MEMORANDUM OF UNDERSTANDING (MOU)

BETWEEN

THE CLIMATE CHANGE ADAPTATION AND AGRIBUSINESS SUPPORT PROGRAMME (CASP) OF THE FEDERAL MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT OF NIGERIA (FMARD)

AND

INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS (ICARDA)

FOR CONDUCTING

SUSTAINABLE LAND MANAGEMENT ACTIVITIES

IN CASP AREAS OF THE SAVANNAH BELT OF NORTHERN NIGERIA

PARTICIPATORY SURVEY ON SOIL AND WATER CONSERVATION PRACTICES AND WATER HARVESTING SYSTEMS IN THE SAVANNAH BELT OF NORTHERN NIGERIA

REPORT

JUNE 2018

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SUGGESTED CITATION:

Diwediga B., Zucca C. (2018). “Participatory Survey on Soil and Water Conservation Practices and Water Harvesting Systems in the Savannah Belt of Northern Nigeria”. Technical Report. International Center for Agricultural Research in Dry Areas (ICARDA). Rabat, Morocco.

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Acknowledgement

- IFAD-CASP team from Katsina Headquarter
- SSO and staff (in Katsina, Zamfara, Yobe, Kebbi, Sokoto, Dutse & Borno)
- LGSO teams and supporting teams in the visited VA/CDA, and
- All farmers and the communities in the Savannah Belt of Nigeria

List of Acronyms

CAP	: Community Action Plan
CCS	: Climate Change Specialist
CDA	: Community Development Area
FYM	: Farm Yard Manure
ICARDA	: International Center for Agricultural Research in Dry Areas
IFAD-CASP	: International Fund for Agricultural Development – Climate Change Adaptation and agribusiness Support Programme
IFAD-CBARDP	: International Fund for Agricultural Development – Community-Based Agricultural and Rural Development Programme
LGSO	: Local Government Support Office
NPC	: National Programme Coordinator
NPK	: Nitrogen (N) Phosphorus (P) Potassium (K)
PLUP	: Participatory Land Use Planning
SLM	: Sustainable Land Management
SSO	: State Support Office
SSP	: Single Super Phosphate
SWC	: Soil and Water Conservation
VA	: Village Area
WH	: Water Harvesting
WOCAT	: World Overview of Conservation Approaches and Technologies

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1. Introduction

Given the increasing population relying on scarce land resources and the subsequent increase in food needs for both animal and human, it is important that focus is given to how land resources can be managed to secure sustainability for future generations. Even though innovations are needed for boosting sustainable management practices, an understanding of current soil management and cropping systems is required to identify site-specific options that better fit sustainability principles for a better rural transformation in the context of climate change. In this regard, a diagnostic survey is important to identify, through a participatory approach, current soil and water conservation practices and water harvesting systems, and to understand their association with land degradation issues and with land use/management and cropping systems.

The Climate Change Adaptation and Agribusiness Support Programme (CASP) of the Federal Ministry of Agriculture and Rural Development of Nigeria (FMARD) aims at mainstreaming climate change adaptation measures in the savannah belt of Northern Nigeria, through a landscape rehabilitation approach focused on sustainable land management. Demonstration sites will be established across seven Nigerian states (Borno, Yobe, Jigawa, Katsina, Zamfara, Kebbi, Sokoto). ICARDA is supporting CASP in identifying and implementing location-specific, effective and innovative soil and water conservation (SWC) and water harvesting (WH) adaptation techniques in the rainfed production systems, and technology packages that support the sustainable introduction of improved ICARDA's wheat varieties in the irrigated production systems.

This report is part of the collaborative work between IFAD-CASP and ICARDA. It summarizes the results of the diagnostic survey of the current adoption of SWC practices by farmers in the CASP sites, including the assessment of their effectiveness and their association with current cropping and farming systems and soil degradation processes.

2. Methodology

The diagnostic survey was implemented based on a methodological protocol purposely developed by ICARDA and discussed and agreed with CASP team (Annex 1 & Annex 2).

The protocol was drafted based on the outcomes of two preparatory missions conducted in Nigeria by ICARDA scientists who visited several CASP communities located in four States (Jigawa, Kebbi, Sokoto, and Zamfara). The visited sites were selected because representative of different bio-physical and socio-economic conditions, and affected by a range of land degradation problems (particularly water erosion) and land management issues.

Schematically, the protocol includes 6 steps organized in 2 phases, with group interviews and individual interviews, as follows:

Phase 1: Group interview with community members, to i) introduce the main, most frequent crops and farming systems in the community land, ii) discuss SWC issues and related actions as previously identified by the communities in the frame of the CASP activities, and iii) Identify farmers ("adopters" of SWC/WH practices, or "non-adopters") for individual interview at fields.

Phase 2: Farm visit with selected farmers, individual interview, and direct field observations, to document i) soil and water degradation processes, soil type, and water availability, ii) farming practices, iii) specific SWC/WH practices, and iv) georeference the observations.

All the collected data were organized in a spreadsheet dataset to enable data analysis.

3. Survey implementation

3.1. Study area

IFAD-CASP sites are located in the northern savannah belt of Nigeria (Fig 1). Seven states are targeted by this project: Kebbi, Sokoto, Zamfara, Katsina, Jigawa, Yobe, and Borno. All the sites fall in the semi-arid agroclimatic zone of Africa. During this survey six states were visited, all but Borno, involving 16 communities (Fig 1).

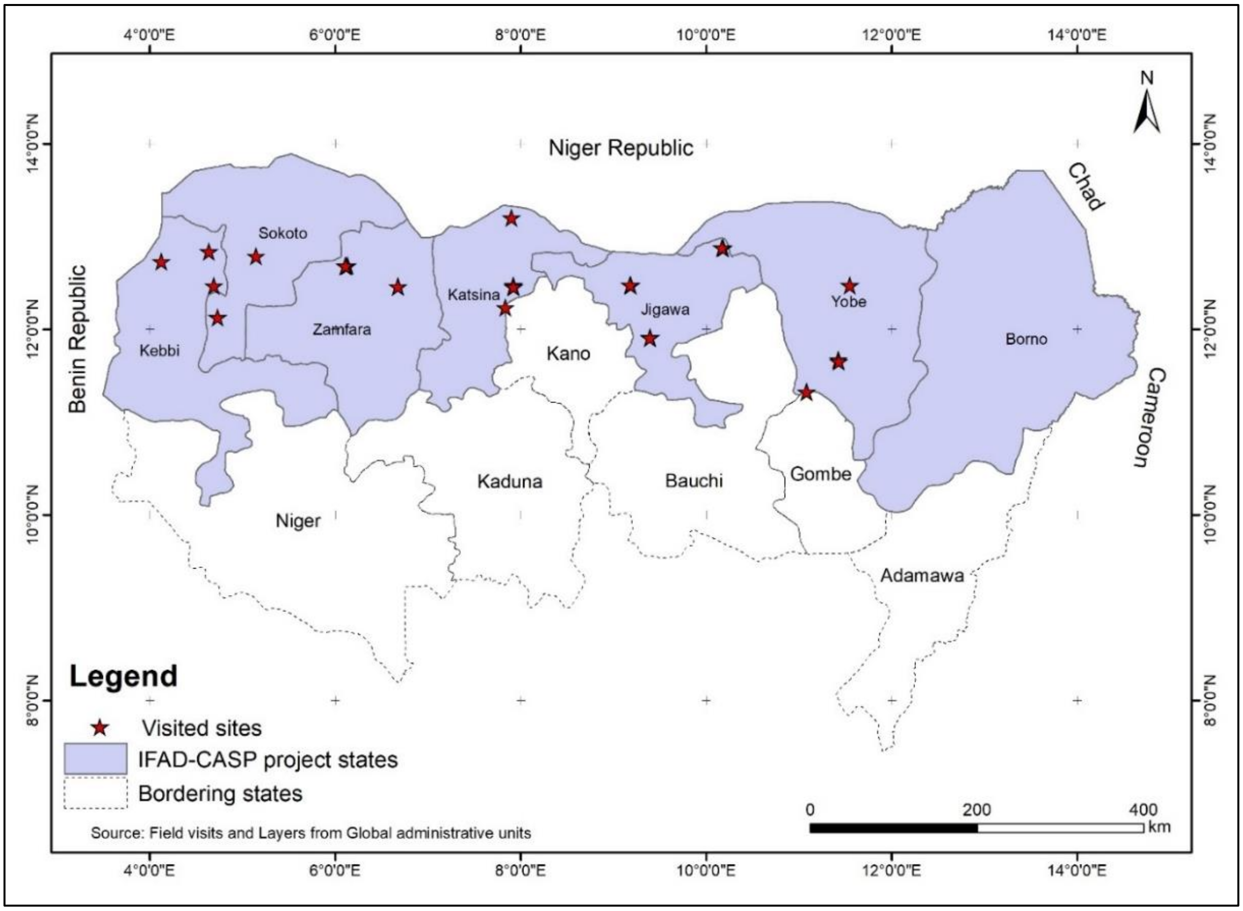

Fig 1. Visited Community Development / Village Areas (CDA/VA) in IFAD-CASP States (Source: Authors' elaboration, May 2018).

3.2. Data collection and analysis

This section briefly describes how the two main components of the survey protocol were implemented in the field in the 16 communities visited.

Phase 1. Group discussion at the community level

The visited communities were selected based on relevance of land degradation issues as documented by the community action plans (CAPs) drafted by the communities in the frame of the CASP programme, and on accessibility (time constraint). Community entrance was ensured by the IFAD-CASP team who helped in identifying the sites and in engaging the communities. During group discussions, representative farmers were gathered and participated interactively to introduce the main, most frequent crops and farming systems in the community land. Thanks to this approach the data collection process was sufficiently understood by the communities, among which representative farmers offered availability to be engaged for the second phase (individual interview).

During the group meetings the discussion addressed several aspects of the land degradation issues and of the inherent mitigation actions, as described in the CAPs. To have an overview of the common initiatives undertaken to mitigate these issues at the community level, farmers were asked to describe and explain what measures they were already practicing, either traditionally or as a consequence of development initiatives supported by institutions.

In addition, information was gathered on gender and age aspects (roles and responsibilities of household members in land management practices), level of mechanization, land resources and tenure, and institutional aspects (land governance and ownership, access to market and credit, etc.), social integration (farmers 'association, access to information, etc.), surface water availability and management, water shortage occurrence and related solutions, etc.

The final step of this phase was the identification of farmers adopters/non-adopters of SWC/WH practices, for individual interview at farmer's fields.

Group discussions in Bangarawa VA/CDA (Kebbi)

During discussions in Jimbam VA/CDA (Yobe)

Phase 2. Individual interview with selected farmers at the farm field level

During the face-to-face interview, efforts were made to eliminate as much as possible interference from peer farmers by isolating the interviewees. From the group discussions, it became clear that several farmers hold several cultivated fields/plots at different locations. In this regard, emphasis was made only on the farm plots on which SLM practices were adopted or where the farmer was experiencing the land degradation issues.

Field visit in Daura VA/CDA (Yobe State)

On-site questionnaire survey in Jimbam VA (Yobe State)

Specific SWC/WH practices were documented in the field by collecting elements for their description, purpose, inputs/costs, technical specifications, etc. Soil and water degradation processes addressed by the measures were also documented.

Direct observations conducted in the farmers' fields helped in documenting specific site conditions such as soil color, texture, structure, and cropping systems (trees/animals integration, on-farm tree species diversity, etc.). The geographical coordinates of the main farm fields were also collected to generate location-specific information on the SWC or WH practices documented.

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4. Outputs of the participatory survey

4.1. Observed SWC and WH measures by State

4.1.1. Kebbi State

4.1.1.1. Common SWC and WH systems in the visited communities

Three CDA/VA were surveyed in Kebbi state: Bui, Bangarawa and Masama. The communities actively participated in the sessions: participants were 22 to 50 with average female ratio and youth ratio of 0.41 and 0.29, respectively (Fig 2).

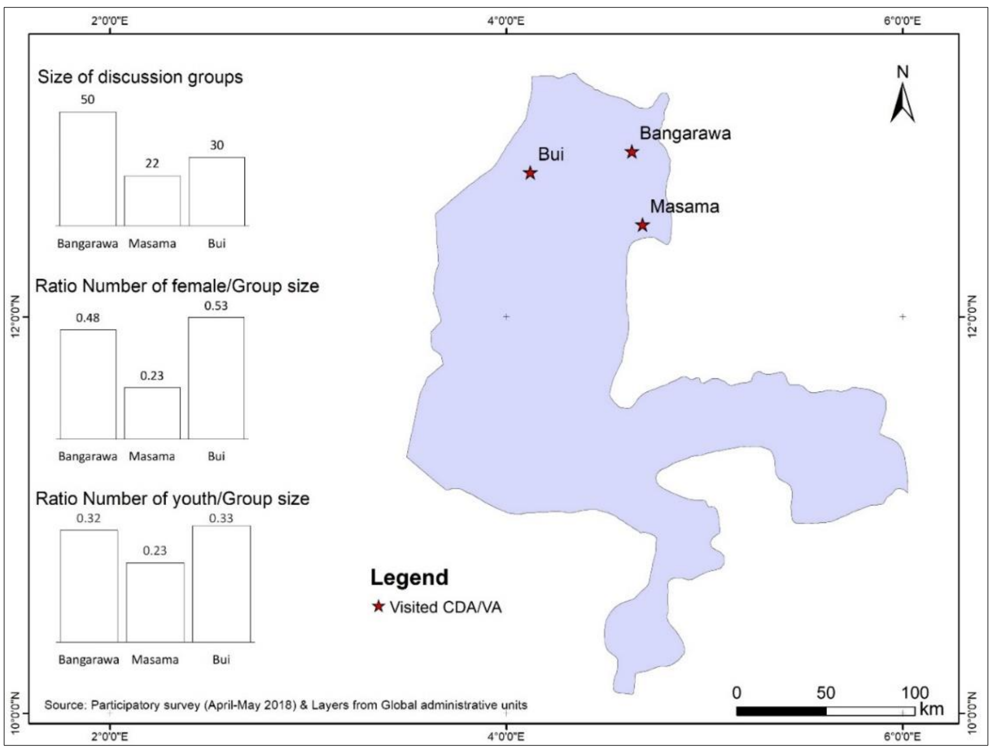


Fig 2. Visited Community Development / Village Areas (CDA/VA) in Kebbi State (Source: Authors' elaboration, May 2018).

An overview of the SWC measures adopted at the community level is shown in Table 1. Specifically, these measures aim at conserving efficiently soil moisture, restoring soil fertility, and mitigating gully and sheet erosion. Contour bunds, contour ploughing/ridges and planting grasses as well as sand bags are used for water erosion control. Planting pits, contour ploughing and half-moon techniques aim at rainwater harvesting and moisture conservation for growing crops. Beside manuring and fallowing, the communities reported that planting leguminous crops, such as cowpea and groundnut, contributes to improve soil fertility management.

Concerning water harvesting systems for both animal drinking and multipurpose human consumption, no measure was reported in the visited communities. The main reason is that the State lies within a relatively more humid environment in the savannah belt of Nigeria. However, some open wells exist for multipurpose uses (human consumption and animal drinking; see photo below).

Table 1. SWC/WH measures adopted in the visited communities of Kebbi State

CDA / VA	Adopted measures	Mitigation targets
Barangawa, Masama	Manuring	Soil infertility
Barangawa, Masama, Bui	Planting pits	Soil infertility, soil moisture
Barangawa	Planting Vetiver grass	Sheet erosion
Masama	Planting grasses (e.g., *Datura arborea*)	Gully erosion, Sheet erosion
Masama	Sand bags	Gully erosion, Sheet erosion
Masama	Fallowing	Soil infertility
Masama	Planting leguminous species (cowpea, groundnut)	Soil infertility
Masama, Bui	Contour ridges/contour ploughing	Gully erosion, Sheet erosion, Soil moisture conservation
Masama	Contour bunds	Gully erosion, Sheet erosion
Masama, Bui	Half-moon	Soil water harvesting and moisture conservation

Contour ploughing/planting in Bui VA (Kebbi State)

Earth/stone bunds for controlling runoff in Bangarawa VA (Kebbi State)

Farmer managing manure in Bangarawa VA (Kebbi State)

Open well for human and animal drinking in Masama VA (Kebbi State)

4.1.1.2. Brief description of selected SWC and WH measures

- **Planting pits**

Planting pits are a common SWC technique in the Barangawa, Masama and Bui communities of the Kebbi State. These pits are dug at planting using hoe to harvest rain water and enhance soil moisture, and to lose the compacted and crusted soil surface. In the visited site (farm of Mr. Mohamad Muazu) in Bangarawa VA, the farm was located on slightly sloping land (3 %). The size of pits was 20 cm depth and 20 cm radius. Consecutive pits were 90 cm spaced and dug in row or anyhow in the field. This size recalls elephant foot prints (“*Sawungiwa”* in Haussa language). Main crops (millet, cowpea, late millet) are planted following the pit patterns (on row or erratic). The benefits of this practice is that crop development is facilitated by the loose soil in the pits. The farmer liked this practice for its effectiveness in soil moisture harvesting and conservation. However, it is time-consuming and hectic for large-scale holders.

- **Contours bunds (embankments)**

Contour bunding is a SWC measure consisting in establishing earth embankments aiming at runoff control. It aims at preserving land from water erosion. Bunds are constructed with stones and earth associated with vegetative components (*Vetiveria sp.*, *Lawsonia inermis*). In one visited farm in Masama (Mr. Mohamed Ine) this SLM was implemented with support from IFAD-CBARDP since 2008. This practice served as a demonstration case for that project. All the farmland was crossed with bunds that contributed to store runoff water, conserve soil moisture and nutrients. This induced an effective control of water erosion and a yield increase. On average, a bound was 80 to 100 m long, 0.5 to 1 m wide, and 0.5 m high. The average slope was around 1 % (very gently sloping terrain). The surface runoff was originated from the adjacent lands. The main crop types on the managed lands were millet, sorghum and late millet. The establishment cost was not estimated by the farmer as it was born by the CBARDP. The maintenance was deemed by the farmer as tremendous activity in terms of inputs of material (stones, plants) that need to be frequently supplied. The farmer was trained on the maintenance activities by the CBARDP. Family labor was used for annual maintenance with an estimated cost of 20,000 naira.

Earth/stone bunds for controlling runoff in Bangarawa VA (Kebbi State)

- **Contour ploughing**

This SLM practice consists of ploughing across the slope in order to prevent high surface runoff and sediment transportation. It also aims at conserving soil moisture. It was reported in Masama and Bui CDA (Mr. Djibril Tela in Bui). The size of the visited plot where the SLM was implemented was about 200 m x 50 m. Nearly, 3/4 of the land had low slope angle (5 %). Ploughing was done on the length direction of the farm plot. Millet, sorghum and cowpea were the main crop types on the managed lands. It was difficult to estimate the establishment cost of this practice as compared to downslope ploughing; depending on slope it may require more time and effort. Since ploughing is done on annual basis, there was no maintenance cost associate to this SWC practice.

Land ploughed across the slope gradient in Masama (Kebbi State).

4.1.2. Sokoto state

4.1.2.1. common SWC and WH systems in the visited communities

In Sokoto state the visited CASP sites were Badau and Kebbe, respectively located in the central and southern part of the State (Fig 3).

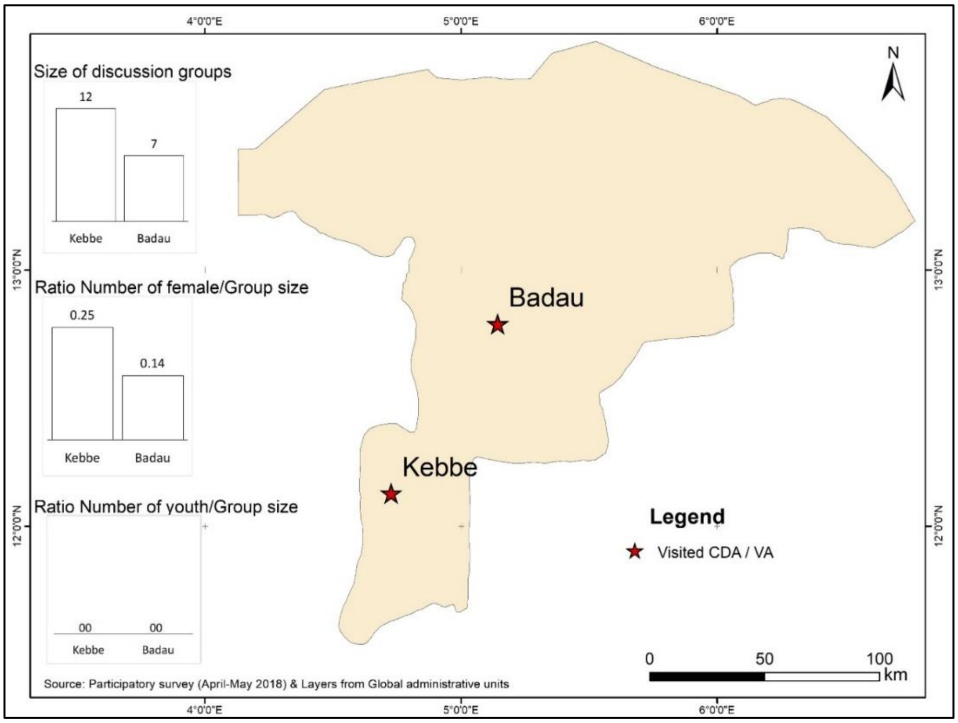


Fig 3. Visited Community Development / Village Areas (CDA/VA) in Sokoto State (Source: Authors' elaboration, May 2018).

The community participation in the sessions was lower compared to Kebbi; only 7 people were mobilized in Badau and 12 Kebbe. Female ratio was low (0.14 and 0.25, respectively) whereas no young participated in both communities (Fig 3).

Table 2 summarizes the SWC measures in the visited communities. The conservation measures mainly aim at erosion (wind and water) control and soil fertility increase. Erosion control measures include area closure, contour ploughing and ridging, planting grasses and cover species, stone bunds, etc. In some cases different measures were associated to each other (two examples are described in the next section). Manuring and fallowing, and to some extent crop residue on-site, are measures to restore and maintain soil fertility and increase yield.

Table 2. SWC measures adopted in the visited communities of Sokoto State

CDA / VA	**Adopted measures**	**Mitigation targets**
Badau, Kebbe	Planting cover species (*Datura arborea*)	Gully erosion, Sheet erosion
Badau, Kebbe	Contour ridges /Contour ploughing	Gully erosion, Sheet erosion
Badau	Sand bags	Gully erosion, Sheet erosion
Badau	Stone bunds	Gully erosion, Sheet erosion
Badau	Crop residues on-site	Wind erosion & deposition
Kebbe	Agroforestry and earth bunds	Gully erosion, Sheet erosion
Kebbe	Planting Vetiver grass	Gully erosion, Sheet erosion
Kebbe	Planting cover species (*Tchikarami in Haussa*)	Gully erosion, Sheet erosion
Kebbe	Planting graminea grass (*Kakarkua in Haussa*)	Gully erosion, Sheet erosion
Kebbe	Manuring	Soil infertility
Kebbe	Fallowing	Soil infertility
Kebbe	Area closure	Gully erosion, Sheet erosion

Table 3 shows that ponds are the only WH system mentioned in both communities (drinking water point for animal and domestic use). During the field visits in the Badau CDA, a small dam built by the community and rehabilitated by the local government was visited. This dam serves only during rainy season and few months in dry season (dries up by February). This implies an acute shortage of water during the dry season, especially from January-February until May-June, depending on the dry season length. There is no measure in place to improve surface water availability and avoid adverse effects of water shortage in the area (February – May).

Table 3. WH measures adopted in the visited communities of Sokoto State

CDA / VA	Adopted measures	Mitigation targets
Kebbe	Ponds	Water shortage for both animal & domestic use
Badau	Ponds	Water shortage for both animal drinking

Dried up animal water drinking point in Kebbe VA (Sokoto State).

4.1.2.2. Brief description of selected SWC and WH measures

- **Agroforestry associated with earth bunds**

It is an agroforestry-based practice consisting in the plantation of *Moringa oleifera* species on earth ridges, in association with crops grown on both the rainy and the dry seasons. In Kebbe CDA, Mr. Sahabi Danani used this practice to manage his land since 2014. Crops are grown between rows of Moringa trees. Moringa seeds were bought from local markets at 700 naira per bag of 2.5 kg. On average, slope angle was 2-3 % in the visited plots. The ridges were approximately 4 m from each other. The space between two consecutive trees was about 0.5 m along the ridge constructed across the slope. A bore hole was associated to this farming system in order to promote dry season farming, especially market gardening. The bore hole was located about 20 m outside the plot where SLM was implemented. Pipes were used to collect and water market garden vegetables. The main crop types were millet and vegetables. Income was improved by this practice and the farmer estimated an annual income up to 100,000 naira in 2018. The main weakness of the system is that it was practiced at small-scale. The main challenge to its larger adoption was the destruction by animals in transit through the farm.


Moringa oleifera trees on contour bunds (left). The farmer near the bore hole used for watering (right). Kebbe, Sokoto State.

- **Combination of measures (*Datura arborea*, *Vetivera sp.* with earth bunds, stone lines)**

This SLM practice is a combination of structural and vegetative measures along a gully to slow down runoff. It was observed in Badau CDA at the farm of Mr. Umaru Wakili. The earth bunds were 25 m long, the stone bunds 10 m long. Average slope was 4 - 5 %. Waterlogging was reported to occur at the edge of the earth bund. The associated grasses were planted on both sides of the gully. The main plant material (Vetiver grass) was collected free-of-charge from own farm. Other grasses were generally collected from wild lands free-of-charge. The stones and earth used to construct the bunds were collected from the materials resulting from a well excavation. The SLM was implemented since 2012. The main crops in the field were sorghum, millet, cowpea, and vegetables. The annual maintenance cost was estimated to 10,000 naira for the reconstruction (material collection and labor input) of the bunds damaged by the runoff.


Combination of structural (earth bunds) and vegetative (planted grasses) measures for erosion control in Badau VA (Sokoto State).

4.1.3. Zamfara state

Two CASP sites were visited in Zamfara state: Goran CDA and Yautabaki CDA, all located in the northern areas of the state. Community engagement and participation were high, with 30 and 31 participants in Yautabaki and Goran, respectively. Female and youth participation was medium (Fig 4).

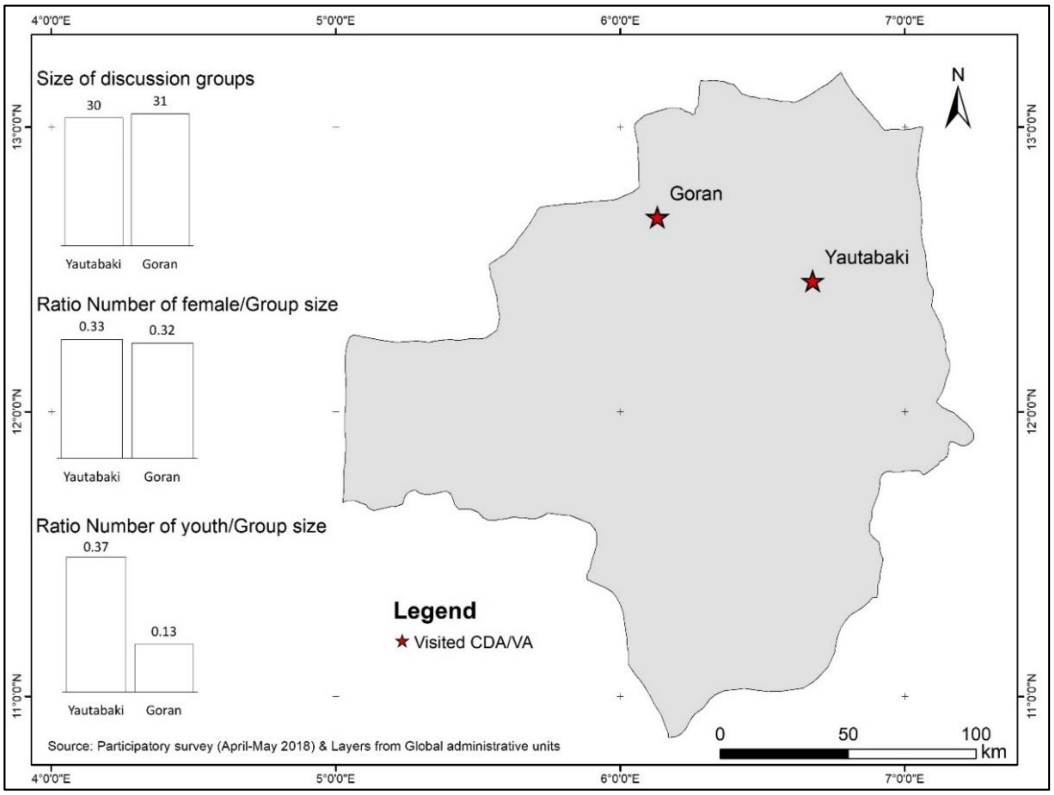


Fig 4. Visited Community Development / Village Areas (CDA/VA) in Zamfara State (Source: Authors' elaboration, May 2018)

4.1.3.1. Common SWC and WH systems in the visited communities

Table 4 summarizes the SWC measures in the surveyed communities of Zamfara state. In addition to the traditional conservation measures mainly aiming at erosion control (planting grasses, cover crops, etc.), mulching was mentioned as a traditional method not only for soil fertility increase but also for erosion control. Notably, a farmer mentioned the use of locust beans residues available in the community as mulching material. Furthermore, waterlogging in lowlands was addressed by cropping adapted species (e.g. rice).

Regarding the water harvesting measures, for animal drinking the communities rely on the natural ponds in their landscapes (Table 5). However, these ponds do not last throughout the dry season, with negative effects on the animal production during water shortage. Apparently, there are no measures in place to improve surface water availability during the dry season, especially during water shortage periods in the area (February – May).

Table 4. SWC measures adopted in the visited communities of Zamfara State

CDA/VA	Adopted measures	Mitigation targets
Yautabaki	Planting cover species (*Tchikarami in Haussa*) + ron palm	Gully erosion, wind erosion
	Fencing + planting cover grasses (*Datura arborea*)	Gully erosion
	Planting Vetiver grass	Gully erosion
Goran	Sand bag and stone bunds	Gully erosion
Goran	Combination of manuring, mulching, and ridge ploughing	Soil infertility, Erosion
Goran	Contour ploughing	Gully erosion
	Cover crops	Gully erosion + Sheet erosion
	Planting Gamba grasses (*Andropogon species*)	Gully erosion
	Mulching (Crop residues + Locust beans residues)	Soil infertility, Erosion
	Cultivation of adapted crops	Waterlogging

Table 5. WH measures adopted in the visited communities of Zamfara State

CDA/VA	Adopted Measures	Mitigation targets
Yautabaki, Goran	Ponds	Water shortage for animal drinking

4.1.3.2. Brief description of selected SWC and WH measures

- **Planting of cover species and Ron palm**

This SLM is a combination of vegetation-based approaches. Cover species (*Datura arborea*) were planted on gully edges, especially at gully heads, over an area of around 25 m^2. Rows (15 m long, approximately) of ron palm (*Borassus aethiopum*) were established at the farm edge across the wind direction to control wind erosion. The measure was established since 2013 in one visited farm (Mr. Kabiru Magadji) in Yautabaki VA. In the visited plot the SLM was implemented on very gently sloping terrain exposed to both wind and water erosion. *B. aethiopum* plants were 2-3 m far from each other over a 15 m row. The main crops on the managed lands were maize, sorghum, cowpea, millet and cotton. For the establishment, the planting of a row of ron palm costed about 2000 naira. Annual maintenance was conducted but no estimated cost was provided by the farmer. According to the farmer's opinion, this technique is effective in replenishing the soil level in the gully but it reduces the land size as the cover plants occupy part of his land.

Ron palm planting for mitigating gully development in Yautabaki VA (Zamfara State).

- **Fencing plants associated with cover plants**

This SLM consisted of planting cover species in the gullies in order to prevent their enlargement. The vegetative measure was associated with fencing using any materials (deadwood, bush, and metallic remnants) in order to retain the eroded soil at the farm. In the visited plot in Yautabaki CDA, Mr. Lawali Bala has been implementing this SLM since 5 years (since 2013). The managed surface affected by gullies was about 200 m^2 (20 m x 10 m). The slope was moderate (up to 4-5 %). In the managed site sorghum, millet and cowpea were grown, and the area concerned by the SLM covered about 100 m^2, especially on the land portion where erosion was severe. The gully depth was up 1.5 - 2m. Inside the gully the cover species were planted without any regular pattern. Fences were made up with two perpendicular rows of Acacia shrubs and other plant materials.

An estimated cost of 5,000 naira was incurred for planting plants. The fencing cost was estimated to 1,500 naira for a length of about 6 m. The same amount (1,500 naira) was needed for the annual maintenance, especially for repairing the fence damaged by runoff. The fencing materials and covering plants were collected from the wild lands. Even though this SLM was generating positive impacts, its effectiveness was poor, as the farmer is still facing new gully formation and development.

Attempt to control gully development using wild plants in Yautabaki VA (Zamfara State).

- **Combination of manuring and mulching**

This SLM measure consists of spreading the farm yard manure (animal dung) over the cultivation area in order to improve soil fertility and structure. The manure is brought to the farm some weeks prior to land preparation and ploughing. During ploughing time, manure is mixed with the soil to release nutrients for crop growth and productivity improvement. In addition to manure, crop residues are left on site in order to decay into litter and enrich the soil. A supplementary role of the mulching residues is to attract termites that are deemed to increase soil porosity and structure enhancing water infiltration and efficient rainfall use. The observed case was in Goran CDA on the farm plot of Mrs. Salamatou. She was growing millet, sorghum and cowpea. Annually, the farm owner used to bring some 200 kg or more of manure to his land. The source of manure was the farmer's own livestock. Manure and mulch were spread evenly on a flat terrain, before ridge ploughing. No other vegetative nor structural measures were associated to this practice. At planting, only some remnants of crop residues and decayed manure could still be seen, scattered across the field.

Field where a combination of practices are applied (manuring, residues on site, ridging) in Goran CDA (Zamfara State).

- **Sand bags associated with stone bunds**

This SWC measure is a combination of stone bunds and sand bags that are disposed across the surface flow direction (contour-like) to control gully erosion on the slope. The SLM was observed in Goran CDA in the farm of Mr. Nura Sanni where he mainly grows millet, sorghum and rice. Stones and sand bags were locally collected. There was no plant material intentionally associated with this practice. The stone bunds and sand bags were built across the slope (which angle was 3-4 % in the visited plots). The approximate length of the sand bags barrier was 7 m whereas the stones covered a length of 3 m. This structure helped in reducing surface runoff and gully development. The establishment costs were estimated to 25,000 naira four years ago. The amount of money needed for the maintenance (renewal of sand bags and stones) of the managed area was estimated to 20,000 naira per year.

Bunds made of stones and sand bags to control runoff in Goran CDA (Zamfara State).

- **Mulching with crop residues**

This SLM technique is based on the application of the fruit residues of the locust bean (*Parkia biglobosa*) as a mulching material. It is a traditional practice inherited from ancestors. The practice was documented in the farm of Mr. Hamissou Megu in Goran CDA. Here, residues were spread over the field. The residues were collected free of charge from neighborhood farmlands and other providers. The implementation cost of the SLM measure over the farm size of 1.5 ha was estimated to 20,000 naira per year (costs of transportation to farm and labor). Beside the positive impacts on soil structure and moisture, it was effective in preserving soil against episodic events of wind erosion. The main crop types were millet, sorghum, cowpea and *Cajanus cajan.* The main factor of success of the SLM was that crop residues were available free of charge. However, the main challenge was that it was labor demanding for large scale application.

4.1.4. Katsina state

In Katsina state, three CASP communities were surveyed: Baawa in the north, and Kofa and Garu in the central-eastern part of the State. The number of participants was 24, 13 and 30 in Baawa CDA, Kofa CDA and Garu CDA, respectively, with quite low female participation (on average less than 20%). Youth participation was quite high in Baawa CDA, whereas it was null in Kofa (Fig 5).

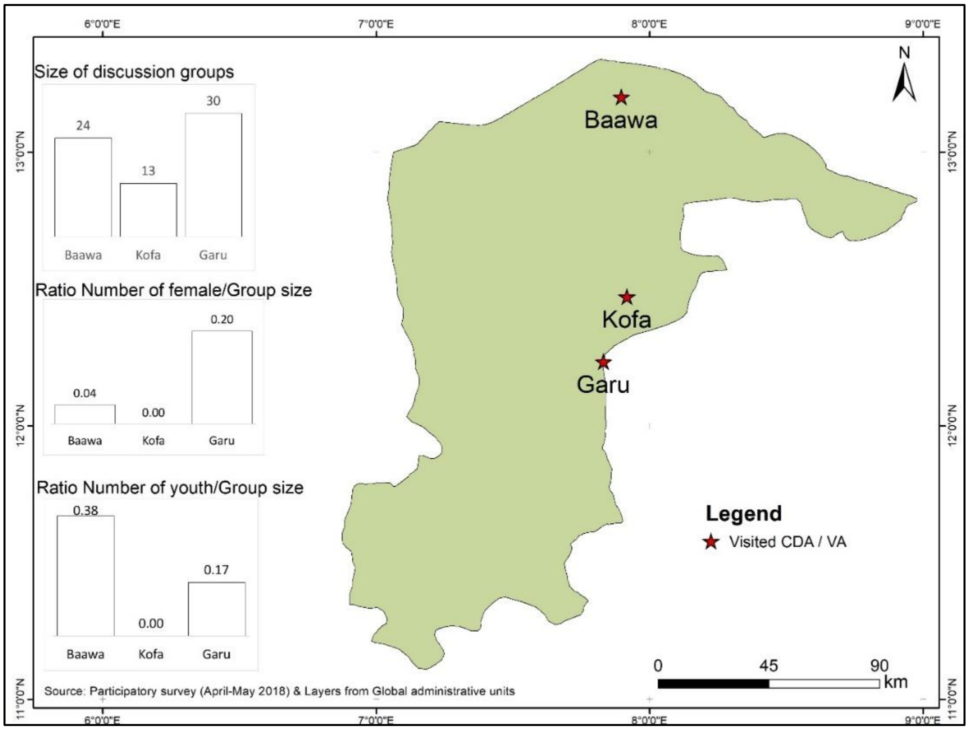


Fig 5. Visited Community Development / Village Areas (CDA/VA) in Katsina State (Source: Authors' elaboration, May 2018)

4.1.4.1. Common SWC and WH systems in the visited communities

Soil and water conservation measures in the visited communities of Katsina state include water diversion, stone bunds, sand bags, planting cover species (*Datura arborea*), cover grasses (*Vetivera species*), and ron palm (*Borassus aethiopum*). These measures aim exclusively at controlling water erosion (sheet and gully). Mulching with crop residues, and manuring (cow dungs mostly) are the observed traditional methods used for increasing soil fertility (Table 6).

Concerning the water harvesting measures, the communities rely on the natural ponds or on excavated/borrowed pits for runoff collection for animal drinking (Table 7). However, these ponds do not last throughout the dry season, obliging the communities to use water from open wells and bore holes to supply animal drinking. This is an indicator that surface water availability is low, especially during dry season (February – May).

Table 6. SWC and WH measures adopted in the visited communities of Katsina State.

CDA / VA	Adopted measures	Mitigation targets
Baawa; Garu	Vetiver grass planting	Gully erosion
Baawa; Garu, Kofa	Sand bags	Gully erosion

Baawa; Garu; Kofa	Manuring	Soil infertility
Baawa	Mulching	Soil infertility
Garu	Planting cover species (*Datura arborea*) & Ron palm (*Borassus aethiopum*)	Gully erosion, Sheet erosion
Kofa	Stone bunds	Gully erosion
	Water diversion	Gully erosion
	Sand bags associated with stones bunds and shrubs	
Kofa, Garu	Sand bags associated with stones bunds	

Table 7. SWC and WH measures adopted in the visited communities of Katsina State.

CDA / VA	Adopted measures	Mitigation targets
Kofa, Baawa	Ponds	Animal drinking points
Kofa, Baawa	Bore holes & Open wells	Water shortage for domestic use

A farm land under severe gully erosion in Garu VA (Katsina State).

4.1.4.2. Brief description of selected SWC and WH measures

- **Planting Vetiver grasses**

This SLM practice consists of planting vetiver grass at the farm edge for the purpose of controlling water erosion. In the visited plots of Mr. Ado Abdou, in the Baawa VA, this vegetative measure was set as 3 rows of vetiver with about 0.6 m width and 1 m length. The plant material was collected from neighboring lands at the establishment time. Annual maintenance was required in order to replace missing spots. Family labor was used for the maintenance and establishment activities. The SLM was expected to stabilize the soil over the whole land under cultivation by reducing runoff velocity upstream where runoff is generated. Additional expected benefit of the SLM was the production of fodder for animals. However, it was difficult to establish vetiver grass as the intense runoff often carried away the newly planted grasses. The grasses also take space and reduce land availability, increasing competition for nutrients at the plantation areas. So, on average, the SLM was established on relatively small areas. In the visited plots slopes was gentle (3%), distance between plant lines along slope was about 2 m, and line length 3 m. Space between grasses on length side was about 1 m.

Vetiver grass for controlling erosion in Baawa VA (Katsina State).

- **Association of sand bagging, stone bunds, and shrub planting**

This SLM consists of a combination of stone bunds, sand bags and shrub planting to control sheet and gully erosion. In the visited site (farm of Mr. Garba Tajo) in Kofa CDA, sand bags and stone bunds were established in a gully in the farm. These structures helped in controlling the gully which depth was almost filled by the trapped sediments. However, land was ploughed along slope gradient, reportedly in order to avoid waterlogging, thus favoring runoff. Slope was relatively gentle (3 %). Sand bags and stone bunds were initially established along the main gully (about 100 m). Then, vegetative measures were associated with the structural ones and shrubs of

Balanites aegyptiaca were planted over the farmland. Estimated plant density was 40 - 50 shrubs per hectare. Establishment costs were not estimated; the farmer said that the input required (labor and time) were expensive. Insufficient moisture during the dry season did not favor the growth of the newly planted shrubs. The measures were applied on a farmland on which available farm manure was also applied on one third of the whole farm each year (thus making a 3-year manuring rotation).

Previous gully area controlled by sand bags and stone bunds in Kofa CDA (Katsina State).

- **Combination of stone bunds and sand bags**

Similar to the above described SLM, this SLM measure consisted in associating sand bags to stone bunds to reduce runoff on a land prone to erosion. In the visited site (farm of Mr. Sadi Maigoro) in Kofa CDA, over the last five years these structural measures were also supported by tree planting along the structure row. Farm land was located on very gentle slope (1-2 %). Only one row of sand bags and stones was established across the slope, making a line about 30m long and 1m wide. The farmer said that the SLM was labor demanding, time consuming and required constant involvement and commitment. During intense rainfall events, the measures were not effective because the farm land was located downstream on a catchment where the runoff source was not addressed in the upland. This caused the partial destruction of the management structures by runoff. Annual efforts were needed to maintain the structures and to combat runoff effects on soil quality and farm size integrity. Ploughing was deliberately made along the slope in order to avoid waterlogging during heavy rainy periods.

Stone bunds and remnants of sand bags used for erosion control in Kofa CDA (Katsina State).

- **Combination of sand bags and stone bunds**

In the farm of Mr. Mama Babagida (Garu CDA), bags filled with sand were aligned to impede gully initiation and development in farm plots having an average slope of 4-5 %. The measure implementation started 11 years ago and required annual maintenance efforts. Sand bag ridges were about 25 -30 m long. Sand bags were installed from the gully initiation point to the junction with the nearby stream (on about 30 m long). Sand bags were disposed without any space between them. Stones were associated to the construction of bag ridges, and placed on the same ridges. No vegetative measure was associated to the structures. The establishment cost for the whole structure was estimated to 22,000 naira by the farmer encompassing buying the bags, packing sand, transportation, and labor inputs. The annual costs for maintenance (replacing destroyed bags) were estimated to 10,000 naira. Even though the SLM was labor and capital demanding, it was useful in preserving the land and maintaining agricultural production.

Stone bunds to control erosion, in a field ploughed downstream (!) in Garu (Katsina State).

4.1.5. Jigawa state

Kukawa, Gana-Kaya, and Dagwaje were the surveyed communities in Jigawa state (Fig 6). On average, the size of the discussion groups was of 18 participants. Females were not present during discussions in Dagwaje, whereas young members were present in all the visited communities. Nearly 50 % of the participants in Dagwaje were young.

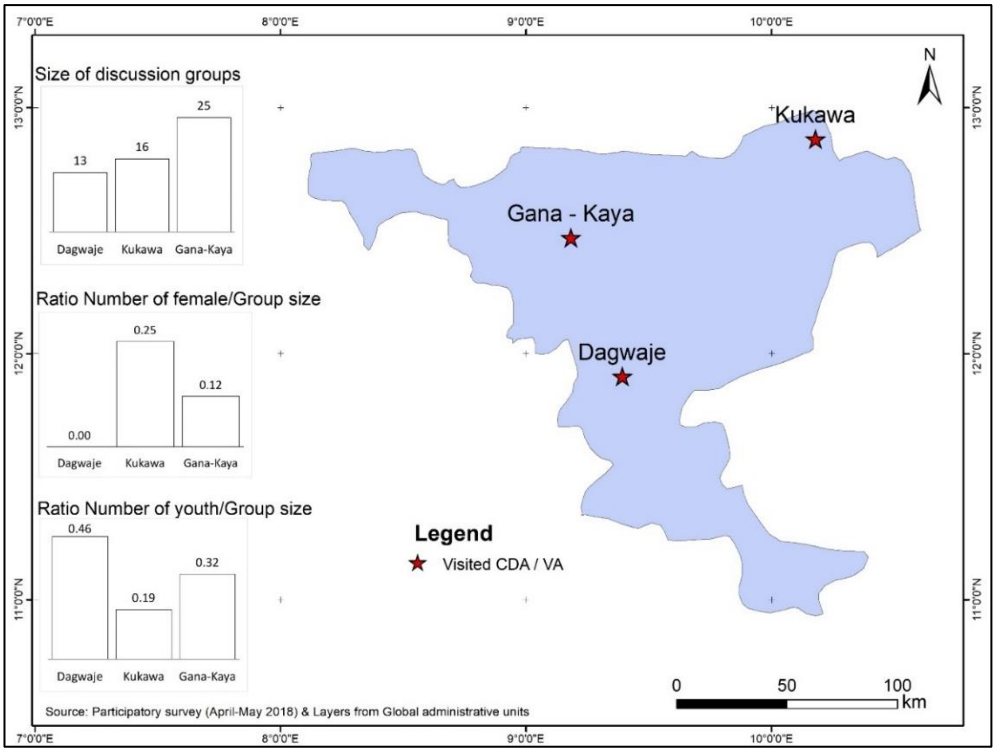


Fig 6. Visited Community Development / Village Areas (CDA/VA) in Jigawa State (Source: Authors' elaboration, May 2018)

4.1.5.1. Common SWC and WH systems in the visited communities

The most common measures to control water erosion in the visited communities are sand bags and stone bunds, and grass planting (*Vetivera sp*.) (Table 8). To control wind erosion, farmers keep crop residues on farm, adopt late land preparation, and make planting holes. Manuring, fallowing and mulching are traditionally used to restore and increase soil fertility.

Concerning water harvesting, the communities rely on natural ponds for animal drinking (Table 9). Like in other sites, ponds do not last throughout the dry season, especially from January to May.

Table 8. Soil and water conservation practices observed in Jigawa.

CDA / VA	Adopted measures	Mitigation targets
Kukawa	Crop residue on-site	Wind erosion
Kukawa	Association of crop residues and cover plants	Wind erosion
Kukawa	Late land preparation	Wind erosion
Kukawa, Dagwaje	Planting holes	Wind erosion & deposition
Kukawa	Filling gullies with shrubs	Gully erosion
Kaya	Stone bunds	Gully erosion
Kaya	Sand bags	Gully erosion
Kaya	Planting grasses & shrub (fencing)	Gully erosion + Sheet erosion
Kaya, Dagwaje	Manuring	Soil infertility
Dagwaje	Fallowing	Soil infertility
Dagwaje	Association of grass planting and fallowing	Soil infertility
Dagwaje, Kukawa	Mulching	Soil infertility

Table 9. Water harvesting systems at the community level in Jigawa

CDA / VA	Adopted measures	Mitigation targets
Dagwaje, Kukawa	Ponds	Water shortage for animal drinking
Kukawa	Solar powered water pipes	Water shortage for animal drinking

Livestock watering point reticulated from a solar powered bore hole located at 1.5 km in Kukawa VA (Jigawa State).

Farm land under severe gully erosion (left) and abandoned (set aside) for recovery (right) in Dagwaje CDA (Jigawa State).

4.1.5.2. Brief description of the common SWC and WH measures

- **Association of Gamba grass and fallowing**

This SLM measure consists of planting Gamba grasses (*Andropogon gayanus*) on farm fields to control surface runoff and catch sediment. In the visited site (farm of Mr. Abdoul-Moumouni Haruna) in Dagawje CDA, the planted grasses were more concentrated downslope, to retain soil carried from the top of the hill and from hillsides. The expected benefits of the SLM adoption were yield increase through the control of erosion and fertility increase. The average slope of the visited plot was around 10 %. The downstream area of the catchment was connected to a lowland located at the hill foot. On the hilltop there was a row of grass with a width of 15 - 20 m. Another row of grasses was planted at the hill foot, which was approximately 10 - 20 m wide and 100 m long; the spacing among plants was erratic, with no pattern. The establishment and maintenance costs were estimated by the farmer to 4,500 naira and 3,000 naira, respectively. The establishment inputs encompass collecting and planting grasses free of charge whereas labor needs constitute the whole establishment cost. Maintenance consists of replacing the destroyed grasses by ether runoff or animals. In addition to planting Gamba grasses, a portion of the farmland was set to fallow and enclosed in order to restore the degraded lands. About 0.40 ha of the farm was enclosed. The factors hindering adoption were the efforts and the cash required to maintain the measure. Also, the land size was reduced by the area enclosure.



Farm planted with Gamba grass for controlling surface runoff in Dagwaje CDA (Jigawa State).

- **Planting Gamba grasses**

This SWC measure consists of planting Gamba grasses in gully-affected areas to reverse erosion. In the visited farm (Mr. Ousmane Rabiou) in Dagwaje CDA, planting was implemented over the last five years (since 2013) on an affected area of 0.5 ha (nearly 1/3 of the farm land). The grasses were planted in and along the gully, starting from its initiation points, without any pattern. Gully depth reached about 1 m, and average slope was 10 - 15 %. The farmland was located on a hillside, on a loose sandy soil. The dimensions of the managed gully areas were 1 - 2 m depth x 50 m length x 1 - 2 m width. The establishment cost for the SLM practice over the affected area was about 10,000 naira including the labor inputs. The annual maintenance cost (labor inputs) could fluctuate between 5,000 and 10,000 naira depending on the intensity and amount of rainfall events during the previous rainy season, which may damage the vegetative measures. Conservation was effective for the areas where interventions occurred but the practice needs to be scaled up over the rest of the farm land. However, wind erosion is still uncontrolled by this practice. To mitigate wind action the farmer applies late land preparation and preservation of native shrubs on site during the dry season. The additional benefits derived from this SLM practice comprise the use of Gamba grasses for house roofing, while the late land preparation increases organic matter availability. It is worth noting that the land had a high regeneration potential of *Piliostigma reticulata,* contributing to the conservation of the soil.

Gully initiation point on steep land (left) and planted Gamba grass (right) to control gully on the same plot, in Dagwaje (Jigawa State).

- **Filling gullies with cut shrubs**

Over 9 years, Mr. Baba Aladji S., farmer in the Kukawa VA, has been filling gullies on his land with cut shrubs and any available solid material in order to control gully development and reverse erosion. Two main gullies affected his farm, over a catchment area of about 6 ha with an average slope between 5-8 %. The filling materials were collected from the bush at no cost and transported to the sites. The main aim of this practice was to trap sediments that were washed away during runoff flowing along the gully. However, the farmer thinks that the measure was not effective as the erosion patterns are still increasing. The association of contour ploughing to gully measures contributed to reduce runoff in areas outside gullies. This has generated a yield increase even though the land size was reduced annually by gully development and by new gully formation. However, the annual maintenance activities increased the work load of the farmer that want to secure productive lands to his children.

Gullies filled in with dead plant materials for controlling erosion in Kukawa (Jigawa State).

- **Association of crop residues with cover plants**

This SLM practice consist of leaving sorghum and late millet residues on site to protect the soil against wind erosion. In the visited farm in Kukawa VA, farmer Mr. Hassan Abdoulaye also planted cover crops such as coloquinte (*Citrullus colocynthis*) as late crops that remain on the soil throughout the dry season, in addition to leaving crop residues in the field. After harvest, the residues of coloquinte were left, to cover the soil against wind erosion besides being a source of organic matter. The coloquinte was planted in an erratic pattern during the last rain events occurring in September/October. It stabilized the soil, improved its fertility and prevented the occurrence of weeds in the field. To establish the cover crop over the farm size (0.75 ha, with average slope of about 2 %), coloquinte seeds were bought at 500 Naira per bag of 2 kg. The maintenance of this SLM practice, through the removal of some weeds, costed about 5,000 naira. The practice increased income and yield, according to the farmer. However, it was labor intensive and time consuming as it expanded the farm activities to the dry season (March-April) during which harvesting and pre-processing occurs.

Cover crop (Coloquinte) associated with crop residue on-site for wind erosion control in Kukawa VA (Jigawa State).

- **Planting grasses associated with shrubs**

This SLM practices consists of controlling water erosion by planting Gamba grasses (*Andropogon gayanus*) on the whole affected farmlands. In a farm in Gana-Kaya CDA, farmer Mr. Hamida Issa planted the grasses without any regular pattern, in association with other vegetative measures along the farm boundaries. A line of shrubs (*Piliostigma reticulata* mixed with other species), about 100 m long and 2-3 m wide, was naturally preserved across the slope at the farm upslope boundary to reduce runoff generation towards the farmlands. The height of the shrub line was between 0.5 and 1 m. The Gamba grass height was about 2-3 m, and the density was about 50 plants per hectare. Average slope was 3 % throughout the farm. At the time of first establishment, the grass stumps were collected from the neighboring farms at a cost of 2,000 naira. For the maintenance and expansion of the technique over the farm plots, plant materials were collected from the established plants. The total implementation cost was estimated to 10,000 naira, while the annual maintenance (replacement of grasses washed away) cost was around 5,000 naira. The main negative feeling of the farmer was that the planted grasses take part of the nutrients reducing their availability to crops. The approach was time consuming and labor demanding especially when heavy rainfall carried away the newly established grasses. At the upland areas of the farm, a woodlot of 0.25 ha of neem trees was also established five years ago for firewood.


Planted Gamba grass and preserved native shrubs for water erosion control in Dogonkuka VA (Jigawa State).

- **Combination of Grass and Shrubs fencing**

In a farm in the Gana-Kaya CDA, this measure was implemented over 10 years by farmer Mr. Abdoulaye Ibrahima. It was a combination of vegetative measures, consisting of using grasses and shrubs to fence the farmland at its boundaries. It was a single line fence about 60 m long and 1.5 - 2.5 m wide. The average slope of the farmland was relatively gentle (2 %), in a catchment of about 0.3 hectares. The measure was used to control runoff from the uplands, and trap the sediments at the fence level. The establishment cost was estimated to 15,000 naira for labor inputs (collecting plant material and planting). The material was locally collected at no cost. The maintenance cost required for repairing the destroyed or decayed materials was about 10,000 naira annually. Farmer estimated that using his own labor and input materials from wild lands were factors of success. However, the practice was costly in terms of energy and time.

Combination of Grass and Shrubs fencing to control runoff in Gana-Kaya CDA (Jigawa State).

4.1.6. Yobe state

In Yobe state, three communities were surveyed, the CDA/VA of Laye, Daura (or Dogonkuka) and Jimbam. The size of the community groups met was 36, 28 and 25, respectively (Fig 7). Female participation was low, except in Daura where nearly half of the participants were females. Youth participation was acceptable in all communities, with an average of 30 % of participants.

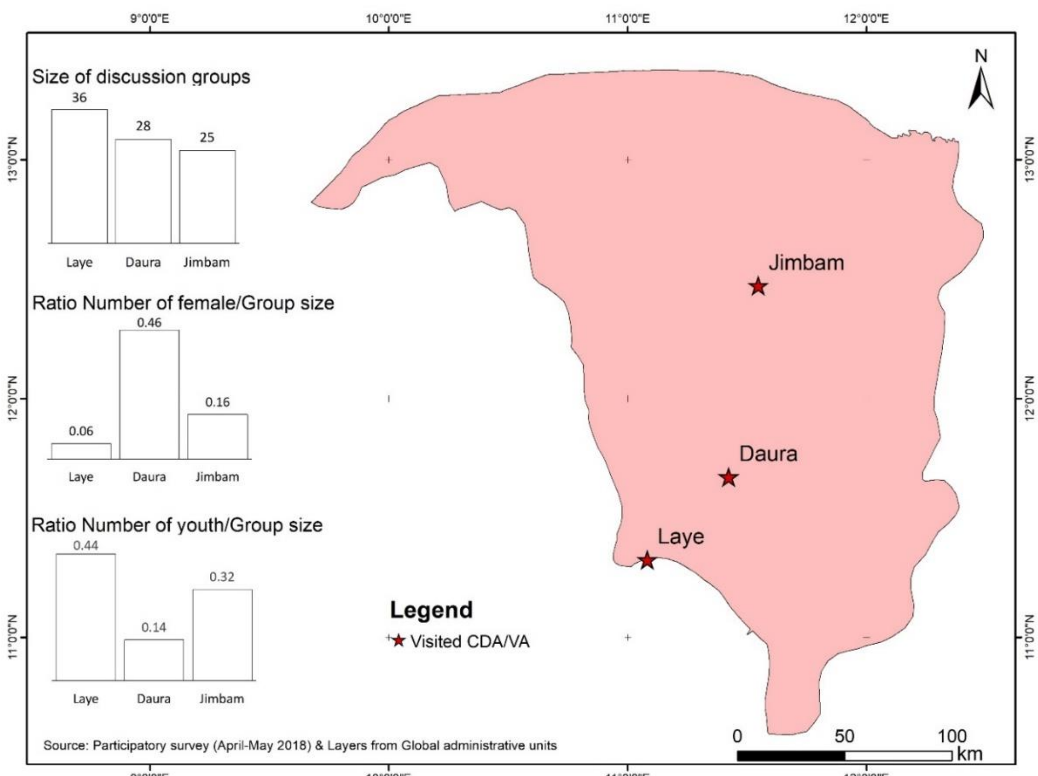


Fig 7. Visited Community Development / Village Areas (CDA/VA) in Yobe State (Source: Authors' elaboration, May 2018).

4.1.6.1. Common SWC and WH systems in the visited communities

Soil infertility, gully and sheet erosion are the land degradation issues reported by the visited Yobe communities (Table 10). To mitigate the soil infertility issues, the most common measures are the use of manure, the adoption of crop rotation and intercropping (including crop association). The severity and extent of gully and sheet erosion are reduced through contour ploughing, Gamba grass planting, and land abandonment for restoration associated with assisted natural regeneration. The latter, which is a kind of long-term fallow (i.e. assisted natural regeneration), and tree planting (i.e. woodlots), were indicated as efficient measures for restoring farmlands.

Reported water harvesting measures are the natural ponds and the individual containers (Table 11). Ponds are often used for animal drinking whereas the containers are used for both animal and domestic use. Both individual containers and ponds often dries up during every dry season, especially in the periods of acute water shortage that occur between January and May.

Table 10. Soil and water conservation practices at the community level in Yobe state

CDA / VA	Adopted measures	Mitigation targets
Laye, Dogonkuka, Jimbam	Manuring	Soil infertility
Laye, Dogonkuka	Crop rotation	Soil infertility
Laye	Intercropping	Soil infertility
Laye, Dogonkuka	Contour ploughing	Gully erosion, Sheet erosion
Laye, Dogonkuka, Jimbam	Tree planting/Woodlots	Gully erosion, Sheet erosion
Laye	Earth embankment	Gully erosion, Sheet erosion
Dogonkuka	Gamba grass planting	Gully erosion, Sheet erosion
Dogonkuka	Planting Gamba grass and Datura arborea around contour ploughed lands	
Dogonkuka, Jimbam	Sand bags	Gully erosion, Sheet erosion
Dogonkuka, Jimbam	Abandonment associated to assisted natural regeneration	Gully erosion, Sheet erosion

Table 11. Water harvesting systems at the community level in Yobe state

CDA / VA	Adopted measures	Mitigation targets

Jimbam	Ponds	Water shortage for mostly animal use
Jimbam	Individual containers	Water shortage for both animal & domestic use
Dogonkuka	Dams	Water shortage for animal drinking

4.1.6.2. Brief description of the common SWC and WH measures

- **Earth embankment associated with shrub planting**

This practice for preserving land against erosion consists of creating earth bunds approximately 0.5 m to 1 m high. In the farm of Mr. Muhamud Hudubi, in Laye VA, the earth bunds were approximately 100 m long and 1 - 2 m wide with an irregular height varying between 0.5 m and 1 m. They were constructed at one edge of the farm, on a gentle slope (1-2 %), to collect and divert surface runoff. The vegetative component (*Piliostigma, Jatropha and Moringa* plants) was erratically scattered along the earth bunds. The bunds were constructed manually, with family labor. In the visited farm the practice was implemented since 3 years and costed approximately 10,000 Naira for the first year implementation of the structural component (100 m). The farm household undertook annual maintenance activities to repair damages made by runoff, estimated to cost approximately 10,000 naira. The plant materials used to consolidate the earth bunds were locally collected from bush seedlings, and from some nurseries. Specifically, *Moringa oleifera* seedlings were bought at 250 naira each, while the *Jatropha curcas* seedlings were collected free of charge in the neighboring lands. Native plant species such as *Piliostigma reticulata* were also used to consolidate the earth embankments. The interviewed farmer said that this practice was labor-demanding even though it was effective in addressing erosion.

Earth embankment and shrub planting for water erosion control in Laye VA (Yobe State).

- **Contour ploughing**

This SLM practice consists of ploughing the farmland across the slope gradient to reduce surface runoff. It has the triple benefit of controlling sheet erosion, and conserving soil moisture and nutrients from runoff washing. In a visited farm in Laye VA, farmer Mr. Souleymane Wakilu implemented contour ploughing over about 0.25 ha, on a gentle slope. No other measure was associated to it. The ridges were 25 m long and 0.10 m high. The space in between the ridges was approximately 15 - 20 cm. The measure was quite an inexpensive practice as there was no additional cost for implementation, apart from the ploughing cost. The interviewed farmer stated that it was an effective and costless measure for conserving soil, even though it needed some maintenance works after heavy rainfall events.

Adjacent fields ploughed in two perpendicular directions in Laye CDA (Yobe State).

- **Assisted fallowing and contour ploughing**

This SLM practice was observed on a farmland where part of the land was set to fallow while the remaining area under cultivation was ploughed across slope gradient. The observed gullies had their head in the farmland. Land was ploughed on a gentle slope (2%) The fallow duration was not mentioned by the farmer; the re-cultivation of the fallowed portion would depend on the farmer’s appreciation of soil quality. In the fallowed portion, natural regeneration was promoted and protected. Some species such as *Gardenia spp.* were naturally scattered without any pattern while *Azadirachta indica* was planted. The shrub density was very low (about 10 shrubs/ha). The fallowed land was enclosed and protected against animal grazing and bushfires. This portion was approximately 0.20 hectares. On the cultivated portion (about 2.5 ha), the farmer usually did contour ploughing. Annually, the maintenance costs of the combined practices (preserving the fallow land and applying contour ploughing) were estimated to 18,000 to 20,000 naira. In the visited farm this SLM was implemented over a period of 6 years. The farmer said that the practices were effective and helped to preserve land, even though the land size was reduced in the erosion- or gully prone portion, affecting his production.

Abandoned plot for natural regeneration to control water erosion in Dogonkuka VA (Yobe State).

- **Planting Gamba grass and *Datura arborea* around contour ploughed lands**

This SLM practice consists of planting Gamba grass (*Andropogon gayanus*) and *Datura arborea* on contour-ploughed land to control sheet and gully erosion. The grasses are often planted at the farm boundary to maintain the full farm size. In a visited farm in Dogonkuka VA, farmer Mr. Umaru Gajere planted scattered shrubs of *Piliostigma reticulata* mixed with *Datura arborea* on a 100 m long and 2-3 m wide strip. Gamba grasses were concentrated on a 50 m long strip. Slope was gentle (2 %). Gully depth was around 1.5 m before SLM, and below 0.5 m after SLM. Gamba grasses were spaced about 0.25 - 0.5 m, in an erratic pattern. *Datura arborea* was planted with an approximated distance of 0.5 to 1 m between plants, at the farm boundary. About 20 shrubs of spontaneous *Piliostigma reticulata* were observed in an erratic pattern, mixed with *Datura arborea* at the farm edge. Five years ago at the establishment of the 100 m long strip, the combined cost of planting of Gamba grasss and doing contour ploughing was estimated to about 30,000 naira. The annual cost of maintenance (replacement of grasses and ploughing cost) was estimated to about 20,000 naira. Gamba and Datura plants were collected from the nearby lowlands at the establishment time. For the maintenance, the farmer used the grasses planted on his own land, and additional ones if needed. The benefits derived from this practice were multiple:

reducing wind and water action by providing soil coverage, and improving soil structure. In the visited farm the practice was implemented by family labor. The farmer liked the measure for its effectiveness in controlling runoff and preventing gully development (gullies are being progressively filled in). However, there were some constraints affecting the maintenance of the SLM, including illegal cutting of *Piliostigma* by people for use as cords, and grazing by unknown animals of Gamba grasses inducing degradation of soil structure. Farmer disliked the fact that the practice reduced land area under cultivation.

Row of Gamba grass (left) and row of shrubs (right) for controlling runoff in Dogonkuka VA (Yobe State).

- **Abandonment for natural regeneration**

This practice is similar to long-term fallowing but the likelihood to re-cultivate the land is low. It is a kind of land abandonment for possible future cultivation in case land health becomes acceptable for reuse. It was observed on the farm of Mr. Chiroma Kolo in Jimbam VA. The farm was previously cultivated for millet. Spontaneous species regrowth was observed over the visited area. However, the erosion intensity was high and land degradation severe.

Abandoned land for natural recovery in Jimbam VA (Yobe State).

4.2. Summary of the SWC/WH in the visited CASP sites

In this section the documented SWC/WH measures are categorized according to the purposes, groups and types of measures using the nomenclature of the WOCAT[1] system (Tables 12 and 13).

The reported measures can be grouped into four main SLM types:

- Vegetative-based: e.g. planting cover crops, planting grasses, planting trees/woodlots.
- Structural-based: e.g. contour ploughing, stone bunds, half-moon, planting pits, earth bunds, etc.
- Agronomic-based: e.g. on-site crop residues, manuring, mulching, crop rotations, fallowing, intercropping/crop association, cropping leguminous species, etc.
- Management-based: e.g. area closure, late land preparation, land abandonment, etc.

Some of the measures are combined with each other to be more effective. The most observed combinations are the following:

- Structural-vegetative measures: e.g. fencing + planting grasses.
- Agronomic-Structural measures: intercropping on contour ridges.
- Management-vegetative measures: abandonment assisted by natural regeneration (tree planting and selective maintenance of natural seedlings).

Vetiver grass associated to ridge across gentle slopes, and manuring

Abandoned lands for regrowth of natural seedlings

[1] www.wocat.net.

More in detail, the following types of single measures and of combinations of measures were observed.

a. Single measures

Vegetative measures

- Planting grasses (Planting grasses (Vetiver, *Datura arborea*, Iri-iri[2], *Andropogon gayanus*)
- Planting of cover species (*Datura arborea*) & Ron palm (*Borassus aethiopum*)

Agronomic measures

- Adoption of adapted crops

Structural measures

- Contours bunds (Embankments)
- Sand bagging
- Planting pits (Elephant footprints)
- Half moon

Management measures

- Mulching
- Manuring
- Fallowing
- Crop rotation
- Crop mixture/Intercropping
- Contour ploughing
- Association of grass planting with earth bunds

b. Combination of measures

Structural & Structural

- Stone bunds + Sand bagging

Vegetative & vegetative

[2] *Iri-iri* is a Hausa name of a grass species used to control erosion.

- Fencing + Planting cover species
- Grass + Shrubs fencing

Management & Management

- Manuring + Mulching

Management & vegetative

- Mulching + Cover grasses
- Filling gullies with cut shrubs
- Abandonment associated to tree planting and natural regeneration
- Planting grasses (*Andropogon gayanus* and *Datura arbora*) associated with contour ploughing
- Abandonment associated with natural regeneration

Agronomic & Management

- Mulching (crop residues) + Late cover crops (coloquinte)
- Planting grasses (*Andropogon gayanus*) + Row of preserved shrubs

Structural & vegetative

- Earth embankment associated with tree planting
- Agroforestry (*Moringa oleifera*) associated with earth bunds

The documented practices can be also classified according to the following WOCAT SLM groups:

- G5: e.g. area closure, abandonment with assisted natural regeneration
- G6: e.g. crop rotation, intercropping, fallowing
- G9: e.g. cover crops, grass planting, tree planting
- G11: manuring, mulching, leguminous crops
- G12: contour ridges/ploughing, stone bunds, contour bunds
- G14: adapted crops to waterlogged lands
- G15: planting holes/pits (elephant feet), half-moon
- G17: water diversion by earth bunds, stone bunds, sand bags

Finally, based on their main <u>purposes</u>, the SWC measures can be classified as follow:

- P1 (improving production): e.g. manuring, mulching, adapted crop selection,
- P2 (reduce/prevent/restore land degradation): e.g. fallowing, contour bunds, cover crops, planting grasses
- P3 (Conserve ecosystem): area closure, land abandonment
- P6 (Reduce risk of disasters): water diversion
- P7 (Adapt to climate change): adapted crops

Concerning WH, all the documented systems are structural, even if ponds are most often natural structures in the visited sites (Table 13). These measures aim at improving production (irrigated crops), and at adapting to the impacts of climate change (resilience to droughts). Natural ponds, dams and individual containers are categorized as "water harvesting" whereas bore holes and open wells are considered as "ground water management" systems.

Open well for irrigating orchards and other uses in Daura CDA (Yobe)

Dam constructed for animal drinking in Daura village (Yobe)

Table 12. Summary (not exhaustive) and classification of the documented soil and water conservation techniques.

SLM practice	Reported issue addressed	Type of measures	Group of measures	Purpose	State	CDA/VA
Abandonment associated to tree planting and natural regeneration	Gully erosion + Sheet erosion	Management	G5	P2, P3	YOBE	Dogon kuka
Adapted crops	Waterlogging	Agronomic	G14	P1, P7	ZAMFARA	Goran
Area closure	Gully erosion + Sheet erosion	Management	G5	P3	SOKOTO	Kebbe
Contour bunds	Gully erosion + Sheet erosion	Structural	G12	P2	KEBBI	Masama
Contour ploughing	Gully erosion + Sheet erosion	Structural	G12	P2	ZAMFARA	Goran
					YOBE	Laye, Dogon kuka
					SOKOTO	Badau, Kebbe
					KEBBI	Masama, Vui
	Soil water harvesting and moisture conservation	Structural	G12	P2	KEBBI	Vui
Cover crops	Gully erosion + Sheet erosion	Vegetative	G9	P2	ZAMFARA	Goran
Cover grass & Ron palm planting	Gully erosion + Sheet erosion	Vegetative	G9	P2	KATSINA	Garu
Crop residue on-site	Wind erosion & deposition	Agronomic	G9, G11	P1, P2	SOKOTO	Badau
					JIGAWA	Kukawa
Crop rotation	Soil infertility	Agronomic	G6	P1, P2	YOBE	Laye, Dogon kuka
Earth bunds	Gully erosion + Sheet erosion	Structural	G17	P2	YOBE	Laye
Fallowing	Soil infertility	Management	G6	P1, P2	JIGAWA	Dagwaje
					KEBBI	Masama
					SOKOTO	Kebbe

Fencing + planting cover grasses (Datura arborea)	Gully erosion	Combination	G9	P2	ZAMFARA	Yautabaki
Gamba grasses	Gully erosion + Sheet erosion	Vegetative	G9	P2	YOBE	Dogon kuka
					ZAMFARA	Goran
Intercropping	Soil infertility	Agronomic	G6	P1, P2	YOBE	Laye
Late land preparation	Wind erosion	Management	G9	P2	JIGAWA	Kukawa
Manuring	Soil infertility	Agronomic	G11	P1	KATSINA	Baawa, Garu, Kofa
					JIGAWA	Kaya, Dagwaje
					YOBE	Laye, Dogon kuka, Jimbame
					KEBBI	Barangawa, Masama
					SOKOTO	Kebbe
Mulching	Soil infertility, Erosion	Agronomic	G11, G9	P1, P2	KATSINA	Baawa
					ZAMFARA	Goran
					JIGAWA	Dagwaje
Planting cover species (Tchikarami)	Gully erosion, Sheet erosion	Vegetative	G9	P2	SOKOTO	Kebbe
Planting grasses & shrubs	Gully erosion, Sheet erosion	Vegetative	G9	P2	JIGAWA	Kaya
Planting grasses (Datura arborea)	Gully erosion, Sheet erosion	Vegetative	G9	P2	KEBBI	Masama
					SOKOTO	Badau, Kebbe
Planting grasses (Kakarkua)	Gully erosion, Sheet erosion	Vegetative	G9	P2	SOKOTO	Kebbe

Planting grasses (Vetiver)	Gully erosion, Sheet erosion	Vegetative	G9	P2	KEBBI	Barangawa
					SOKOTO	Kebbe
					ZAMFARA	Yautabaki
					KATSINA	Baawa, Garu
Planting holes	Wind erosion & deposition	Structural	G15	P2	JIGAWA	Kukawa, Dagwaje
Planting leguminous species (Cowpea, groundnut)	Soil infertility	Agronomic	G11	P1	KEBBI	Masama
Planting pits	Soil water harvesting, infertility & moisture conservation	Structural	G15	P2	KEBBI	Barangawa, Masama, Vui
Sand bags	Gully erosion, Sheet erosion	Structural	G12, G17	P2	KATSINA	Baawa, Garu, Kofa
					JIGAWA	Kaya
					YOBE	Dogon kuka, Jimbame
					KEBBI	Masama
					SOKOTO	Badau
Stone bunds	Gully erosion	Structural	G12, G17	P2	KATSINA	Kofa
					JIGAWA	Kaya
					SOKOTO	Badau
Tree planting	Gully erosion, Sheet erosion	Vegetative	G9	P2	YOBE	Laye, Dogon kuka
Water diversion	Gully erosion	Structural	G17	P2, P6	KATSINA	Kofa

Table 13. Summary of the water harvesting measures used during water shortage period.

SLM practice	Reported issue addressed	Type of measures	Group of measures	Purpose	State	CDA/VA
Bore holes + Open wells	Water shortage for domestic use	Structural	G19	P1, P7	KATSINA	Kofa
Individual containers	Water shortage for both animal & domestic use	Structural	G15	P1, P7	YOBE	Jimbam
Dams	Water shortage for animal	Structural	G15	P1, P7	YOBE	Daura
Half-moon	Soil water harvesting and moisture conservation	Structural	G15	P1	KEBBI	Vui, Masama
Ponds	Water shortage for both animal & domestic use	Structural	G15	P1, P7	KATSINA	Kofa
					ZAMFARA	Yautabaki
					JIGAWA	Kukawa, Dagwaje
					YOBE	Jimbame
					SOKOTO	Kebbe

4.3. Farming systems and environments

4.3.1. Cropping systems, main crop types and soil management

Cropping systems across the CASP sites are dominated by rainfed annual cereal. Farmland under cultivation is generally small (2 to 4 ha), and the primary objective of farmers is to meet subsistence needs. The main crops are sorghum, maize, millet, cowpea, groundnut, Bambara-nut, rice. There is also a large diversity of subsidiary crops, and cassava and vegetables are also grown. Important parts of the harvested products are sold as raw and/or processed products.

Cropping operations are mostly done manually, with family labor as major input. Animal traction (e.g. work bulls) is the common form of mechanization, even though in some areas tractors are used.

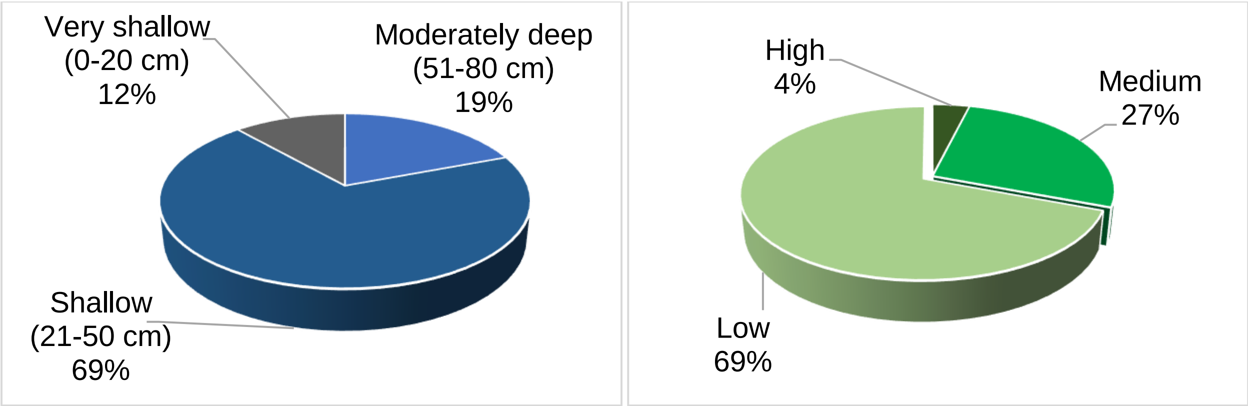
Given the limited land resources in the zone, intercropping, crop association or simultaneous cultivation of more than two crops in the same farm plot are common throughout the sites. According to the communities, this cropping system maximize benefits from scarce land resources and inputs (labor, fertilizers). However, even though the associated crops are of different growing periods and lengths, this cropping system in most cases can be considered as a form of soil overuse leading to degradation.

Crop rotation, organic fertilizer (mostly manure), and inorganic fertilizers, and in some cases fallowing (rarely observed) are means for fertility management and restoration.

4.3.2. Soil types

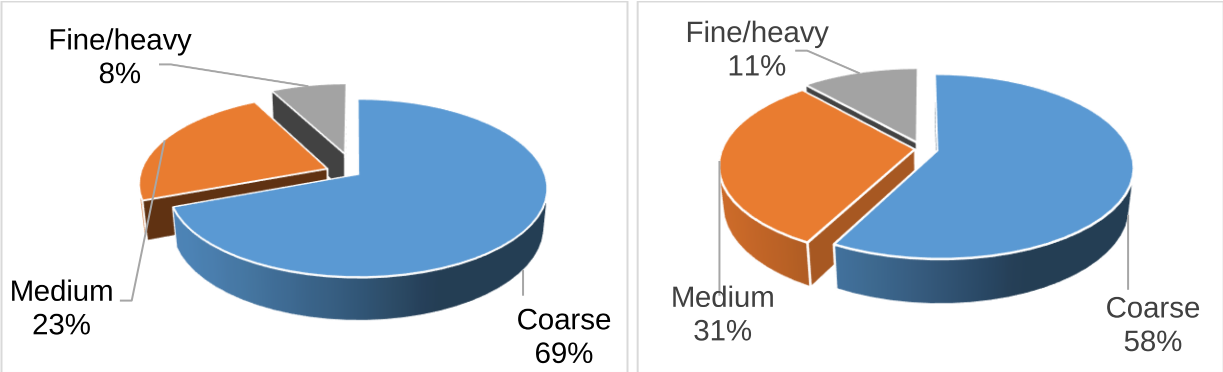
In the study area, 69 % of the observed soil types are shallow (21 – 50 cm) and 19 % are moderately deep (51 – 80 cm). In general, 88 % of the soils are deeper than 20 cm, the average tillage depth reported by the farmers.

Regarding the soil organic matter (SOM), its content is low for 69 % of the soils and medium for 27 %. Some lowlands (i.e. "*fadama"*) exhibited high SOM content. This soil condition is explained by the soil overuse, the poor vegetation cover and improper cropping systems.



Soil depth class (left) and organic matter class (right) at farm level.

In the topsoil, the texture is dominated by coarse soils (69 %) and medium ones (23 %). Similarly, in the subsoil (> 20 cm), texture is coarse in 58 % of cases and medium in 31 %. This texture, along with the poor SOM content, makes the soils prone to erosion by water and wind.



Texture in the topsoil (left) and in the subsoil right), at farm level.

4.3.3. Soil fertility management

In addition to SWC measures targeting soil fertility, farmers commonly rely on organic and inorganic fertilizers to improve crop productivity. The most common inorganic fertilizers are NPK, urea, and SSP. About 88 % of the interviewed farmers declared the application of fertilizer on their farms. The application period varies substantially among farmers. Some farmers mixe fertilizers with seeds before planting. Others apply fertilizers between 10 days to 7 weeks after plant germination, depending on the crop type, fertilizer type (SSP/NPK/Urea) and the budget availability.

The farmyard manure (FYM) is the most commonly used organic fertilizer. FYM is composed of animal dungs, organic wastes and crop residues. The manure is often applied some weeks prior to land preparation or land ploughing. The application rate strongly depends on the manure availability at farm household level.

While the FYM commonly comes from the farm household livestock, the inorganic fertilizers (NPK, SSP, Urea) are mostly purchased on the local markets. The challenges of soil fertility management also encompass financial aspects (lack of capital), presence of transhumance/nomadic herders, and off course water erosion.

4.3.4. Agroforestry practices, multipurpose trees and livestock

During the group discussions and farm visits, many multipurpose tree species were observed that are preserved in farmland. These species are preserved for their services (fruits, firewood through pruning, shade, organic matter, etc.). Common species are *Azadirachta indica, Piliostigma reticulata, Parkia biglobosa, Mangifera indica, Borassus aethiopum, Tamarindus indica, Eucalyptus spp., Diospyros mespiliformis, Adansonia digitata, Vitex doniana, Daniella oliveri, Prosopis africana, Moringa oleifera, Balanites aegyptiaca, Acacia spp., Combretum spp., Vitellaria paradoxa, Blighia sapida, Goyava spp., Anacardium occidentale,* etc.

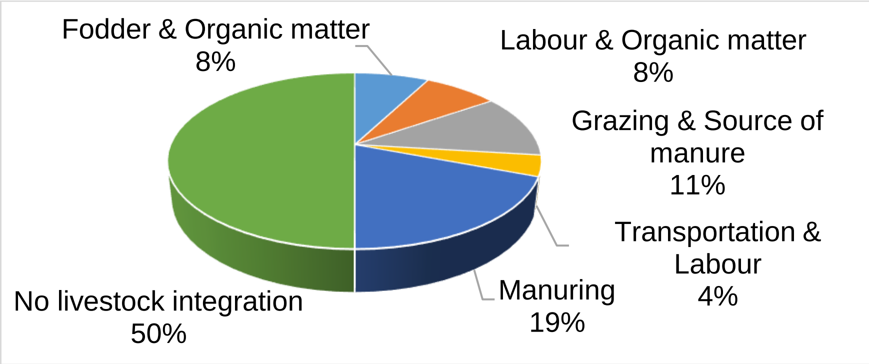
The benefits of these trees are diverse and can be summarized as below:

- Economic: firewood, forage, cash income
- Ecological: shade/shelter, windbreak, wind and water erosion control, soil cover
- Agronomic: moisture conservation, organic matter/fertilizer
- Socio-Cultural: fruits, wood for roofing, leaves/legumes, medicine

Preserved multipurpose trees in farm lands (Daura CDA/VA, Yobe)

Multipurpose trees in farm lands (Garu CDA/VA, Jigawa)

Livestock (big and small ruminants) are integrated into the farming systems in 50 % of the visited farms. The main roles played by livestock are the production of manure/organic matter, also through grazing on stubbles, transportation, and work/labor. Most often, farmers reported at least two roles of the integration of livestock to farming systems. The other 50 % of the respondent farmer declared that they do not integrate livestock into their farming systems.

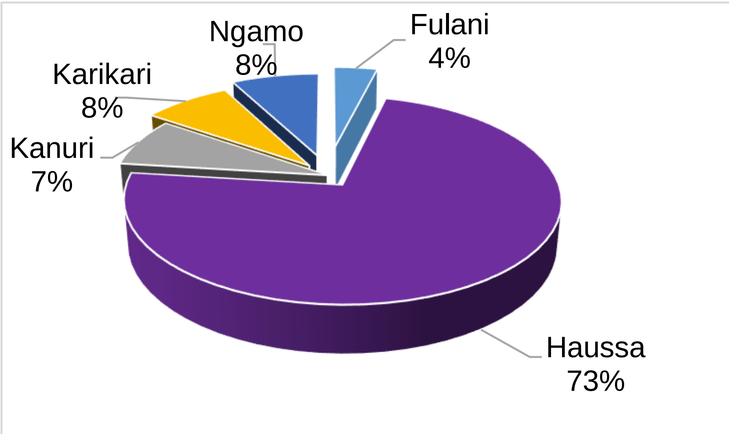


Role of livestock integration in farming systems.

4.4. Socio-economic conditions

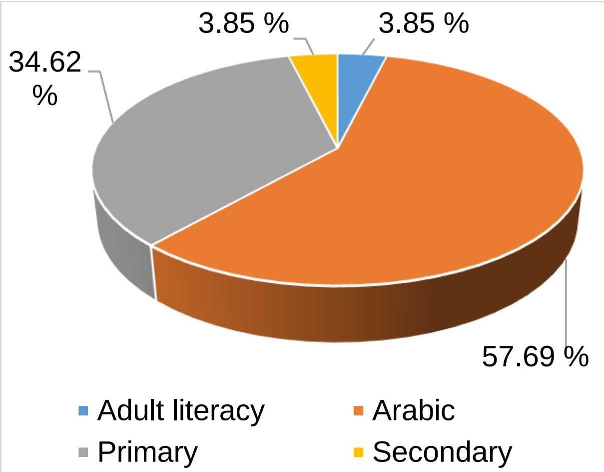
4.4.1. Household characteristics

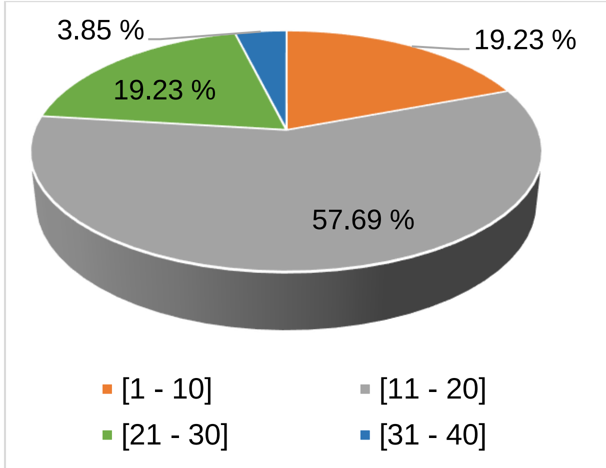
Almost all the respondents were male farmers (25 males versus 1 female), although gender was quite balanced during the group discussions. The age range was 30 – 82 years, with about 77 % having less than 55 years. The ethnic groups of the respondents was dominantly Hausa (73 %). Other respondents were Karikari (8 %), Ngamo (8%), Kanuri (7 %) and Fulani (4 %).



Ethnic group of respondent farmers.

The education level was fundamentally the Arabic school (58 %), and the primary school (35 %). Regarding the household size (number of people), the class of [11 – 20] was the most represented, denoting that the communities are dominated by large farm households.

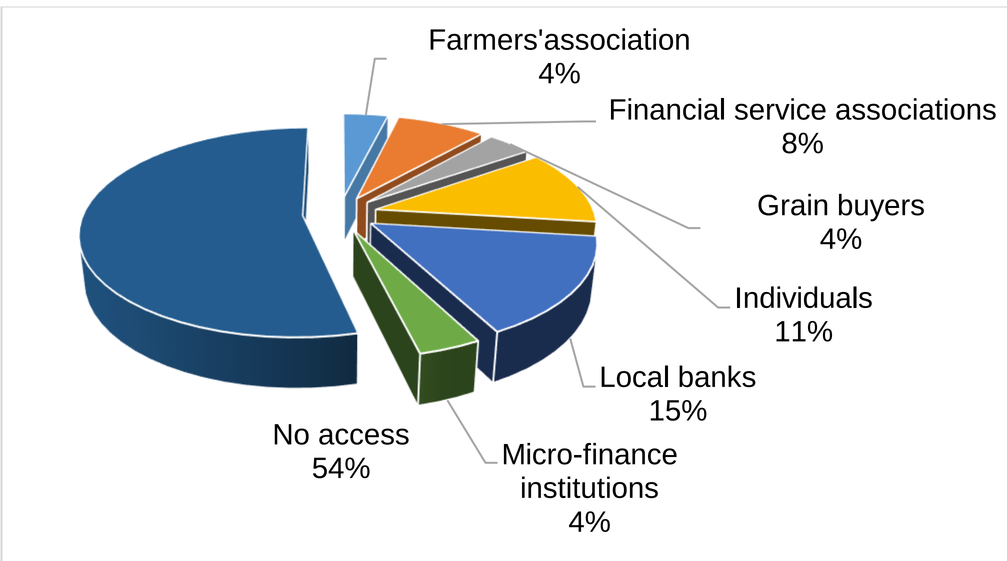




Education level of household heads (left) and classes of farm household size (right).

4.4.2. Accessibility to services and information

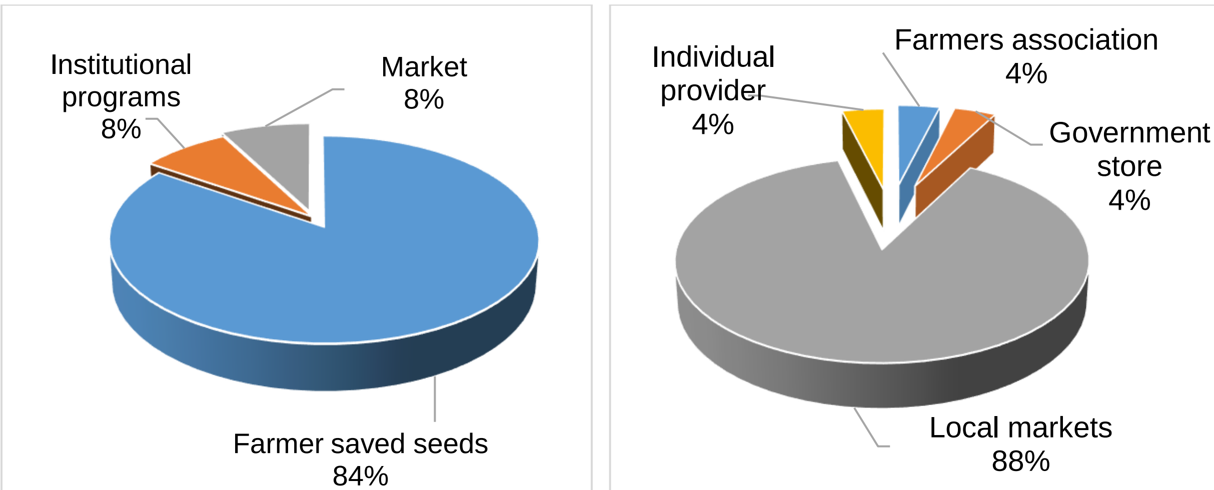
Many farmers (46%) have access to financial credit through local banks (15%), individuals (11 %), and financial services associations (FSA; 8 %). Farmers associations are source of credit to 4 % of the farmers.



Access to financial credit and financial services.

Seed origins are diverse. Among the interviewees, 84 % usually rely on their own saved seeds for planting at the rainfall onset. Some use seeds directly bought from local markets (8 %), or those provided by institutional programs such as IFAD-CASP programs, universities and research institutions (8%).

Local markets are the main source of the inorganic fertilizers for 88 % of the interviewed farmers. Benefits from farmers' associations comprise the provision of fertilizers to farmers.



Origins of seeds used by farmers (left) and origins of inorganic fertilizers (right).

5. Conclusions.

The aim of this survey was to identify the soil and water conservation measures and water harvesting systems adopted by the communities in the CASP areas. A participatory approach was undertaken in two phases (phase 1 targeting community group discussions, and phase 2 targeting individual farm households).

The visited communities were selected based on the knowledge of the CASP teams and extension agents, and on the consultation of the Community Action Plans elaborated at the village and community level in the frame of the CASP Programme. The selection approach was aimed at identifying a set of representative sites that could constitute a model, and a basis for future scaling-up, in the respective states and regions.

The results obtained indicate that land degradation and water scarcity are common environmental challenges in the Savannah Belt of Nigeria. In this semi-arid environments, main land degradation processes are water erosion (sheet and gully), wind erosion and deposition, soil fertility depletion, and depletion of surface water for animal and human consumption. The survey showed that several measures are adopted at small-scale (plot/farm level) either as single measure or as combination of measures (vegetative, structural, management and agronomic). These, are both traditional and introduced (either by government agents, or services of development projects/programs).

There is great similarity (biophysical, socio-economic) among sites, but also heterogeneity in terms of practices adopted, with high potential for cross-fertilization among communities, and for developing packages of proposals for improvements of the current SWC strategies. This will be the specific objective of the following project phase, that is the elaboration of sets of sit- specific best-bet practices (“matrix of options”) adapted to the local contexts.

Regarding the water harvesting techniques, there is poor engagement of the communities towards endogenous efforts to develop community-based infrastructures. Indeed, only few communities have WH structures. In most of the communities, natural ponds and exaction/borrow pits are used as animal drinking points which dry up during dry season. Water shortage occurs most acutely during the period February – May of each year.

Gender representation during community meetings appears to be a challenge, most likely due to socio-cultural and religious constraints.

6. Relevant documents consulted

- Community Action Plan of Kofa CDA/VA, Kusada LGA/ Katsina State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan of Baawa CDA/VA, Kaita LGA/ Katsina State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan of Garu CDA/VA, Musawa LGA/ Katsina State, Federal Republic of Nigeria. IFAD-CASP/FMARD. December 2017.
- Community Action Plan of Bui CDA/VA, Arewa LGA/ Kebbi State, Federal Republic of Nigeria. IFAD-CASP/FMARD, February 2018
- Community Action Plan of Bangarawa CDA/VA, Augie LGA/ Kebbi State, Federal Republic of Nigeria. IFAD-CASP/FMARD, January 2018
- Community Action Plan of Masama CDA/VA, Gwandu LGA/ Kebbi State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan Badau CDA/VA, Bodinga LGA/ Sokoto State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Kebbe CDA/VA, Kebbe LGA/ Sokoto State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Goran CDA/VA, Maradun LGA/ Zamfara State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Yautabaki CDA/VA, Birnin Magaji LGA/ Zamfara State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Kukawa CDA/VA, Birniwa LGA/ Jigawa State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Gana - Kaya CDA/VA, Garki LGA/ Jigawa State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Dagwaje CDA/VA, Dutse LGA/ Jigawa State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Jimbam CDA/VA, Kaita LGA/ Yobe State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Daura CDA/VA, Fune LGA/ Yobe State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017
- Community Action Plan, Laye CDA/VA, Fune LGA/ Yobe State, Federal Republic of Nigeria. IFAD-CASP/FMARD, 2017

- GIFSEP (2017). Mapping of community natural resources for 21 village areas of CASP participating states. A report of Global Initiative for Food Security and Ecosystem Preservation (GIFSEP) for the IFAD-CASP of the Federal Ministry of Agriculture and Rural Development of Nigeria. November 2017, 245 pages.

7. Annexes

Annex 1. Survey questionnaire – Phase 1

SUSTAINABLE LAND MANAGEMENT ACTIVITIES

IN CASP AREAS OF THE SAVANNAH BELT OF NORTHERN NIGERIA

GUIDANCE FOR GROUP DISCUSSION

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Focus group ID: ………………………… Date: ………………………...

Village: ……………………………………… State: …………………………

Group size: …………… Gender ratio: …………… Age range: Min :………; Max …………

Composition: Farmer…… Herders…… Local authorities…… Others (specify)……………

---*---

1. Survey structure and approach

This diagnostic survey questionnaire (SQ) targets not only SWC and WH measures, but also their perceived effectiveness by farmers and their association with soil degradation processes and with current cropping and farming systems.

The SQ will be implemented at project CASP sites. It will target the communities that already went through the participatory planning process identifying and ranking problems and preparing a community action plan (CAP). Among these, priority will be given to sites where soil conservation, including fertility management, and water availability, are recognized as major issues by the community. Based on knowledge of CASP officers, sites where farmers are already applying conservation practices will be given the highest priority in selection.

The approach will include the following steps:

Step 1

i) Ask farmers to introduce the main, most frequent crops and farming systems around the village, to make sure that in the following step you will visit representative farmers.

ii) Refer to the SWC issues and related actions as described by the CAP: discuss them briefly to clarify. Then ask farmers to describe what they are doing already to mitigate the problems, including either traditional practices or introduced by development agents.

Step 2

iii) Identify farmers (“adopters” of SWC/WH practices, or “non-adopters”) for individual interview at fields. Then go to phase 2. In case of non-adopters, skip point 5.

Note: This document is produced for the implementation of the survey (Phase 2) on soil and water conservation (SWC) and water harvesting (WH) under the ICARDA-CASP collaboration.

2. Details of the group interview

2.1. Farming systems and SWC/WH practices in the community agricultural landscapes

2.1.a. What are the main, most frequent, cropping systems around the village?

- The main rainfed crops (identified in the CAP as crops grown under wet season)
  ……………………………………………………………………………………………………

- The main irrigated crops if any (identified in CAP as crops grown during the dry season using irrigation)
  ……………………………………………………………………………………………………

- The main crop rotations (describe sequence)
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- Have the types of crops, coverage, or sequence changed over time – including due to climate variability or market demand? If yes, how?
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- Livestock numbers and species (types as identified in the CAP), and role/integration in cropping system (e.g., grazing on stubbles; grazing)
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- How much of the crop and animal product is taken to the market and how much is consumed at home?
  ……………………………………………………………………………………………………

- In what form are they taken to the market? Raw product or processed? If processed – who does the processing?
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- How far is the nearest market? And how often do they go to the market?
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- Integration of multipurpose (useful) trees in the farmlands (agroforestry practices). If yes, which species and which main product (fruit, honey, wood…)
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- Average (typical, most frequent) farm size (in ha)
  ……………………………………………………………………………………………………

- Average number of family members
  ……………………………………………………………………………………………………

- Who does the works, how are the tasks subdivided (family labor; other; men, women, young) on major activities, e.g.
  land preparation ……………………………..……………………………………………………
  planting …………………………………………………………………………………………….
  weeding ……………………………………………………………………………………………
  harvesting …………………………………………………………………………………………
  transportation………………………………………………………………………………………
  processing ……………………………………………………………..…………………………..
  marketing ………………………..…………………………………………………………………
  Other ………………………………………………………………………………………………

- Forms of mechanization, if any
  ……………………………………………………………………………………………………

- Source of credit – where would farmers go to borrow money to purchase agricultural inputs or invest in agricultural technologies?
  ……………………………………………………………………………………………………

- Where do farmers get their information on agricultural technologies (e.g., other farmers, extension agents, farmer associations/cooperatives, etc.)?
  ……………………………………………………………………………………………………

2.1.b. Land resources, land tenure.

- Land tenure in rangelands (if such land use exists) –private/common/government/other
  ……………………………………………………………………………………………………

- Pasture management (e.g., form of regulation of access to common land)
  ……………………………………………………………………………………………………

- Land tenure in forests–private/common/government (if such land use exists)
  ……………………………………………………………………………………………………

- Forest management (if any)
  ……………………………………………………………………………………………………

- Main source of firewood for community members (direct tree cutting/buying)
  ……………………………………………………………………………………………………

- Is tree cutting a relevant source of income?
  ……………………………………………………………………………………………………

- Are there communal structures to govern communal land? (E.g., if we wanted to adopt a watershed management approach which considers interventions both in the upstream and downstream areas – how would we go about it? or if we want to introduce some sort of area closure to give time for vegetation to grow? Etc.)
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- Seasonal presence of nomadic herders (regular, occasional, absent, just transhumance corridors; if present, estimate their livestock numbers)
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

- Surface water management (water points, rivers/streams, dams, etc.) for multiple uses, especially agricultural and pastoralism.
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………
  ……………………………………………………………………………………………………

2.1.c. Refer to the SWC issues and related actions as described by the CAP.
What are the main land degradation (LD) issues (decreasing fertility/productivity, water erosion (sheet or channeled), wind erosion, water logging, soil crusting, soil acidity...)?

- How do farmers judge the intensity/severity of LD in their land?
  Issue 1……………………………………………………………………………………
  Issue 2……………………………………………………………………………………
  Issue 3……………………………………………………………………………………
  Other……………………………………………………………………………………..

- How do officers/experts judge their intensity/severity (fill this in later, do not raise discussion on this)
  Issue 1…………………………severity…………………………………………………………
  Issue 2…………………………severity…………………………………………………………
  Issue 3…………………………severity…………………………………………………………
  Issue n…………………………severity…………………………………………………………

- Are these LD features there since longtime?
  Issue 1………………………………since……………………………………………………
  Issue 2………………………………since……………………………………………………
  Issue 3………………………………since……………………………………………………
  Issue 3………………………………since……………………………………………………

- Did their intensity/severity increase lately? If yes, for which issue?
  ……………………………………………………………………………………………………

- Are they affecting productivity and income? If yes, for which issue?
  ……………………………………………………………………………………………………

2.1.d. Refer to the SWC issues and related actions as described by the CAP.

What are the main issues related to water availability (water shortage, lack of drinking water for human/animals, aridity/drought spells, etc.)?

- How/where the community gets its drinking water?
  ……………………………………………………………………………………………………

- How/where the community gets water for animals?
  ……………………………………………………………………………………………………

- Is water quantity enough, is it stable/decreasing (why)?
  ……………………………………………………………………………………………………

- Is water quality improving, stable, or worsening (why)?
  ……………………………………………………………………………………………………

Try to clarify when do they lack water (for human or animal drinking; orchards, other), the main source of water during water shortage period.

……………………………………………………………………………………………………
……………………………………………………………………………………………………

If the main source is groundwater (GW), take note of (average) GW table depth.

……………………………………………………………………………………………………

2.1.e. Are the community members applying any SWC/WH practice, e.g., to mitigate degradation processes (e.g., gullies) or to preserve soil fertility, soil moisture, or increase water availability.

List such practices and for each of them ask if

- What issue is the practice intended to mitigate
- Is it traditional, or introduced (by whom)
- how did they learn it (e.g., learnt from fathers, or inherited)
- Whose task is it (men, women, youth, children)

As an example, about fertility, ask if they apply manuring, rotation, fallow, mulching… any other.

About water erosion, ask if they apply terracing, contour bunds, ridging, if they are avoiding grazing or tree-cutting in areas under erosion, or any other…..

About water availability ask if they capture and store rain water in any way (cisterns, ponds, dams, tanks…), if they ridge fields to maximize water use by crops, try to increase infiltration and slow-down runoff, or any other.

Also use the list in Annex to Phase 2 questionnaire (point 2) as further reference.

SWC Practices	Mitigation target	Traditional/Introduced	Task responsible	Inherited/ trained/innovation	Percentage of adoption
…………	…………	…………..	…………	…………	…………
…………	…………	……………	…………	…………	…………
…………	…………	……………	…………	…………	…………
…………	…………	…………	…………	…………	…………
…………	…………	…………..	…………	…………	…………
…………	…………	…………..	…………	…………	…………
…………	…………	……………	…………	…………	…………
…………	…………	…………..	…………	…………	…………
…………	…………	…………..	…………	…………	…………
…………	…………	…………	…………	…………	…………....
…………	…………	……………	…………	…………	…………....
…………	…………	…………..	…………....	…………	

2.2. Identification of individual farmers for second phase (see Questionnaire)

If there are farmers that apply one or more SWC/WH practices (“adopters”), call for two or three representative adopters, that are facing actual problems in their fields, and are available to continue the interview in their fields (clarity of communication is crucial to avoid being driven by enthusiastic farmers to fields that are not relevant). Then go to phase 2.
If it appears that no SWC/WH practice is applied, identify all the same two or three representative farmers that face real problems (as above) by applying normal (“business as usual”) practices. Then go to phase 2 but skip point 5.

Pick small farmers that are implementing the main community crops. The selected farmers should not be “average” farmers. They should instead represent a best-case, e.g., be among the most progressive, or keenest to innovation (even if they are not “adopters”). We want to build on the best experience and awareness.

Annex 2. Survey questionnaire – Phase 2

SUSTAINABLE LAND MANAGEMENT ACTIVITIES

IN CASP AREAS OF THE SAVANNAH BELT OF NORTHERN NIGERIA

QUESTIONAIRE FOR FARM HOUSEHOLD SURVEY

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Questionnaire ID: ………………………… Date: ……………………

1. Farmer identification

Name of Village: ……………………………	State:……………………………………………		
Farmer name:		Sex :	Age:
Family Role: *1=Father, 2=Son/daughter, 3=Wife,*		Ethnic group: ……………………………	
Origin: *1=Resident; 2=Migrant*	If migrant, since when?:………………………………………	Coming from?......................	

2. Farm and farming system, crops, management

2.1. Farm household: family members (oldest to youngest)

N.	**Sex (M/F)**	**Age (years old)**	**Education level**	**Relationship to the household head**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Note: This document is produced for the implementation of the survey (Phase 2) on soil and water conservation (SWC) and water harvesting (WH) under the ICARDA-CASP collaboration.

2.2. Land ownership and farm characteristics

2.2.1. Please specify the land ownership:

Owned ☐ Rented ☐ Buying ☐ Usufruct ☐ Harvest-shared ☐

2.2.2. Please specify your farm size

< 1ha ☐ 1 – 3ha ☐ 3 – 5ha ☐ 5 – 10ha ☐ >10ha ☐

2.2.3. Please mention the availability of hired labor in the area

Always Easy ☐ Always Expensive ☐ Seasonally expensive ☐

2.2.4. What is the common mechanisms to mobilize the community labor for large tasks, if any?
………
………

2.2.5. Mention any off-farm income generation activity, if any (*Especially if agriculture is not the only or main source of income for the household)* ?
………

2.2.6 Do you contract a financial credit for implementing your farm-based activities? Yes ☐ No ☐

If Yes, please specify the source of credit:

Local banks ☐ Micro-finance institutions ☐ Individuals ☐ Others (*specify*)………………

2.2.7. Please mention the source of information on agricultural technologies in your communities

State agencies ☐ Extension services ☐ Local authorities ☐ Farmers organization ☐
Individuals ☐ Others (*specify*) ☐ ……………………………………

2.2.8. Are you a member of any agricultural cooperatives (e.g. farmers' organization)? Yes ☐ No ☐

If Yes, please mention the benefits received through your membership to this organization…………………………………………………………………………………………
………

2.3. Farming, and task distribution within household

2.3.1. If the SWC/WH practices are implemented in cropped fields, for each main crop describe the below works/inputs. Specify who does each of the listed works (man, woman, young, children).

Activities	Crop 1 (mention Crop type) ………………………	Crop 2 (mention Crop type) ………………………	Crop 3 (mention Crop type) ………………………	Crop 4 (mention Crop type) ………………………	Crop 5 (mention Crop type) ………………………
Ploughing *(1=animal, 2=machine, 3=human* *(times, dates, depth)*	……………… ……………… ……………… ………………	……………… ……………… ……………… ………………	……………… ……………… ……………… ………………	……………… ……………… ……………… ………………	……………… ……………… ……………… ………………
Planting *(1=manual, 2=machine* *method, pattern)*	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………
Origin of the seeds *(officers may answer this)*	………………	………………	………………	………………	………………
Fertilizing *(Yes/No)*	………………	………………	………………	………………	………………
Fertilizer *(product type; Application period; Rate)*	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………
Fertilizer provider *(in case Yes above)*	………………	………………	………………	………………	………………
Manuring *(1=Yes, 2=No)* *(Type, Time & Rate)*	……………… ……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………
Weeding (*1=manual; 2=mechanized*) Period, Frequency (How many times)	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………
Irrigation practices used during the dry seasons *(e.g., furrow, drip, etc.)*	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………	……………… ……………… ………………
Other works (specify)	………………	………………	………………	………………	………………

Livestock role in cropping system *(e.g., grazing or feeding on residues; source of manure)*	………………	………………	………………	………………	………………
Presence of useful trees *(1 = Yes; 2 = No)*	………………	………………	………………	………………	………………
Role of multipurpose trees *(1 = windbreak, 2 = fuel for cooking, heating, 3=Shade, fruit, honey, etc.)*	………………	………………	………………	………………	………………

2.3.2. Is the SWC/WH practice implemented in pasture ☐ or forest land ☐
If yes, specify:

	Pasture lands	Forest lands
Land tenure of lands *(1=private; 2=common; 3=government; 4=other)*		
Land management *(e.g., form of regulation of access to common land, grazing timing)*		

2.3.3. Livestock numbers by species

Cattle………………………………………….
Goats………………………………………….
Camels…………………………………………
Sheep………………………………………….
Donkeys………………………………………
Poultry…………………………………………

2.3.4. Are the animal reared by the household used for:

Household consumption ☐ Selling ☐ Other ☐

2.3.5. What are the sources of fuel for:

- cooking……………………………………………………………………………………
- heating……………………………………………………………………………………
- lighting………………………………………………………………………………………
- Other………………………………………………………………………………………

2.3.6. Is tree cutting a relevant source of income for the farmer? Yes ☐ No ☐

If Yes, please mention how often you cut trees:

Daily ☐ Weekly ☐ Monthly ☐ Bi-monthly ☐ Other ☐………

2.3.7. Is farmer performing relevant tree planting? Yes ☐ No ☐
Specify:…………………………………………………………………………………………

2.3.8 Is farmer performing relevant forage species planting? Yes☐ No ☐

2.3.9. Are the nomadic herders present in your lands or community lands? Yes☐ No☐

2.3.9.a. If present, please estimate the average livestock number: ……………………..

2.3.9.b. How often are present the nomadic herders on your lands?

Regular☐ Occasional☐ Absent☐

4. The soil and water degradation processes, the soil type, and water availability at farmer field

4.1. Soil and water degradation processes (in farmer's fields)

4.1.1. Do you think that your soil is less productive, or your soil and water resources are now reduced, compared to 10 or more years ago? Yes☐ No☐

4.1.2. Are you observing recent/ongoing degradation of the productivity of your land *(e.g., decreasing yield, soil loss due to erosion, deterioration of soil health, more recurrent droughts, decreasing water depth in wells, etc.)?* Yes ☐ No☐

4.1.3. How do you evaluate the quality of the soil of your farm compared to the land of the surrounding farms having similar settings *(e.g., similar slope, similar crops, similar soil type, …)?*

Average☐ Lower ☐ Higher ☐

4.1.4. Go through the list below (A to Q) and pick the types of degradation recognized by the farmer:

☐ A. Water erosion *(i.e. Loss of topsoil/ surface erosion, by water)*:
- -Sheet *(even removal of top soil) or rill (small channels, not larger than 1 square foot in section)* ☐
- -Gully *(erosion channels, larger than 1 square foot in section)* ☐

☐B. Wind erosion *(i.e. Loss of topsoil/ surface erosion, by wind)*
- -Loss of topsoil *(i.e. uniform displacement)* ☐
- -Deflation & deposition *(i.e. uneven removal of soil material and on-site or off-site deposition)* ☐

☐C. Fertility / productivity decline (quantity and/or quality)
☐D. Salinization (salt efflorescence at surface and/or on peds)
☐E. Soil pollution: contamination of the soil with toxic materials
☐F. Compaction (deterioration of soil structure by trampling or and/or use of machinery)
☐G. Crusting (development of thin crust at surface, obstructing infiltration)
☐H. Waterlogging (frequent water saturation of soils -excluding paddy fields)

☐ I. Acidification: decrease of average soil moisture content, crops suffering water stress
☐ L. Decreasing groundwater level in wells
☐ M. Decline of groundwater quality (salinity, contamination)
☐ N. Decline of surface water quality (salinity, contamination)
☐ O. Loss of soil life (decline of useful soil fauna, e.g., earthworms, pollinators)
☐ P. Spreading of weeds, invasive species (herbs, shrubs, trees)
☐ Q. Increase of pests/diseases

4.1.5. For each specific type of land degradation identified, ask the farmer to evaluate the extent, trend and severity as follows:

Extent *(farm % area):*	0-20 % ☐	20-50 % ☐	>50 % ☐
Trend *(change in affected area during the last 5 years)*:	Increasing ☐	Stable ☐	Decreasing ☐
Intensity/Severity:	Low ☐	Medium ☐	High ☐

4.2. Soil type

4.2.1. Give soil type as:
Traditional name *(if any)*: ………………………………………………………………………..
Modern name *(according to current classification system as used in the country, if available):*…………………………………………………………………………………………..…..

4.2.2. Soil depth at farm, on average

very shallow (0-20 cm) ☐ moderately deep (51-80 cm) ☐ very deep (> 120 cm) ☐
shallow (21-50 cm) ☐ deep (81-120 cm) ☐

4.2.3. Soil texture at farm, dominant type (topsoil, 0-20 cm)

coarse/ light *(*sandy, to sandy loam*)* ☐ medium (loam) ☐ fine/heavy (clay) ☐

4.2.4. Soil texture at farm, dominant type (> 20 cm below surface)

coarse/light (sandy, to sandy loam) ☐ medium (loam) ☐ fine/heavy (clay) ☐

4.2.5. Organic matter/ (topsoil, 0-20 cm). *(Can evaluate based on color reference at the end of Annex 2.1).*

low (< 1%) / light brown ☐ medium (1-3%) / brown ☐ high (> 3%) / dark brown ☐

4.2.6. Soil structure

Weak *(aggregates are barely observable in place; when gently disturbed, the soil material breaks down into mainly fine particles)*; ☐

Moderate *(aggregates are observable in place; when disturbed, the soil material breaks into a mixture of smaller aggregates and fine particles)* ☐

Strong *(aggregates are clearly observable in place; when disturbed, the soil material separates mainly into smaller aggregates)*. ☐

4.3. Water availability

4.3.1. Availability of surface water

excess *(e.g. frequent waterlogging, high runoff)* ☐ medium *(e.g. not available year-round)* ☐

good *(e.g. available year-round)* ☐ poor/ none ☐

4.3.2. Quality of available surface water (untreated)

good drinking water ☐ for agricultural use only *(irrigation)* ☐

poor drinking water *(treatment required)* ☐ unusable ☐

4.3.3. Groundwater table: depth

< 10 m ☐ 10-20 m☐ 20-50 m ☐ > 50 m ☐

4.3.4. Is water salinity a problem? No ☐ Yes ☐

If Yes, please specify:
……………………………………………..

4.3.5. Is flooding occurring in the area/field? Yes ☐ No ☐

If Yes, how often? Frequently☐ Episodically ☐

4.3.6. Please provide any comments and further specifications on water quality and quantity

(e.g. seasonal fluctuations, pollution, etc…,)
....
....

5. Characterize the SWC/WH practices (hereafter, SLM, sustainable land management) in the field, following the WOCAT SLM documentation framework.

5.1. Name of the SLM practice
Name: ....
Locally used name:……………………………………………...

5.2. Description of the SLM practice *(Based on guidance questions below, the description should ideally be around half a page long by hand writing):*

What are the main characteristics/ elements of the SLM practice?
What are the purposes/ functions of the SLM practice, and the crop and farming practices associated with?
What major activities/ inputs are needed to establish/ maintain the SLM practice?
What are the benefits/ impacts of the SLM practice?
What do land users like / dislike about the SLM practice?

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5.3. Main purpose(s) of the SLM practice *(Please choose one or more from WOCAT framework in Annex 2.1 (point 1):*
……………………………………………………………………………………………………

5.4. SLM group to which the SLM practice belongs *(Please choose one from WOCAT framework in Annex 2.1 (point 2)* ………………………………………………………………………………

5.5. Type measures comprising the SLM practice *(Choose one from WOCAT framework in Annex 1 (point 3)*
……………………………………………………………………………………………………

5.6. Technical specifications *(Provide technical explanations about the SLM practice, particularly if this consists of physical structures. Refer to technical features indicated by WOCAT framework (as in point 4 of Annex 1), add others if appropriate. Summarize, also by means of multiple clear photos, the technical specifications, e.g.:*

- *Dimensions (height, depth, width, length) of structures or vegetative elements*
- *Spacing between structures or plants/ vegetative measures*
- *Vertical intervals structures or vegetative measures*
- *Slope angle (before and after implementation of the SLM practice)*
- *Lateral gradient of structures*
- *Capacity of dams, ponds, etc.*
- *Catchment area and beneficial area of dams, ponds, other water harvesting systems*
- *Construction material used*
- *Species used*
- *Quantity/ density of plants (per ha)*

Add one or several photographs suitable to illustrate the technical features. Deliver the photos as original graphical file (e.g., .jpg, .tif) but add captions with explanation of photos into the text. Example: Photo 1. Detailed view of terraces built by farmer, showing terrace height and slope angle. Photo taken by Richard Casp. 30/02/2018)

Technical specification:
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Illustrative photos *(Provide codes or numbers of the photos)*……………………………………......

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5.7. Ask the farmer to identify the likely/expected on-farm benefits of the SLM practice, in terms of either increased performance, or reduction of resource degradation (us list below as reference)

a. Income ☐
b. Crop production ☐
c. Crop quality ☐
d. Fodder quality ☐
e. Animal production ☐
f. Tree production ☐
g. Reduced drudgery ☐
h. Availability of surface water ☐
i. Availability of ground water ☐
j. Soil moisture ☐

k. Consumption of water ☐
l. Waterlogging ☐
m. Surface runoff, soil erosion ☐
n. Impact of floods ☐
o. Soil crusting/ sealing ☐
p. Soil compaction ☐
q. Soil salinity ☐
r. Pests/diseases ☐
s. Invasive species (herbs/shrubs/trees) ☐

5.8. If the farmer has identified one or more of the above impacts of the adopted SLM practice, for each one the extent of such benefit should be rated as % **change** (not improvement; just change. *e.g., more yield; more soil salinity; less yield; less erosion*), as follows:

Expected impacts	Increase (+20-50% or beyond)	Slight increase (+5-20%)	Negligible effect	Slight decrease: (– 5-20%)	Decrease (– 20-50% or below)
………….	☐	☐	☐	☐	☐
…………….	☐	☐	☐	☐	☐
…………….	☐	☐	☐	☐	☐
…………….	☐	☐	☐	☐	☐
…………….	☐	☐	☐	☐	☐

5.9. Factors affecting the adoption and incentives of SLM techniques (from the perspectives of farmers and agricultural extension services)

Factors of success of the SLM technique: ……………………………………………………………..

Factors hindering the SLM technique: …………………………………………………….................

What factor could be useful to enhance adoption:……………………………………………………..

Are there any cooperative groups (farmers' organizations, self-help, etc.) for the implementation of SLM related activities? ………………………………………………………………………………

5.10. List and explain any constraint or challenge to the implementation of the conservation practices that the farmer adopts or wishes to adopt

(Examples: manuring; insufficient residues, lack of capacity for composting; gully plugs; lack of stones, lack of capacity to build stone bunds, lack on man power; tree planting; lack of seedlings…, etc.)

………
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6. Georeference the most representative farm field where SLM has been documented (see Annex 2 for possible reference).

Geographic coordinates (WGS84):
………………..……..……………E…………………………………..…….N

Annex 2.1: Elements from WOCAT framework for SLM documentation (www.wocat.net)

1. Purpose of the SLM practice

P1 = improve production (crop, fodder, wood/ fibre, water, energy)
P2 = reduce, prevent, restore land degradation (soil, water, vegetation)
P3 = conserve ecosystem
P4 = protect a watershed/ downstream areas – in combination with other Technologies
P5 = preserve/ improve biodiversity
P6 = reduce risk of disasters (e.g. droughts, floods, landslides)
P7 = adapt to climate change/ extremes and its impacts (e.g. resilience to droughts, storms)
P8 = mitigate climate change and its impacts (e.g. through carbon sequestration)
P9 = create beneficial economic impact (e.g. increase income/ employment opportunities)
P10 = create beneficial social impact (e.g. reduce conflicts on natural resources, support marginalized groups)
P11 = other purpose (specify):

2. SLM group to which the practice belongs

G1 = natural and semi-natural forest management
G2 = forest plantation management
G3 = agroforestry
G4 = windbreak/ shelterbelt
G5 = area closure (stop use, support restoration)
G6 = rotational system (crop rotation, fallows, shifting cultivation)
G7 = pastoralism and grazing land management
G8 = integrated crop–livestock management
G9 = improved ground/ vegetation cover
G10 = minimal soil disturbance
G11 = integrated soil fertility management
G12 = cross-slope measure
G13 = integrated pest and disease management (incl. organic agriculture)
G14 = improved plant varieties/ animal breeds
G15 = water harvesting
G16 = irrigation management (incl. water supply, drainage)
G17 = water diversion and drainage
G18 = surface water management (spring, river, lakes, sea)
G19 = groundwater management
G20 = wetland protection/ management
G21 = waste management/ waste water management
G22 = energy efficiency
G23 = beekeeping, aquaculture, poultry, rabbit farming, silkworm farming, etc.
G24 = home gardens
G25 = ecosystem-based disaster risk reduction
G26 = post-harvest measures
G27 other (specify)

***Natural and semi-natural forest management**: encompasses administrative, legal, technical, economic, social, and environmental aspects of the conservation and use of forests.*

***Forest plantation management**: plantation forests comprise even-aged monocultures and are established primarily for wood and fibre production. They are usually intensively managed and have relatively high growth rates and productivity.*

***Agroforestry**: integrates the use of woody perennials with agricultural crops and/ or animals for a variety of benefits and services including better use of soil and water resources; multiple fuel, fodder, and food products; and habitat for associated species.*

***Windbreak**: or shelterbelt is a plantation usually made up of one or more rows of trees or shrubs planted in such a manner as to provide shelter from the wind and to protect soil from erosion. They are commonly planted around the edges of fields on farms.*

***Area closure (stop use, support restoration)**: enclosing and protecting an area of degraded land from human use and animal interference, to permit natural rehabilitation, enhanced by additional vegetative and structural conservation measures.*

***Rotational systems (crop rotation, fallows, shifting cultivation)**: is the practice of growing a series of dissimilar/ different types of crops/ plants in the same area in sequenced season, letting it fallow for a period of time, shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation while the cultivator moves on to another plot.*

***Pastoralism and grazing land management**: is the grazing of animals on natural or semi-natural grassland, grassland with trees, and/ or open woodlands. Animal owners may have a permanent residence while livestock is moved to distant grazing areas, according to the availability of resources*

***Integrated crop–livestock management**: optimizes the uses of crop and livestock resources through interaction and the creation of synergies.*

***Improved ground/ vegetation cover**: any measures that aim to improve the ground cover be it by dead material/ mulch or vegetation*

***Minimal soil disturbance** refers to no-tillage or low soil disturbance only in small strips and/ or shallow depth and direct seeding.*

***Integrated soil fertility management** (IFSM) aims at managing soil by combining different methods of soil fertility amendment together with soil and water conservation. ISFM is based on three principles: maximizing the use of organic sources of fertilizer (e.g. manure and compost application, nitrogen-fixing green manure and cover crops); minimizing the loss of nutrients; and judiciously using inorganic fertilizer according to needs and economic availability.*

***Cross-slope measures:** are constructed on sloping lands in the form of earth or soil bunds, stone lines, or vegetative strips, etc. for reducing runoff velocity and soil erosion.*

***Integrated pest and disease management (incl. organic agriculture):** Integrated pest and disease management is a process to solve pest and disease problems while minimizing risks to people and the environment.*

***Improved plant varieties/ animal breeds**: refers to the development of new plant varieties or animal breeds that offer benefits such as improved production, resistance to pests and diseases, or drought tolerance, in response to changing environmental conditions and land users' needs.*

***Water harvesting**: is the collection and management of floodwater or rainwater runoff to increase water availability for domestic and agricultural use as well as ecosystem sustenance.*

***Irrigation management (incl. water supply, drainage)** aims to achieve higher water use efficiency through more efficient water collection and abstraction, water storage, distribution, and water application.*

***Water diversion and drainage**: is the natural or artificial diversion or removal of surface and sub-surface water from an area*

***Surface water management (spring, river, lakes, sea)**: involves the protection of springs, rivers, and lakes from pollution, high water flows(floods), or over-abstraction of water, as well as protection measures against damage from waterbodies (e.g. river bank erosion, floods, tidal erosion)*

***Groundwater management**: involves securing the recharge of groundwater reserves and their protection from pollution, overexploitation/ overuse, and rising groundwater levels leading to salinization.*

***Wetland protection/ management**: managing wetland typically involves manipulating water levels and vegetation in the wetland, and providing an upland buffer.*

***Waste management/ waste water management**: is a set of activities that include collection, transport, treatment and disposal of waste, prevention of waste production, and modification and reuse/ recycling of waste.*

***Energy efficiency technologies**: reduce the amount of energy required to provide products and services, e.g. for cooking and heating, reducing the demand for fuel (fossil, wood).*

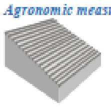
***Beekeeping, aquaculture, poultry, rabbit farming, silkworm farming, etc.**: allow food production and agricultural products requiring small surfaces of the land.*

***Home gardens** (also called backyard or kitchen gardens): are a traditional multifunctional farming system applied on a small area of land around the family home. They have the potential to supply most of the non-staple foods (including vegetables, fruits, herbs, animals and fish). They also provide a space for recreation, leisure, and relaxation.*

***Ecosystem-based Disaster Risk Reduction:** is the sustainable management, conservation, and restoration of ecosystems with the aim of enabling these ecosystems to provide services that mitigate hazards, reduce vulnerability, and increase livelihood resilience.*

***Post-harvest measures:** encompasses activities to deliver a crop from harvest to consumption with minimum loss, maximum efficiency, and maximum return for all involved – such as drying, storage, cooling, cleaning, sorting, and packing.*

3. Type of SLM measures

Type of measure	*Subcategories*	*Examples*
Agronomic measures  • *are usually associated with annual crops* • *are repeated routinely each season or in a rotational sequence* • *are of short duration and not permanent* • *do not lead to changes in slope profile* • *are normally independent of slope*	A1: Vegetation/ soil cover A2: Organic matter/ soil fertility A3: Soil surface treatment A4: Subsurface treatment A5: Seed management, improved varieties A6: Others	*Mixed cropping, intercropping, relay cropping, cover cropping* *Conservation agriculture, production and application of compost/ manure, mulching, trash lines, green manure, crop rotations* *Zero tillage (no-till), minimum tillage, contour tillage* *Breaking compacted subsoil (hard pans), deep ripping, double digging* *Production of seeds and seedlings, seed selection, seed banks, development/ production of improved varieties*
Vegetative measures  • *involve the use of perennial grasses, shrubs, or trees* • *are of long duration* • *often lead to a change in slope profile* • *are often aligned along the contour or against the prevailing wind direction* • *are often spaced according to slope*	V1: Tree and shrub cover V2: Grasses and perennial herbaceous plants V3: Clearing of vegetation V4: Replacement or removal of alien/ invasive species V5: *Others*	*Agroforestry, windbreaks, afforestation, hedges, live fences* *Grass strips along the contour, vegetation strips along riverbanks* *Fire breaks, reduced fuel for forest fires* *Cutting of undesired trees and bushes* *Tree nurseries*
Structural measures  • *are of long duration or permanent* • *often require substantial inputs of labour or money when first installed* • *involve major earth movements and/ or construction with wood, stone, concrete, etc. are often carried out to control runoff, erosion, and wind velocity, and to harvest rainwater* • *often lead to a change in slope profile* • *are often aligned along the contour/ against prevailing wind direction* • *are often spaced according to slope* *If structures are stabilized by means of vegetation, also select relevant vegetative measures!*	S1: Terraces S2: Bunds, banks S3: Graded ditches, channels, waterways S4: Level ditches, pits S5: Dams, pans, ponds S6: Walls, barriers, palisades, fences S7: Water harvesting/ supply/ irrigation equipment S8: Sanitation/ waste water structures S9: Shelters for plants and animals S10: Energy saving measures S11: Others	*Bench terraces (slope of terrace bed <6%); Forward-sloping terraces (slope of terrace bed >6%* *Earth bunds, stone bunds (along the contour or graded), semi-circular bunds ("demi-lunes")* *Diversion/ drainage ditch, waterways to drain and convey water* *Retention / infiltration ditches, planting holes, micro-catchments* *Dams for flood control, dams for irrigation, sand dams* *Sand dune stabilization, rotational grazing (using fences), area closure, gully plugs (check dams)* *Rooftop water harvesting, water intakes, pipes, tanks, etc.* *Compost toilet, septic tanks, constructed treatment wetlands* *Greenhouses, stables, shelters for plant nurseries* *Wood-saving stoves, insulation of buildings, renewable energy sources (solar, biogas, wind, hydropower)* *Compost production pits; reshaping of surface (slope reduction)*
Management measures  • *involve a fundamental change in land use* • *usually involve no agronomic and structural measures* • *often result in improved vegetative cover* • *often reduce the intensity of use*	M1: Change of land use type M2: Change of management/ intensity level M3: Layout according to natural and human environment M4: Major change in timing of activities M5: Control/ change of species composition (if annually or in a rotational sequence as done e.g. on cropland → A1) M6: Waste management (recycling, re-use or reduce) M7: Others	*Area closure/ resting, protection, change from cropland to grazing land, from forest to agroforestry, afforestation* *Change from grazing to cutting (for stall feeding), farm enterprise selection (degree of mechanization, inputs, commercialization), vegetable production in greenhouses, irrigation; from mono-cropping to rotational cropping; from continuous cropping to managed fallow; from open access to controlled access (grazing land, forests); from herding to fencing, adjusting stocking rates, rotational grazing* *Exclusion of natural waterways and hazardous areas, separation of grazing types, distribution of water points, salt licks, livestock pens, dips (grazing land); increase of landscape diversity, forest aisle* *Land preparation, planting, cutting of vegetation* *Reduction of invasive species, selective clearing, encouragement of desired/ introduction of new species, controlled burning (e.g. prescribed fires in forests/ on grazing land)/ residue burning* *Includes both artificial and natural methods for waste management*
Other measures • *comprises any measures which do not fit into the above categories*		*Beekeeping, smallstock farming (e.g. poultry, rabbits), fish ponds; food storage and processing (including post-harvest loss reduction)*
Combinations • *occur where different measures complement each other and thus enhance each other's effectiveness* • *may comprise any two or more of the above measures*		*Terrace (S1) + Grass strips and trees along riser (V2, V1) + Contour tillage (A3)* *Zero grazing/ stall feeding (M2) + Construction of stables and fence (S10) + Compost/ manure production pits (S12) + Application of manure and compost on cropland (A2)*

4. Technical specifications/ explanations of technical photos

Summarize, also by means of multiple clear photos, the technical specifications, e.g.:
- Dimensions (height, depth, width, length) of structures or vegetative elements
- Spacing between structures or plants/ vegetative measures
- Vertical intervals structures or vegetative measures
- Slope angle (before and after implementation of the SLM practice)
- Lateral gradient of structures
- Capacity of dams, ponds, etc.
- Catchment area and beneficial area of dams, ponds, other water harvesting systems
- Construction material used
- Species used
- Quantity/ density of plants (per ha)

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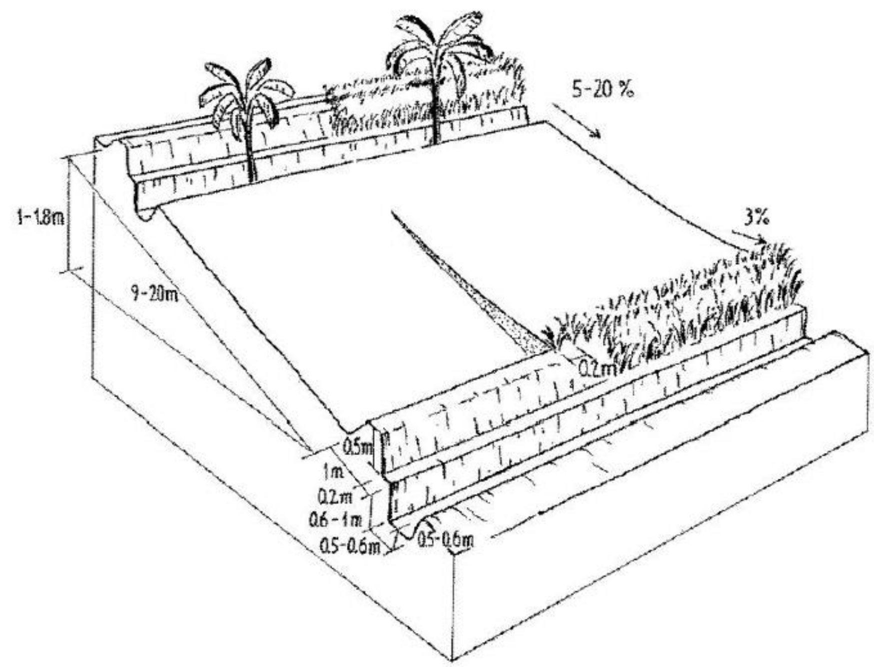
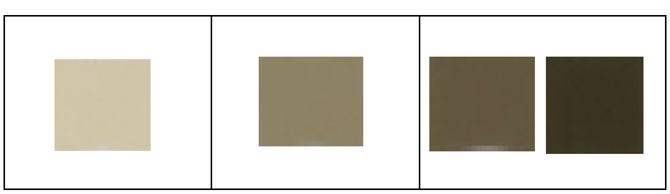


***Example**: Technical drawing indicating technical specifications, dimensions, spacing*

5.a. Color reference for estimation of low, medium, and high organic matter content (non-lateritic, non-ferruginous soils) (Can use the color chart application from Google playstore on Smartphone)



ANNEX 2.2: Procedure to geo-reference the location of the selected farms by using software apps commonly available on smartphones and easily manageable by technicians (Maps, by Google).

Geo-referencing farms will be possible, with a satisfactory level of geometric approximation, without a professional GPS receiver. The below procedure is based on a very common App for Android (Google Maps) that will best perform on a GPS-smartphone (phone with built-in GPS). Using this App (or another with similar capacity), a technician will be able to easily record the geographical coordinates of the fields where a given SLM practice is being implemented.

If in one farm the SLM practice is implemented in more than one plot, the technician/farmer can decide to geo-reference the main field, the biggest and most representative.

Besides the simplicity of the procedure, a major advantage of it is that the coordinates are automatically recorded by the app as geographical degrees (decimal degrees; dd.ddddd) referred to the international WGS84 ellipsoid, or reference system. There is no need to get lost in setting the reference system in the GPS, which is most often quite an obstacle to the non-expert user. Most important, the data can be easily re-projected to whatever local or international reference system.

That means that we will be able to directly plot the data on Google Earth, or to overlay them into databases to the Nigerian national system. Finally, you can take photos and attach location information to them. Having this point data, and being able to geographically project them on Google Earth and on whatever available information layer, will provide us with many options to analyze the data geographically.

The procedure:

First of all, switch the location setting of your GPS phone to "high precision" (GPS + networks). This will increase the precision of the location where GPS signal is not strong, but the telephone network is there, or the other way round.

To save the location of the target field, follow the "Save favorite places" procedure of Maps described below[3]. Since this is a Google App, you will need to have a Google Account.

Save a place

Save your favorite places to a list, to easily look them up later.

1. When you are in the target plot, open the Google Maps app on your iPhone or iPad.

2. Give time to the GPS receiver to determine the location. When this is done a blue dot appears at the center of your screen, indicating your location. If this does not happen, you can center the map at the spot by tapping the grey "target" dot in the lower-right corner of the screen.

3. Zoom on the blue dot, touch and hold it until a marker appears on the map.

[3] (Modified from https://support.google.com/maps/answer/3184808?co=GENIE.Platform%3DAndroid&hl=en&oco=2).

4. As soon as the marker appears, the location's coordinates also appear (Latitude: dd.ddddd; Longitude: dd.ddddd) in the text box at the top of the screen. You can copy them if you like.

5. To save them, note that a box has also appeared at the bottom of the screen. Touch it to see details and options.
   Touch "Label" to give a name to the place.
   Than touch "Save" to save it to an existing "list" or to a new list that you can create (e.g., if you want to geo-reference several fields in the same study area).

Note: Your saved places are visible only to you unless you create and share a list of places.

To see your saved places

1. Open the Google Maps app .
2. In the top left, tap Menu > **Your places** > **Saved**.