content

The contents and participants of the workshops depended on their respective objective. Table 15 provides an overview of dates, locations, topics, and participants of main workshops held as part of the project.

Workshops and presentation of the climate change study and agricultural inventory

Theses workshops presented the results of the climate change study and the agricultural inventory. The presentation of the results served as a basis for the identification, prioritization, and selection of adaptation measures. The results of the study and the inventory are presented in chapters 2.1 and 2.2 of this report. The selection process for the adaptation measures is presented in chapter 2.3.

Farmer exchange workshops

The presentations of the results and the testimonials of participants revealed that participants in the different departments concerned greatly appreciated the adaptation measure and the farmer-trainer approach, introduced with the second year of implementation.

Among the benefits of the measures as mentioned by the participant were, an increase in agricultural productivity, additional cash benefits as well as a better resistance of the seed to both drought and striga. In view of the good results obtained, producers in both evaluation workshops have expressed their willingness to continue implementing the measures during the next year. A higher workload in implementing the technical management measures learned during the training sessions than the ones they apply traditionally, a lack of material as well as an absence of storage capacities were named as the major constraints by the farmers.

Participants evaluated the FFS approach as highly effective. It appears that the approach is well suited to the context in the Lake Chad Basin. It was stated by the participants that the proximity between the farmer trainer and the farmer students is a clear benefit, as it facilitates discussion and encourages the motivation of other farmers. The NGOs that accompanied the tests even found that this approach is the most effective for the implementation and dissemination of experiences and good practices in a local context. With the support of the project and after training, the farmer trainers were able to provide technical advice and it was stated that the students were capable to apply what they have learned on their respective fields. Further, the involvement of pilot farmers from the first year was highly appreciated as it allowed for direct contact and the incorporation of lessons learned from the first year of implementation.

In addition, students and trainer farmers alike acknowledged that trainers were well motivated and almost always accessible, and hence able to provide continuous support and follow-up to their students. The continuous exchange throughout a growing season has thus created strong links between them. Several student farmer students have stated that they feel confident to implement the adaptation measure independently on their own fields. In addition, many of them even feel to be able to provide technical training to other farmers and several have confirmed the interest in becoming a farmer trainer during a future campaign. The illiteracy of some as well as travel difficulties seem to be among the major challenges in implementing this approach.

It was widely recommended to continue the implementation of these adaptation measures through the farmer trainer approach and even to expand this experience to other regions, activities or production systems. In view of the costs related to the adaptation measures regarding material, fertilizers or seeds, the continuation of external support was highly recommended.

In each of the two evaluation workshops, approximately 50 participants were reached.

Table 15: Overview of dates, locations, topics, and participants of main workshops held as part of the project

date	**location**	**contents**	**participants**
13.-14.10.2014	N'Djaména, Chad	• Presentation of preliminary results of the agricultural inventory in Chad • Presentation of preliminary results of the climate change study • Identification of adaptation measures	LCBC, GIZ, AHT, NGOs, FAO
10.-11.12.2014	N'Djaména, Chad	• Presentation of preliminary results of the agricultural inventory in Chad and Cameroon • Identification of adaptation measures	GIZ, AHT, NGOs
05.03.2015	N'Djaména, Chad	• Presentation of the final climate change study	LCBC, GIZ, AHT, NGOs, PRODEBALT, public (including civil society and university representatives)
26.03.2015	N'Djaména, Chad	• Presentation of the final results of the agricultural inventory • Development of criteria for the selection and hierarchisation of adaptation measures	LCBC, GIZ, AHT, NGOs
22.04.2015	Bongor, Chad	• Presentation of the final results of the agricultural inventory • Discussion of implementation arrangements of adaptation measures	LCBC, GIZ, AHT, NGOs, technical services
24.04.2015	Yagoua, Cameroon	• Presentation of the final results of the agricultural inventory • Discussion of implementation arrangements of adaptation measures	LCBC, GIZ, AHT, NGOs, technical services
22.02.2016	Bongor, Chad	• Transboundary workshop to exchange experiences with the adaptation measures	Farmers and agropastoralists, LCBC, GIZ, AHT, NGOs, RTN, technical services
12.05.2017	Bongor, Chad	• Transboundary workshop to exchange experiences with the adaptation measures	Farmers and agropastoralists, LCBC, GIZ, AHT, NGOs, RTN, technical services

2.7.4 Radio broadcasts

Introduction

In Chad and in particular in rural areas were access to electricity, internet and television is limited, radio is the most accessible and predominately used medium for mass-communication and reaches a high number of potential listeners. It allows for widespread dissemination of information at comparably low costs. Radio plays an important role in people's daily lives and is one of the most important means of information.

Hence, the project relied heavily on the radio as a method to disseminate adaptation practices and inform about the project and its activities and increase curiosity in the communities. Within the framework of this Project, radio programs were developed in cooperation with Radio Terre Nouvelle, a community radio based in the south of the project pilot zone and with the Chadian National Radio.

Radio Terre Nouvelle (RTN) is a community radio, created by the Catholic Diocese of Pala and has offices in Pala and Bongor. The station broadcasts its programs in parts of Chad and Cameron, with a broadcasting range covering the south-west, the departments of Mayo-Kebbi Est and Ouest and Tandjilé in Chad and two regions in the north of Cameroon (Nord et Extrême-Nord), with a population of approximately three million people. RTN broadcasts in French as well as in several local languages of the area, namely in Massa, Moussey, Toupouri, Zimé Ngambaye et Fulfulde and Arabic.

Radiodiffusion Nationale Tchadienne (RNT), the Chadian National Radio commonly known as Radio Tchad, has eighteen regional stations across the country. Namely in Ati, Abéché, Adré, Amtiman, Bol, Bardaï, Bongor, Doba, Faya, Fada, Gozbeïda, Kelo, Kyabé, Moundou, Sarh et Pala.

RNT broadcasts in 13 of Chad's most widely spoken languages. In addition, the station produces several programmes in French. It is the main radio station in Chad with the widest coverage and number of potential listeners. RNT covers all of Chad's 23 regions via shortwave. Outside of Chad, RTN is accessible via satellite and online. Official statistics on the number of listeners are not available.

Objective and Target audience

The target audiences and objectives of the radio broadcasts by Radio Terre Nouvelle and the Chadian National Radio were different:

- **Radio Terre Nouvelle (RTN):**
  - **Objective**: They aim of the broadcasts was to raise awareness about climate change and its impacts on agricultural livelihoods. Furthermore, they aimed to inform people farming in the pilot zone about practical measures to adapt their agricultural practices to climatic variability and change. The broadcasts focused on adaptation measure in rainfed agriculture.
  - **Target audience:** The broadcasts produced by RTN were designed for farmers and agro-pastoralists living and working in the pilot zone.
- **Chadian National Radio (RNT):**
  - **Objective**: The programs produced within the framework of the project aimed to increase awareness about climate change and its effect on agricultural

livelihoods in the Lake Chad Basin, to disseminate knowledge about best practices of adaptation, and to increase the visibility of the projects and to highlights its achievements.

- **Target audience:** A cooperation with RNT was pursued to produce additional radio programs to reach a wider audience. The programs were aimed at practitioners in the field of climate change adaptation, potential project partners, and a wider public with an interest in climate change adaptation in the Lake Chad Basin.

Content

As for the objectives and target audiences, the programs by RTN and Radio Tchad covered different issues.

Radio Terre Nouvelle:

The radio program on the project was structured around 11 individual radio broadcasts with a length between 20 and 40 minutes and broadcasted a total of 24 times between July 2016 and June 2017. The individual radio programs were part of series on climate change adaptation and broadcasted within the framework of two thematic journals of RTN on “Our Environment and Partners Platform”, which regularly cover topics on environment and the protection of biodiversity. The broadcasting schedule is presented in Table 16.

At first, a general overview of the project and the need for adaptation was provided in an introductory show. This program was followed by thematic programs on the preliminary training of farmers and six individual radio broadcasts on the methods and means of adaption. To this end, strategic stages during implementation of the adaptation measures were accompanied by the radio to inform about characteristics of the adaptation measures and relevant practices.

Specific characteristics of the adaptation practices were explained for the six stages of the agricultural calendar (sowing, use of fertilizer, weeding, pest management, selection of seeds for seed production, and harvest). Farmer’s testimonials were an integral part of each program. Finally, a radio program was produced to cover the transboundary workshop in Bongor in June 2017 as well as a final radio show, providing a condensed overview over the entire training cycle.

Chadian National Radio

The programs produced by the Chadian National Radio consisted to a large part of recorded interviews with representatives of GIZ, the CBLT, implementing partners as well as of testimonies of participating farmers. The material was collected during implementation of the adaptation measures in 2018 (rainfed agriculture, recession agriculture and livestock production). Audio material was collected in N’Djamena, as well as within the project’ intervention zone, namely, Guélendeng, Lina Mai and Dourbali.

The following radio programs were developed:

- A radio spot presenting the project (ca. 15 minutes) and
- Four shorter and thematic radio spots (ca. 5 minutes each) about climate change impacts and specific adaptation measures and best practices in agriculture.

The introductory program introduced the project and its context, basic information on the general characteristics of the adaptation measures as well as on the main results and impacts of the adaptation measures.

The thematic radio spots covered specific and more technical topics, including good practices

identified during the implementation of the measures regarding the different production systems. Each thematic program contained a brief reference to the project. The four thematic spots were produced under the titles and covered:

- Climate Change in the Lake Chad Basin and its effects on the major agricultural production systems.
- Good agricultural practice: Introduction of early seeds;(Rainfed agriculture).
- Good agricultural practice of fodder production (Livestock).
- Good agricultural practice: Diversification of livelihoods and development of recession agriculture (Recession agriculture).

The programs were produced and disseminated in French between November 2018 and March 2019. In total, 18 broadcasts were made. The broadcasting schedule is presented in Table 17on the following page.

Table 16: Topics, dates, and durations of radio programmes at Radio Terre Nouvelle (RTN)

topic	1st broadcast	2nd broadcast	3rd broadcast	4th broadcast	5th broadcast	duration
Introduction	23.07.2016 08:20	25.07.2016 08:20				00:35:13
Initial training 1	27.07.2016 18:20	30.07.2016 08:20				00:28:22
Initial training 2	10.08.2016 18:20	13.08.2016 08:20				00:35:15
Practical training 1 (sowing)	24.08.2016 18:20	27.08.2016 08:20				00:30:42
Practical training 2 (use of manure)	07.09.2016 18:20	10.09.2016 08:20				00:30:12
Practical training 3 (weeding)	21.09.2016 18:20	26.09.2016 08:20				00:33:09
Practical training 4 (pest management)	05.10.2016 18:20	10.10.2016 08:20				00:20:22
Practical training 5 (selection of seeds for the following year)	12.10.2016 18:20	17.10.2016 08:20				00:32:51
Practical training 6 (selection of plants and harvest)	19.10.2016 18:20	22.10.2016 08:20				00:41:52
Transboundary workshop	17.05.2017 18:20	27.05.2017 08:20				00:19:16
Final broadcast	21.06.2017 18:20	24.06.2017 08:20	28.06.2017 19:30	30.06.2017 08:20		00:28:12

Table 17: Topics, dates, and durations of radio programmes at Radio Nationale du Tchad (RNT)

topic	1st broadcast	2nd broadcast	3rd broadcast	4th broadcast	5th broadcast	duration
Presentation of the project	13.11.2018 20:05	16.11.2018 03:30	27.11.2018 20:05	28.11.2018 13:00	30.11.2018 03:30	00:17:17
Climate change in the Lake Chad Basin and its effects on major production systems	05.02.2019 20:05	08.02.2019 13:10	08.02.2019 03:30			00:10:06
The introduction of early seed varieties as a best practice	12.02.2019 20:05	15.02.2019 13:10	15.02.2019 03:30			00:13:02
The production of fodder crops as a best practice	19.02.2019 20:05	22.02.2019 13:05	22.02.2019 03:30			00:11:29
Crop diversification and recession farming as best practices	12.03.2019 20:05	14.03.2019 13:05	14.03.2019 03:30	19.03.2019 20:05		00:12:47

2.7.5 Production of a video

Introduction

A contract was awarded to Electron TV, a privately-owned Television Stations in Chad, for the production of a video about the project and its results. The activities were implemented between October 2018 to October 2019.

Objective and target audience

Objective: The objective of the production of the video was to inform target groups about the project and its context, and to disseminate knowledge about climate change, its impacts on agricultural livelihoods in the Lake Chad Basin, measures to adapt to climate variability and change, and the about the results and best practices developed as part of the project.

Target audience: The video was produced to attract the attention of the general public, practitioners in the field of climate change adaptation, project partners, other potential intervention partners in the region with activities related to climate change adaptation as well as farmer in the pilot zone.

Content

The video provides an overview about the project, the general characteristics of the adaptation measures in three agricultural production systems: rainfed agriculture, recession agriculture and livestock production and its results. To this end, the video visualizes the practical implementation of adaptation measures and experiences by presenting testimonies, including from pilot farmers, but also from NGOs, technical services, and other stakeholders, especially CBLT and GIZ. Material was collected during implementation of the adaptation measures in the project pilot zone.

The video is essentially comprised and structured according to the following parts:

- Introduction of the project and presentation of its context
- Documentation and visualization of the implementation of the adaptation measures in 3 production systems; by presenting:
    - The general characteristics of the adaptation measures.
    - The results and impacts during strategic stages of the cropping calendar.
- A summary of results and best practices.

To allow for wide dissemination of the video, the following options are recommended:

- Presentation of the video on the website of the LCBC, GIZ, and other video platforms.
- Organization of a public screening of the video in selected intervention zones of the project to target farmers.
- Distribution of copies to extension agents from government and NGOs.
- Presentation of the video during conferences and workshops at LCBC.

The original audio of the production was produced in French language with French subtitles for farmers' testimonies. A version with English subtitles is equally available.

2.7.6 Information material

Objective and target audience

Objective: The objective of the different information materials was to inform target groups about the project and its context, and to disseminate knowledge about climate change, its impacts on agricultural livelihoods in the Lake Chad Basin, measures to adapt to climate variability and change, and the about the results and best practices developed as part of the project.

Target audience: The video was produced to attract the attention of the general public, practitioners in the field of climate change adaptation, project partners, other potential intervention partners in the region with activities related to climate change adaptation as well as farmer in the pilot zone.

Fact sheets and posters

The information material includes:

- **Four thematic fact sheets:** one fact sheet about the project's context, its general objectives, and results, as well as three thematic fact sheets in order to present best practices regarding the three agricultural production systems: rainfed agriculture, livestock production, and recession agriculture.
- **A poster:** To present the project context and approach as well as the main results of the adaptation measures.

The material was disseminated via the homepage of the LCBC and through the distribution of the material to implementation partners and interested partners to enable dissemination beyond the project pilot zone.

Website CBLT / Regional database / Lake Chad Information System (LIS):

To support presentation of project results and activities on the Website of LCBC; a new section in the 'download' category was created in order to gather all the materials and products related to the project in one place. Further, a short abstract for each knowledge product produced by the project was developed.

Climate change relevant information has been integrated into the LIS sub-menu "Climate Change" and specific reports and figures from the CC study are available for download in the Document Management System of the LIS.

Photo exhibition

A photo exhibition organized within the framework of project took place in the premises of the Lake Chad Basin Commission (LCBC) in N'Djamena in May 2016. The exhibition was organized under the motto 'Climate Change – Life and Survival under the African sun', in N'Djamena, Chad. The photos on display document the first successes of the pilot measures implemented, such as an increase of yields and more reliable harvest; generation of income and of greater food security through diversification of crops as well as improved resilience of households and farmers to the effects of climate change.

More than 40 public representatives from LCBC member states and the African Union attended the event. It provided a great opportunity to learn from good adaptation practices and to inform

and sensitize the participants on climate change and agricultural adaptation. The exhibition was later hosted in GIZ premises in Bonn, Eschborn, and Berlin.

International conferences

From 01 to 03 April 2019, the Consultant's expert for climate change adaptation and agriculture attended the 13th Community-Based Adaptation (CBA13) conference in Addis Ababa, Ethiopia.

Apart from exchanging with national and international practitioners in the field of climate change adaptation, the Consultant presented the approach and results of Component C Adaptation to Climate Change of the Programme Sustainable Water Management in the Lake Chad Basin.

2.7.7 Un-guided dissemination

The previous chapters have provided a brief overview of the project's 'guided dissemination' activities. Guided dissemination activities allowed for a fairly wide dissemination. The farmer trainer approach multiplied the number of pilot farmers compared to the first campaign. Already for the preliminary training of farmer trainers and student farmers, the project brought together participants from Cameroon) and Chad, thus allowing cross-border exchange of farmers. The radio programmes produced during implementation have increased the number of potential beneficiaries and facilitated dissemination beyond the project pilot zone.

The 'un-planned' or 'un-guided' dissemination in the region took place during the preparation and the implementation of adaptation measures through seed distribution to neighbors or family or spontaneous exchange between pilot farmers and farmers passing near the test field. Some farmers have voluntarily started to apply the adaptation measure on their fields, either with the help of additional seeds distributed by the NGOs or other farmers. In addition, some participants expressed a willingness to pass on the new technical knowledge acquired to others even without involvement of the project. Pilot women farmers who are members of a women's group play a key role and encourage other women to adopt new practices.

3 Lessons learned and conclusions

3.1 External evaluation and recommendations

An assessment by GIZ, carried out after the end of the initial project in June 2018 (GIZ, 2019), found that, without exception, the chosen measures correspond to the needs and interests of all target groups. In terms of agricultural methods, the project has managed to convince farmers to combine traditional methods of farming with new farming techniques adapted to the new climate realities.

However, the evaluation also highlighted that the project design and implementation did not make enough provisions for farmers having access to agricultural tools after the project ends. This carries a risk for the long-term sustainability of the project interventions.

The evaluation did not find any unintended negative results of the interventions. However, it made few recommendations with respect to the planning and implementation of measures that were integrated into the project activities in the period from June 2018 to June 2019:

- **Exploring possibilities of ecologically friendly techniques to combat plant pests and diseases jointly with pilot farmers:** To reduce the dependency on costly external inputs and increase the environmental sustainability of the adaptation measures, during the rainy seasons and dry seasons of 2018 and 2019, farmers were trained in the preparation of biopesticides from the seeds of the Neem tree. While farmers use these biopesticides for pest control, they continue to use additional chemical pesticides too as the preparation of biopesticides is time and labour intensive.
- **Stronger focus on establishing mechanisms and capacities to reproduce and disseminate improved seed varieties:** Following the evaluation, from 2018 to 2019, the project put a stronger focus on supporting farmers in the selection of seeds for re-sowing in the following seasons.
- **Increase knowledge and awareness about climate change and its effects:** Many farmers appeared not to be aware of the long-term nature of climate change and its effects. To increase the overall knowledge and awareness about climate change and its effects, the radio programmes produced and broadcast by Chadian National Radio in 2018 and 2019 included programmes about the basics of climate change and its impacts on agriculture and natural resources in the Lake Chad Basin.
- **Cover at least three annual cycles to test out new adaptation measures:** . Any project introducing new farming techniques should cover at least three annual cycles – ideally four or five, especially in a socio-cultural context where traditional farming techniques have been applied over generations and changes need time to eventually happen. Adaptation measures in the livestock, rainfed and recessional agricultural systems were replicated in 2018 and 2019 to cover additional seasonal cycles to improve knowledge about the adaptation measures and reinforce their implementation at the local level.
- **Focus more strongly on vulnerable or disadvantage members of the target communities:** Though the project selected the appropriate target group representatives for its approach and concept, it should include interventions to cover more members of the target communities. Steps to bring the new farming techniques to more vulnerable or disadvantaged groups should be considered and integrated into the results matrix and project approach. This recommendation was only partly addressed as the project's focus lay on testing adaptation measures and developing appropriate mechanisms to disseminate them. As part of this approach, farmers with the capacity to motivate and guide their fellow community members were chosen as pilot farmers. As such, these farmers

were relatively well off compared to more vulnerable people living in the same villages. However, this allowed them to take more risks in applying the methods and introducing them to their neighbors, friends, and families.

3.2 Best practices

The measures to adapt agricultural production to climate variability and change described in this report can considered as “best practices” according to the definition presented in chapter 1.4. This means that:

- **Relevance:** The measures contribute to adaptation by building adaptive capacity and reducing vulnerability to climate variability and change. An increase in adaptive capacity is characterised in the beneficiaries’ improved knowledge about good agricultural practices, the availability of improved seed varieties and the additional income generated from these practices. In all three production systems, the reduced vulnerability is evidenced by the increased and more stable agricultural production.
- **Profitability:** All of the tested measures have proven to be profitable in the sense that they increased yields and, in the case of watermelon and musk melon production, directly increased monetary household income.
- **Scalability:** All of the tested adaptation measures can be considered to be easily scalable. The presented measures neither entail high initial investment costs nor long preparation periods. Improved seed varieties that are adapted to progressive climate variability and change can be obtained from governmental and private actors. The preparation and adaptation of training materials for farmers can be done in collaboration with local NGOs with an intimate knowledge of local customs and people’s existing knowledge base. Through the Farmer Field School approach, a large number of beneficiaries can be reached while at the same time increasing local ownership of the new measures. During an unintentional pause in support by the project in 2017, farmers continued using the adaption measures. Participating farmers have shared seeds of the new varieties with their neighbours and people from other villages thereby increasing the dissemination of the varieties in the pilot zone. Finally, neighbours of participating farmers have also adopted the adaptation measures and learned from the project experiences. It has to be noted, that not thorough financial evaluation of the implementation costs of the measures has been done within the scope of this report.
- **Multiple benefits:** The measures to improve the production of sorghum in the dry season, to diversify the production in the recession agriculture system and to improve the fodder production have all provided multiple benefits to the people applying them. Apart from diversifying livelihoods through growing new crops and applying new production methods, the measures have helped participating farmers to increase their income.

3.3 Potential for up-scaling

The measures described in this report can considered to the best practices that help farmers to adapt to the impacts of climate variability and change. Apart from the positive effects that the measures have on individual farmers and households, they also lead to transboundary effects which can be further enhanced through vertical up-scaling measures. In this regard, the following observations must be highlighted:

- **Transboundary effects of adaptation measures:** Initial actions focused on adaptation measures for three production systems at household/farmer level, increasing resilience to the impacts of climate change in these systems. This is justifiable in the context of limited knowledge of the long-term impacts of climate change at farmer level and the need to strengthen this awareness and resilience, due to the vulnerability of the mainly subsistence production systems to changing rainfall patterns. However, from a transboundary water resources perspective, the activities address the regional water management challenge to agricultural production resulting from the southern shift of the 120-day line (transboundary impact of climate change). Whilst the activities are by nature focused on individual farming households, they are applicable from east to west across the LBC (see Figure 5) and thus potentially of regional relevance in improving local water resources management, and increasing household resilience.
- **Horizontal vs. vertical up-scaling:** So far, the dissemination efforts have focused on “horizontal upscaling” with the spreading of concepts efforts primarily targeting new famers at the same level (through FFS, radio broadcasts and even spontaneous uptake). Information about best practices generated within the scope of the project have informed the formulation of the LCBC’s regional climate change adaptation strategy which was validated by the LCBC Council of Ministers in 2019. To strengthen the capacities of the LCBC in working with adaptation to climate change through agriculture, more vertical upscaling will serve to institutionalise the approaches into the macro-level represented by the LCBC which can provide information to national focal points which can support dissemination beyond farmer-to-farmer contact in border areas.

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5 Photo credits

Figure 7: “Rainfed maize and sorghum” (left photo) by ESPOIR on behalf of GIZ, “Recessional sorghum plant” (centre) by AHT, and “Market gardening” by APR on behalf of GIZ

Figure 8: “Cattle at a watering point” (left photo) by APR on behalf of GIZ and “Transhumant pastoralists” by AHT

Figure 9: “Approaching rain near Bongor” (left photo) by AHT and “Dried up sorghum field near Dourbali” by ESPOIR on behalf of GIZ

Figure 10: “Focus group discussion as part of the agricultural inventory” (left photo) by ESPOIR on behalf of GIZ and “Selected results of workshop at LCBC to select adaptation measures” (right photo) by AHT

Figure 12: “Line sowing of cowpea” (left photo) and “Ridging of sorghum field after fertilizer application” (right photo) by Sana Logone on behalf of GIZ

Figure 13: “Sorghum field (variety CS-61) 29 days after sowing” (left photo) and “Sorghum field (variety CS-61) 64 days after sowing” (right photo) by ESPOIR on behalf of GIZ

Figure 14: "Striga infestation" (left photo) and “Striga hermonthica, a parasitic weed of cereal crops” (right photo) by IITA Image Library (licensed under CC BY-NC 2.0. To view a copy of this license, visit https://creativecommons.org/licenses/by-nc/2.0/)

Figure 15: “Group of farmers weeding a cowpea field” (left and right photo) by ESPOIR on behalf of GIZ

Figure 17: “Preparation of neem-based biopesticides against stemborers” (right photo) by SOS Sahel on behalf of GIZ and Walker, K. (2008) “African sugar-cane borer moth (Eldana saccharina)” (right photo) Updated on 2/8/2008 3:21:59 PM Available online: PaDIL - http://www.padil.gov.au (licensed under CC BY 3.0 AU. To view a copy of this license, visit https://creativecommons.org/licenses/by/3.0/au)

Figure 18: “Sorghum nursery” (left photo) and “Preparation of sorghum plants for transplanting” (right photo) by ESPOIR on behalf of GIZ

Figure 19: “Traditional method of transplanting sorghum on recessional land” by AHT

Figure 20: “Sorghum plants ca. 60 days after transplanting” (right photo) by AHT and “Women preparing flour and weaving baskets from sorghum grain and leaves” by APR on behalf of GIZ

Figure 21: “Farmer with harvested watermelons” (left photo) by ESPOIR on behalf of GIZ and “Watermelons at a market” (right photo) by AHT

Figure 23: “Watermelon damaged by mammals” (left photo) by AHT and “Guard tower in a sorghum field” by ESPOIR on behalf of GIZ (right)

Figure 24: “Cattle grazing on cropland before ploughing to enhance soil fertility” (left photo) and “Direct distribution of dried cow manure” (right photo) by ESPOIR on behalf of GIZ

Figure 25: “Land preparation with ox-drawn plough” (left photo) and “Land preparation with horse-drawn plough” (right photo) by ESPOIR on behalf of GIZ

Figure 26: “Harvest of cowpea” (left photo) by APR on behalf of GIZ and “Transport of crop residues of cowpea” (right photo) by ESPOIR on behalf of GIZ

Figure 28: “Training on preparation of biopesticides” (left photo) by SOS Sahel on behalf of GIZ

and “Selection of plants for seed production” (right photo) by APR on behalf of GIZ

6 Annexes

Technical sheets of improved varieties

Annex 1. Rainfed production: Technical itineraries and cultural calendars of the sorghum varieties Zouaye, CS-54 and Damougari, the cowpea/Niébé varieties Lori and Fékem, and the maize varieties CMS9015, EVDT-99, TZEE and TZE-comp
Annex 2. Sorghum (rainfed): technical itinerary and crop calendar of the varieties Zouaye, CS-54 and Damougari
Annex 3. Sorghum (rainfed): CS-54
Annex 4. Sorghum (rainfed): CS-61
Annex 5. Sorghum (rainfed): S-35
Annex 6. Sorghum (rainfed): observations on technical itinerary of variety S-35
Annex 7. Sorghum (recession agriculture): Red Djiresse
Annex 8. Sorghum (recession agriculture): White Djiresse
Annex 9. Cowpea/Niébé (rainfed): technical itinerary and crop calendar of the varieties Lori and Fékem
Annex 10. Cowpea/Niébé (rainfed): TN5-78
Annex 11. Cowpea/Niébé (rainfed): observations on technical itinerary of variety Fékem
Annex 12. Maize (rainfed): technical itinerary and crop calendar of the varieties CMS9015, EVDT-99, TZEE and TZE-comp
Annex 13. Watermelon (recession agriculture): Crimson sweet
Annex 14. Musk melon (recession agriculture): Charentais

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