RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

Monitoring biophysical and socioeconomic impacts of CSA practices at Doyogena and Basona Climate-Smart Landscapes in Ethiopia

March 2021

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This project is funded by the European Union

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EU-IFAD Project "Building livelihoods and resilience to climate change in East & West Africa: Agricultural Research for Development (AR4D) for large-scale implementation of Climate-Smart Agriculture"

Activity Report

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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To cite this activity report

Nigussie A, Ambaw G, Tesfaye A. 2021. Monitoring biophysical and socio-economic impacts of CSA practices at Doyogena and Basona Climate-Smart Landscapes, Ethiopia. CCAFS Activity Report. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

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About CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is led by the International Center for Tropical Agriculture (CIAT), part of the Alliance of Bioversity International and CIAT, and carried out with support from the CGIAR Trust Fund and through bilateral funding agreements. For more information, please visit https://ccafs.cgiar.org/donors.

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Abstract

This activity was conducted to determine climate-smart agricultural practices' biophysical and socio-economic impacts over the last 12 months, using the Doyogena (Southern Ethiopia) and Basona (North Ethiopia) climate-smart landscapes as a case study. More specifically, this activity addressed if CSA practices (i) guarantee farmers resilience to climate change; (ii) increase food productivity and household income; and (iii) prevent gender-related bias (i.e., improving women's participation in decisions, access/control over resources). From each site, 200 adopters (i.e., farmers who practicing the abovementioned practices) and 200 non-adopters (i.e., farmers` as usual practices) were selected randomly. Hence, 800 households were surveyed from six villages from Doyogena and 25 villages from Basona sites. The activity was conducted between 21 December 2020 to 05 January 2021 at Doyogena and between February 01 - 16, 2021 at Basona climate-smart landscapes. Twelve enumerators for Doyogena and fifteen for Basona sites were selected, trained for three days, and performed pre-testing with 8 – 10 farmers before data collection. At Doyogena, a portfolio of eleven promising CSA options was evaluated, namely, (i) terraces coupled with Desho grass (Pennisetum pedicellatum); (ii) controlled grazing; (iii) improved wheat seeds (high yielding, disease-resistant & early maturing); (iv) improved bean seeds (high yielding); (v) improved potato seeds (high yielding, bigger tuber size); (vi) cereal/potato-legume crop rotation (N fixing & non-N fixing); (vii) residue incorporation of wheat or barley; (viii) green manure: vetch and/or lupin during the off-season (N fixing in time); (ix) improved breeds for small ruminants; (x) agroforestry (woody perennials and crops); and (xi) cut and carry for animal feed. At Basona, on the other hand, the impact of seven CSA options was evaluated, namely, (i) terrace (soil bunds); (ii) terraces coupled with phalaris and tree lucerne); (iii) trenches; (iv) enclosure; (v) percolation pits; (vi) check-dams; and (vii) gully rehabilitation.

About the authors

Abebe Nigussie is an assistant professor at Jimma University and a part-time consultant. His research focuses on the biogeochemical cycle of carbon and nutrients from agricultural soils and developing interventions to reduce soil greenhouse gas emissions.

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Acknowledgements

The authors are grateful to the European Union for providing the EU-funded grant that supports this survey which will assess the socio-economic impacts of CSA practices on farmers in Doyogena and Basona Worena climate-smart villages. A word of thanks also goes to Inter Aide, Areka Agricultural Research Center and Central Statistics Authority Debre Berhan branch for recruiting experienced enumerators for the data collection. We would also like to thank the International Center for Tropical Agriculture (CIAT), Feed the Future Africa RISING program of the United States Agency for International Development (USAID), International Center for Agricultural Research in the Dry Areas (ICARDA), and International Livestock Research Institute (ILRI) for their cooperation. Special thanks go to Sasu Tadesse from the Gudoberet Ketema Agricultural office and Mesele Gintamo and Mesfin Desalegn from Inter Aide Doyogena project office for their kind cooperation in the organization of the survey.

Contents

Acronyms

CCAFS	Climate Change Agriculture Food Security
CCAFS-EA	Climate Change Agriculture Food Security East Africa
CGIAR	Consultative Group for International Agricultural Research
CSA	Climate-Smart Agriculture
CSV	Climate Smart Village
m.asl	Meters below sea level

Introduction

Scientific studies have shown that the agricultural sector is being affected by extreme weather events such as droughts, heavy rainfalls and high temperatures (Lesk et al., 2016). The negative impact of climate change is expected to be more severe in developing countries – where food production depends entirely on rainfall (Recha et al., 2017). In Africa, for instance, the yields of maize (*Zea mays*), sorghum (*Sorghum bicolour*), and millet (*Panicum miliaceum*) are expected to reduce by 5%, 14.5% and 9.6%, respectively, due to climate change at the end of 21st century (Knox et al., 2012). Therefore, it is crucial to develop technologies to curb the adverse impact of climate change on food production and realize sustainable development goals aimed to eradicate poverty and hunger by 2030 (Ambaw et al., 2020).

Climate-smart agriculture (CSA) practices have been promoted as a prominent strategy to improve farmers resilience to climate change and reduce greenhouse gas (GHG) emissions. Evidence also suggested a significant role of CSA practices to ensure food security under a changing climate. With this premises, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) implemented integrated CSA practices in highly degraded landscapes across different developing countries, including at Doyogena (Southern Ethiopia) and Basona (Central Ethiopia). The integrated CSA practices at Doyogena and Basona include soil and water conservation measures, grazing management, crop rotation, incorporation of crop residues and perennial-crop based agroforestry systems. These CSA portfolios are implemented to rehabilitate degraded lands and improve resource-poor farmer resilience to climate change. Therefore, the objective of this study is to assess the perceived effects of CSA practices on biophysical resources, food security, crop and livestock productivity, income and adaptive capacity of smallholder farmers for climate shocks. In addition, this study will examine gender-disaggregated effects of CSA practices on farmers' livelihood and key gender dimensions (i.e., decision making, access over resources). This activity will identify the main climate shocks over the last 12 months and monitor the contribution of CSA options to aid farmers resilience to these climate shocks.

Study sites

Doyogena climate-smart landscape

This climate-smart landscape is located at Kembata-Tembaro zone, South Ethiopia. The farm activity is characterized by Enset (*Enset ventricosum*) based mixed cereal-livestock farming system. Most of the households are small-scale subsistence farmers with an average land size of less than 0.5 ha. The mean annual rainfall ranges from 1,000 to 1,400 mm. It is a highland with an altitude ranging from 2420 to 2740 m.asl. The annual temperature ranges from 12 °C to 20 °C.

Eleven CSA practices were implemented at Doyogena climate-smart landscapes for eight years: Terraces with Desho grass (*Pennisetum pedicellatum*) a soil and water conservation measure; Controlled grazing; Improved wheat seeds (high yielding, disease-resistant & early maturing); Improved bean seeds (high yielding); Improved potato seeds (high yielding, bigger tuber size); Cereal/potato-legume crop rotation (N fixing & non-N fixing); Residue incorporation of wheat or barley; Green manure: vetch and/or lupin during the off-season (N fixing in time); Improved breeds for small ruminants; Agroforestry (woody perennials and crops) and Cut and carry for animal feed.

Figure 1: Treatment (left) and control (right) groups landscapes at Doyogena

Basona climate-smart landscape

This climate-smart landscape is situated in central Ethiopia's Amhara region. A mixed cereal-livestock farming system characterizes the main farm activity. Most of the households are small-scale subsistence farmers with an average land size of less than 0.5. Seven CSA practices have been implemented at Basona climate-smart landscape: Terraces (soil bunds): Terraces (soil bunds) with biological measures (phalaris and tree lucerne), Trenches, Enclosures, Percolation pits, Check-dams (gabion check-dams and wood check-dams) and Gully rehabilitation. Photos and detailed descriptions of the CSA practices at Doyogena and Basona climate-smart landscapes are found in Appendix 2:

Figure 2: Treatment (left) and control (right) groups landscapes at Basona Worena district

Survey tools and sampling techniques

This field study was conducted between 24 December 2020 to 05 January 2021 at Doyogena and from 04 February to 16, 2021 at Basona Worena. This study used a Geofarmer tool to collect the data and summarize the output. The Geofarmer tool is used to (i) monitor the impact of CSA practices on biophysical resources, (ii) identify climate shocks over the last 12 months, (iii) assess the farmers' resilience for climate shocks and (iv) investigate gender-disaggregated perceived effects of CSA options on farmers' livelihood and key gender dimensions. On average, it took 45 –60 minutes to administer per household, a digital platform to store and aggregate incoming data and analysis code to quantify indicators and visualize results.

A total of 400 farmers from Doyogena and 400 farmers from Basona were selected randomly. In each site, 200 households - who have practised CSA practices (i.e., treatment group) and 200 households - who have not received CSA interventions were used in this study. The control groups are those who live in the nearby climate-smart landscapes. This study approach helps monitor the impacts of CSA options by comparing the treatment groups with the control in terms of livelihood/welfare indicators (i.e., food security, productivity, income and resilience of farmers for climate shocks).

Table 1. Farmer list included in the study

Locations	**Treatment group**			**Control group**		
	Village name	**Male**	**Female**	**Village names**	**Male**	**Female**
Doyogena	Tula; Suticho; Gewada; Cholola; Gendo; Duna	173	26	Minatofa Lay Barbaricho Minatofa	160	40

Basona	25 villages	167	33	25 villages	174	26

Training workshop for data enumerators at Doyogena

Prior to data collection, eleven enumerators for Doyogena and 15 enumerators for Basona were selected. These enumerators are working at the regional agricultural research centre, university and central statistics authority. The lists of the enumerators are presented in Appendix 1. A three-day training was held for the enumerators on the Geofarm tool from 21 December 2020 to 23 December 2020 for Doyogena and between February 1-3, 2021, for the Basona site. The training helps the enumerators have confidence in using the software and the digital data collection interface. Each question was discussed one by one with the enumerators to ensure the data quality. The discussion provided a forum for questions about the software and the survey. Each question was discussed during the training to ensure if the enumerators understood all the questions. During the training, the enumerators were requested to interview each other. When the training was over, field practice and pre-test was organized for a half-day. Accordingly, nine household heads - that were not part of the main survey - were used for pre-testing. On average, enumerators in both districts used to fill in three survey questions per day, resulting in 399 and 396 completed questionnaires from Doyogena and Basona Worena districts, respectively.

Limitation of the study

Some responders were unwilling to give information for some questions, particularly on the household income, production (i.e., yield), the number of livestock owned and land size. In addition, few respondents were unwilling to make themselves available for the interview; in such cases, we replaced them with other household heads with similar household characteristics. Sometimes, the Geofarm tool was not working at all and/or was very slow. Data synchronization takes a very long time, and on average, it took about 15-30 minutes to synchronize the data. At Basona, it wasn’t easy to get female respondents.

Feedback

The questions on income and production should be designed so that farmers can respond to the questions honestly. The Geofarm tool needs to be improved for (i) efficient and quick off-line data collection; and (ii) fast data synchronization.

Expected output

This activity report aims to present the steps followed in the data collection process, which will monitor the uptake of CSA practices in the climate-smart villages in the Doyogena and Basona Worena districts. Based on the data collected, the following steps will be:

- characterization of rural farming systems and livelihoods to determine household incomes, productivity and food availability, indicators of food security and poverty, and farm and household characteristics;
- Examine the perceived effects of CSA options on farmers' livelihood (agricultural production, income, food security, food diversity and adaptive capacity) and key gender dimensions (participation in decision-making);
- Provide recommendations that can help donors and policymakers to justify funding and guide priorities in scaling up the adoption of CSA technologies and practices;
- Produce CCAFS Working paper and info notes; and
- Produce manuscript and submit to a peer-reviewed journal.

Appendices

Appendix 1. List of climate-smart landscape enumerators

Doyogena climate-smart landscape enumerators

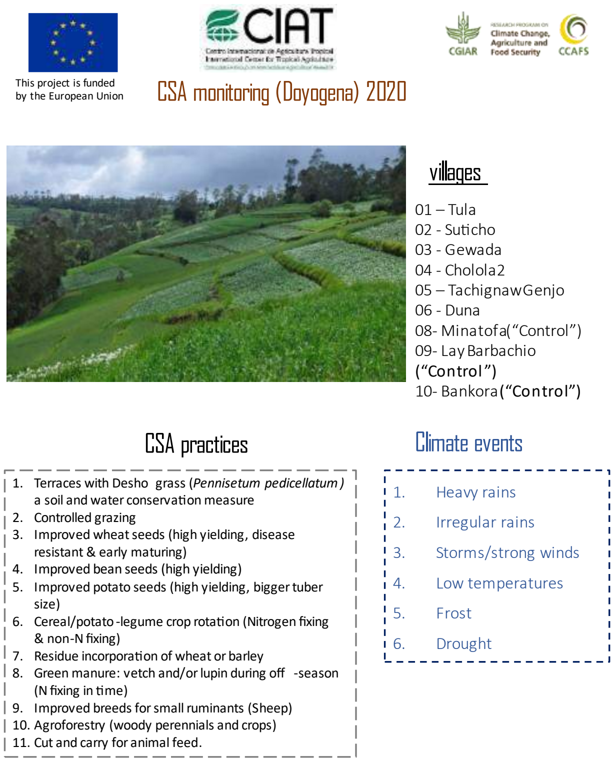
Name	Organization	Position /Role	Contact
Abonesh Tesfaye	CCAFS	CSA monitoring Trainer	abonesh.tesfaye@gmail.com
Abebe Nigussie	Jimma University	CSA monitoring Trainer	abenigussie@gmail.com
Gebermedihin Ambaw	CCAFS East Africa	CSA monitoring Trainer	g.ambaw@cgiar.org
Mesfin Mengistu	Areka Agricultural Research Center	Trainee and enumerator	+251 913 645251
Tilahun Kifle	Areka Agricultural Research Center	Trainee and enumerator	+251 912 244757
Sewawit Yohannes	Areka Agricultural Research Center	Trainee and enumerator	+251 927 160190
Biniyam Biru	Student	Trainee and enumerator	+251 923 199963
Mebratu Asrat	Areka Agricultural Research Center	Trainee and enumerator	+251 913 720395
Tucho Tumato	Areka Agricultural Research Center	Trainee and enumerator	+251 912 082240
Tessema Watumo	Wachamo University	Trainee and enumerator	+251 910 875626
Teshale Tigistu	Doyogena Agricultural office	Trainee and enumerator	+251 932 662561
Kebede Habtegiorgis	Areka Agricultural Research Center	Trainee and enumerator	+251 941 843411
Tesfaye Fatalo	Areka Agricultural Research Center	Trainee and enumerator	+251 915 582283
Berhanu Wolde	Student	Trainee and enumerator	+251 926 324489
Tesfaye Abiso	Areka Agricultural Research Center	Trainee and enumerator	+251 916 832950

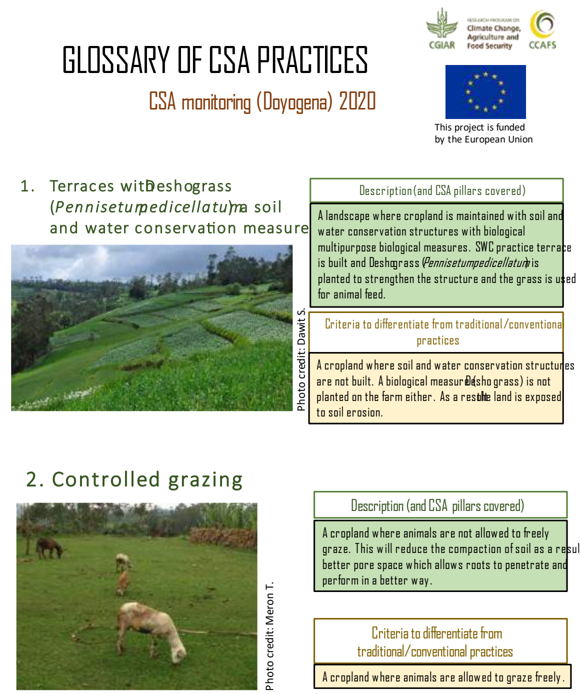
Basona Werana climate-smart landscape enumerators

Name	Organization	Position /Role	Contact
Kassa Alemu	Central statistics agency	Trainee and enumerator	+251 913872492
Tesfaye Moges	Central statistics agency	Trainee and enumerator	+251 922571153
Workye Gebrewold	Central statistics agency	Trainee and enumerator	+251 965920833
Asabnesh Alene	Central statistics agency	Trainee and enumerator	+251 942845760
Abreham Kefelew	Debre Berhan University	Trainee and enumerator	+251 929377839
Getahun Alemayehu	Debre Berhan University	Trainee and enumerator	+251 912709124
Sinknesh Lema	Central statistics agency	Trainee and enumerator	+251 925127747
Kabite Abebayew	Central statistics agency	Trainee and enumerator	+251 923770193
Engidasew Demissie	Central statistics agency	Trainee and enumerator	+251 923771402
Mindahun Abebe	Central statistics agency	Trainee and enumerator	+251 922344291
Wegagen Missawey	Central statistics agency	Trainee and enumerator	+251 937454891
Ayele Negash	Debre Berhan University	Trainee and enumerator	+251 915563979
Belayhun Tesfaye	Debre Berhan University	Trainee and enumerator	+251 919319033
Mebrate Getabalew	Debre Berhan University	Trainee and enumerator	+251 929040882
Argaw Moges	Central statistics agency	Trainee and enumerator	+251 921141090

Appendix 2. Detail descriptions and photos of CSA practices at Doyogena and Basona climate-smart landscapes

CSA practices (Doyogena)





GLOSSARY
CSA monitoring (Doyogena) 2020

3. Improved wheat seeds (high yielding, disease resistant & early maturing)


Photo credit: Dawit S.

Description (and CSA pillars covered)

This improved wheat seed are high yielding, disease resistant, and early maturing. By using this CSA practice, farmers reduce the risks associated with crop failure and improve food security. It also increases yield as a result income and enhance resilience. The varieties that the farmers are planting are Hidase, Huluka, Kingbird, Shorma, Ogolcho and Kekeba.

Criteria to differentiate from traditional/conventional practices

Traditionally, farmers grow wheat varieties which are less productive, susceptible to pests and taking long maturing period.

4. Improved bean seeds (high yielding)


Photo credit: Gebermedihin A.

Description (and CSA pillars covered)

This improved bean seed are high yielding. By using this CSA practice, farmers are able to get higher yield as a result improved income and food security and enhanced their resilience. The varieties that the farmers are planting are CS200K, Dosha and Gebelcho.

Criteria to differentiate from traditional/conventional practices

Traditionally, farmers grow bean varieties which are less productive.

GLOSSARY
CSA monitoring (Doyogena) 2020

5. Improved potato seeds (high yielding, bigger tuber size)


Photo credit: Dawit S.

Description (and CSA pillars covered)

This improved potato seed are high yielding and have bigger tuber sizes. By using this CSA practice, farmers are able to get higher yield as a result improved income and food security and enhanced their resilience. The varieties that the farmers are planting are Gudene, Jalene and Belete.

Criteria to differentiate from traditional/conventional practices

Traditionally, farmers grow potato varieties which are less productive with smaller tuber size.

6. **Cereal/potato-legume crop rotation (Nitrogen fixing & non-N fixing)**


Photo credit: Dawit S.

Description (and CSA pillars covered)

Cereal/potato-legume crop rotation is the practice of growing a series of dissimilar or different types of crops in the same area in sequenced seasons. This CSA practice is done so that the soil of farms is not used for only one set of nutrients. It helps in reducing soil erosion and increases soil fertility and crop yield.

Criteria to differentiate from traditional/conventional practices

Traditionally, farmers grow the same crop or same family crops (e.g. wheat and barely) in sequenced seasons.

GLOSSARY
CSA monitoring (Doyogena) 2020

7. Residue incorporation of wheat or barley


Photo credit: Meron T.

Description (and CSA pillars covered)

Crop residue management is the practice of incorporating crop residue to the soil. This CSA practice provides seasonal soil protection from wind and rain erosion, adds organic matter to the soil, conserves soil moisture, and improves infiltration, aeration and tilth.

Criteria to differentiate from traditional/conventional practices

Traditionally, farmers remove the crop residue from their field or burn it.

8. **Green manure: vetch and/or lupin during off-season (N fixing in time)**


Photo credit: Gebermedihn A.

Description (and CSA pillars covered)

Green manuring is a practice where farmers grown nitrogen fixing crops such as vetch and lupin during off-season for the purpose of soil amendment and mulching.

Criteria to differentiate from traditional/conventional

Traditionally, farmers leave their cropland bare.

GLOSSARY
CSA monitoring (Doyogena) 2020

9. Improved breeds for small ruminants (Sheep)


Photo credit: Gebermedihin A.

Description (and CSA pillars covered)

Community Based Breeding program is a technology of choice for genetic improvement of small ruminants; measurable genetic gains in performance traits and impact on livelihoods; ensure food security under a changing climate, providing households with both nutrition and disposable income. Their small body size, flexible feeding habits and short generation intervals make them suited to climate-risk management. Their low investment costs are affordable to subsistence farmers and are often owned and tended by women and youth.

Criteria to differentiate from traditional/conventional practices

Traditionally, farmers use local breeds with less body weight and less ability to produce offspring. As a result, the productivity level is below its genetic potential. In addition, different production constraints and lack of appropriate breeding strategies developed for the breed in the production system contribute to less genetic potential.

10. Agroforestry (woody perennials and crops)


Photo credit: Gebermedihin A.

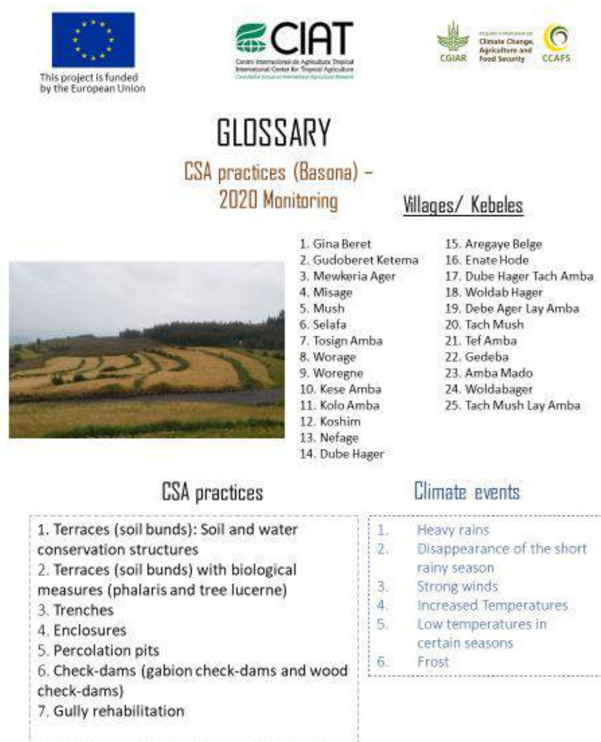
Description (and CSA pillars covered)

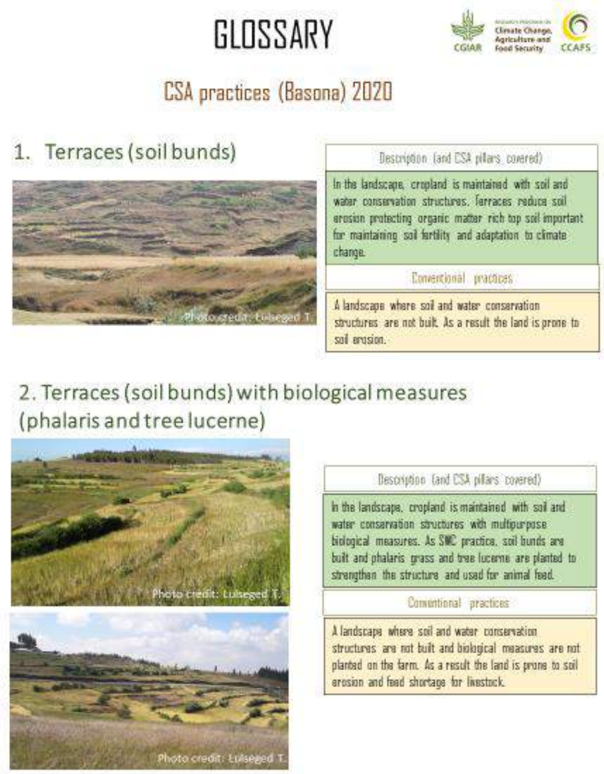
This practice is a dynamic, ecologically based natural resource management system through the **integration of trees on farms** and in agricultural landscapes which diversifies and sustains production for increased economic, social and environmental benefits for land users.

Criteria to differentiate from traditional/conventional practices

The main criteria that helps farmers are (i) if intentional (combinations of trees, crops and/or animals are intentionally designed and managed) (ii) if intensive (management wise to maintain their productive and protective functions) (iii) if interactive (biological and physical interactions between the tree, crop and animal components) (iv) if integrated (the tree, crop and/or animal components are structurally and functionally combined into a single integrated management unit)

CSA Practices (Basona)





GLOSSARY

CSA practices (Basona) 2020

3. Trenches

Photo credit: Africa RISING

Description (and CSA pillars covered)

In the landscape, trenches are formed by digging short ditches across the slope to trap water as a means of soil and water conservation measure to reduce soil erosion, improve soil moisture and recharge underground water.

Conventional practices

A landscape where there is no soil and water conservation structures. The soil is prone to erosion and water is lost through runoff.

4. Enclosures

Photo credit: Lulseged T.

Description (and CSA pillars covered)

In the landscape, degraded lands are enclosed from human interferences and let to rehabilitate and regenerate. This practice is very beneficial for biodiversity conservation and ecological regeneration.

Conventional practices

A land exploited beyond its carrying capacity and left untreated leading to sever land degradation and carbon release from soils.

GLOSSARY

CSA practices (Basona) 2020

5. Percolation pits

Description (and CSA pillars covered)

Percolation pits are dug in the landscape to reduce the speed of water flow and trap the water, allowing it to percolate to the soil and stabilize gully downstream. The percolation pits reduce the erosive power of runoff, recharge ground water and improve soil moisture as a means of adaptation to climate change.

Conventional practices

A landscape where soil and water are lost through runoff in the absence of climate smart technologies to reduce the velocity and trap the water improving percolation.

6. Check-dams

Description (and CSA pillars covered)

Check-dams are constructed with gabion and wood to reduce the speed of water flow to prevent gully erosion.

Conventional practices

Check-dams not constructed resulting in runoff and exacerbating erosion and gully formation.

GLOSSARY

CSA practices (Basona) 2020

7. Gully rehabilitation

Description (and CSA pillars covered)

In the landscape, gullies are stabilized and rehabilitated through check-dams and biological options.

Conventional practices

Gullies are left untreated leading to further degradation, sever damage to agricultural lands and carbon release from soils.

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