The Climate-Smart Village approach: what research and insights from current implementation in Daga-Birame CSV in Senegal?

Case study of Daga-Birame CSV for CCAFS ISP11/6.1.2 – Senegal

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Abbreviations

AGF: Agroforestry
AGRECOL: AGRiculture ECOLogique
AGRHYMET: Centre Régional de Formation et d'Application en Agro-météorologie et Hydrologie Opérationnelle
ANACIM: Agence Nationale de l'Aviation Civile et de la Météorologie
ANCAR: Agence Nationale de Conseil Agricole et Rural
ASPRODEB: Association Sénégalaise pour la Promotion du Développement à la Base
BFS/USAID: Bureau for Food Security/United State Agency for International Development
CCAFS: Climate Change Agriculture and Food Security
CGIAR: Consultative Group for International Agricultural Research
CIAT: International Centre for Tropical Agriculture
CINSERE: Climate information services for increased resilience and productivity in Senegal
CIS: Climate Information Services
CORAF/WECARD: Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles/West and Central Africa Council for Agricultural Research and Development
CSA: Climate-Smart Agriculture
CSE: Centre de Suivi Ecologique
CSV: Climate-Smart Village
DA: Direction de l'Agriculture
ECOWAS: Economic Community of West African States
EIG: Economic Interest Group
ENRACCA: Strengthening the capacity of resilience and adaptation to climate change through integrated management of land, water and nutrients in the Semi-Arid areas of West Africa
ESPIV: Inter-village Silvo-Pastoral Lands
FMNR: Farmer Managed Natural Regeneration
GDP: Gross Domestic Product
GHG: Greenhouse Gases
GTP: Groupe de Travail Pluridisciplinaire
ICRAF: World Agroforestry Centre
IFAD: International Funds for Agricultural Development
INDCs: Intended Nationally Determined Contributions
INSAH: Institut du Sahel
IP: Innovation Platform
ISFM: Integrated Soil Fertility Management
ISRA: Institut Sénégalais de Recherche Agricole
IUCN: International Union for Conservation of Nature
M&E: Monitoring and Evaluation
MEDD: Ministère de l'Environnement et du Développement Durable
MWG: Multidisciplinary Working Group
NAPA: National Adaptation Program of Actions
NARES: National Agriculture Research institutions
NGO: Non-Governmental Organization
NTFP: Non Timber Forest Products
PAFA: Projet d'Appui aux Filières Agricoles
PICSA: Participatory Integrated Climate Services for Agriculture
SDM: System Dynamics Models
TOP-SECAC: Trousse à Outils de Planification et de Suivi-évaluation des Capacités d'Adaptation aux Changements Climatiques
UNEP: United Nation Environmental Program
WA: West Africa
WACSAA: West African Climate-Smart Agriculture Alliance

1. Background, rationale and objectives of the Daga-Birame Climate-Smart Village (CSV)

1.1. Overview of Senegal

Senegal, with 196,712 km² land area, is located at the extreme west of the African continent (Longitudes 11°21W - 17°32N and Latitudes 12°8N - 16°41N). The country's soils are in general of low fertility, fragile and very susceptible to wind and water erosion. The climate is of Sudano-Sahelian type characterized by alternating dry season (November to May) and rainy season (June to October). The 700 km coastline brings climatic differences between coastal areas and inland zones. Rainfall amount follows a latitudinal variation going from 300 mm in the north semi-desertic areas to 1200 mm in the south. Senegal is divided into 7 agro-ecological zones for management perspectives: River Valley, Niayes, Groundnut Basin (North and South), Silvo-Pastoral zone, Eastern Senegal and Upper Casamance, Lower Casamance (CIAT-BFS/USAID, 2016). The country's economy is mainly driven by crop and livestock production contributing 17% of the GDP and employing about 70% of the population (NAPA, Republic of Senegal 2006). Like other sub-Saharan African countries, Senegal faces food insecurity as a consequence of climate variability and change combined with other global changes (Zougmoré et al., 2015).

1.2. Climate-Smart Agriculture (CSA) development in Senegal

Senegal's economic growth strategy identifies agriculture as the key driver for poverty reduction and enhancement of food security. Such a strategy can only be viable if it integrates both the productivity and sustainability aspects with the latter calling for consideration of adverse effects of agricultural production on the environment and climate. Nowadays, the Senegalese government has advocated for the adoption of CSA to improve the adaptive capacity of the agricultural sector to climate change and variability and build more resilient livelihoods for sustainable development. CCAFS has been a strategic partner on this government agenda (MEPN Senegal, 2006) and the work with the Senegalese National Civil Aviation and Meteorological Agency (ANACIM) on the dissemination of downscaled climate information services through community rural radio across the country contributed to improve the adaptive capacity of many farmers (Lo and Dieng, 2015). Indeed, about 7 million rural people having access and to climate information, and the government of Senegal is now considering climate information as an agricultural input, similar to fertilizers and improved seeds (CCAFS 2015).

Also, a number of current agricultural practices (deforestation, fire for cropland cleaning, poor fertilization practices, inadequate livestock raising practices, etc.) may generate GHGs. Therefore, agricultural development plans need to consider implications of GHG–emissions, particularly for the expansion of rice cultivation and livestock production. It is in line of this vision that Senegal engaged as a member of the West Africa CSA Alliance created by ECOWAS which aims at coordinating initiatives, mobilizing resources, strengthening institutional and inter-sectorial coherence to support implementation and monitoring of CSA in agricultural investment programs (see WACSAA). In addition, the country's Intended Nationally Determined Contributions (INDCs) to emission reductions under unconditional (based on national resources) and conditional (support from international community) situations, amount to 5% and 21% respectively by 2030 (MEDD Senegal, 2015). It is to note that the national science-policy dialogue platform put in place since 2012 with the support of CCAFS, has been successful in sensitizing and raising awareness of national decision makers on the mainstreaming of CSA into national development initiatives (see http://ccasa-senegal.org/).

1.3. Brief description of Daga-Birame village

When CCAFS initiated work in Senegal in 2010, sites for field work were considered and after stakeholder consultations, the Daga-Birame village was chosen as one of the seven villages within the CCAFS' site of Kaffrine (block of 30 x 30 km). The geographic coordinates of the

Kaffrine site are 13.9-14.2 Lat. North and 15.4-15.68 Long. West. Specific challenges identified by the village community during the participatory diagnosis (Sanogo et al., submitted manuscript) highlighted droughts, floods and winds as the main climatic risks. Poor harvests, destruction of crops and harvests, post-harvest losses due to pests and diseases, destruction of farmlands due to wind and water erosion, and declines in market gardening and, livestock production were identified as the most important constraints to agriculture and natural resource management. While the lack of appropriate mechanisms for obtaining financial credits was the largest financial challenge, the weak functioning of existing institutions/organizations was pointed out as the main social constraint. Other challenges related to lack of infrastructure. According to the village baseline study conducted in 2011 in Toune Mosquée, a village close to Daga-Birame, soils are degraded with low fertility, and crop production cannot meet the food needs of a family throughout the year; thus families must buy food to fill the food gap and consequently, may harvest and sell forest products, which creates a vicious cycle of resource degradation (Goudou et al., 2012).

In a view to tackle these challenges, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) has been working with a range of partners (CGIAR centers, NARES, State technical agencies and services, NGOs, local authorities…) and rural communities, to test and validate several agricultural interventions aimed at sustainably improving agricultural productivity and households' income, improving the resilience of farmers and their ecosystems and reducing greenhouse gas emissions or sequestering carbon when possible. A CSV approach has been used – a participatory approach that, in the Daga-Birame CSV, targets four main components: (i) delivering climate information and services, (ii) developing climate smart practices/technologies, (iii) strengthening local knowledge and institutions and (iv) supporting local development plans (Aggarwal et al., 2013).

2. What are the research questions supporting activities in the CSV?

2.1. Assumptions for the development of Daga-Birame CSV

The CSV approach in Daga-Birame builds on the following assumptions: (i) Improved understanding of farmers' perceptions and demands will lead to better tailoring of options and effective implementation of climate-smart technologies and innovations for improved resilience and climate mitigation; (ii) Addressing barriers to adoption of climate-smart technologies and practices, taking into consideration gender and social differentiation, institutional, political and financial mechanisms, will boost integrated and inclusive local development that can be brought to scale.

These assumptions emerged after an initial diagnosis of local constraints and opportunities, including the use of the TOP-SECAC toolkit (Somda et al., 2011) to (1) analyze the vulnerability and adaptation capacity to climate change, (2) map the livelihood resources and climate hazards in the village territory, (3) analyze the perception of community members about the impact of climatic hazards on main livelihood resources; and finally, (4) define current and future adaptation strategies based on existing resources in the village.

2.2. Research questions investigated during implementation of the CSV approach

Based on the above assumptions, the following research questions are being addressed during implementation of the CSV approach:

- What are the food and nutritional security's drivers of households in the context of climate change?
- What combination of climate-smart water and crop-livestock-trees technologies and practices enhance the adaptive capacity of smallholder farmers; i.e., how beneficial is CSA implementation for smallholder farm communities?
- What are the enabling social, institutional, political and financial determinants for adoption of incremental change in water- and climate-smart crop-livestock-trees technologies?
- What are gender-related barriers to adoption of CSA?

3. What does a CSV approach looks like in Senegal?

3.1. Approach to setting up the CSV

Setting up Daga-Birame CSV commenced after selecting potential CSV sites based on climate risk profiles, potential land-use options, and assessing willingness of farmers and local government to participate (Förch et al., 2013). Initially, a household baseline study was conducted and covered 7 villages including Daga-Birame (Yacine et al., 2011).

In 2011, two villages including Toune Mosquée and Ngouye-Daga-Birame, were selected for the implementation of the CSV approach but the latter was the main focus given the social motivation of the village for innovation. The visions for the future, as well as actions and partnerships needed to reach this desired future, were elaborated with farmers and key stakeholders using a participatory approach. Village communities indicated that for natural resources management, they envision the following to happen, in a positive future:

- Crop production provides sufficient food as well as surplus stocks
- Livestock numbers increase, and their health and conformation (shape and structure) improve
- Pest and diseases from the location are eradicated
- Water erosion is controlled through better management of farmlands
- Market-gardening incomes increase
- Livestock deaths due to flooding are reduced

The community also wished to eradicate diseases related to drought and rainfall events, to have better access to financial resources, to have dynamic, autonomous, well-structured and functional organizations and strengthened partnerships.

Subsequent to the defined vision, specific actions to be undertaken were agreed upon during the community meetings. The community recognized that a key condition to getting an operational CSV was strong partnerships, with partners implementing the different actions in an integrated manner. For Daga-Birame CSV, research and extension services, met services, NGOs, private sector, local decentralized authorities and community organizations were key playing actors (Sanogo, 2014; Bayala et al., 2016). Regional and international organisations such as Aghrymet, INSAH, CORAF/WECARD, ICRAF, CCAFS-WA, provided scientific, technical and financial support. Through a number of these partners, community voices, successes and lessons could be relayed to policy-related decision makers.

3.2. Actions in the Daga-Birame CSV

The set of actions identified by the village community was used to shape the CSV. The actions selected are discussed in relation to four major components (Figure 1). These actions are local in character, but have to be framed and selected in the context of feasible scaling up strategies (see later section):

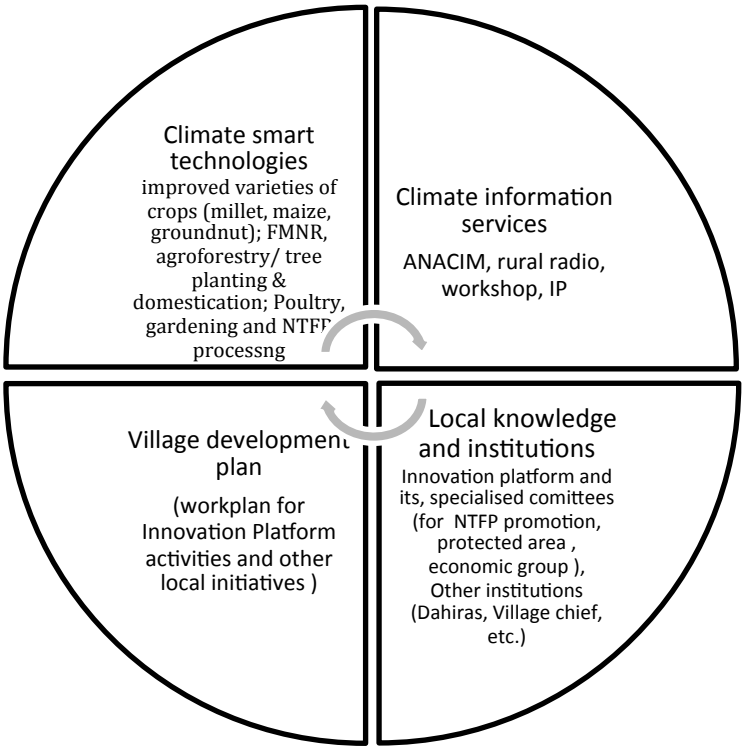

Figure 1: Components of the Daga-Birame CSV in Senegal

(1) ***Participatory testing of CSA technologies and practices.*** The resulting technological solutions are expected to contribute to the following desired changes: reducing water erosion and improving management of farmlands; improving crop and livestock production; and increasing income generation. Action research includes: (i) The use of demonstrations on drought-tolerant crops varieties through comparing traditional varieties with improved cultivars selected on the basis of the seasonal forecast information. Improved varieties tested included those of maize (Early Thai, Swan, and Obatampa) and millet (Souna 3, Thialack 2). Initial results show an average 50% increase in yield, that consequently contributes to improved food availability; (ii) *Combined soil tillage, microdosing and farmer-managed natural regeneration (FMNR) for integrated soil fertility management (ISFM).* Suitable ISFM options could sustainably intensify agricultural production and generate income. Demonstration trials are being conducted to compare combined soil tillage (land scraping), different densities of FMNR and fertilizer microdosing (about 4 g/pit, 15 days after sowing) against the local practices (clear cutting and burning of biomass coupled with local fertilization practices - about 9-10 g/pit); (iii) *Fruit tree planting for improved vegetation cover and income generation.* Five tree species are being used in community demonstration trials as well as in individual plantations owned by women in order to identify options of fruit trees and products that fit local needs and context. This includes *Ziziphus mauritiana, Adansonia digitata, Tamarindus indica, Psidium guajava and Annona muricata*. Three grafted varieties of *Z. mauritiana* (ICRAF 08, ICRAF 09, Gola), three grafted varieties of *T. indica* (a sweet variety, Niger 309 and TB 3) and one grafted variety of *A. digitata* (Nonokène) are being compared with local ones. (iv) *Gardening for nutritional security and income generation.* This activity is mainly conducted by women organized in sub-groups with the aim to increase income while also contributing to nutritional diversity.. The gardens are rain-fed during the rainy season while clean energy (solar power) irrigation is used during dry season. For the past season (2015), the women'a groups produced water melon (*Citrullus lanatus*), okra (*Abelmoschus esculentus*), mint (*Mentha spicata*) and pepper (*Capsicum annuum*). Water melon and okra generated 76 and 20 Euro respectively, while mint was only for self-consumption; (v)

Processing of non-timber forest products (NTFP). An NTFP promotion committee composed of women has been established to process baobab fruit into powder with the aim of generating income. During 2015, 29 kg of baobab powder were sold, resulting into 171 Euro of income for the women's association. The money has been deposited in the common village savings. Such income could serve to purchase food provisions and to rescue community members during poor harvest years. It could also serve to invest in resilient sustaining activities of the community.

Overall in Daga-Birame CSV, options trialed under the climate-smart technologies/practices component have been looking for improved soil conditions through ISFM, FMNR or directly for increased production or income generation through appropriate crop varieties, fruit tree cultivars, and NTFPs processing. A recently published paper that used data from 700 surveyed farming households in five CSV sites in WA, confirmed that markets and climate are driving rapid change in farming practices in Savannah West Africa (Ouédraogo et al., 2016). Through better management of tree biomass, local improvement of environmental conditions could alleviate hazards such as strong winds, erosion, etc. while contributing to mitigation through carbon sequestration.

(2) ***Climate information services for improved climate risk management.*** Knowledge on local climate conditions, through seasonal forecasts, information on dates of the start and end of the rainy season, and 10-day forecast, may allow farmers to better synchronize their farming activities (and other livelihood activities) to climate variability and improve their resilience to climatic shocks. Since 2011, a local multidisciplinary working group (made of various decentralized institutions, local farmers and private sector organisations, and the media) established by ANACIM, has been sharing climate and weather information with farmers through trainings (at the beginning of the season), mobile phones and local radios. As a follow up to the seasonal forecasts training, individuals from the innovation platform (IP – see below) also relay the climate information to their colleagues through the IP. In addition, some farmers in the different neighborhoods of Daga-Birame receive climate information on their mobile phones and share it with others. The field tests conducted through ANACIM consistently report reduced crop failure and increased crop production (about 50% yield increase) as a result of using CIS for farm management (Lo and Dieng, 2015). A study to analyse the effectiveness of the various dissemination mechanisms is underway. For this 2016 rainy season, PICSA (Participatory Integrated Climate Services for Agriculture), a new approach to guiding farm management decision making, is being trialed with 30 farmers including 16 women. This approach helps farmers long before the season starts, to match their production and other livelihood options to local climate features and individual circumstances, and subsequently use other climate information (seasonal and short term forecasts and warnings) to adjust their plans and operations.

(3) ***Village development planning.*** Although there is not yet a formal village development plan, the initial diagnosis of constraints and opportunities and the definition of a vision for the village, prompted the community to plan a number of initiatives: *(i) Baobab trees protection within the village territory*: in the village, baobab trees were previously being overused for livestock feeding, causing progressive scarcity and reduced productivity of NTFPs from this important tree species. Nowadays, following the collectively agreed decision to protect the remaining population of baobab trees in the village, all baobab individuals have been marked and their use prohibited; the use of baobab leaves as animal feed has now shifted to other vegetation resources, crops residues and cereal by-products. This protection initiative is yielding results as women now have baobab fruits available for their processing and income generating activities. *(ii) Establishment of protected areas.* This initiative also results from the initial diagnosis exercise that identified progressive degradation of the vegetation as a major contributory cause to climatic risks (strong winds, erosion, flooding and drought). The community therefore implemented participatory management of 128 ha of community land, prohibiting fire and wood cutting while allowing grazing. A committee made up of 11 people including 4 women, has been officially recognized and appointed by local authorities (the

municipality of Ndiognick, Office of Environment and the prefect) to ensure enforcement of the management rules. Baseline information on vegetation condition has been collected. The CCAFS partner in the CSV approach – ISRA – has participated to a similar initiative in the region of Kaolack, a region close to Kaffrine (Sanogo et al. 2014). *(iii)* *Establishing a borehole*: A borehole was established in the village to improve water availability especially during dry season because of the need to irrigate the demonstration field on improved tree cultivars. Establishment of the borehole was funded mainly through the ENRACCA project, funded through CORAF/WECARD and implemented by INSAH and CCAFS-WA. This initiative was a result of the synergistic partnership established among various actors in order to develop the CSV model and to tackle the multifaceted challenges facing the village. *(iv)* *Access to advisories and technical services.* Prior to the ISRA/CCAFS interventions, Daga-Birame had no access to advisories and technical services. Today, Daga-Birame communities interact with staff from the Meteorology, Agriculture, Environment, Livestock husbandry, and Research services, as well as with development NGOs, local politicians and administrators.

(4) ***Strengthening local knowledge sharing and institutions.*** An innovation platform (IP) has been put in place as a driving force for CSV development. The IP is regarded as the local institution that decides and leads the implementation of the work plan as defined collectively by the community. It is a functional structure made of all social components of the community i.e. men, women, youths, traditional and religious leaders, and marginalized groups. It also brings together external actors such as technicians, administrative staff, local elected officials, researchers and members of associations, local organizations and savings and loans schemes. The IP bureau is made of 17 members including 6 women, who meets regularly to discuss and suggests decisions to the community for the CSV's activity planning. Major decisions are taken through its general assembly which is held annually, its board meeting every 3 months, and neighbourhood level meeting when specific needs arise. Also, information generated (lessons learnt) from implementation of the practices/technologies are shared through the IP. It has allowed women to get land for market gardening and to plant priority local fruit trees in a demonstration plot. The Innovation Platform also coordinated the process to obtain agreement from the local authority to protect and manage the community lands. The IP has also been used as a channel to relay climate information to farmers. As part of the IP, 3 other structures were created and tasked with specific goals:

- The economic interest group (Groupe d'Intérêt Economique). This is in charge of promoting economic activities (NTFPs – baobab fruits processing, market gardening, maintenance of tree cultivars demonstration plot and groundnut production through intercropping in the plot) within the village;
- The committee for protected areas. This is in charge of sustainable management of the protected area. For instance, the committee is responsible for overseeing the enforcement of the rules;
- The committee for promoting NTFPs. This is initially in charge of developing a business model with baobab fruit powder

The IP is legally recognized through its GIE named *Soukhali* and it is through the GIE that initiatives can be developed to seek for loans and other forms of assistance (insurance, etc.), although such initiative have not yet been tried because of insufficient capacities; indeed, there is need for capacity building (also elaboration of code of conduct) to allow the IP engage in resource mobilisation.

3.3. Learning from implementing the CSV approach

On the four CSV components

An analysis of the linkages/interrelations between the four components (see Figure 1) in the case of Daga-Birame indicates that climate information services (CIS) have been a key entry point to guide farmers' decisions and selections of crops, agro-sylvo-pastoral systems, production timelines and levels of investment. Thanks to the greater availability and access of

CIS, largely through the ANACIM-facilitated local multidisciplinary groups, mobile phone text messaging and rural radio broadcasts, as well as the now initiated PICSA trainings, it is apparent that farmers are becoming convinced about the effectiveness of using CIS for farm management. Therefore, farmers' decisions on the type of crops, varieties, technologies, arable land size, level of intensification, etc. (the "CSA technologies and practices" component) are now commonly guided by the climate information shared through the various dissemination channels. Given with new knowledge required to understand and implement the defined climate-relevant technologies and practices, various activities related to the "Local knowledge and institutions" component have become crucial. These have included capacity building to share knowledge amongst CSV actors. Also important was the setting up of the IP and other sub-committees, thus improving community organization to collectively benefit from the capacity building and to discuss and plan CSV. Lessons learnt from the demonstrations tests and from individual decision makings are iteratively shared among the IP members to guide next steps and plans within and outside the CSV. This has also led to activities in the "Local development planning" component. Local institutions put in place have facilitated women's access to production assets especially land and water. For instance, they obtained land for market gardening and for fruit trees planting, thus empowering them economically and socially.

On the biophysical impacts of the CSV approach

Quantitative evaluations are planned and data has been collected since 2012. The research questions aimed at providing understanding and evidence of the functioning and effectiveness of the various technological options with respect to climate variability. Their cost-benefits are also being assessed. In this regard, a special issue on climate-smart agricultural technologies in West Africa with 12 scientific papers from the five CCAFS pilot countries is currently submitted to *Agriculture & Food Security*. ICRAF has published an occasional paper (peer reviewed) that documented approaches and lessons learnt from CSV development research in West Africa (see: Lessons from CSV development research-WA). Based on data available from the various CSVs, a PhD student from Wageningen University is currently exploring how a system-based approach can be used to evaluate the impact of CSA. A System Dynamics Models for CSA at village level will be designed to simulate the behaviour of a system and understand the impact of current interventions and the effectiveness of current interventions against future climate change shocks, population growth, and policy change.

On social change

Learning from changes in social processes, perceptions of climate risks and the related options constitute an important way to improve and accelerate the CSV approach. A key partner has been IUCN West and Central Africa who have conducted monitoring and evaluation of behavioral changes in the intervention sites. Table 1 summarizes behavioral changes as recorded in stories of changes gathered in 2013 and 2014. The results showed that the CSV approach has enacted significant shifts in knowledge, practices and organizational change. A recent survey (early 2016) indicated that the innovation platform has been instrumental in enhancing participation in decision making by community members, and enhancing their role in shaping development activities. The community particularly appreciated the collective learning developed through the various demonstration trials, the exchange visits, experience and knowledge sharing with farmers from other areas and the regular assistance they get from technicians to implement their activities.

Table 1: Attributes of the occurred behavioral changes in Daga-Birame village, based on data collected in 2013 and 2014 with 25 people from the CSV (expressed in % of people showing changes in knowledge and practices, and changes in perceptions about partnerships and institutions).

Domains of changes/attributes	**Men**	**Women**
1. Changes in knowledge		
Knowledge about agricultural techniques (relationship between climate change and improved varieties, soil tillage (ploughing) and row planting, compost preparation, etc.)	50	67
Knowledge on how to implement on-farm assisted natural tree regeneration techniques	69	11
Knowledge on poultry husbandry (feeding, maintenance, etc.)	31	56
Knowledge about the importance of climate information	81	56
2. Changes in farming practices		
Agricultural practices (use of improved seeds, row planting, compost application, fertilizers use, etc.)	81	44
Practicing on-farm assisted natural regeneration of trees (associated with anti-erosion structures)	75	11
Use of climate and weather information	86	33
Poultry husbandry	31	56
3. Organizational and partnerships changes		
Changes in relationships among farmers	94	44
Changes in in-community collaboration (exchange of information, services and goods)	63	22
4. Access to productive resources (on-farm trees, etc.)		
Access to on-farm and to medicinal trees	13	0
5. Change in food security		
Diversification of diets and early harvesting from early maturing crops	19	44
Total pilot sample size	16	9

On gender and social inclusion

It is clear that men, women, youth and migrants have varying abilities to adapt to climate shocks and longer-term climate change because of differentiated access to entitlements, assets, and decision-making (Bayala et al., 2016). In Daga-Birame CSV, women have always been involved in the CSV process; from the identification of constraints and opportunities during the first meeting that gathered 76 agro-pastoralists including 39 women. Women farmers were also involved in the participatory testing of CSA technologies and practices, especially for the tree cultivar demonstrations and garden vegetable production, which was mainly entrusted to women's groups. Emphasis has also been placed on interventions that are likely to be more beneficial to women, including finance management and accounting, composting for gardening production, and processing of NTFPs notably baobab fruits. Climate information services are shared through the innovation platform, where women's membership is higher than that of men. Locally established institutions have kept the momentum on the gender focus, with the IP made of 110 women out of 194 members, 35 women out of 92 members in the EIG, 4 women out of 11 members of the ESPIV monitoring committee, 47 women out of 59 members of the committee for NTFPs promotion. All capacity building activities in the framework of the CSV (e.g. tree

grafting and planting techniques, crop residues treatment with urea, etc.) have involved about 50% women participants.

3.4 Pathways for scaling up

Using successfully tested results and outputs from the CSV approach to influence major next users has been the primary pathway to scaling up and out. To this end, a number of linkages with agricultural development projects and programs has been initiated at the early stage of the CCAFS intervention in Senegal in order to mainstream and disseminate lessons to large numbers of beneficiaries.

- The best success to date from the Kaffrine CSV site relates to the use of downscaled climate information services to informing farm management decision making (through the pluri-disciplinary working groups (GTPs), the community rural radios and the mobile phone text messages). As of today in Senegal, ANACIM has strengthened the capacity of 82 rural community radio stations across the 14 administrative regions to develop special broadcast programs on CIS in local languages, and together with SMS transmitted through mobile phones, allowed to potentially reaching 740,000 rural households across Senegal. Climate information in Senegal is now considered an agricultural input just like seeds, fertilizers and equipment, which are at the basis of production (CCAFS 2015).

- In the framework of the dissemination initiatives of the national science-policy dialogue platform (see science-policy dialogue platform), research results and experiences from the CSV site are regularly shared by ISRA scientists and used to illustrate and demonstrate how effective various CSA technologies and practices could be. These results are also used when the platform analyses how CSA is mainstreamed into national development plans (e.g. the Accelerated Program for Agriculture in Senegal). Overall, the national science-policy is seen as the government's commitment to foster a multi-sectoral approach that will enable actionable CSA initiatives in the country (CIAT-BFS-USAID, 2016). The platform recently organized a high level event to discuss on the roles expected from policy makers in order to mainstream CSA into national plans and strategies (see High level event-decision makers). USAID/CINSERE project: Based on the above successful achievements of CCAFS and partners in Senegal (ANACIM, ISRA), and as a follow up to the request expressed by Senegalese stakeholders, the USAID-Senegal office has decided to finance an activity that focuses on the scaling of climate information services in order to increase the resilience and productivity of the Feed the Future projects beneficiaries. With a total budget of 3.5 million US$ over 3 years (2016-2019), this project aims to strengthen the capacity of ANACIM and other structures implementing the Feed the Future projects, to succeed in developing and communicating tailored and salient CIS in support of farms', fisheries' and pastoralists' communities, both women and men, in their management decision making for increased resilience and productivity (see: CINSERE-Senegal project).

- A project proposal of 10 million US dollars aiming to scale up the Daga-Birame CSV model across Senegal has been developed by ISRA in partnership with ANACIM, ASPRODEB and ANCAR, and submitted to the Green Climate Funds. The project expects to set up 100 CSVs and to impact about 1 million people from 63 districts.

- South-South scaling up: The experience from the Kaffrine CSV site has even informed CIS strategy in Latin America. Based on the successful pilot South-South exchange between Colombian and Honduran farmers with the Senegalese actors was organized in 2013 for the Latin American partners to learn from the farmers in Senegal (see: South-South learning outcome or UNEP south-south cooperation case). As a result, Latin American farmers and service providers gained new skills and knowledge of how to incorporate climate and site-specific information into their planning systems and strategies. In Colombia, 154,000 farmers are now receiving agro-climatic advisories, and an additional 6,000 have adopted

climate-smart practices. In the medium-term, the project is expected to reach 1,500,000 farmers.

4. Gaps and challenges

The CSV process has shown good progress towards an integrated model where the various components are iteratively feeding each other to help the community achieve its vision. In addition, the initial scaling up activities have shown much promise. However, some challenges need to be tackled soon to strengthen the institutional framework that regulates the functioning of the CSV:

- Though formally registered through the Economic Interest Group, the IP does not have a validated reference document on rules and regulations that could guide its proper operation. This also includes how to manage the benefits and incomes generated from the CSV activities as well as the mode of remuneration of individuals working for the IP.
- The text message sharing CIS through mobile phones are in French and not often understandable to most people in the village. An alternative could be to design voice messages in local language.
- It is clear that the community is mostly interested in agro-sylvo-pastoral production systems that deliver cash incomes. However, their capacity to design and implement business-led activities is weak. The PICSA trainings have revealed strong capacity building needs on agro-business development for small scale farmers. This also concerns their ability to develop bankable projects that would generate financial resources in support to their local development plan.

On the research front the CSV approach deals with complex systems, requiring significant data collection to analyse synergies and trade-offs. The research teams have endeavored to set up simplified action research protocols that allow easy understanding by farmers of the research activities while also allowing to collect the minimum set of data needed for generating scientific evidence. However:

- The participatory nature of most research trials makes it challenging to collect data that has statistical rigour.
- Also challenging is the multiple interactions amongst variables in the CSV production systems (which in West Africa involve numerous crops/livestock in mixed farming systems) and their linkage with climatic variables. Because CSA interventions span across various disciplines and require understanding of synergies and trade-offs over time, the challenge remains to monitor and evaluate CSA, taking into consideration the complexity of food production systems and the uncertainty of climate change.
- One option to deal with the complexity is system dynamic modeling that can simulate the behaviour of the system and understand the impact of current interventions as well as the effectiveness of these interventions against future climate change shocks, population growth, and policy change. The system dynamic modeling could allow analysing conditions that trigger CSA, and how to support inclusive business-oriented development through associated technologies and digital agriculture.
- For effective scaling-up, M&E systems need to be strengthened to allow understanding of: (i) how interventions impact other inter-dependent domains - economic, social, and environmental - within a system (ii) what are the key feedback mechanisms and their synergies and trade-offs (iii) which paths and interventions should we focus on now to tackle climate change impacts in the future (iv) how interventions change the food production system and its elements and determine intervention opportunities in the future, and (v) whether the scale of current climate-smart practices at village level is able to meet the demands of a growing population and resist future climate change shocks.

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