Understanding socioeconomic aspects influencing CSA adoption

Working Paper No. 247

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

Fanny Howland
Nadine Andrieu
Osana Bonilla-Findji

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CGIAR CCAFS

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Correct citation:
Howland F., Andrieu N., Bonilla-Findji O. 2018. Understanding socioeconomic aspects influencing CSA adoption. CCAFS Working Paper no. 247. Wageningen, The Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at www.ccafs.cgiar.org.

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The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic partnership of CGIAR and Future Earth, led by the International Center for Tropical Agriculture (CIAT). The Program is carried out with funding by CGIAR Fund Donors, Australia (ACIAR); Ireland (Irish Aid); The Netherlands (Ministry of Foreign Affairs); New Zealand Ministry of Foreign Affairs & Trade; Switzerland (SDC); Thailand; The UK Government (UK Aid); USA (USAID); The European Union (EU); and with technical support from the International Fund for Agricultural Development (IFAD). For more information, please visit https://ccafs.cgiar.org/donors.

Contact:
CCAFS Program Management Unit, Wageningen University & Research, Lumen Building, Droevendaalsesteeg 3a, 6708 PB Wageningen, The Netherlands. Email: ccafs@cgiar.org

Abstract

This working paper presents the development and piloting of a qualitative methodological approach aiming to better understand the socioeconomic factors that influence adoption of Climate-Smart Agricultural (CSA) options in smallholder farming communities. The field work was conducted in the Cauca Climate-Smart Village (CSV) located in Colombia. Two types of results are presented.

First is the three-step methodology developed to answer: (1) Which CSA options promoted by CCAFS have been adopted by farmers? (2) Who within the community is adopting which CSA option(s)? What is the diversity in the types of farmers according to their CSA adoption profile? (3) What are the motivations and enabling/constraining factors for each farmer type to adopt a CSA option?

Then, results show the use of this methodology made from direct CCAFS beneficiaries and non-CCAFS-related farmers. Results show that home gardens were the most commonly adopted practice, followed by compost preparation and water harvesting. Three types of farmers were identified: *older larger-scale displaced adopters*; *middle-aged medium-scale non-displaced adopters;* and *smaller-scale non-adopters who perceive climate change risks and feel unprepared*. The main farmers' motivations for adopting CSA options were associated with cost saving and interest in organic production. Assets, knowledge, and agency have been key for the adoption of CSA options.

Keywords

Climate-Smart Agriculture; adoption; enabling and constraining factors; farmers' typology; Colombia.

About the authors

Fanny Howland is a PhD student in anthropology at EHESS University, France. She is currently a research associate and her work focuses on the social analysis of processes of adaptation to climate change by producers. Contact: f.c.howland@cgiar.org

Nadine Andrieu is a CIRAD senior scientist with 13 years of experience in systemic analysis and modeling of farming systems taking into account synergies and trade-offs between different production activities. Her main research area is the co-design with stakeholders of innovative agroecological farming systems. She has a PhD in agronomy and sustainable development from ABIES (Paris). Contact: nadine.andrieu@cirad.fr

Osana Bonilla-Findji is science officer for the CCAFS Climate-Smart Agricultural Practices Flagship based at the International Center for Tropical Agriculture, Cali, Colombia. With a PhD in environmental sciences, she has combined expertise in research, project management, and outreach within international science-for-development initiatives. Her recent work has focused on technical and institutional decision support tools for strengthening agricultural stakeholders' ability to face the impacts of climate variability and change as well as on the development of sound metrics to track programmatic progress and outcomes related to Climate-Smart Agriculture interventions. Contact: o.bonilla@cgiar.org

Acknowledgments

This work was implemented as part of the International Center for Tropical Agriculture (CIAT) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is carried out with support from CGIAR Fund Donors and through bilateral funding agreements. For details please visit https://ccafs.cgiar.org/ donors.

The authors are especially grateful to the CCAFS gender and social inclusion (GSI) team for its financial support and for providing comments and guidance to this work as well as to Ecohabitats for its support and facilitation of the field work.

Contents

Acronyms

AR4D	agricultural research for development
CC	climate change
CCAFS	Climate Change, Agriculture and Food Security (CGIAR program)
CSA	Climate-Smart Agriculture
CSV	Climate-Smart Village
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NGO	non-government organization
ToC	theory of change
UMATA	Unidad Municipal de Asistencia Técnica Agropecuaria/Municipal Agricultural Technical Assistance Unit

Introduction

Climate change (CC) currently constitutes a major risk for many sectors, including agriculture, and for rural populations whose livelihood base depends on and is exposed to high hazard and vulnerability (IPCC, 2014). Climate change is expected to affect water availability and supply, food security, and agricultural incomes (IPCC, 2014), and, specifically in Central and South America, risks will translate into both decreases in water availability, food production, and quality and increases in flooding and landslides associated with drought and extreme precipitation (IPCC, 2014).

Recognizing that food security and climate change are closely interlinked and that current global challenges call for a shift and reorientation in agriculture, Climate-Smart Agriculture (CSA) has been proposed as an approach aiming to promote institutional and technical options and a set of strategies (FAO 2010, Lipper et al., 2014, Steenwerth et al., 2014) that support the triple goal of (1) achieving a sustainable increase in agricultural productivity and incomes, (2) improving adaptive capacity and building resilience to climate change, and (3) reducing and/or removing greenhouse gas emissions, when possible (FAO, 2013). The GCIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) Flagship 2 agenda focuses on generating evidence-based knowledge to support the major players in bringing CSA effectively to scale by designing appropriate, context-specific, gender-sensitive, and socially inclusive climate-responsive strategies and solutions.

Climate-related vulnerability is often tightly related to poverty, availability of resources, knowledge, and ability to adapt (Steenwerth et al., 2014). Given the heterogeneity of socioeconomic and cultural conditions existing within farming communities, initiatives aiming to promote CSA options require, as with any area of agricultural development, adopting a "social differentiation lens."

In its Phase II (2017–2021), and in the context of designing CSA practices, technologies, services, and policies that meet farmers' specific needs, CCAFS aims to actively address socioeconomic power differences from the local level (farm) to the global level (policy) and ensure social inclusion. This includes considering the characteristics that shape different types of farmers in terms of needs and access to resources, such as gender, socioeconomic status, ethnicity, and age (CCAFS, 2016a).

In an effort to build evidence and co-develop context-specific and gender-sensitive CSA options, the CCAFS program has developed the Climate-Smart Village (CSV) AR4D Approach (CCAFS, 2016b; Aggarwal et al., 2018). This participatory approach aims to evaluate, improve, and scale out CSA technical and institutional interventions that can synergistically improve productivity and food security, decrease when possible GHG emissions, and build communities' resilience to a variable and changing climate across a range of socioeconomic and agro ecological contexts. This includes ensuring the participation of women farmers and other marginal communities in the identification of CSA options,[1] prioritization, and scaling processes that should imply strategies to foster adoption. CCAFS envisions the CSV approach to be relevant to the local context, sustainable, and inclusive, involving women, youth, and marginalized groups.

In this context, it is necessary to understand how distinct characteristics of vulnerable groups can influence adoption. Much evidence has shown indeed that social characteristics such as age, household type and size, education level, access to information and social capital, as well as perceptions of CC and its potential negative effects play a key role in the decision-making process associated with the adoption of adaptive measures (Chandra Sahu and Mishra, 2013; Alauddin and Sarker, 2014; Basu et al., 2015; Jianjun et al., 2015; Steenwerth et al., 2014; Tesfahunegn et al., 2016).

Objectives

This work aimed to establish and pilot a practical methodology to understand the socioeconomic and cultural factors that influence the adoption of CSA practices and technologies accounting for the different types of farmers that may exist in a community, in order to inform the design and scaling of more socially inclusive CSA interventions.

In a second phase, this effort will be integrated into a broader methodology that will complement the new Climate-Smart Village Monitoring Plan[2] being rolled out by CCAFS (see Methodology section). It will specifically aim to expand and deepen our understanding of

[1] Technologies, practices, and services

adoption rates by addressing enabling and constraining factors and integrating further social inclusion and intra household gender analyses.

The methodology developed aimed to address the following research questions:

1) Which CSA options promoted by CCAFS in the CSV have been adopted by farmers?

2) Who within the community is adopting which CSA option(s)? How diverse are the different types of farmers based on their adoption level/trends?

3) Which are the motivations and enabling/constraining adoption factors among each farmer type?

Underlying assumptions are that

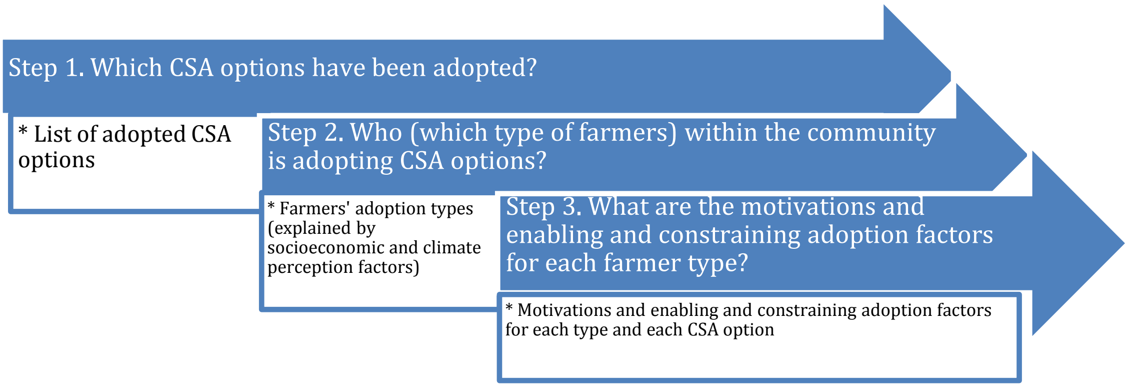
- Adoption of CSA options by farmers is diverse and influenced by socioeconomic characteristics, including household headship, age, capacity (e.g., education level), ethnicity, composition of the household, and degree of vulnerability (e.g., displacement).
- Adoption of CSA options by each type of farmer also responds to specific enabling and/or constraining factors (cultural, technical, environmental…) that, once understood, will allow the identification and design of more gender-sensitive and socially inclusive interventions adapted to this diversity.

Methodology

Conceptual framework

To address the research questions (Which CSA options promoted by CCAFS in the CSV have been adopted by farmers? Who within the community is adopting which CSA option(s)? How diverse are the different types of farmers based on their adoption level/trends?, and Which are the motivations and enabling/constraining adoption factors among each farmer type?), we propose a three-step method allowing us to first determine adoption, then make a typology of farmers according to these adoption trends, and finally analyze (for each type of farmer) the associated motivation as well as the enabling and constraining factors (see Figure 1).

Figure 1: Analysis steps and associated results



Step 1: Screening for adoption of CSA options (research question 1)

To determine which CSA options could be considered as adopted (rather than only tested), farmers' answers to CSA adoption questions are examined for the fulfilment of any of the following criteria: (1) the CSA option was implemented for more than one cropping season, (2) the farmer invested some resources (financial, labor, inputs) to implement it, and/or (3) the farmer made changes in the promoted practice (extension, modification). These criteria to define adoption might be adjusted according to the context.

Step 2: Construction of farmers' adoption typology (research question 2)

A multiple-factor analysis (MFA) and a cluster analysis are used to assess farmers' adoption typology from the information gathered through the interviews. The MFA allows linking farmers' socioeconomic characteristics and general climate perceptions (explanatory variables) with the adopted CSA practices determined in the previous step (variable to explain), while the cluster analysis identifies groups of farmers with similar characteristics.

As described by Roncoli et al. (2008), "perceptions vary according to the respondents' birthplace, residence, experience, and worldview," which is particularly relevant in the sense that this also reflects that adaptive capacities are grounded in cultural identities and social relations mediated by kinship and community.

Step 3: Analysis of motivation and enabling and constraining factors for CSA adoption (research question 3)

A specific analysis of motivations and enabling and constraining factors is done for each type of farmer identified in step 2.

Motivations analysis

Motivations leading to CSA adoption are assessed from the classification and analysis of the frequency of farmers' responses (e.g., food security, improving productivity, etc.).

Composite framework to assess enabling and constraining adoption factors

Farmers' responses related to enabling and constraining factors are categorized according to a composite framework specially designed for this study. This framework is based on the five dimensions proposed by Cohen et al. (2016) to assess rural communities' adaptive capacity in a more holistic way (described below), to which we add two dimensions that play a key role in adoption: perception of climate risk and perception of efficiency of the adopted CSA practice (Adger et al., 2009; Grothmann and Patt, 2005).

The five dimensions from Cohen et al. (assets, flexibility, learning, social organization, and agency) allow a more nuanced understanding of the factors that foster or constrain the adoption of CSA options as they go beyond the traditional and predominant focus on ecological, physical, economic, or technical dimensions. If these traditional categories are attractive because of their easily quantifiable (ecological thresholds, economic cost of adaptation) and actionable (modeling, cost-benefit analysis) nature, they do not take into account endogenous dynamics that can influence evenly (or more) the adoption of a new practice (Adger et al., 2009). As recalled by Adger et al., "limits to adaptation are endogenous to society and hence contingent on ethics, knowledge, attitudes to risk, and culture."

The categories of Cohen et al. (2016) cover both the ecological/physical and technical aspects (through "assets") and also (through the other dimensions) the cognitive and cultural ones. "Learning" considers information and knowledge (training). "Social organization" considers relationships and social network. "Agency" covers decision-making processes (people's ability to make their own choice). "Flexibility" embraces livelihoods and physical mobility (influenced by social norms).

Results (case study in Colombian CSV)

Case study zone

This methodology was implemented in Cauca, the Colombian Climate-Smart Village (CSV) located in the department with the same name, which is characterized by small-scale family farmers that grow (in areas from 1 to 5 ha) coffee and sugarcane (*caña panelera*) as cash crops and plantain and cassava as staple crops (Paz and Ortega, 2014). Coffee production plays a key role in the economy of the department but it is expected to potentially suffer from future climate-related impacts (Avelino et al., 2015). Epidemics such as coffee rust, partly caused by meteorological factors from 2008 to 2011, have also led to increased coffee vulnerability, which, combined with increased input costs, is reflected in low profitability (Avelino et al., 2015).

The Cauca CSV is part of the CCAFS Global CSV network present in five regions of the world (CCAFS, 2017). In these locations, farmers take part in participatory action research aiming to test and evaluate agricultural options for their potential benefits regarding the three CSA pillars (productivity, adaptation, and mitigation). In the case of Cauca, farmers received partial financial/material support to set up and test prioritized CSA practices, through Ecohabitats, the local implementing partner.

In 2018, CCAFS Flagship 2 initiated the implementation of the CSV Monitoring Plan. This standard multi-level methodology associated with key indicators has been developed to (1) monitor CSA adoption trends and drivers, (2) track CSA-related outcomes at the farm and household level, and (3) assess the effectiveness of CSA practices (in productivity, adaptation, and mitigation dimensions) at the plot level. The main objective is to gather evidence and guide regional teams and researchers engaged at different levels in CSA evaluation and scaling activities across the global CSV network. The present qualitative work aims to complement the results of the CSV Monitoring by addressing further the enabling and constraining adoption factors while integrating further social inclusion and intrahousehold gender analyses.

Sampling and data collection

Data collection was carried out from April to August 2016 through semi-structured interviews approximately 1 hour long (Annex 1) conducted with a subsample of 40 men/women, identified to equally represent two groups: direct CCAFS beneficiaries and non-CCAFS-related farmers (Table 1).

Table 1: Characteristics of farmers interviewed

	Direct CCAFS beneficiaries	Non-CCAFS-related
No. of villages	7	2
No. of women interviewed	9	9
No. of men interviewed	11	11
Age quartiles	38-49-58	41-60-63
Productive area quartiles	1.25-1.75-3.00 ha	0.31-0.67-1.00 ha

The first group included farmers involved in CCAFS activities (direct CCAFS beneficiaries) and the second one involved farmers that had never directly interacted with the program (non-CCAFS-related). Both groups were interviewed to examine to what extent adoption of selected CSA options expanded beyond the direct program intervention sphere. The sample size established to ensure representativeness for each group (20 farmers) was defined considering that the total number of direct CCAFS beneficiaries accounted for 30 farmers in the previous year.

During the interviews, farmers were asked about their socioeconomic characteristics, their general climate perceptions, and their implementation of specific CSA practices promoted by CCAFS and its implementing partner (see Annex 1) to determine the following:

i) whether those were adopted (research question 1),
ii) what were their main motivations to implement the practices (research question 3), and
iii) which were the key enabling or constraining factors in the adoption process (research question 3).

Data analysis

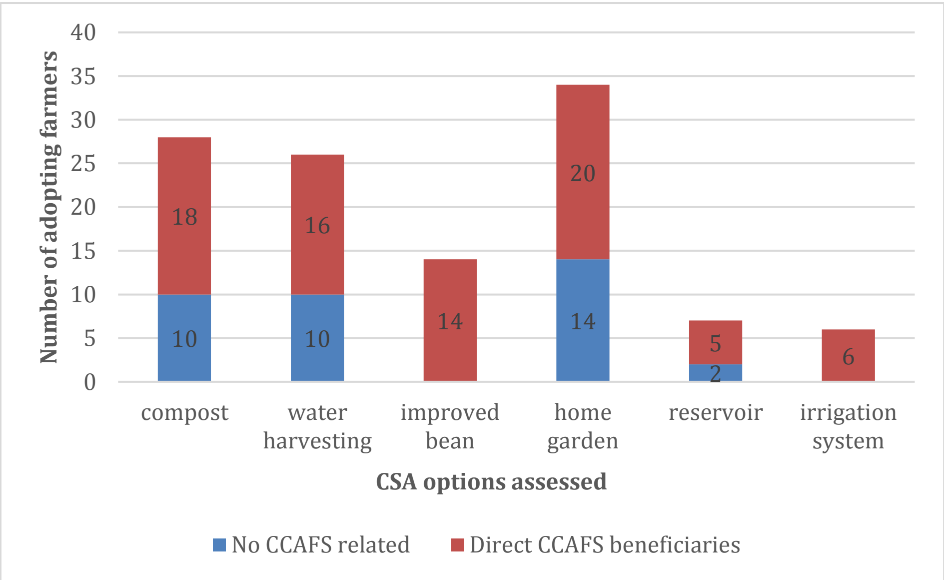
The data analysis included three steps (Figure 1) and the analyses of the responses from all 40 farmers (direct CCAFS beneficiaries and non-CCAFS-related farmers).

Step 1. CSA practice adoption (research question 1)

In Cauca, six CSA options promoted by the local NGO through CSA interventions to improve food security and/or to improve efficient water management and soil fertility were screened for their fulfilment of the adoption criteria proposed in the methodology. These practices included compost, improved varieties of beans, home gardens, water harvesting, reservoirs (bigger capacity), and irrigation systems, respectively. CSA options were usually combined (e.g., a home garden with water harvesting). The compost is mainly used for the production of vegetables, is made from inputs produced on-farm (vermicompost, livestock manure, poultry manure, husks or coffee pulp, leaves and cane bagasse, leaf litter, pastures), but requires training given by the implementing local NGO (Ramirez, 2016). Improved varieties of fickle beans (MAC 27, ENF 34, MAN 24, MAC 74, NEF 177, MRC 8, ENF 207, MAN 21, RAD 51) have been tested by CCAFS beneficiaries on their farms to assess their adaptability and acceptance by the community. The home gardens promoted by CCAFS are established to grow vegetables and they can be associated with water harvesting and/or the use of compost (Ramirez, 2016). Reservoirs are tanks that recollect water on a larger scale than water harvesting while irrigation systems refer to drip irrigation for the home gardens, generally connected to water harvesting.

Home gardens were the most commonly adopted practice (85% of farmers) among all 40 farmers (Figure 2), followed by compost preparation (70%) and water harvesting (65%). Those three practices could be considered as a group that complements each other as they were found implemented together on the same farms.

Figure 2: Frequency of adoption of CSA options by CCAFS direct beneficiaries and non-CCAFS-related farmers



Four out of the six CSA options examined were adopted by both groups, farmers involved and not involved in CCAFS activities (even if in a lower proportion for farmers not involved). This means that these CSA options are not new and are already promoted by other institutions and projects working with farmers (RESA, Municipal Units of Agricultural Technical Assistance, etc.). Two CSA options, improved beans and irrigation systems, were adopted only by farmers that were directly involved in CCAFS-led activities.

Step 2. Adoption typology (research question 2)

Table 2 shows the socioeconomic data to collect for this step. Those were gathered through the interviews but can otherwise also be obtained from the CSV monitoring.

The MFA applied to the total sample of interviewed farmers (CCAFS direct beneficiaries and non-beneficiaries) allowed us to link farmers' socioeconomic characteristics and general climate perceptions (explanatory variables) with the adopted CSA practices, determined in the previous step (variable to explain).

The subsequent cluster analysis led to the identification of three different farmer types (Table 3):

- the older larger-scale displaced adopters (type 1),
- the middle-aged medium-scale non-displaced adopters (type 2), and
- the smaller-scale non-adopters, perceiving climate change risks but feeling unprepared (type 3).

The first two types of farmers share common household characteristics (male-headed and from three to five people in the household): they usually own their land,[3] cultivate the same crops, are direct CCAFS beneficiaries, and adopt similar CSA options. The main differences between these two groups relate to farmers' age, farm area, and presence or not of displaced persons.

Type 1 is characterized by having adopting farmers older than 62 years, displaced, with large areas, and who consider that their crops have been strongly affected by climate. In contrast, type 2 is made up of middle-aged non-displaced adopting farmers with smaller farms that believe that climate-related impacts mostly affected their farm infrastructure rather than their crops. The first group of CSA adopters felt more prepared than the second group to face future climate-related shocks/events. Type 3 includes farmers that are not adopting or adopt very few CSA options, have less than a hectare of land and less diversity of crops, and who did perceive climate-related risks but felt unprepared to face future climatic events. The factorial and cluster analysis revealed that sex (men/women) was not in this case a relevant factor to

[3] Note than 80% of the sampled farmers are owners.

define/characterize the three farmer types. In addition, direct CCAFS beneficiaries are more represented in type 1 (92%) and type 2 (63%) than in type 3 (6%).

Table 2: List of collected socioeconomic and general climate perception data used for the MFA. **(Those can be collected through the CSV monitoring or separately.)**

Category			Variable
Explanatory variables	socio-economic and farm characteristic variables	Sex	man/woman
		Age	open ended
		Household type	01 = male headed, with a wife, 02 = male headed, divorced, single, or widowed, 03 = female headed, divorced, single, or widowed, 04 = other, specify
		Education level	00 = no formal education; 01 = primary; 02 = secondary; 03 = post-secondary
		Numbe of persons in household	open ended
		Ethnic group	01 = indigenous; 02 = Afro-descendant; 3 = no ethnic group; 4 = other
		Displaced	yes/no
		Cultivated crops	coffee, sugarcane, plantain, maize, cassava, bean
		Plot number	open ended
		Land ownership	yes/no
		Farm area	open ended
		Productive area	open ended
		Forest area	open ended
		Group membership	open ended
		Source of agricultural information	1 = other farmers; 2 = technician; 3 = both; 4 = TV
		Source of climate info	0 = none; 1 = other farmers; 2 = own knowledge; 3 = TV
	CCAFS direct beneficiary/non-CCAFS-related		1 = CCAFS direct beneficiary; 2 = non-CCAFS-related
	general climate perception	Perceived change in climate	1 = change in climate pattern, 2 = change in event intensity, 3 = both, 4 = none
		Risk perception	1 = no risk; 2 = low risk; 3 = risk; 4 = don't know/God knows
		Adaptation capacity perception	1 = not prepared; 2 = unprepared; 3 = prepared; 4 = don't know/God knows
		Past negative experience with climate	yes/no
		Most affected crop/asset	1 = coffee; 2 = bean; 3 = home garden; 4 = house
Variables to explain	CSA practices adoption	Compost	yes/no
		Improved bean	yes/no
		Home garden	yes/no
		Water harvesting	yes/no
		Reservoir	yes/no
		Irrigation system	yes/no

Table 3: Description of the three farmer adoption types coming out from the factorial and cluster analyses based on socioeconomics, climate perception, and CSA adoption level

	Relevant variables	Type 1: Older larger-scale displaced adopters	Type 2: Middle aged medium-scale non-displaced adopters	Type 3: Smaller-scale non-adopters who perceive climate change risks and feel unprepared
Socio-economic variables	Number of persons in household	Medium (from 3 to 5)	Medium (from 3 to 5)	Low (less than 3)
	Household type	Male headed + divorced, single, or widowed	Male headed + divorced, single, or widowed	Not relevant to characterize this type
	Age	Older farmers (more than 62 years old)	Middle-aged farmers (from 40 to 62 years old)	Not relevant to characterize this type
	Displaced	Displaced	Not displaced	Not relevant to characterize this type
	Land ownership	Owner	Owner	Not relevant to characterize this type
	Farm area	Larger farmers (more than 3 ha)	Medium farmers (from 1 to 3 ha)	Smaller-scale farmers (less than 1 ha)
	Forest area	Larger area	Larger area	No forest area
	Cultivate crops	Sugarcane, plantain, maize, and cassava	Sugarcane, plantain, maize, and cassava	No sugarcane, plantain, maize, and cassava
	Participation in CSA intervention	Yes	Yes	No
Climate perception variables	Perceived change in climate	Not relevant to characterize this type	Not relevant to characterize this type	Perceive change in intensity of climate events
	Risk perception	No risk perception	Not relevant to characterize this type	Feel risk related to climate
	Crop/asset most affected by climate	Plantain/cassava/maize/bean	Farm infrastructure	Not relevant to characterize this type
	Adaptive capacity perception	Feel prepared	Feel little prepared	Feel not prepared at all
CSA adoption	Adopted CSA practices	Compost, water harvesting, irrigation system, and improved bean	Compost, water harvesting, irrigation system, and improved bean	Higher proportion of farmers adopting any practice (and few adopting one practice)

Step 3. Motivation and perceived adoption factors (research question 3)

The proportion of each type of farmer adopting CSA options was calculated in order to assess whether their adoption was specifically associated with certain farmer types (Table 4).

Table 4: Adoption of CSA options per farmer type

Adopted CSA options	Type 1: Older larger-scale displaced adopters	Type 2: Middle-aged medium-scale non-displaced adopters	Type 3: Smaller-scale non-adopters who perceive climate change risks and feel unprepared
Compost	**30%**	**18%**	**13%**
Water harvesting	**28%**	**20%**	**13%**
Improved bean	**28%**	8%	0%
Home garden	**30%**	**23%**	**23%**
Reservoir	10%	3%	3%
Irrigation system	10%	3%	0%

In bold: Practices on which the analysis on motivation and enabling and constraining factors was focused.

The proportion of farmers adopting a given practice is higher for the older larger-scale displaced farmers (type 1) than for the other types.

The subsequent analysis of the motivation and perceived factors fostering/constraining CSA adoption for each type of farmers focused on those options with an adoption rate above 10%[4] for at least two types of adopting farmers: compost, water harvesting, and home garden (Table 4).

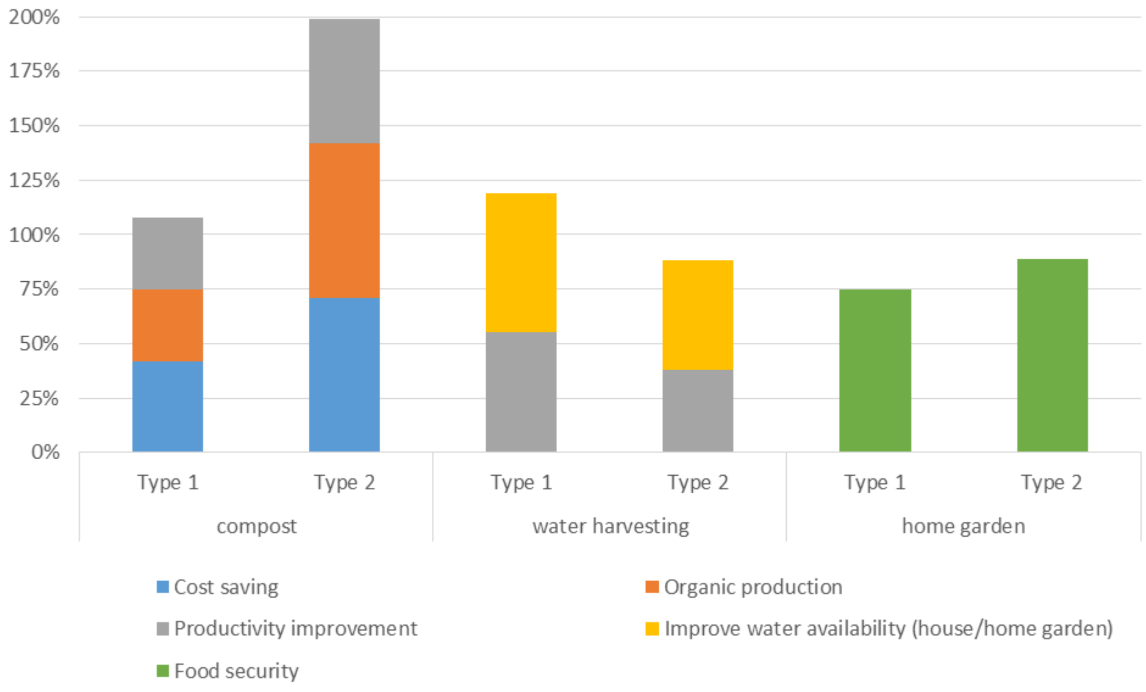
Motivations

Figure 3 shows the different motivations related to specific CSA options for the two types of adopting farmers.

The motivations leading to adoption are practice-specific rather than farmer-type-specific. For example, for both types of adopting farmers, home garden adoption is mainly linked to the aim of improving food security whereas compost is associated with cost saving, enhancing organic production, and increasing productivity. The motivations for adopting water harvesting were mainly related to improving water availability for household consumption and to some degree improving farm productivity. These results show that the motivation to adopt compost, home gardens, and/or water harvesting was primarily related to the first pillar of CSA: improving productivity and food security.

[4] This threshold is a virtual limit that can be adjusted according to the sample size.

Figure 3: Most frequent motivations for compost, water harvesting, and home gardens for each type of adopting farmer



Note: Farmers, during their interview, were free to give more than one motivation that fostered adoption. That is why for each row more than 100% in total can be found.

Enabling and constraining factors for adoption

The answers given by the farmers on their enabling and constraining factors were analyzed and classified according to the seven dimensions of our composite framework (see illustration in Table 5).

Table 6 presents the enabling and constraining adoption factors related to each CSA option for each of the three farmer types. Because of the low adoption rate for irrigation systems (6 adopters), reservoirs (7 adopters), and improved beans (14 adopters) at the time of this methodological development, we did not include those practices in the analysis

The enabling factors for adopting farmer types 1 and 2 (older larger-scale displaced adopters and middle-aged medium-scale non-displaced adopters, respectively) do correspond to the constraining factors for farmer type 3 (smaller-scale non- or lower adopters perceiving climate change risks and feeling unprepared for future climate impacts).

Table 5: Examples of enabling and constraining factors

	Assets	Flexibility	Knowledge & learning	Social organiz ation	Agency & decision making	Perception of climate risk	Perception of CSA option efficiency
Enabling factors	Land availability, topography	Time availability	Training	Implemen ting practice in group	Willingnes s to implement new practice		Not observed
	Material received through training	The tradition to implement practice	Farm experiment ation	Share advice among group members	The desire to do things		
Constrai ning factors	Lack of economic resources	No time to participate in training	Lack of project/tra ining follow-up	Lack of solidarity	Lack of decision-making power within the household	Temperature and lack of precipitation affected home garden	
	Lack of workforce availability	Not able to leave the house (task distribution)	Lack of knowledge on a practice	No access to training		Lack of precipitation makes water harvesting useless during summer	

Table 6: Perceived enabling and constraining factors for adoption of compost, water harvesting, and home gardens by each type of farmer.

	Factor	Type 1 (enabling factors)	Type 2 (enabling factors)	Type 3 (constraining factors)
Compost	Assets	**67% (natural)**	**100% (natural)**	**80%**
	Flexibility	25%	0%	40%
	Knowledge & learning	**75%**	**71%**	**80%**
	Social organization	25%	29%	0%
	Agency	42%	29%	20%
Water harvesting	Assets	36%	63% (physical)	67%
	Flexibility	0%	13%	0%
	Knowledge & learning	73%	88%	50%
	Social organization	45%	38%	0%
	Agency	45%	63%	17%
Home garden	Assets	75%	56% (physical)	67%
	Flexibility	17% (physical)	11%	33%
	Knowledge & learning	42%	78%	17%
	Social organization	58%	33%	0%
	Agency	42%	33%	17%
	Perception of climate risk	*8%*	*11%*	*33%*

Note: The total values within a row can be higher than 100% because farmers were free to mention more than one enabling or constraining factor during their interview.

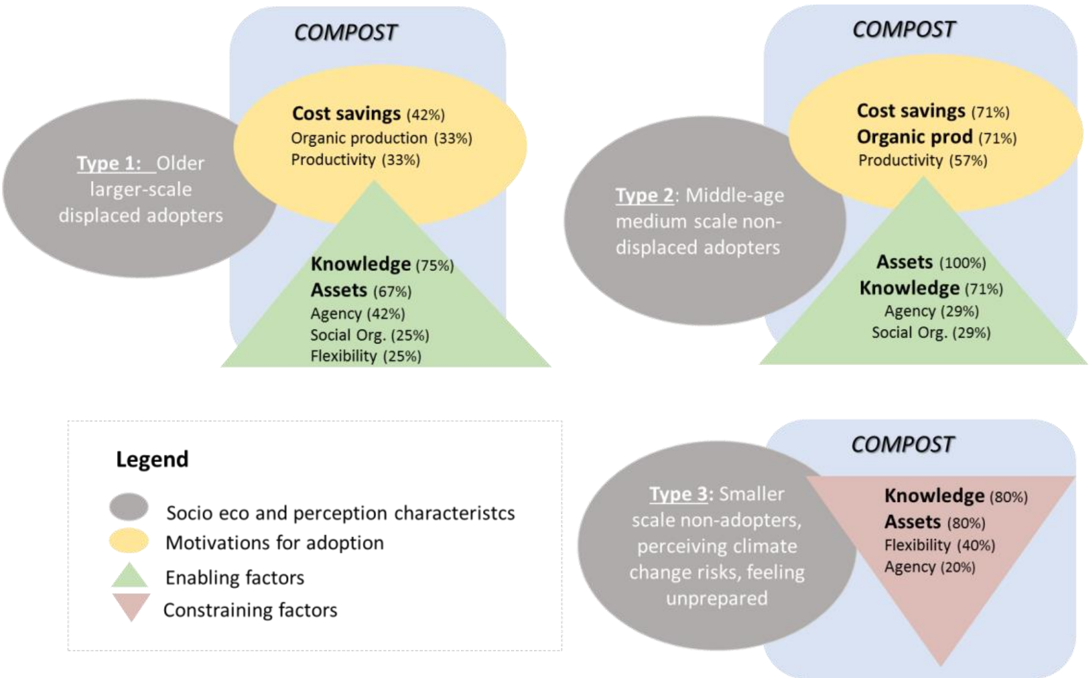
Compost

In the case of type 1 farmers (older larger-scale displaced adopters) as well as type 2 farmers (middle-aged medium-scale non-displaced adopters), a**ssets, knowledge and learning, and agency** have been key to facilitating the adoption of compost (Table 6). On the contrary, for smaller-scale non-adopting farmers perceiving climate change risks but feeling unprepared (type 3), the lack of assets and knowledge and learning has prevented adoption.

The main assets influencing adoption of compost concerned natural assets already available on the farms such as organic matter, materials such as bamboo (to build the bin), waste from the kitchen, and land availability to implement compost. Knowledge and learning aspects associated with adoption concerned access to training, in which farmers learned how to prepare compost.

Conversely, the constraining adoption factors for compost were related to a lack of knowledge and learning (e.g., specific training on this practice) and assets such as organic matter, land, and workforce availability and financial resources to pay for them. Type 3 small-scale farmers had fewer crops (less organic matter produced) and households had fewer members able to contribute to agricultural activities (Figure 4).

Figure 4: Socioeconomic factors enabling (type 1 and 2 farmers) and constraining (type 3 farmers) the adoption of compost

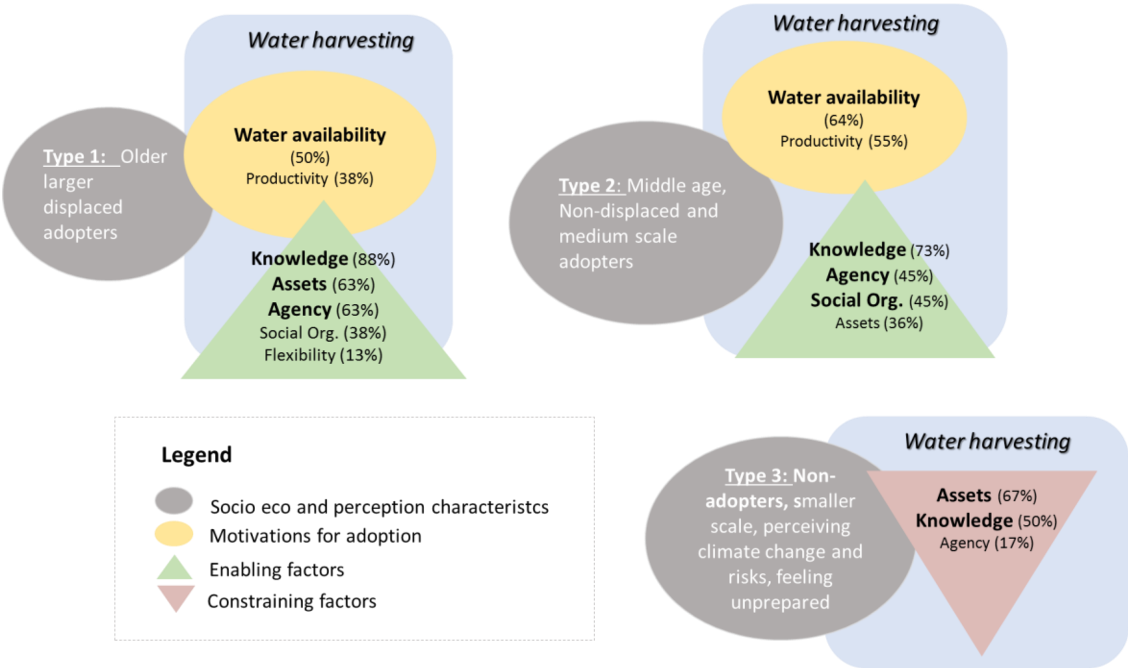


Water harvesting

Adoption of water harvesting by type 2 farmers (middle-aged medium-scale non-displaced adopters) was associated with assets, knowledge and learning, and agency (Table 6). For type 1 farmers (older larger-scale displaced adopters), knowledge and agency were also key adoption factors but social organization appeared to be more determining than assets, highlighting the enabling role of collective participation in CSA activities.

Similarly, type 3 farmers (smaller-scale non-adopters, perceiving climate change risks and feeling unprepared) also identified the lack of assets (water canals, tanks, financial resources, wood and organic material) as the first constraint preventing the adoption of water harvesting, followed by the lack of knowledge and learning (Figure 5**Error! Reference source not found.**).

Figure 5: Socioeconomic factors enabling (type 1 and 2 farmers) and constraining (type 3 farmers) the adoption of water harvesting

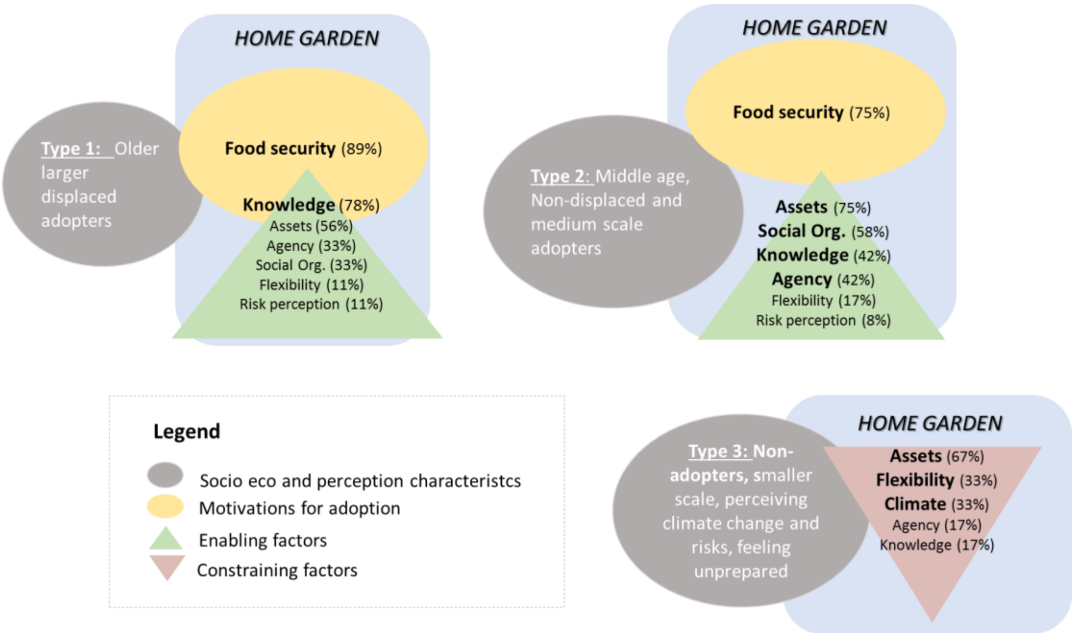


Home garden

For the three farmer types, the enabling and constraining factors (if absent) associated with the adoption of home gardens were assets (material such as seeds, nets, and plastic provided in previous training activities, and land availability). For water harvesting, type 2 farmers (middle-aged medium-scale non-displaced adopters) highlighted the role of training while type 1 farmers (older larger-scale displaced adopters) mentioned the importance of social organization and mutual aid within the group involved in CSA interventions (Table 6).

The factors that prevented adoption by type 3 farmers (smaller-scale non-adopters) were related to the lack of land availability, the lack of water availability (dry season), and the lack of resources to buy nets to protect crops from small animals (Figure 6).

Figure 6: Socioeconomic factors enabling (type 1 and 2 farmers) and constraining (type 3 farmers) the adoption of home gardens



Discussion and recommendations

Reflection on the design of a methodology allowing us to understand the socioeconomic factors that influence CSA adoption

Methodologies to assess the adoption of practices are not new (Ashby, 1986; Biggs, 1990; Chambers and Ghildyal, 1984; Douthwaite et al. 2002; Ghadim and Pannell, 1999; Rogers, 2015) but few have been developed in the context of climate change and CSA. Lopez-Ridaura et al. (2016) used farmer typologies and included climate change perceptions but focused on the benefits and constraints of CSA adoption and not on the enabling and constraining factors. Determinants and barriers to CSA adoption have been addressed using social learning and social network analysis (Tran et al., 2017) as well as farmers' adaptive capacity but not considering CSA options (Chaudhury et al., 2017). Mishra and Pede (2017) looked at intra household perceptions of climate change but did not consider other aspects influencing adaptation strategies. Finally, the Practical Guide to Climate-Smart Agricultural Technologies in Africa (Bell et al., 2018) considered general and rather technical adoption constraints as understood by Adger et al. (2009).

The value of the new methodology developed in the current study is that it includes farmers' typology of adoption, farmers' perceptions, and multi-dimensional factors that can enable and/or constrain CSA adoption. In addition, it can be used at the design stage of CSA interventions to assess what is currently adopted and what are the potential opportunities and constraints for types of farmers as recommended in the CCAFS Gender and Inclusion Toolbox (CCAFS, 2014). The methodology can also be used to assess ongoing CSA interventions to obtain guidance on how to improve actions to foster adoption.

However, this methodology aiming at understand enabling and constraining factors perceived at the individual level could be improved by refining disaggregation in data collection, including both men and women of the same household, to understand the perceptions of both about enabling and constraining factors of CSA options (CCAFS, 2014). It is also planned to test the methodology with a bigger sample in other CSVs.

Adoption of CSA options promoted by CCAFS

The six CSA options examined were adopted both by farmers involved in CCAFS activities and by farmers that were not. Farmers not involved in CCAFS activities had access from other sources to a combination of assets, knowledge, social organization, etc., that facilitated adoption. Knowledge and social organization were provided by other farmers (neighbors, producer associations), by the Cauca Department coffee committee, by the local extension unit (UMATA), or through the media (television), etc. Home gardens, compost, water harvesting, and water reservoirs were not new; they were promoted by these other actors but without a particular CSA perspective and thus with differences in their implementation mode (e.g., home gardens were not always associated with water harvesting). The fact that home gardens, compost preparation, and water harvesting were the options more frequently adopted can be explained by the synergies existing among them (Andrieu et al., 2017) and they can consequently be considered as a portfolio of practices rather than three distinct practices.

Socioeconomic (including climate perception) characteristics shaping the types of farmers that adopt CSA options

Three types of farmers were identified: two types of adopters and one type of non-/low adopters. Interestingly, the small-scale farmers (with farms less than 1 ha) that adopted fewer CSA options belong to type 3 that do perceive changes in the intensity of climate related events, feel the risks, but also feel unprepared to face potential future impacts.

Lower adoption by this type of farmer having the smallest and least diversified farms can also reflect previous research findings pointing out that concerns on climate change, in this case reflected through the adoption of CSA, can be linked to farmers' access to resources (smallest farm, least diversified) as less access also means fewer resources (assets) to face the impacts (Lo, 2014). A farmer from the study area expressed, for instance: *"What can be done with nature? Who can? With nature nothing can be done.*" As already observed in other contexts, the lack of feeling of preparedness could lead to a "wait and see" strategy (Barnes et al., 2013; Grothmann and Patt, 2005). Another plausible reason to find lower/no adoption of CSA options in cases where farmers do perceive climate-related changes and feel their risk is, as defined by Grothmann and Patt (2005), that risk perception is the "perceived probability of being exposed to climate change impacts and the appraisal of how harmful these impacts would be (perceived severity), relative to the appraisal of how harmful and urgent other problems or challenges in life are." In Cauca, climate might not be the most harmful and urgent challenge perceived by this type of farmers (type 3).

Conversely, the two other farmer types that feel more prepared (type 1 and type 2) and have larger and more diverse farms were also the ones adopting more CSA options.

The more relevant factors to describe each farmer type were age, household type (Table 2) – (1) male headed, with a wife; (2) male headed, divorced, single, or widowed; (3) female headed, divorced, single, or widowed; (4) other, specify) – and size, farm area, and presence/absence of displaced people. Women were present in the three types in different proportions: type 1 included 38% women, type 2 included 54%, and type 3 41%.

Direct CCAFS beneficiaries were mainly represented in type 1 (92% of the type) and type 2 (63% of the type) in proportions that reflect that involvement in CCAFS activities played a key role in adoption rates.

Adoption motivations and enabling or constraining factors for each farmer type

Motivations

According to Theory of Change (ToC) thinking,[5] attitude (Shapiro, 2006; Vogel, 2012) or motivation (Douthwaite et al., 2002) is the factor that influences adoption of, or changes in, practices. Information on motivation is useful to guide institutions on how to design and promote practices that directly address farmers' interests and needs. Although half of the farmers interviewed in this study participated in CSA activities promoted by CCAFS, including sensitization to climate change-related challenges, **only in a few cases were climate-related risks identified as a motivation to implement a CSA option**. One man mentioned that compost helps to mitigate greenhouse gas emissions, a few men and women farmers mentioned that improved beans were more resistant to drought and flood, and some suggested that a home garden combined with other CSA options (water harvesting, plastic roof) helps to face climate variability. As explained by Weber (2016), "A major obstacle to motivating action on climate change is the fact that for many people the phenomenon appears not just abstract, but also personally distant in space and in time."

Type 1 and 2 farmers shared similar motivations to implement CSA options. These were mainly related to ensuring **food security** and improving **productivity** and, to a lesser extent, to cost saving (for compost), thus pointing out specifically one of the three CSA pillars. For most of the farmers, these objectives were more important first hand than building resilience or increasing their capacity to adapt to future climate-related events.

The most adopted practices focused on home gardens and home needs (water availability for the house) rather than on the most affected crop (coffee) according to farmers 'perceptions.

Role of enabling/constraining adoption factors

The two most mentioned enabling/constraining factors that facilitated/slowed down adoption of CSA options among all farmers were physical and natural assets and knowledge and learning. In general, training offers an interesting space to access new ideas (agency), build social networks and mutual social aid (social organization) among participants, and, in some cases, allow farmers to benefit from some assets (seed distribution, water tank, etc.). Research has already shown that learning can influence farmers' willingness to test new practices (Cohen et al., 2016) and adopt adaptive measures (Alauddin and Sarker, 2014; Bhatta et al., 2015;

[5] Theory of change is defined as "an outcomes-based approach which applies critical thinking to the design, implementation and evaluation of initiatives and programmes intended to support change in their contexts" (Vogel, 2012).

Tesfahunegn et al., 2016). As expressed by a woman farmer, “People say that they don’t have things [meaning innovative practices such as a water harvest system] but it is because they are not creative,” explaining that training gave her the idea to implement new practices on her farm. According to farmers’ workforce, collaboration and social cohesion fostered by training events were key elements, often interacting, that facilitated adoption. As observed by Ghadim and Pannell (1999), some farmers need more “observation of success” than others before testing new practices and adoption is influenced by the frequency of interactions with farmers that have adopted an innovation.

In the case of Cauca CSV and for the CSA option of water harvesting, observations of success have been possible through training events and visits to the farms of adopting farmers.

Direct CCAFS beneficiaries highlighted that the training events gave them the opportunity to see other farmers’ experiences, which influenced their own implementation of home gardens: “What motivated me was to see the practices implemented.” This idea is also shared by women: “Ecohabitats took us to visit farms. There, we saw farmers, like us, who had a lot of food. They had tomatoes, everything. And they did not need to go out to buy them. This touched me a lot. It was a shame that having some piece of land we were not taking advantage of it.”

Adoption is closely linked to a mix of changes in knowledge, skills (through training), **and attitudes** (witness experiences of success) according to Theory of Change thinking (Shapiro, 2006; Vogel, 2012). As one woman presented it, her change in attitude influenced adoption**.**

In the same way, men and women considered that social organization supported adoption. “Of course, working in groups is very helpful. Sometimes, alone you don’t have materials or the motivation to do things,” explained one woman. Another male farmer mentioned that they “didn’t have any difficulty because (they) shared advice and gave support to each other,” showing that, besides providing motivation, farmers’ groups offered a space for feedback and collaboration. Those spaces were facilitated by training since normally farmers do not gather to discuss their problems, successes, etc. (Howland et al., 2015) and this had an influence on agency or decision-making.
Some men mentioned that one factor that fostered the adoption of rainwater harvesting was linked to belonging to the local government, which facilitated their participation in CSA activities and, in the end, enabled them to receive support (e.g., materials) required to implement the CSA option. In this case, participation in training is seen as a means to obtain assets, which is allowed by hierarchical status in the community. As Adger (2014) summed up: “Social hierarchies and inequalities in resources and entitlements are rarely overturned in the course of adaptation.”

Knowledge and learning events, however, are not enough to enable adoption. Farmers identified issues such as the lack of continuity of some training, bad quality in certain assets offered (old or unsuitable seeds for the area), or unbalanced benefits (a tablespoon of seed offered compared to the time spent in such events). As expressed by one female farmer, "All the time that we lost in these trainings, we could have gone to work and would have produced three times the seeds they gave us. I didn't like that." **Farmers do need to identify clear and concrete benefits to participate and to adopt practices.**

Another challenge related to learning is the sometimes contradictory or inadequate discourse that can be channelled to farmers from different institutions working in the same area. One example shared by farmers accounted for the fact that some time ago the Federation of Coffee Growers used to strongly promote the cutting of coffee shade while Ecohabitats was promoting the use of tree planting to protect coffee from extreme climate events. One woman said, "Before, I used to have shade. But the technicians came and told us to cut everything. And, as all of us used to obey… because they (technicians) say that they are the ones that know best. But the elders didn't listen and they didn't cut the trees. And they have been scolded. The young ones, we let ourselves get influenced." The discourses of heterogeneous local institutions can be problematic for younger or less experienced farmers receiving contradictory information. Interestingly, when asking farmers how they were making decisions when facing contradictory information, they all responded that they were triangulating the information and selecting what was making more sense for them. Well-coordinated local institutions would highly benefit farmers.

Another challenge identified by farmers for adopting CSA (e.g., home gardens) was related to climate risk itself. For instance, one farmer said, "In a hailstorm, the plastic broke, then I had to remove it. (…) It was already very hot and there was no way to give water to the plants." In this case, the way the CSA option was implemented did not consider the ability to face an extreme climate event such as hail or drought. The home garden was protected from strong rains (by a plastic roof) and did harvest water, but it was not prepared to face a hailstorm or drought. The adoption of this practice would be a "coping strategy" aimed at addressing short-term shocks (Basu et al., 2015) rather than an adaptation strategy. Even in the case of farmers having home gardens with water harvesting systems, the lack of rain during the dry season made the water harvesting useless and made some farmers stop it during this period.

Enabling factors mentioned by type 1 and type 2 adopting farmers were the constraining factors for type 3 non-adopting farmers: assets (expectable) but also knowledge and learning (for water harvesting and compost).

Adoption, a complex process including socioeconomic characteristics, motivations, and enabling/constraining factors

This study showed that the planning of CSA interventions should take into account the diversity of both the farmers and the practices. Indeed, for each type of farmer, a specific strategy should be designed to foster adoption. For instance, type 2 farmers should be involved in training, which is consistent with the CCAFS intervention strategy. It should not be underestimated that, in general, assets remain a key enabling factor for all farmers.

For specific CSA options, different configurations of factors led to adoption. For example, in the case of water harvesting by type 2 farmers, a key factor was agency (coming from participation in training), whereas, for type 1 farmers, the main factor enabling them to adopt home gardens was social organization (translated into the support received from other farmers to set up a plastic roof, for instance).

Conclusions

This study contributed to the development of a new methodology allowing us to understand the socioeconomic factors that foster or on the contrary slow down adoption of CSA options.
Its key added value is that (1) the composite analytical framework proposed goes beyond assessing multi-dimensional enabling/constraining factors by adding new dimensions to the ones from Cohen et al. (2016): assets, flexibility, knowledge and learning, social organization, and agency, as it accounts for the influence of farmers' perceptions of climate change and CSA efficiency and (2) it does not apply a "socially blind" but rather a socially differentiated approach by identifying farmers' types associated with adoption.

The results of the pilot implementation in Colombia allowed us to identify three main types of farmers based on their socioeconomic characteristics, climate change perceptions, and adoption of CSA practices. Motivations leading to adoption by type 1 and type 2 farmers were practice-specific rather than farmer-type-specific. They were mainly related to ensuring food security and improving productivity and, to a lesser extent, to cost saving (for compost), highlighting that at the study site those concerns are more important than building resilience or increasing capacity to face future climate-related events.
Physical and natural assets and knowledge and learning were the two most mentioned factors that facilitated/slowed down CSA adoption, which supports the idea that adoption processes are very closely linked with a mix of changes in farmers' knowledge, attitudes, and skills and that they are fostered the clear association to concrete and often near-term benefits than can respond to their more urgent needs.

Finally, this study showed that CSA adoption is a complex arrangement (socioeconomic, enabling, and constraining factors, perceptions, and motivations), and stressed the need for specific strategies that account for the diversity of both the farmers and the practices when it comes to the design of CSA interventions that aim to foster adoption.

By generating concrete recommendations on how to adjust current and future interventions to be more socially inclusive, this methodology supports CCAFS and its partners' CSA planning, implementation, monitoring, and learning emerging from CSV participatory A4D research.

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Appendix

Appendix 1: semi-structured interview guide

	Question	Question type	Category
1	name	open-ended	information socio-economical for farmer typology
2	age	open-ended	information socio-economical for farmer typology
3	household (HH) type	01=Male headed, with a wife or wives, 02=Male headed, divorced, single or widowed, 03=Female headed, divorced, single or widowed, 04=Female headed, husband away, husband makes most household/agricultural decisions, 05=Female headed, husband away, wife makes most household/agricultural decisions, 06=Child headed (age 16 or under)/Orphan 96=Other, specify	information socio-economical for farmer typology
4	education level	00=No formal education,01=Primary, 02=Secondary, 03=Post Secondary	information socio-economical for farmer typology
5	number of person in the HH	open-ended	information socio-economical for farmer typology
6	ages of persons in the HH	open-ended (list)	information socio-economical for farmer typology
7	farm area (ha)	open-ended	information socio-economical for farmer typology
8	productive area (ha)	open-ended	information socio-economical for farmer typology
9	forest area (ha)	open-ended	information socio-economical for farmer typology
10	cultivated crops	open-ended (list)	information socio-economical for farmer typology
11	number of plot	open ended	information socio-economical for farmer typology
12	land ownership	yes/no	information socio-economical for farmer typology
13	ethnic group	categories	information socio-economical for farmer typology
14	displaced	yes/no	information socio-economical for farmer typology
15	participation in CSA intervention	yes/no	information socio-economical for farmer typology

16	Do you implement CSA practice?	yes/no	information to identify adopted practices
17	do you lead/take part to/no take part to the implementation of CSA practice?	open ended	information on who is in charge of the practice
18	Since when do you implement this practice?	open ended	information to identify adopted practices
19	Why did you start to implement this practice?	open ended	motivation for adoption
20	If the "why" is linked to address climate challenges: What have been the efficacy of this practice to address climate challenges?	open ended	perception of measure efficacy
21	With what resources implement this practice?	open ended	information to identify adopted practices
22	What facilitated the adoption of this practice?	open ended	factors of adoption
23	What constrained the adoption of this practice?	open ended	factors of adoption
24	do you know this practice?	open ended	information to understand barrier to adoption
25	Do you know how to implement it	open ended	information to understand barrier to adoption
26	Do you consider that this practice could benefit your farm?	open ended	information to understand barrier to adoption
27	someone in the HH implemented the practice?	open ended	information to understand barrier to adoption
28	(if yes) Why did he stop implemented it?	open ended	information to understand barrier to adoption
29	why you never implemented this practice?	open ended	information to understand barrier to adoption
30	what are the main barriers to implement this practice?	open ended	information to understand barrier to adoption
31	what would facilitate the adoption of this practice	open ended	information to understand barrier to adoption
32	Have you perceived change in the climate?	open ended	information on climate perception
33	how the climate changed?	open ended	information on climate perception
34	how was the climate before?	open ended	information on climate perception
35	how is the climate now?	open ended	information on climate perception
36	Climate has affected farms in this area? How? Who have been the most affected? Why?	open ended	past negative experience with climate
37	Do you remember a specific event where your farm has been affected by climate?	open ended	past negative experience with climate
38	what crop(s) is/are the most affected by change in the climate?	open ended	crop affected by change(s) in climate

39	Do you think that climate could affect your farm in the future? How?	open ended	risk perception
40	How prepared do you feel to address change in the climate?	open ended	adaptive capacity perception
41	What do you have (to address it)? What is missing?	open ended	adaptive capacity perception
42	So far, what have you done to face changes in climate? Did it worked?	open ended	perception of measure efficacy
43	What else could be implemented in your farm so that your most affected crops do not suffer form climate?	open ended	perception of measure efficacy
44	What are the main barriers to implement this measure in your farm? Why?	open ended	perception of measure efficacy
45	Do you belong to a group/ association? Which one(s)?	open ended	information socio-economical for farmer typology
46	What are the benefits to belong to this/these groups?	open ended	
47	Who do you go to (person/institutions) when you want to ask something related to your farm/crops?	open ended	information socio-economical for farmer typology
48	How reliable are these advices?	open ended	
49	Who do you go to (person/institutions) when you want to ask something related to climate?	open ended	information socio-economical for farmer typology
50	How reliable are these advices?	open ended	

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CGIAR

CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is led by the International Center for Tropical Agriculture (CIAT). CCAFS is the world's most comprehensive global research program to examine and address the critical interactions between climate change, agriculture and food security. For more information, visit us at **https://ccafs.cgiar.org/.**

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

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