Norad

CLIMATE-SMART AGRICULTURE

THE ROLE OF NORWEGIAN DEVELOPMENT ASSISTANCE

REPORT 2022

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Acronyms & abbreviations

AWD	Alternate Wetting and Drying
CCAFS	Climate Change, Agriculture and Food Security
CIP	Crop-Intensification Programme
COMESA	Common Market for Eastern and Southern Africa
CSA	Climate-Smart Agriculture
CSI	Climate-Smart Initiative
DTMA	Drought-Tolerant Maize for Africa
EAC	East African Community
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization
CGIAR	Consultative Group on International Agricultural Research
GHG	Greenhouse Gas Emissions
GCDT	Global Crop Diversity Trust
HABP	Household Asset Building Programme
ICTs	Information and Communication Technologies
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
MAFFA	Malawi Farmer-to-Farmer Agro-ecology
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NICFI	Norway's International Climate and Finance Initiative
ODA	Official Development Assistance
OECD-DAC	Development Assistance Committee of the Organisation for Economic Co-operation and Development
PSNP	Productive Safety Net Programme
SADC	Southern African Development Community
SDG	Sustainable Development Goal
SLM	Sustainable Land Management
USAID	United States Agency for International Development
VCRMC	Village Climate-Risk Management Committee
WCIS	Weather Climate Information Services
WALA	Wellness and Agriculture for Life Advancement

Executive summary

Climate change, food security and food systems are crucial and closely interlinked concepts, which have gained considerable attention, especially in the context of developing and foreign aid, given the global efforts to achieve the sustainable development goals (SDGs) by 2030, in accordance with the Paris Agreement.

Climate change affects every aspect of food security, particularly in the developing world, as the former interacts with other social, economic, demographic and institutional changes, by producing non-linear outcomes (Sanga et al., 2021). Agriculture is at the heart of sustainable development (Chiriac et al., 2020): in Asia and SSA it contributes up to 15% of the GDP, and over 50% of employment in SSA regions (based on the 2019 World Development Indicators). Small-scale farmers are estimated to provide nearly 80% of the food produced in these regions, but they also tend to be more vulnerable to climate change and less able to cope with exogenous shock, such as pandemics (Chiriac et al., 2020).

An integrated approach that has been proposed as a feasible solution is '*climate-smart agriculture*' (CSA), which is based on three pillars: 1) sustainably increasing agricultural productivity and incomes, 2) adapting and building resilience to climate change, and 3) reducing and/or removing greenhouse gas emissions.[1] This integrated and multifaceted context-dependent approach (Van Noordwijk et al., 2018), if efficiently designed and implemented, should lead to sustainable development and higher food security.

It can be argued that any attempt to accommodate climate change inherently involves a **trade-off** with the goal of providing better economic and welfare outcomes in developing countries. This is, however, not necessarily true, as many interventions in the food, agriculture and land use sectors have also proven to create some synergies between these three pillars (FAO, 2009, 2010, 2013; Lipper et al., 2014; Asrat and Simane, 2017).

The interdependence between food security, poverty and climate change should not be considered separately (Synnevag and Lambrou, 2012), and this report has a twofold purpose. The first is to provide an *overview of climate-smart agriculture* (CSA) practices, possible synergies and trade-offs, the outcomes that have been assessed by the recent literature, the major challenges that may prevent its widespread uptake, and the potential that is inherent to the CSA practices. Secondly, with the aim of better understanding the role played by Norwegian foreign aid in promoting CSA in developing countries, we attempt to provide a *snapshot of funding flows for climate change-related measures in the CSA context* in the past decade, by focusing on bilateral assistance. The role of international funding is, indeed, crucial in order to address climate change in developing economies through CSA.[2]

[1] https://www.fao.org/climate-smart-agriculture/en/
[2] Dinesh et al., 2017; Weiler et al., 2018; Huang and Wang, 2018; Amadu et al., 2020

1. Introduction

Agriculture undoubtedly represents the most crucial source of livelihood in many poor countries and contributes immensely to their economy, by providing the main source of employment, by providing food and raw materials that serve as an input for the industrial sector, and by contributing to international trade and exports. In most cases, as in SSA regions, agriculture and rural development are closely interlinked, as the former relies on a rural base. However, this poses many challenges: current food systems are required to produce more and better, challenged by the unstoppable growth of the global population, combined with weak productivity in the agricultural sector, and not least the volatility of agricultural and food prices. Another important element that may have further complicated agriculture development over the years has been underinvestment within the sector, which would otherwise be required in order to speed up progress, and to increase R&D and productivity.

Despite these challenges, agriculture is considered to be at the heart of sustainable development (Chiriac et al., 2020), as it accounts for 70% of global freshwater withdrawals for economic activities, and for 90% of global freshwater consumption (FAO, 2020a).[3] It is also well-known as having an ambivalent role for the environment, by producing both positive (e.g. carbon sequestration) and negative environmental externalities (e.g. water pollution). Agri-food systems (including crops, livestock, fisheries, aquaculture, agro-forestry and forestry) account for one third of global anthropogenic GHG emissions (Crippa et al., 2021), but the sector is also considered to offer great potential for global climate goals (FAO, 2019a).

At the same time, climate change, which is often described as long-term shift in temperatures and weather patterns (increase in mean air temperature, sea-level rise, changes in rainfall patterns, etc.), deeply affects agriculture as well. Climate risk is also a threat to food and nutritional security, which is further aggravated by the projected increase in the global population (which is expected to increase by 1.3 times by 2050).[4] This would require a minimum of a 60% increase of current agricultural production to meet the higher demand (Bhattacharyya et al., 2020), together with a fairer global food redistribution and less food waste. Global warming, as a direct consequence of climate change, is expected to lead to substantial losses in tropical regions, and to a rapid decline of major staple crops. Covid-19 has further increased the vulnerability of rural communities in developing economies, further complicating and slowing down the plan for climate change adaptation. **Achieving food security, while also adapting to climate change and reducing greenhouse gas (GHG) emissions, is a matter of urgency on a global scale.** According to Dwyer et al. (2021), 72% of countries adopted at least one national-level adaptation planning instrument in 2020.

Despite the global scale of the problem, the direct consequences seem to produce heterogeneous effects and hit some specific groups of actors more severely (Makate, 2019). **Poor rural farmers** living in developing countries tend to be more exposed to climate change, and are undoubtedly the most **vulnerable** groups, as their livelihoods heavily rely on non-remunerative agricultural sectors and, more generally, on inefficient agri-food systems that have been severely affected by climate risk in recent decades. According to Weiler (2018), vulnerability refers to a twofold criterion: i) *physical* predisposition to climate risks, and ii) *adaptive capacity*. These elements play an important role in

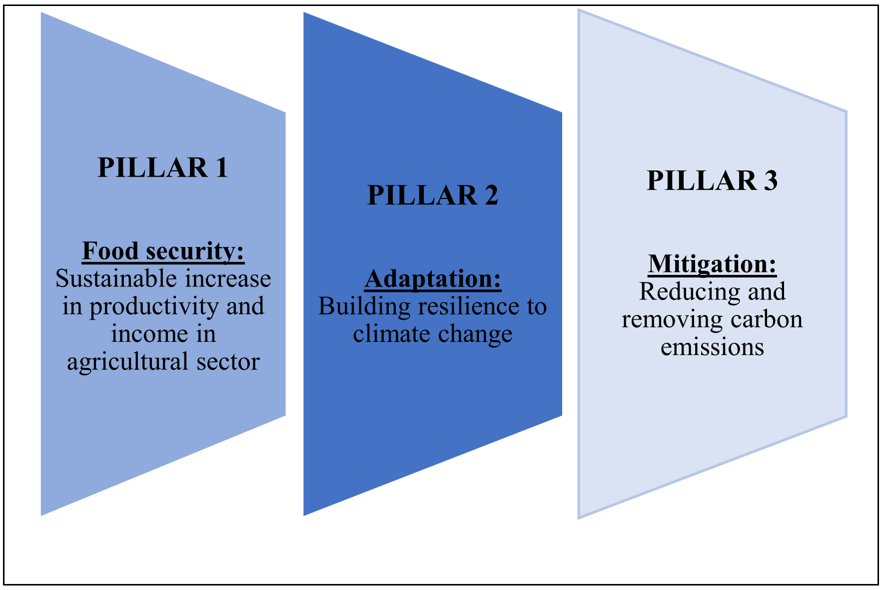
[3] https://www.oecd-ilibrary.org/agriculture-and-food/sustainable-agriculture/indicator-group/english_22c0adbc-en

[4] Food security includes four different dimensions: i) availability of food; ii) access to food; iii) stability of food; iv) food utilisation. See Sanga et al. (2021)

donors' decision-making concerning the allocation of development aid across poorer economies, with the physical vulnerability element often being predominant when dictating development aid decisions (Barrett, 2014; Weiler et al., 2018).

In this context, climate-smart agriculture (CSA) has been proposed as a useful approach to simultaneously increase food productivity, sustainability, resilience and food security. CSA was first coined in 2009 and is described as "an integrated approach for developing technical, policy, and investment conditions to achieve sustainable agricultural development for food security under climate change" (FAO, 2013). It has also been defined as a multifaceted approach "for transforming and reorienting agricultural development under the new realities of climate change" (Mango et al., 2018). This dynamic approach relies on *three pillars*, as shown in Figure1 below:

Figure 1: The three pillars of the CSA approach



An important aspect to be considered is the ***context-dependence*** of CSA practices, and their great **variability** at **national, regional** and **local level.** In other words, **one size does not fit all**. In a global context, for example, the focus in South Asia has been primarily devoted to scaling up CSVs (Climate Smart Villages) and renewable energy, whilst in East and West Africa there has been more emphasis on increasing the resilience of smallholder farmers (Dinesh et al., 2017). Failing to understand this important aspect might create further frictions to the widespreading of CSA interventions. Despite its great potential, different types of barriers exist, which translate into a low CSA uptake rate, and with some farmers selectively picking a subset of CSA technologies (Lemos et al., 2016; Lungu, 2019).

For a climate-smart agriculture approach to be effective and successful, it is crucial to: i) generate knowledge and awareness of CSA among farmers, ii) promote the use of climate information services, iii) increase climate-smart technology diffusion (Zougmoré et al., 2021), and iv) promote a science-policy interface. With regard to the latter, many initiatives in developing countries have been taken, (Zougmoré et al., 2021), such as the African-Union-NEPAD Agriculture Climate Change Programme, involving 25 million farm households, with the goal of adopting CSA by 2025. COMESA, SADC and EAC all collaborated on a project aimed at promoting the adoption of conservation agriculture, investing in CSA programmes, and reducing emissions from deforestation and degradation. The overall final goal aimed to improve food security and welfare for at least 1.2 million small-scale farmers during the period

2013-2017. Similarly, ECOWAS has promoted a smart-agricultural programme supporting climate change and agro-ecology transition in West Africa. This covers 15 economies, and aims to reach 25 million households by 2025. This involves i) the implementation of best practices via public policies, and ii) the provision of training to farmers, producers and NGOs.

This report consists of seven chapters: Chapter 1 is the introduction, Chapter 2 provides an overview of the different CSA tools, and also discusses possible synergies and trade-offs, providing a more comprehensive overview, and Chapter 3 reviews the most recent and updated literature on the determinants and the effects of CSA interventions in different countries and areas. Chapter 4 discusses the barriers and the major challenges that still need to be overcome. Chapter 5 focuses on the role of foreign aid in support of CSA, and, most specifically, on what Norway has done so far with regard to CSA finance. A descriptive analysis of Norwegian finance flows will be presented, with the aim of identifying trends and patterns over time, across sectors and regions. An important consideration to bear in mind is that the analysis is confined to bilateral assistance only, even though we acknowledge that multilateral agreements play a large part in development assistance, and with regard to sustainable agriculture and climate change mitigation and adaptation efforts.. Therefore, the results are conservative and provide a partial figure of the Norwegian CSA finance that is channelled to recipient countries. Chapter 6 discusses some additional important elements that could contribute to unleashing the potential of CSA practices. This is followed by conclusions and open questions.

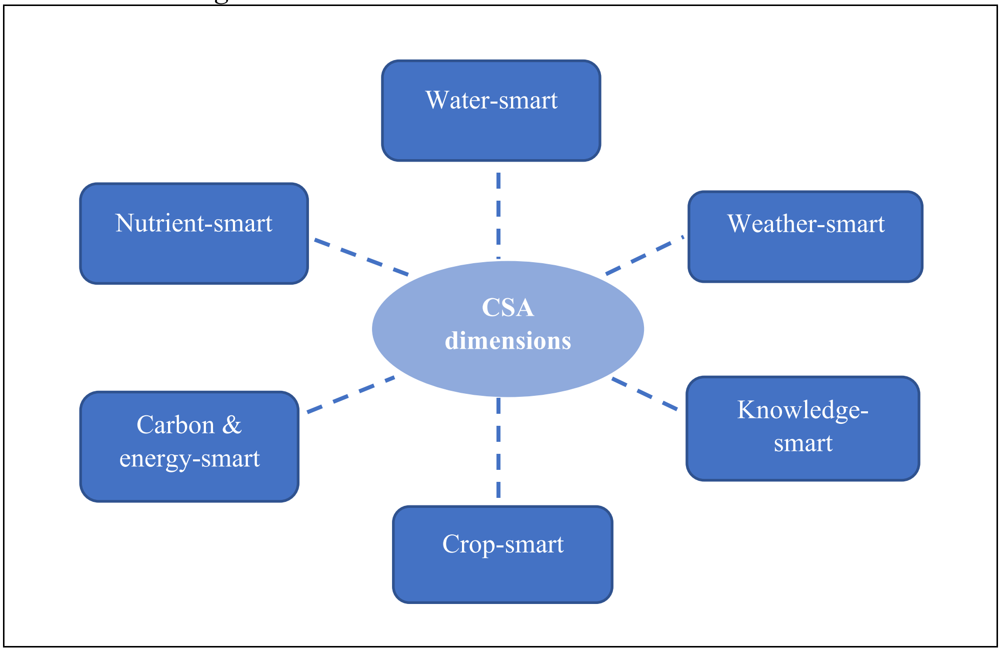
2. Overview of CSA tools and practices

Several practices and interventions have been implemented in the context of CSA in different areas and regions. In this section, we present an overview of the most common CSA practices and the characteristics that differentiate them, which may contribute to their large-scale diffusion or, conversely, to their low adoption rate. Flexibility appears to be the key in order to make CSA practices successful: farmers in different regions and territories might prioritise different CSA technologies and interventions (FAO 2021), and "**factors that may act as enablers in one context can also function as barriers in another context**" (Sanga et al., 2021). It has also been observed that there is a higher rate of success for those projects aimed at adopting a combined set of CSA practices, rather than a single practice implementation.[5]

The spectrum of the dimensions involved in CSA practices is very broad, and they are all interrelated and interconnected (Bhattacharyya et al., 2020): they can be categorised as *water-smart* (e.g. system of rice intensification), *weather-smart* (agro-advisory services and robust weather forecasting), *crop-smart, nutrient-smart, energy-smart* and *carbon-smart* (adoption of zero tillage), or *knowledge-smart*. The latter mainly refers to the ICTs (information and communication technologies), gender equality, and training and awareness campaigns to increase capacity-building.

[5] Kangogo et al., 2021

Figure 2: Overview of the different CSA dimensions



Source: Author's elaboration based on Bhattacharyya et al., 2020.

2.1. Technology intensity

One of the features that differentiate these practices lies in the degree/intensity of the **technology adopted**. Technology may, indeed, have the merit to strengthen data capacity and develop demand-driven applications in target countries, even though this might come at the price of higher upfront economic costs. Some of these systems may rely on innovative technologies, such as the WaPOR tool that exploits remotely sensed data to monitor water productivity in Africa in order to improve water management (Zougmoré et al. 2021), or the GreenSeeker measure implemented in Mexico and India, which is a precision nutrient-management technology aimed at increasing productivity and mitigation, and enabling farmers to make better informed decisions (Bhattacharyya et al., 2020).

On the other hand, some CSA practices have long been known and applied by the rural and indigenous communities (such as crop rotation).[6] When it comes to agricultural technology adoption, there are conceptual similarities with the **climate change adaptation methods** (Asrat and Simane, 2017), as both are based on the perceived utility maximisation of the farmers: they will be incentivised to adopt new technologies (including in the CSA context) if they expect a gain in their utility.

In a recent study, the farmer-level types of CSA practices were grouped into six categories, ranked from the most to the least likely for adoption:[7] 1) residue addition and retention, 2) non-woody plants, 3) assisted regeneration, 4) woody plants, 5) physical infrastructure, and 6) mixed measures. Woody plants and infrastructures are among the most rewarding practices, but they are also very costly. Therefore, **external support** in this case may play a crucial role, as it **would lower transactional costs**.

[6] www.fao.org/land-water/databases-and-software/wapor
[7] Amadu et al., 2020

Table 1: Overview of the major CSA practices, by dimension

CSA Dimension	Major Components
Weather-smart	• Real-time monitoring and reporting of weather parameters • Radio broadcasted weather forecasts • Weather-based crop agro-advisory (CA) services • Real-time weather-fluctuation-based crop insurance (CI) • Climate-awareness • Climate-smart housing for livestock
Water-smart	• Rainwater harvesting • Aquifer recharge • *In situ* moisture conservation • Efficient water (irrigation) application system • Drainage management • Integrated farming system
Crop-smart	• Abiotic stress cultivars • Improvement and adaptation of varieties having higher input use efficiencies • Mixed cropping • Intercropping • Legume-based crop diversification • Change of planting methods
Nutrient-smart	• Green manuring (GM) • Brown manuring (BM) • Site-specific integrated nutrient management (SINM) • Leaf colour chart (LCC)-based nitrogen application • Soil test-based nutrient management (SSNM) and soil health card-based nutrient management • GreenSeeker measure
Carbon & energy-smart	• Resource conservation technologies (RCTs) • Adoption of zero tillage • Conservation agriculture (CA) • Agro-forestry • Integrated pest management (IPM) • Reduction in the use of chemicals through IPM modules or nano-based delivery system
Knowledge & technology-smart	• Gender equality & self-help group (SHG) formation of women • ICTs • Micro-insurance • Capacity-building • Community-based seed and fodder bank • Participatory community • Nursery for rice • Village climate risk-management committee • Custom hiring centre for farm machinery • Leadership development • Adequate training

Source: Author's elaboration based on information retrieved by Bhattacharyya et al., 2020.

2.2. Targeted pillars: synergies and trade-offs

CSA practices may also differ in the combination of pillars they target, and therefore in the synergies they create. An example of a **triple objective CSA practice** can be found in **agro-forestry**, which is a land management system aimed at ensuring food security (improving productivity), providing system resilience and promoting mitigation, by reducing GHG emissions through carbon storage below and above the ground in the long-term (Amadu et al., 2020; Chiriac et al., 2020).[8] Other CSA practices target only two of the three pillars, such as the provision of climate forecasting services, which supports food security (through productivity) and adaptation, or the GreenSeeker technology, which targets food security and mitigation. Adaptation strategies that are effective in terms of sustainability and productivity enhancement (and are thereby positively linked to economic development) are likely to generate an overall improvement in welfare.[9]

Whilst some **synergies** are more likely to occur between CSA strategies targeting Pillars 1 (food security and productivity) and 2 (adaptation) (Weiler et al., 2018) – such as diversification, micro-insurance and integrated production systems – others might raise some internal conflicts among the pursued targets (FAO, 2009, 2010, 2013; Lipper et al., 2014). A trade-off may, indeed, exist between Pillar 1 (productivity/food security) and Pillar 3 (mitigation), even though some studies result in opposite findings (Khan, 2019; Masron and Subramaniam, 2019).

A two-way relationship between food security/productivity and mitigation is to be expected: food systems account for 21-37% of GHG emissions, and they are expected to increase by 2050 if food production continues as usual (FAO, 2021). At the same time, climate change is affecting the agricultural sector, making it more vulnerable and less productive. Indeed, "CSA strategies or practices that rely on intensification principles may involve potential **trade-offs** with long-term resilience of the production system when they rely on high-performing crop varieties or animal breeds that are more susceptible to environmental stress and change" (FAO, 2021). Technical adaptation options (irrigation) may, for instance, also involve some trade-offs with regard to the landscape scale. In these cases, compensation schemes could be introduced to limit and reduce this trade-off, but this would require equal access for all food producers. In a panel of 48 sub-Saharan countries between 2010 and 2016, Koçak et al. (2019) discovered the presence of a strong trade-off between climate mitigation (CO_2 emission reduction) and poverty. Nonetheless, they also identified a potential mitigator in the institutional environment (also confirmed by Rizk and Slimane (2018) in their analysis of a sub-sample of poor and less developed countries), suggesting that enhancing the policy framework and the institutional reform context could help in pursuing different and, in principle, potentially divergent goals at the same time. This implies that any attempt to achieve the three pillars would require the close cooperation and collaboration of both scientific communities and policy-makers.

2.3. The complexity of CSA practices

An additional element that allows for the differentiation of CSA practices is the type of activities involved and the **complexity** of the steps/phases required to accomplish the outcome. Some of the CSA

[8] Agro-forestry fertiliser trees (mainly Faidherbia trees) enhance soil fertility and, consequently, crop yields and the productivity (in terms of yields per acre). Similar results have been observed in other African countries and beyond the continent. Examples of an increase in crops due to these types of trees are linked to Ethiopia, Nigeria, Zambia and Malawi

[9] Lemos et al., (2016)

measures focus on single stages/activities, such as the production stage of the food system (examples of this include crops, landscapes, livestock, policies and services). There are, however, practices that embrace the whole **value chain**, meaning that they involve the whole range of value-adding activities that allow the transformation of raw agricultural output in the final product marketed to consumers, from use and water management, to post-production storage, distribution, and consumption (Dinesh et al., 2017; Chiriac et al., 2020). These activities mainly involve food production but are not limited to it, and may also involve low GHG emissions, improved agricultural production, improved supply chains, capacity building, R&D, technical assistance to policy makers, wellbeing and improved access to finance.

2.4. Short vs long-term view

One important element that may differentiate CSA practices is the timing of the investment return – whether it is expected to occur in the short or the long term. Smallholder farmers tend to adopt short-term SLM (sustainable land management) practices with a shorter turnover (such as mulching, cover cropping, composting and manuring) that yield results within a single planting season, rather than long-term practices (such as agro-forestry). The choice of one over the other could depend on the benefit-cost ratios or high upfront costs, but also on other cultural and socio-economic factors (land availability, risk preferences, social norms, etc.). Long-term CSA practices require knowledge-sharing and experience.

However, short and long-term CSA measures are not *a priori* mutually exclusive – on the contrary, they could be combined to achieve better outcomes (Kansanga et al., 2021). As economic benefits, in some cases, will only materialise many years after the CSA intervention, **long-term monitoring of costs and benefits is required** in order to conduct ex-post analysis and assessment, which represents a significant knowledge gap in this context.

2.5. Heterogeneity in adoption rates

The adoption rates of CSA practices can be quite heterogeneous, and it may be important to understand which types of CSA practices are more likely to be adopted under different circumstances, such as in the context of aid funding (Amadu et al., 2020). Not many works have studied the most adopted CSA practices, and the few that are available have focused on country case studies. According to Asrat and Simane (2017), the most successful and most adopted practices in some rural communities in **North-West Ethiopia** were soil and water management, adjusting planting date, use of manure, crop rotation, intercropping and use of irrigation. Rainfed agriculture is, indeed, considerably more vulnerable than irrigated agriculture (FAO, 2021,b) and rural farmers' preferences for water management practices do not come across as surprising.

Ouedraogo et al. (2018) provide an overview of the ten most adopted CSA practices in three different countries: Ghana, Mali and Niger. In **Ghana**, the following practices were involved, from the highest to the lowest rank of adoption: intercropping, crop rotation, compost manure, early sowing, agro-forestry/tree planting, use of climate information, contour farming, minimum tilling, late sowing, and monoculture. In **Mali,** the top three practices were (in descending order) farm mechanisation, new crop, and compost manure, followed by monoculture, crop association, farmed managed natural regeneration, crop rotation, micro-dosing, improved variety, and use of climate information. Similarly, the most adopted CSA practice in **Niger** was crop association, followed by compost manure, farmer managed natural regeneration, mulching, early sowing, improved variety, new crop, monoculture, agro-forestry, and then zai.

The GRAD project is funded by the 'Feed the Future Programme' of the USAID (United States Agency for International Development). Its aim is to improve food security in rural communities in **Ethiopia**. It covers 16 *woredas* (districts) across four regions. According to intermediate evaluation reports, there was an increase by 9% from the previous year with regard to the adoption of at least two practices, and 96% adapted to at least one of them (Adem et al., 2017). The main adopted CSA practices were early maturing crop varieties, moisture conserving practices, and drought tolerant crop types and varieties. The measures that were either not adopted or less adopted demanded a higher level of sophistication and technical background, such as crop insurance, rope and washer pumps.

Although some CSA practices are common and widely adopted across these countries, it is also interesting to note the heterogeneity and the adoption of different tools, which points to the **context-specific** feature of the CSA (Zougmoré et al., 2021). On this note, the uptake of some CSA practices remains quite low, especially in **SSA regions**: agriculture insurance is one example of this, despite the huge need for it (USD 8-15 million in premium value according to the report of the ISF & Syngenta Foundation, 2018).[10] International finance has also lacked initiative in this respect, with a few exceptions (Huang, J. & Wang, Y., 2018). In Chapter 5 we will discuss more thoroughly the presence of barriers and the major challenges that may impede a high uptake rate of some CSA tools.

3. Determinants and outcomes of the CSA approach

To better understand the ways in which CSA works in practice and how to speed up its adoption across the most vulnerable countries, it is important to identify the determinants of climate-smart agriculture (CSA). Indeed, as already mentioned, **CSA interventions are required to be site-specific, transformative and flexible, in order to be more easily adapted to different contexts and scenarios**. More importantly, **CSA is not an externally driven concept.** Despite this heterogeneity, however, it is also crucial to understand whether some common determinants and factors exist, which might, to some extent, explain and generalise the success or the failure of the CSA practices across the most vulnerable areas and communities.

In this chapter, a review of the most recent literature on CSA practices is presented, with the aim of **systematising** the results available so far concerning the **major determinants** of CSA adoption and the **ex-post quantitative and qualitative evaluation** of the CSA interventions. Some of these works refer to CSA interventions that have been financed directly by local governments in the most vulnerable areas, whilst others were funded by foreign aid. The bulk of the literature on CSA, despite being relatively recent, is already quite wide and substantial.[11] Most of the works reviewed in this section refer to different contexts, local communities and countries. On the one hand, some of the results, with regard to the major determinants of CSA adoption and ex-post evaluations, are systematically confirmed in the literature; on the other hand, some findings are somehow antithetic, and more research should be devoted in order to explore this. A common feature of both qualitative and quantitative studies on CSA is the relatively small sample size and the short-term view on which the analyses rely, as many of the studies focus on small samples of local rural communities.[12]

[10] https://www.raflearning.org/sites/default/files/ sep_2018_isf_syngneta_insurance_report_final.pdf?token=1i4u5GwD

[11] "The focus of literature research on 'climate-smart' agriculture identified mostly studies in the crop and livestock sectors, few studies on forestry and integrated farming systems, and none in the fisheries and aquaculture sectors." (FAO, 2021)

[12] In identifying the determinants of adoption, most of the reviewed quantitative reports implement non-linear models, such as recursive bivariate probit regression/ binary logistic model of adoption

3.1. The determinants of CSA adoption

i. Socio-economic, demographic and geographic factors

A diverse and multifaceted set of factors – *socio-demographic*, *economic*, *institutional*, *behavioural*, and *geographic* – play an important role in explaining CSA adoption among rural communities of farmers (see Figure 3). These can be considered as those *inputs* that are needed for a successful CSA approach. Plenty of studies have identified the major factors that are likely to affect the decision to adopt and keep in place the CSA interventions, shedding light on the type of relationship in different contexts, countries, scales and time horizons, where the aim is "to arrive at solutions tailored to the local context" (Dines et al., 2015, p.10).

According to the study of Lungu et al. (2019) in **Northern Zambia**, socio-demographics and economic variables, such as age, income, family size and gender, are statistically significant when linked to technological adoption decisions in the context of CSA (i.e. crop rotation practice), jointly with geographic (location), human and social capital (group formation) characteristics, such as the wealth status of the heads of households, farmers' awareness of climate change, off-farm income, location, and crops grown. Indeed, the larger the households' size, the income (Marenya et al. 2007) and the awareness of climate change, the higher the probability of adopting labour-intensive CSA technologies. The older the household's head, taken as proxy of experience, the higher the adoption rate (as younger farmers might be more financially constrained). Similarly, Ouedraogo et al. (2018) empirically investigated the determinants of CSA practices in **Mali**, finding that those positively linked to CSA farming adoption are: education, technical training, number of workers in the household, access to subsidies, use of animal traction, and training on how to use climate information.

Figure 3: Overview of the CSA major determinants

CSA Determinants			
Socio-demographic /Economic	Geographic	Behavioural	Institutional
Age Gender Education Income Wealth Family size Technical training Livestock ownership Land ownership/access ….	Location Plot size Distance to markets Temperature /drought rate % Plot with steep slope % Semi-fertile plots and infertile plots ……	Risk preferences Entrepreneurial orientation Cognitive traits Awareness of climate change Social capital Perceived soil fertility …..	Provision of credit Provision of fertilizer subsidies Provision of technical training Land-use policy …..

Source: Author's elaboration based on the literature review.

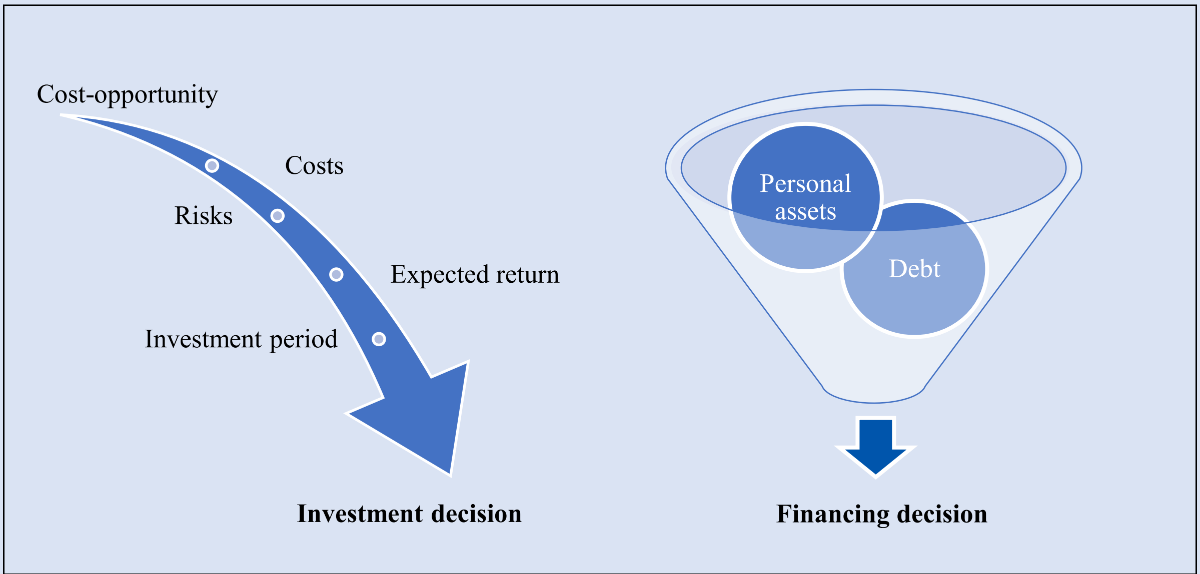
BOX 1 – The economic decision process of CSA adoption

To better understand the economic process behind the farmers' decision to invest in and profit from CSA practices, Figure A1 illustrates and simplifies the main phases and elements that must be considered as part of this process.

When it comes to **investment** decisions, farmers need to: i) screen the available alternatives and identify the *cost-opportunity* of investing in CSA; ii) identify the *costs* involved, which may be monetary (e.g. by acquiring new tools and technical equipment), but also those costs relative to the time spent in gathering information and understanding the potential and the implications of CSA; iii) identify and assess the potential *risks* related to CSA projects (closely linked to the risk profile of the farmer, who might be a 'risk lover' or 'risk averse'); iv) evaluate the expected (net) *return of investment* that would maximise the farmer's utility and minimise the costs; v) identify the *investment period* (short vs long-term planning). Farmers also need to account for possible mismatches in the time-profile between costs and future revenues: very often, upfront costs might be high, whilst revenues might materialise over a longer period. Therefore, they need to determine the present value of the future cash-flows from the investment, to ensure they are worth more than the capital outlay needed to fund the initial project.

As for the **financing** decision, smallholder farmers in poor rural contexts are subject to very strict budgetary and credit constraints, which limit their financing decision, as they might not be able to rely on personal assets (earnings, savings, wealth, financial assets) nor on family networks (informal mechanism). In addition, most of the times they are unbanked, which translates into their financial exclusion from credit markets and standard borrowing lines. Even when they manage to access credit, they might not be able to be granted the necessary amount of resources they would need for their investments, and the cost of borrowing is likely to be very expensive, translating into high interest rates, thereby also affecting the farmers' discounting process.

Figure A1: The CSA adoption as an economic decision process



Asrat and Simane (2017) focus on rural communities in **Ethiopia**, where agriculture still represents the main livelihood. The authors find a positive correlation between the CSA adoption and a diverse set of variables, mostly socio-demographic, economic and geographic – namely, the household size, gender (with the male household heads more likely to adopt), education and farmer's experience (age), livestock ownership, extension advice received, temperature and drought rate, proportion of plot with steep slope, and the percentage of semi-fertile plots and infertile plots. In a previous work focusing on a sample of rural farmers in Ethiopia, Adimassu et al. (2016) provided an analysis of the CSA determinants both at household and plot level. As for the former, the authors confirmed the positive effect of the farmers' family size, especially for those CSA practices that are more labour-intensive and employ many family members. The correlation between livestock holding and CSA adoption is often inconsistent or negative, as many households rely on this for their livelihood and are less willing to invest in CSA practices, considering them substitutes rather than complements. Other factors that are positively associated with investment in CSA practices are the households' investment propensity/capacity, and the higher (perceived) profitability of technology, whilst the presence of off-farm income is negatively associated with farmers' land management investment. Climate (perceived) risk and the risk of losing the property may also affect farmers' decisions concerning investing in CSA. As for the plot-level studies, findings suggest that farmers are more willing to invest in physical CSA practices if their plots have higher slopes, which translates into a higher risk of erosion, and they are thereby more exposed to risky/catastrophic climate events.

Based on survey data of 808 households in **Southern Malawi** over the period 2012-2014, Amadu et al. (2020) confirm the positive relationship between the CSA adoption rate and the age of the household's head, social capital (group membership), the gender of extension workers, the intra-household receipt of extension services, the self-reported number of extension visits, land ownership, institutional support (in the form of fertiliser subsidies), and the perception of soil fertility. The factors that are, instead, negatively related to the CSA adoption rate include gender (presence of female household heads), household head's opinion about extension advice, opinion about extension service quality, and receipt of food aid. A more recent quantitative study (Kansanga et al., 2021) was conducted on a sample of 512 farming households in 2019, attempting to identify the determinants of sustainable land management practices (agro-ecology and CSA) in Malawi, both in the short and long-term. This was performed in the context of the MAFFA project (Malawi Farmer-to-Farmer Agro-ecology), which involves a very broad set of partners, and it is funded by Global Affairs Canada and the Canadian Food Grains Bank. The project promoted farmer-to-farmer knowledge-sharing and training in order to spread awareness and skills development among smallholder farmers. Its focus was specifically to target the poor smallholder farmers and make them use the locally available resources as inputs. Results suggest that farm size and agricultural information-sharing are statistically significant factors that concur in the adoption of both short and long-term practices.[13] Age, gender (females are less likely to adopt due to gender social norms) and having a chronically sick person in the family were all factors that negatively affected the likelihood of adopting both short and long-term CSA practices.[14] Conversely, active household labour size, education, household wealth, plot size, food security, and the independence of women in the households increased these odds. Similarly, land access dynamics play a major role in adopting both short and long-term CSA, as does income: poor smallholder farmers might prefer to adapt to short-term CSA practices only, whilst the richest ones might have the capacity to also invest in long-term CSA practices.

[13] Farmers who shared the information were 2.09 times more likely to adopt CSA practices than those not sharing the information

[14] The ones without sick people in the family were over 3 times more likely to adopt both short and long-term CSA practices

Zambia, **Malawi** and **Mozambique**, also known as the *'Chinyanja Triangle'*, were the focus of a study by Mango et al. (2018), who investigated the role of small-scale irrigation among independent farmers, as a CSA practice, and the determinants of adoption. Despite the abundance of water resources, irrigation agriculture contributes to less than 10% of produce, and the principal reason is to find in the unexpected weather. Their findings suggest that "off-farm employment, access to irrigation equipment, access to reliable water sources and awareness of water conservation practices, such as rainwater harvesting, have a positive significant influence on the adoption of small-scale irrigation farming. On the other hand, the farmer's age, distance travelled to the nearest market and nature of employment negatively influence the adoption of small-scale irrigation farming decisions" (Mango et al., 2018, p.1) They do not, however, find any statistically significant evidence for some variables, such as gender, household size, education, extension, casual labour, skilled labour, credit access and cultivated land size.

Additional success factors in CSA adoption have been found in the outreach and the extension support (including the inclusion of indigenous knowledge support), which creates an interactive format, along with the inclusion of the key stakeholders from the very early stage of the project.[15]

Some of these determinants have, at times, returned inconclusive results across studies, and there may be ambivalent economic theories capable of explaining both types of findings (Adimassu et al., 2016). The variable '*age*', a proxy for the farmers' experience, is one of them. Although in some works it has been found to be positively associated with the adoption rate (as older farmers are more experienced and more willing to adopt CSA and SLM practices), there is some empirical evidence that has pointed towards a negative relationship (the older the farmer, the less the CSA adoption rate), such as in the analysis of Danso-Abbeam et al. (2017) regarding improved maize variety in **Northern Ghana**, or non-statistically significant results in rural communities in **Nigeria** (Apata, 2011). This aligns with the narrative of a higher propensity of young farmers to adopt CSA, given their risk-time preferences and their longer planning/investment horizon.

Education is another example that may, in principle, lead to ambivalent results in empirical studies: as illiteracy decreases, a better ability to process technical information and a higher climate change awareness are expected, which may translate into a prompt response via higher CSA adoption rates and investments (most studies confirm this). However, more highly educated farmers could be more reluctant to invest in CSA practices, given the lack of the prospect of gaining returns in the short-term, high upfront costs, and the higher cost-opportunity they face, as they can rely on more exit-options outside the agricultural sector.

Finally, *land holdings* could be positively associated with CSA practices, via the interaction with the households' wealth. At the same time, however, it is not possible to rule out the presence of a negative correlation, as farmers may not care about land degradation when they can rely on more extensive lands and, consequently, may reduce the CSA investments.

ii. **Weather climate information-sharing**

Awareness and information-sharing concerning climate change and weather-related information contributes greatly to the adoption of CSA, and <u>radio</u> has played an important role in this. **Senegal** provided a perfect example of how both the coordination and the cooperation of scientists, national meteorological agencies and rural-community based radio stations has, since 2011, succeeded in

[15] Dinesh et al., 2015

promoting economic development through information-sharing and seasonal forecasting (Zougmoré et al., 2021). The number of rural dwellers reached throughout the country was nearly 7.5 million. The WCIS (Weather Climate Information Services) was used as a CSA tool to build resilience among rural farmers and to improve their decision-making by means of more efficient risk management (Diouf et al. 2020). Similar conclusions apply in the case of **Somalia** (FAO, 2021), where radio was part of the strategy to spread CSA's adoption among female farmers. Information is vital and can be a valid compass for decision-making in order to navigate uncertainty and volatility. Farmers in **Ghana** have shown a high degree of willingness to pay in exchange for climate service information (CSI), such as seasonal climate forecasts, agro-advisory services, etc. (Ouédraogo et al., 2018).

iii. **Behavioural factors**

Entrepreneurship has been proven to be positively associated with farm performance, both in terms of income and technology adoption (Etriya et al., 2019). A new strand of literature has recently emerged, which aims at investigating whether farmers' **cognitive traits** and **entrepreneurial orientation** may exert an influence on CSA adoption. Previous works have confirmed the role of entrepreneurship in enabling farmers to better adapt to environmental challenges (De Rosa et al., 2019; Pindado et al., 2018).

Kangogo et al. (2021) highlight the lack of entrepreneurial orientation as a possible reason for the low uptake rate of CSA practices in SSA regions. The profile of an entrepreneur requires a set of features that could dictate the choice of whether or not to adopt the CSA approach. **Risk-taking** is positively associated with CSA practices that are skilled-labour-intensive and require a substantial amount of financial resources. **Proactiveness** is found to be positively associated with the adoption of finance-intensive practices, but negatively associated with unskilled-labour-intensive practices. Finally, **innovativeness** is negatively correlated with expensive CSA interventions.

iv. Foreign aid as a successful driver of CSA?

The role of foreign aid may contribute greatly to the design and implementation of CSA practices. According to Huang and Wang (2018), the two main areas where foreign aid has worked efficiently in the context of climate change and sustainable agriculture have been the **reductions** in both paddy field **methane emissions** and **CO2 soil emissions** such as soil carbon sequestration through land-use conversions. Two other major areas of intervention are crucial in adaptation to climate change and could be financed by international aid: **investment in community planning and management capacity**, and **subsidized agricultural insurance**.

The CSA adoption dynamics in **Southern Malawi** were investigated in the context of international aid funding, as part of the WALA programme sponsored by USAID (Amadu et al., 2020). The aim was to evaluate whether participation in externally funded CSA interventions could result in smallholder farmer adoption of more intensive CSA practices. If so, **receiving externally funded CSA could be a determinant for successful adoption**. The study aimed to identify which categories of farm-level CSA practices were more likely to be adopted as a direct result of the participation in the WALA aid-funded programme. The main goals of the project were: i) maternal and child health nutrition, ii) human and community development, and iii) community disaster risk-reduction. Participation in the CSA programme significantly increased the odds of adopting any CSA practices sponsored by the aid-funded WALA programme by 28%. Other significant factors included kinship networks, hired labour, and perceived soil fertility, which increased the probability of CSA adoption by 3%, 15%, and 10%, respectively.

3.2. Ex-post evaluation of CSA practices. What has been learnt so far?

Assessing the effectiveness of CSA interventions may help to identify the successful pathways and to correct the most inefficient ones. Whilst some works have applied quantitative (econometric) analysis, others are more qualitative in nature, relying, for example, on in-depth interviews.[16] The **ex-post evaluation** and assessment are sometimes difficult to conduct, given their context-specific nature, the lack of data, and/or the insufficient time-span (lack of follow-up) that prevents the assessment of the long-term effects of the intervention. In most cases, these effects refer to the specific context being studied, which does not automatically translate into more generalisable findings. Nevertheless, it is important to understand which effects these interventions have produced in vulnerable economies, either as a form of foreign aid or as a domestic government intervention. **CSA interventions can be effective, but their success depends on the context-specificity and design, along with the institutional capacity and the policy framework** (Dinesh et al., 2015).

The positive outcomes of CSA

One of the first multi-year and multi-country programmes was funded by the Rockefeller Foundation back in 1998, with the aim of supporting the research and technological transfers of drought-tolerant rice in Asia (**India**, **China and Thailand**). Based on the case study evaluation report, it is believed to have generated drought-tolerant varieties, associated with a rise in **food security** and **productivity**, and a contextual increase in both research and **technological capacity** in the targeted countries (Pray et al., 2011). Similarly, the DTMA (Drought Tolerant Maize for Africa) programme in **Africa**, which was sponsored by the Buffet Foundation, USAID and the UK Department for International Development, was a 10-year programme (2006-2016) aimed at increasing the resilience of farmers and the drought-tolerant maize. According to Huang and Wang (2018), local communities experienced a **surge** of **investment returns in science and technology**.

The Region of Visayas (**Philippines**) was affected by declining rice productivity and ineffective water management. In 2007, the National Irrigation Administration (NIA) initiated the BIIS action plan to improve the efficiency of water management, reduce methane emissions, increase rice productivity in Bohol, via the construction of a new dam and water-saving technology AWD (Alternate-Wetting and Drying). As a result, there has been an increase of 41% in crop-intensity reduction and in methane emissions, a decrease in water use, an increase in productivity, and an improvement in food security (Huang, J. & Wang, Y., 2018).

[16] As for the quantitative studies, some of them implement RCT (randomised control trials), recursive bivariate probit models, local average treatment effect (LATE) models, quantile regressions or instrumental variables techniques.

BOX 2 – Adaptive Capacity (AC): Generic vs Specific

Vulnerable rural households in developing countries must respond to climate change by relying on different type of assets that shape their adaptive capacity (**AC**). The AC needs to be built by taking into account not only *climate-related risk* (**specific capacity**) but also *structural deficits* (**generic capacity**), such as income, financial, human, social and technological determinants, and political resources, which might affect their overall level of vulnerability. Households that rely on both types of adaptive capacities are more resilient and better-off.

The building of adaptive capacity requires a **strengthening of people's ability to plan, monitor results** and changes, and identify the actions needed to **manage risks** and uncertainty in livelihoods (Dazé, 2014c).

One **case study** that has investigated this twofold adaptive capacity is the work of Lemos et al. (2016), which surveyed 476 households in 2012 (year of severe drought) in 6 *municipios* of the state of Ceara, one of the poorest regions located in a semi-arid region in **Brazil**. The authors categorised data into generic and specific capacities at the household level, and quantitatively analysed them in relation to food security (proxy for vulnerability in presence of drought).

- **Aim of the study**: To investigate how these two kinds of adaptive capacity (generic and specific) influence the overall vulnerability of subsistence rainfed agriculture households.
- **Sample**: 476 households in 6 *municipios* of the state of Ceara, Brazil in 2012. Four types of families used in the analysis: 1) households with no insurance and no irrigation, 2) households with irrigation only, 3) households with insurance only, and 4) households with insurance and irrigation.
- **Specific capacity**: Irrigation
- **Generic capacity**: Insurance
- **Findings**: Households with both insurance and irrigation, relying on both types of adaptive capacity, owned more pieces of farm equipment, used more pieces of agricultural technology, and were found to be better-off compared to the farmers relying on one type of AC only. In general, relatively wealthier households are associated with less-severe household-level risk outcomes. Risk management is income-sensitive (the richer are much better able to manage the risks related to climate shocks and food insecurity). Investment in generic capacity may be instrumental in providing households with the flexibility to manage and cope with climate volatility (specific capacity).

Source: Lemos, M. C., Lo, Y. J., Nelson, D. R., Eakin, H. & Bedran-Martins, A. M. (2016). Linking development to climate adaptation: Leveraging generic and specific capacities to reduce vulnerability to drought in NE Brazil. Global Environmental Change, 39, 170-179.

In **China**, a pilot experiment has been conducted with the aim of reducing the use of nitrogen (N) fertiliser through the provision of training programmes. Low-carbon agriculture can play a crucial role in reducing GHG emissions in both rice and maize production. The project was funded by the CCAP (Chinese Center for Chinese Agricultural Policy) and the IDRC (International Development Research Center). The experiment provided an intense half-day training session for the farmers, and preliminary evidence showed a significant and systematic difference (18%) in the use of fertilisers between the trial and non-trial participants. The field trial participants reduced their use of N fertilisers by up to 35%, with no difference in yields.

A comprehensive study by Dinesh et al. (2015) has attempted to assess the effectiveness of CSA interventions in 19 selected case studies, at different scales (local, regional and national). The focus was on the CCAFS portfolio (CGIAR Research Program on Climate Change, Agriculture and Food Security). The goals of the interventions were to reduce poverty, increase food security, and ensure sustainable management of natural resources. The results (based on both quantitative and qualitative assessments) highlight the positive impact in all 19 cases of CSA practices on Pillar 1 – namely, agricultural productivity and farmers' income. A tangible example of a successful CSA intervention, with respect to productivity and mitigation, was the use of the '**GreenSeeker'** (applied in Mexico and India), which had the aim of making farmers more informed about their decisions.[17] The overall effects in India were an increase in productivity (+10%), together with a consequent increase of income (+ USD 187/ha). GHG emissions decreased by 47% (Basak, 2016). Despite its high up-front cost, the GreenSeeker was successful because different contextual measures were implemented to favour its adoption (e.g. tax relief on purchase in Mexico, subsidy programmes, cost-sharing schemes, pay-per-use system). However, overall it remains more complex to quantitatively assess the impact in terms of adaptation (Pillar 2) and mitigation (Pillar 3), as no well-established metrics exist. Besides the direct effects, the CSA interventions also led to **spillover effects**, such as an increase in job opportunities and employment, the overall improvement of social, financial, human capital and health outcomes (the growth of new trees increased the supply of both medicinal leaves and nutritional fruits). Based on the evaluation report, thirteen of these studies appear to have provided, either directly or indirectly, some benefits to women and vulnerable groups, in terms of employment opportunities and a wider access to resources.

A significant **surge** in **productivity** and an **increase** in the **value of production** (+22%) were found for CSA users compared to non-CSA users in a sample of 734 survey farmers in **North-West Ethiopia**, over the period 2007-2015 (Asrat and Simane, 2017). **Higher yields** for both millet and rice crops (an average gain of 158 kg/ha and +140 kg/ha) and an **increase in food security** and **farm income** were experienced by the WCIS-users (Weather Climate Information Services) in a sample of 1,481 farmers in four regions of **Senegal** (Diouf et al. 2020).[18] Similarly, small-scale irrigation CSA practices have been found to increase food security of the CSA-adopter farmers and enhance their income via the productivity channel in **Zambia**, **Malawi and Mozambique** (Mango et al., 2018).[19]

Crop diversification, as part of a CSA strategy in rural **Uganda**, has been identified as a welfare-enhancing strategy that increases consumption and improves household diets. The poorest rural

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[17] This is a precision nutrient management technology aimed at increasing productivity and mitigation

[18] The additional farm income was $ +56 for men and $ +11 for women. This disproportionate benefit for male farmers is explained by the limited access of women "to productive resources such as land, credit, inputs, etc., which reduce[s] their capacity to quickly take appropriate decisions after the reception of SF. The low access to information is also a key constraint for women" (Diouf et al., 2020)

[19] See also Husain et al., 2004 and Tesfaye et al., 2008

households seem to benefit more, compared to the relatively richer ones. This practice also improves consumption-smoothing by reducing "households' reliance on less effective strategies such as informal insurance and involuntary diet changes as risk coping mechanisms" (Tesfaye and Tirivayi, 2020).[20]

The long-run CSA practice of agro-forestry has been evaluated in the context of maize yields (Amadu et al., 2020) as part of a WALA (Wellness and Agriculture for Life Advancement) project funded by the US Agency for International Development in **Southern Malawi** between 2009 and 2014. The project promoted a 'ridge-to-valley approach': it first implemented CSA practices to preserve community watersheds (apiculture), and then promoted individual farmers' CSA adoption at farm level to conserve soil fertility (agro-forestry fertiliser trees, check dams, continuous contour trenches, marker ridges, stone bunds, vetiver grass, water-absorption trenches). A consortium of NGOs was responsible for the implementation of the WALA project in this area. The results, based on 808 surveyed households across five districts, identify a positive and statistically significant effect on yield crops and on the intensity of **agro-forestry** fertiliser trees. Participants in the CSA programme under WALA who decided to adopt agro-forestry fertiliser trees experienced a 20% increase in the productivity of maize yields, and a 2% increase in the intensity of fertilisers.

Learning from the unsuccessful stories

To fully understand the pathways that lead to a successful implementation of CSA practices, it is also worth mentioning some cases that only **partly succeeded** or **failed** to efficiently reach the targets. It is, indeed, important to learn from past mistakes – acknowledging what hasn't worked along the way, and making adjustments accordingly.

Interventions may, at times, not contribute to a reduced vulnerability to climate change, but rather turn into episodes of '*maladaptation'* (Eriksen et al., 2021): some interventions may reinforce existing vulnerabilities, redistribute them, or even create new potential sources. An example of this can be found in poor intervention design, which may involve adaptation measures that support specific agricultural practices/livelihood changes that disproportionally benefit land-owners while penalising the land-poor. Examples of this kind are found in **Vietnam** (Chapman et al., 2016) and in **São Tomé and Principe**, where small-scale farmers were pushed into casual labour for large landowners (Mikulewicz, 2020a).

Clay and Zimmerer (2020) have investigated the effect of the CSA practices in **Rwanda**, focusing on the potential limitations deriving from agricultural intensification and CSA. Their study reports on a multi-year study of rainfed smallholder agricultural systems as part of the Strategic Plan for the Transformation of Agriculture, via the CIP (Crop Intensification Program), which was initiated in 2010 and was aimed at a market-led rural transformation. The data comprised 430 households, crop production data from 3,017 agricultural plots across three growing seasons, and 96 in-depth interviews at household and institutional level over the 2014-2016 timespan. Their findings illustrate a **decrease** in **food sovereignty** and **resilience** for many, despite the efforts for adaptation.

To address the effect of CSA interventions, it is crucial to consider the **socio-ecological processes** that contribute to shaping the resilience of farmers and to better account for the **social dimension of**

[20] The authors did not use both survey and weather data; they used fixed effect instrumental variable methods to assess the impact of crop diversification on household welfare, and quantile regression model to gauge the heterogeneity of the effects across the households

climate change. Indeed, the uneven patterns of the distribution of resources might affect the environmental volatility, resulting in major differences across local and regional dimensions. Major multilateral partners, such as the World Bank, USAID and the Government of **Rwanda,** have committed to state-led agricultural intensification through a set of **land use** and **rural development policies**. The CIP centres have attempted to increase productivity via the imposition of some CSA practices: hybrid seed, increased use of agro-chemicals, large-scale agro-engineering, and agricultural extension services. Although nationally the CIP has been considered a success, more works have recently highlighted the shortcomings of this practice, such as **inequitable provision of inputs, impingement on smallholders' decision-making autonomy**, **increased land sales** by the rural poor, and **decreased food security** and **agricultural productivity** among the poorest households (Clay, 2017). Moreover, non-CPI fields were found to be systematically more resilient than CPI fields, over three seasons, with an average of 21.2% of CIP fields experiencing climate-related **yield reduction,** compared to 9% of non-CPI fields. Land-use consolidation (mostly enforced on terraces, given the higher financial investments for their construction), which was originally planned to create economies of scale, has led to fewer separate fields. Cropping decisions enforced by government authorities limited the food-producers' capacity to use variable soil and regimes within and between fields.

The failure of these CSA practices is rooted in inefficient land-use policies and the lack of participatory approaches (networks and associational life), which would, instead, have provided sufficient flexibility in decision-making across the poor rural households, and better accounting for their vulnerabilities.

In **Zambia**, the lack of coordination between two implementing partners in the provision of training for farmers, funded by Norway (a local NGO and the FAO-MACO Conservation Agriculture in the context of the CSA), not only contributed to internal conflicts, but eventually jeopardised the creation of a synergetic collaboration (Evaluation Report Norad, 2012). [21]

The multi-donor trust-funded component CSI (Climate Smart Initiative) of two food security programmes in **Ethiopia** (the PSNP and the HABP), supported by the World Bank, was implemented in 6 regions of the country and evaluated (Adem et al., 2017).[22] The project was conducted and supervised by many parties, such as experts, development agencies (DAs) and local staff. A focus group discussion, which was used as an assessment and evaluation tool, identified some degree of ambiguity in the findings. Whilst it is undoubtedly true that a step forwards has been taken in CSA's implementation, many **local communities still struggled to articulate** and fully understand the **meaning of 'climate-smart' concept**.

[21] See p. 30 of the Evaluation Norad Report on coordination problems in the context of Norwegian support in Zambia. Evaluation of Norway's Bilateral Agricultural Support to Food Security (norad.no)

[22] PSNP: Productive Safety Net Program; HABP: Household Asset Building Program.

4. Barriers and challenges

In Chapter 2, the heterogeneity across CSA adoption rates was briefly discussed in the context of how CSA practices might be different, multifaceted, and categorised according to their main distinguishing features. In this section, a more thorough discussion is offered, with the aim of better identifying the possible frictions that could represent a major impediment for adoption in the CSA context. This could help actors to better understand the possible reasons for the low uptake rates of CSA practices across the regions in the most vulnerable areas (Lipper et al., 2017; Lungu, 2019; Tankha et al., 2020). **These barriers, both at national and sub-national level, operate in complex, interdependent and dynamic ways** (Sanga et al., 2021). Figure 4, based on Fusco et al. (2020) and Long et al. (2016), reports a comprehensive overview of the major barriers and frictions that may justify a low rate in CSA uptake at national, regional and/or local level.

Whilst some of these barriers mostly pertain to the '**capacity to invest**' (landholdings; financial, social and physical capital; experience; labour availability), other elements (organisational/market/institutional) could be considered as '**external factors**', beyond the control of farmers, in the form, for instance, of *policies* (land tenure), *institutional* factors (provision of training) and *infrastructural support* (transport and communication). On this note, the size and the quality of the road system represent a crucial aspect in this context, as bad quality and insufficient coverage might directly affect the access to information and to the market, as reported in Ribot (2003). More generally, a low quality of infrastructure may raise the prices of inputs, further reducing the agricultural output and the profitability of technology (Adimassu et al., 2016).

4.1. Barriers to adaptive capacity

In Chapter 3, the main determinants of CSA adoption were reported by means of a literature review of some of the most recent empirical-based evidence, which also focuses on the qualitative type of relationship (positive or negative) existing among these variables and the CSA adoption rates. The variables associated with lower CSA adoption rates act as *de facto* barriers to the adaptive capacity of the farmers in the context of the CSA approach. Therefore, we will categorise them briefly in this sub-chapter, as they have already been discussed in sub-section 3.1.

The most recurrent frictions to adaptive capacity can be grouped into: i) **financial** barriers (high upfront costs, low access to credit, land-tenure, high interest rates, etc.); ii) **land**-related barriers (inappropriateness of practices, unequal redistribution of land ownership, collective vs individual plots); and iii) **climate** barriers (drought, temperature, excessive rainfall, etc.). Additional important factors that act as impediments include the high **level of illiteracy** among farmers, the limited **technical capacity,** and the **lack of appropriate information** and **awareness**.[23]

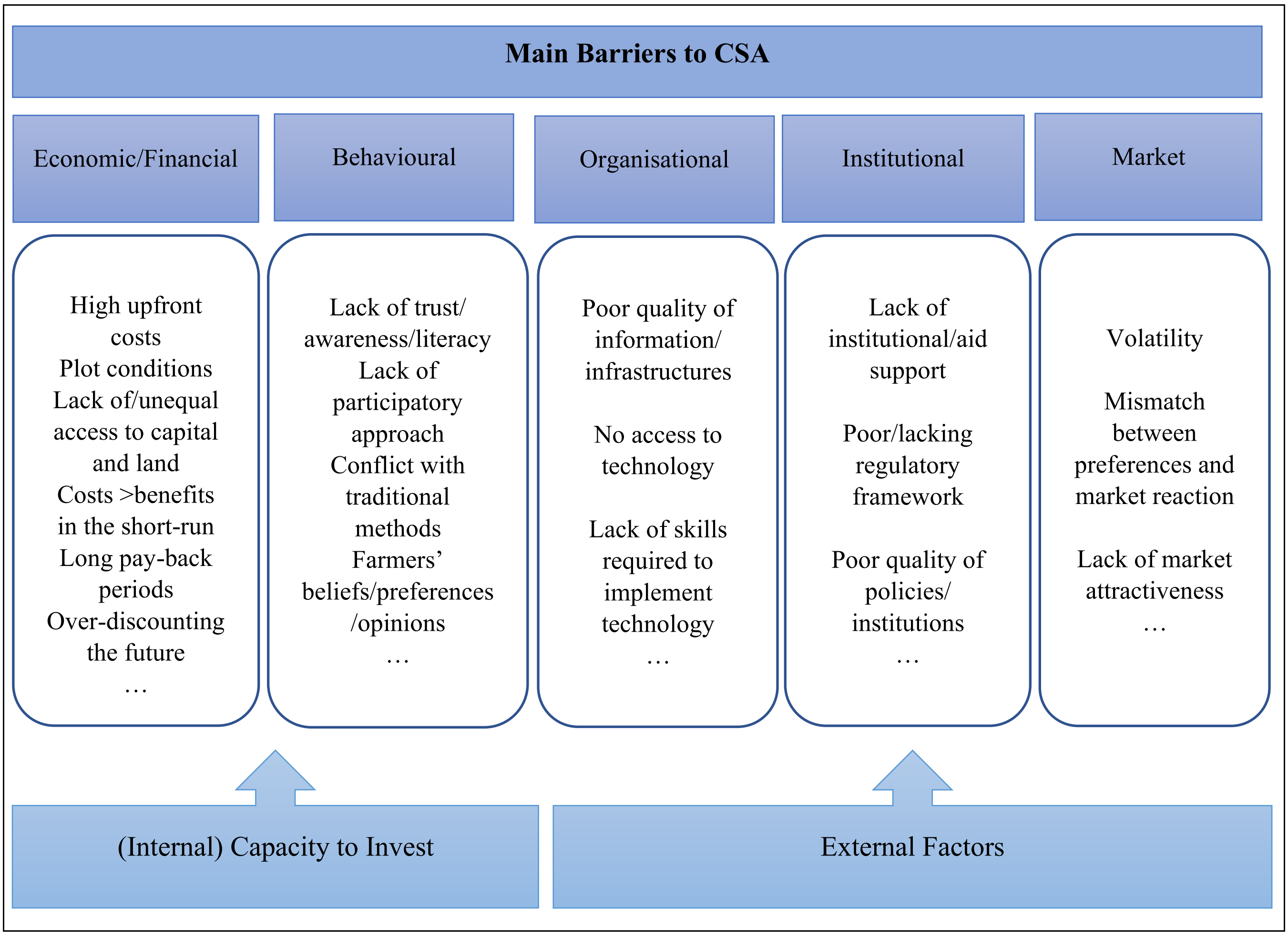
4.2. The role of institutions & governance

Among the major barriers to overcome are the **lack of coordination** among **institutions** in providing support to farmers, and the **lack of policy coherence**, which results in conflict over priorities, targets and resources between governments and/or across different levels of governance

[23] See Sanga et al., 2021; Zougmoré et al., 2021. According to Asrat and Simane (2017), the barriers to adaptation to climate change are identified, from the most to the least recurring, as: lack of financial capital, lack of input, lack of information, labour shortage, lack of water, lack of access to credit, and land shortage

(national/regional/local) (Newell et al., 2019; FAO report, 2021). The **institutional context** plays a crucial role, as it affects both the **capacity** and the **incentive** to invest (Adimassu et al., 2016), most likely yielding positive economic development outcomes, and the scaling-out of many climate-smart technologies (Aggarwal et al., 2018; Branca et al., 2012; Kangogo et al., 2019).

Figure 4: Overview of the barriers to CSA



Source: Author's elaboration based on Fusco et al., 2020 and Long et al., 2016.

Institutions, if well designed and/or supported by international finance, contribute to shaping the generic adaptive capacity of the economic agents (see Box 2), by providing efficient safety nets, technological solutions and tools, which in certain contexts may be the only viable option, as some specific adaptive capacities cannot be implemented in all territories/cases (Lemos et al., 2016). Policy makers also have the potential to incentivise the uptake of CSA practices by creating an environment that is conducive to farmer entrepreneurship.

The pursuit of development goals, such as poverty eradication, welfare improvement and equality, is functional and highly required for the overreaching goals of CSA.

Some of the biggest challenges, however, are found in the lack of clarity and clear instructions on which strategies to adopt and how to effectively put in place good governance, which needs to have an inter-sectoral focus in the context of the CSA interventions. Important institutional aspects, which may vary greatly across countries, need to be considered within the CSA framework:[24]

i) **Governance** and the **role of the state** (resources and power of the state, ideology regarding the State, market vs state-led development pathways);
ii) **Politics of translation**, **'domestication'**, and the **role of sub-national level actors** (different degree of decentralisation and democratisation, levels of participation and consultation);
iii) **Political autonomy** (importance and nature of the agricultural resources, levels of aid dependence, level of involvement of the country in regional/global political economy);
iv) **Political economy** of knowledge and the relationship with global institutions.

Different strategies may be invoked when CSA practices are efficiently targeted and institutions are actively involved. Despite all being vulnerable to climate change and mostly relying on agriculture for their main livelihood, countries such as Kenya, Tanzania, Ethiopia and Rwanda adopted different strategies with regard to the institutional setting, with a state-led development policy in Ethiopia, Tanzania and Rwanda vs. a more market-led approach in Kenya, different degrees of decentralisation (e.g. Kenya vs. Ethiopia), different degrees of civil society participation, and different degrees of donor aid dependence.[25] A typical example of how governments can affect adaptive capacity and induce farmers/value chain actors to adopt CSA practices lies in a wider intensive margin of financial access.[26] Indeed, effective redistributive land-use policies may help some farmers to get access to credit loans by using their lands as collateral, thereby overcoming some of the financial barriers in place (Sanga et al., 2021).

4.3. Poor system of incentives

Without an effective system of incentives, the uptake of CSA practices might remain low, and this can, in part, explain what has been observed in some poor rural communities. More efforts should be devoted to incentivising farmers to bring CSA into their working routine (Adimassu et al., 2016; Kansanga et al., 2021). **Incentive problems** may be relevant in the context of CSA practices. The lack of access to both technical and financial information about CSA can turn into a major challenge. A well-designed incentive mechanism can help in this regard: the **provision of information** and **training** may play a crucial role, as both enable farmers to better understand not only the spectrum of possibilities inherent in CSA, but also its risks and potential, making them more aware and possibly engaged in the adoption process. Farmers might also be discouraged from adopting CSA technologies whenever they perceive an institutional void in the promotion of policies aimed at reducing inequality between farmers, targeting vulnerable (farmer) groups (women, the poor, disabled, youths). A **bad regulatory framework** can act as a major disincentive, and may jeopardize the CSA uptake and its diffusion, including pervasive but unequally distributed subsidies, burdensome and very strict regulatory requirements, price regulation, and inefficiencies in the market such as the presence of monopolies along the value chains (e.g. in the output processing).[27]

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[24] See Newell et al., 2019

[25] Ibid

[26] Value chain actors include farmers, associations of farmers, agri-entrepreneurs, and registered businesses that support agricultural production by providing services, products and market connections

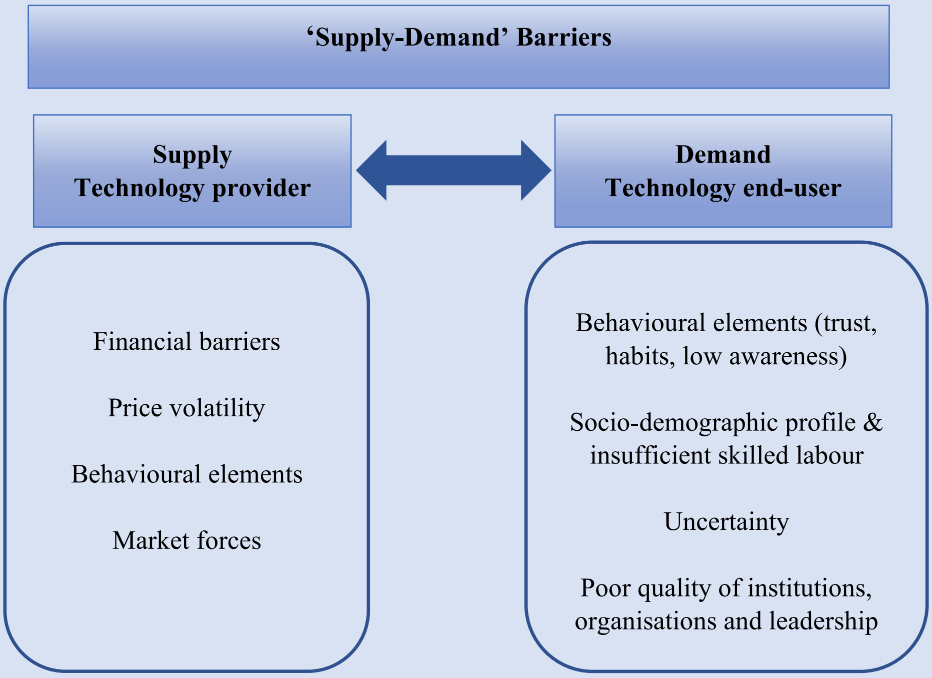
[27] According to the report of Chiriac et al. (2020), "only 7% of the (global) climate finance tracked targeted value chain actors (such as agri- SMEs or finance institutions)." These statistics refer to the years 2017 and 2018, and are based on different sources (OECD-DAC, Bloomberg New Energy Finance, Climate Bonds Initiative, Convergence Blended Finance, Climate Funds Update, International Energy Agency, IJ Global)

BOX 3 – Barriers from ‘Supply-Demand-side’ chain

An alternative way to identify the barriers that may prevent the uptake of CSA technologies and practice is through the lenses of supply and demand. Indeed, existing barriers can also be categorised based on who provides and who uses the **technology** in the context of the CSA approach.

The ‘demand-side’ refers to the end-users of technology, whilst the ‘supply-side’ describes the provider/inventor of the CSA technology. Figure A2 presents this alternative categorisation, which helps to increase understanding of how, in the end, the adoption of the CSA technologies is a common ‘supply-demand-side’ problem and both sides react and respond to each other in a dynamic way.

Figure A2: Overview of the ‘Supply-Demand-side’ barriers



For the **‘supply-side’ chain**, different elements may act as obstacles: financial barriers are represented by high and prohibitive upfront costs at the early stage and for the product development process; lack of investment capital and access to financial resources/credit; difficulty in reaching a wide target of potential consumers; disincentive of investing due to delayed economic benefits. Finally, a crucial role is played by market forces, as it might be more difficult for a new technology to be adopted if well-established products (and leading actors) dominate the market.

As for the **‘demand-side’ chain**, potential consumers (farmers and secondary consumers) are greatly affected by cognitive traits, due to their lack of awareness, information and trust, and their own consumption habits. Whenever a new product is introduced to the market, the initial demand might be low and some time will be needed for it to be ‘understood’ and, possibly, adopted. Socio-demographic characteristics (e.g. experience and education) and technical skills are also important in technology adoption. Similarly, poor regulation and an ineffective institutional framework may also contribute to the creation of frictions from the demand side, as end-users might not feel protected or incentivised.

Source: Bhattacharyya, P., Pathak, H. & Pal, S. (2020). *Climate Smart Agriculture: Concepts, Challenges, and Opportunities*. Springer Nature.

A good incentive system may also help to reduce and moderate some other frictions that are represented by **personal farmers' attributes:** the **lack of wealth/income** and **risk aversion preferences** might, indeed, induce rural farmers to perceive the CSA practices as too costly and too risky, or simply as being too focused on long-term returns (for a case study of Zambia, see Adimassu et al., 2016).

4.4. Scaling up CSA practices

Incentivising the adoption of CSA practices and technologies at the local level is important, and is also one of the most useful ways to assess both the effects of the interventions and the identification of the mechanisms in place. However, it is equally important to attempt to scale them up, to reach a higher number of rural communities, involving several actors and, hopefully, exerting a bigger and more meaningful impact on vulnerable groups across regions and countries. Scaling is the process that leads to the introduction of CSA technologies to a broader target group of users, over a wider geographical area, more quickly, and with long-lasting effects.[28] Possible approaches that have been used in the scaling process involve the value chain development approach, the climate-smart village approach, the innovation platform approach, the social movement approach and the market-driven approach.

Removing or sensibly reducing **market constraints** may improve the scaling up of CSA technologies, as the transaction costs would decrease and the access to market output would widen. Market development is crucial, and this is targeted in order to boost demand for CSA technologies in the market-driven approach.

As for the **value chain development approach**, it could be very effective in scaling CSA practices, as it actively engages every actor involved along the value chain (research, input procurement, production, processing and consumption) and helps to increase demand for the CSA technologies in smallholder farming value chains. Despite having huge potential, scalability is still not common practice and receives a low amount of resources (domestically and internationally), most likely due to the presence of several frictions and major challenges, such as the **lack of information, access to credit**, and **coordination** along the **value chain**. Possible reasons for this can be found in the **low level of agro-business development**, the **lack of technological support and public investments**, **low financial returns of financial service providers**, and **investment risks due to information gaps**.

Effective scaling requires a combined and integrated approach involving science, technology, local contexts, socio-economic and cultural background.

[28] *Scaling out* refers to a quantity-intensive margin (more people can be reached), and it involves replication/expansion/extension/copy-paste/technology transfer/adoption, whilst *scaling up* refers to the extensive margin or quality improvement, and it involves transformation/institutionalisation/ integration/incorporation. Whilst scaling out preserves the same attributes and replicates them on a wider scale, scaling up leads to new attributes along the process. See Makate (2019)

There are some factors that might play an important role in scaling up decisions in the context of CSA practices:[29]

- *Technologies* that are *low-cost* and have clear and *tangible benefits* are more likely to be scaled, whilst those technologies with benefits that are not immediate face more challenges in scaling;
- Investing to scale-up innovation related to solar energy, biogas, seed banks and food storage technologies might help CSA practices more effective;
- *Peer learning/monitoring/assessment* are crucial elements to facilitate the scaling of CSA innovations. Researchers/development partners should do the best they can to spread knowledge and awareness across farmer communities (human capital element);
- Support from all involved *stakeholders*;
- *Access to crucial resources* (credit, land, markets, information, favourable political environment);
- The *role of credit* is crucial for CSA adoption and for scaling, as many technologies require relatively large upfront investments.
- *Political will*, *advocacy*, *accountability*, *capacity building*;
- Support for *local institutions* and *indigenous knowledge*;
- The role of *foreign aid* (Huang & Wang, 2018) may be crucial for scaling up CSA projects and increasing local capacity.[30]

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[29] Makate, 2019; FAO, 2021

[30] Four main areas for ***mitigation intervention*** via foreign aid: i) reduction of nitrous oxide emissions from soils, ii) limiting methane from ruminants and paddy fields, iii) soil carbon sequestration via land-use conversion/conservation, and iv) scaling down CO2 emissions by modifying farming practices and energy-saving technologies. Four main areas for ***adaptation intervention*** via foreign aid: i) water conservation, ii) agricultural science and technology, iii) capacity of governments, communities and farmers to adapt to climate change; and iv) risk management (micro-insurance agriculture, warning and information systems, etc.)

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BOX 4 – Gender norms, empowerment of women & CSA

An important element that is worth discussing more thoroughly concerns the role of gender norms and gender inequality in the CSA practices. This element is crucial when setting-up **inclusive** and effective **approaches** in order to improve the adaptive capacity of rural communities and ease the CSA adoption (Adem et al., 2017). The role of women in agriculture is well-known, as they make up almost half of the **agricultural labour force** in SSA regions, and they are **key actors in food security** (UNDP 2012a) and adaptation to climate change (FAO, 2021).

Despite their crucial contribution, women are among the most **vulnerable groups**, as they tend to be socially and economically disadvantaged compared to their male counterparts, in terms of both income and assets: they rely on relatively smaller lands and have less access to credit (Lungu, 2019; Diouf et al., 2020). If hit by a negative exogenous shock, they will be less-well insured and less able to recover over time. This condition may greatly affect the adoption and the scalability of CSA, which require active interventions that enable the **empowerment of women** and a reduction in gender (and income) inequality.

In contexts characterised by **strict gender norms** and **heavy gender and economic imbalances**, CSA interventions might not be as effective as expected, given the limited adaptive capacity of poor rural households. Whilst male farmers are found to benefit from the consequent increase in agricultural productivity and income, as in Northern Ghana (see Partey et al., 2020), women tend to be harmed by these interventions whenever an **equal redistribution of resources** is in place (see Sanga et al. (2021) for a case study of Mali). This suggests the need for **interventions (domestic and international)** that could target other equally important SDGs, which are needed for the successful diffusion of CSA practices – for instance, designing **policies** aimed at **increasing** and **extending access to land ownership for female farmers**, which could change the standard and dominant cropping pattern and increase climate-resilient production (Sanga et al., 2021).

5. Norwegian ODA & CSA. A descriptive financial analysis

This section provides a financial overview, in both a static and a dynamic way, to shed light on the contribution that Norwegian ODA (Official Development Assistance) has offered, over the years, in the context of CSA interventions. As previously mentioned, foreign aid can be a valuable resource in this respect, and analysing ODA flows could provide useful insights for policy makers.

In June 2021, the Nordic Council of Ministers engaged in a political discussion on **food systems** at their annual meeting (MR-FJLS), in preparation for the Global food system summit that took place in September 2021.[31] They highlighted the importance of *equitability* and *inclusivity* as ultimate targets guiding all polices for sustainable food systems, identifying the empowerment of women, and support for indigenous people and local communities as being conducive to a more structural transformation of food systems, leaving no one behind. *"The Nordic countries have made ambitious commitment to carbon neutrality to reach the Paris goals, and innovations to improve carbon sequestration and storage are being developed. At the same time sustainable and climate smart consumption has to be further encouraged. Equally important is adapting agriculture to climate change, as well as to recognize the interlinkages between climate change and biodiversity*." [32]

In recent years, Norway has engaged in several initiatives aimed at providing support for food security and the eradication of hunger, while also taking the issue of climate change into account. The food security strategy "*Matsikkerhet i et Klimaperspektiv*" ("Food security from a climate perspective") was launched in December 2012, covering the period 2013-2015. Afterwards, the Government's action plan on sustainable food systems in the context of Norwegian foreign and development policies was developed for the period 2019-2023, the overall objective of which is to "*ensure increased food security through the development of sustainable food systems*."[33] The action plan was designed to directly address SDG 2 (Ending hunger), while also supporting all the other SDGs.[34] Due to a shift of governments, the action plan was terminated in early 2022, and will be replaced by a new policy document.

Figure 5 shows the total amount of bilateral assistance (also including that earmarked for multilateral assistance) over time targeting **food security** and **food systems**, via agriculture (DAC 311) fishing (DAC 313), other multisector (DAC 430. 71-72-73), through the Global Crop Diversity Trust (GCDT), and core contributions to multilateral organisations (CGIAR, FAO, IFAD). [35] After a steep increase in 2013, there was a generalised decline across these sectors, followed by an ongoing increase since 2016. However, despite the overall positive long-term trend over the years, Other multisector (DAC 430. 71-72-73) has experienced a decline in 2021.[36]

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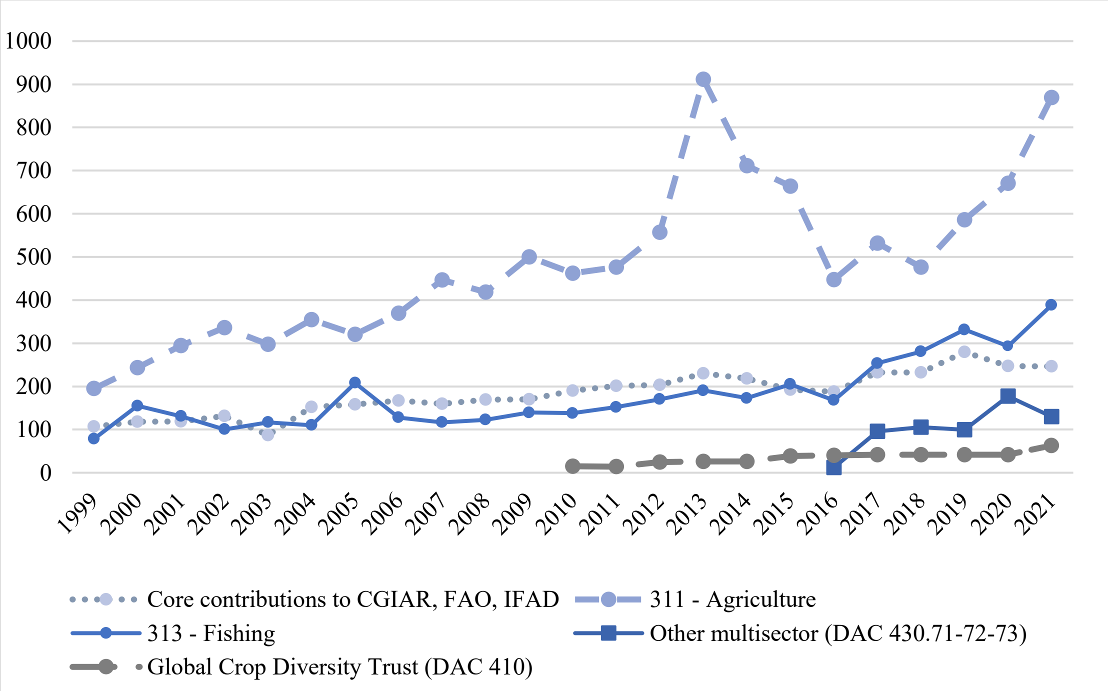
[31] Denmark, Finland, Iceland, Norway and Sweden, and Greenland, Faroe Islands and Åland Islands
[32] https://www.norden.org/en/declaration/towards-sustainable-food-systems-nordic-approach
[33] For a mid-term evaluation of the action plan, see the KPMG report (2021) "Mid-term review of the government's action plan on sustainable food systems in the context of Norwegian foreign and development policy"
[34] https://www.regjeringen.no/globalassets/departementene/ud/dokumenter/planer/sustainablefood_actionplan.pdf
[35] For the definition of total bilateral assistance, see page 12 of Statistical Classification Manual 2021
[36] The DAC sector 430 "Other multisector" included in the figure refers to "Food security policy and administrative management" (71), "Household food security programmes" (72) and "Food safety and quality" (73). As for the GCDT, the main targeted sector has been the "General Environmental Protection" sector (DAC 410). There was one funded project in 2013 in the field of Agriculture, which has been excluded from calculations (as it was already included in DAC 311 – Agriculture)

Figure 5: Support for food security 1999-2021 (in million Norwegian kroner)



Source: Author's elaboration based on Norad's database.

5.1. Data and methodology

The statistics and the descriptive analysis provided in this section are based on Norway's official aid database.[37] The analysis refers to the **objectives** of the projects, aggregated at DAC sectoral level, for the period 2009-2021, but not their actual outcome (for which a different type of data would be required).[38] The type of information retrieved for the presentation of this analysis concerns the:

i) OECD-DAC sector according to which every project is categorised (and for which disbursements were provided);
ii) Policy (Rio) marker for mitigation and adaptation;
iii) Year and amount of disbursements;
iv) Recipient region.[39]

The analysis aims to provide a macro-sectoral snapshot of the CSA finance, and the focus is therefore not on the individual projects falling within the targeted sectors.

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[37] https://resultater.norad.no/microdata

[38] Whilst in the official OECD statistics, policy markers for adaptation were only introduced in 2010, in the Norwegian Bistand database, the projects were screened ex-post and manually assigned the policy markers for the year 2009. This is the reason why it was possible to gather data on Norwegian ODA on policy markers since 2009

[39] The statistics refer to all types of extending agencies/funding modalities (such as Norad, Norwegian Ministry of Foreign Affairs (MFA), embassies, FK Norway, Norfund, etc.) and types of agreement partners (local/Norwegian/international NGOs, Norwegian private sector, public sector, consultants, etc.)

Quantifying the allocations to CSA is not an easy task, and no well-established practice has reached consensus so far. First, climate-smart agriculture interventions may differ from more traditional agricultural development and natural resources management interventions, crosscutting with other relevant sectors and activities. Second, calculating the amount of aid directed to the agricultural sector, in all its ramifications and components, is extremely challenging in developing countries.[40] Indeed, other flows that do not constitute direct aid to the recipients might still be categorised as ODA, such as administrative costs, or support for NGOs in donor countries, meaning that only part of the original disbursement will eventually be used for the main developmental purpose. Third, in foreign aid databases, there is no systematic or explicit way to identify projects targeting CSA practices.

Hence, a **degree of discretion** was exercised to assess and choose the most appropriate methodological approach in identifying the most relevant sectors for CSA. In doing so, and given the close link with the most used CSA practices, only the projects targeting agriculture, forestry (respectively OECD-DAC sectors 311 and 312) and sustainable food systems via 'Other Multisector' (DAC 430. 71-72-73) and the GCDT (in DAC 410) were kept in the analysis. Instead, other sectors such as fishing and manufacturing, etc., and contexts that are not directly related to agricultural land (i.e. coastlines and fisheries), were not taken into account (see Fusco et al., 2020).[41]

Within these sectors, we have only tagged those projects that have adaptation and mitigation as either a significant (Rio marker=1) or principal (or main) objective (Rio marker= 2) as being CSA-related.[42] In line with the OECD-DAC methodology, aid activities can target multiple objectives, and can, therefore, be reported under both the mitigation and adaptation markers. Therefore, sectoral statistics for both markers must be measured and interpreted separately (to avoid double counting).[43] The main analysis focuses on total **bilateral assistance** (bilateral and that earmarked for multilateral assistance) and does not include multilateral assistance (which cannot be sector-specific and is therefore not feasible for the analysis), acknowledging that this may underestimate the statistics reported in the report and provide a partial picture of it.[44] Therefore, these estimates are conservative and may be lower than the actual financial disbursements.[45]

[40] Umbadda & Elgizouli, (2013)

[41] Norway also contributes to food security through the funding of emergency food assistance (OECD-DAC code 720.40) and of developmental food aid (OECD-DAC code 520). Despite their relevance for food security, these sectors are not directly connected to CSA. They were therefore excluded from the sample. Similarly, core support contributions to WFP have been omitted, as these are defined as "short term" and are not directly linked to the main topic of this report

[42] The Development Assistance Committee of the Organization for Economic Co-operation and Development (OECD-DAC) categorises each sector by assigning a unique DAC code. In this analysis, the scaling coefficient of 40% for the significant policy marker used for reporting to the UN Framework Convention on Climate Change was not applied

[43] https://www.oeko.de/fileadmin/oekodoc/Background_paper_Oeko-Institut_climate_finance_agriculture_2020.pdf

[44] Triangular cooperation flows are not included, as they represent roughly 0.02% of the agricultural sector, and none of them are marked with either a principal or significant policy objective over the period 2009-2020

[45] According to the Statistics NORAD manual 2019, the "Use of type of assistance 3 (multilateral assistance), which is general contributions, cannot be sector-specific and, hence, the fields for the policy markers are left blank (code 0, none)." More generally, Rio markers are not applicable to flows for general budget support, imputed student costs, debt relief except debt swaps, administrative costs, development awareness, or refugees in donor countries. Therefore, these types of flows have not been considered in this analysis

BOX 5 – Policy markers

Policy or **Rio markers** (developed by the OECD-DAC) are specific markers for tracking aid that identify projects with objectives that contribute to certain important issues (gender, climate change adaptation, climate change mitigation, gender equality, education, biodiversity, etc.). They are descriptive variables rather than quantitative indicators; therefore, they do not allow an exact quantification of aid targeted at certain specific objectives. However, they do give an indication of the policy objectives of aid, and can be useful in the analysis of trends and patterns of foreign aid. Policy markers can assume three different values, depending on their policy objectives:

- **Non-targeted (=0):** refers to projects that, in the context of this analysis, do not target climate change mitigation/adaptation or have not been screened against this objective. According to the OECD's handbook, this category should include projects where climate objectives are 'extremely limited' or 'superficial' with regard to the project's overall aim.

- **Significant (=1):** adaptation or mitigation is not the primary target, and, although important, is not the main reason for the project to be undertaken.

- **Principal or Main (=2):** adaptation/mitigation is the main objective, and the projects would not "have been funded but for that objective", which represents the '*condicio sine qua non*'.

On a global scale, "the increase in bilateral ODA targeting climate change adaptation has largely been driven by increases in funding for projects that 'significantly' rather than 'principally' target climate change adaptation" (Dweyer et al., 2021). In the original statistics, it is likely that the volume of funds as ODA mobilised for mitigation/adaptation is overestimated, due to the **self-reported nature** and the high degree **of subjectivity** in how donors mark and categorise activities. This may also push some donors to tag existing projects with the Rio marker 'adaptation' or 'mitigation', given the political pressure, even though these objectives are not the intended ones. Policy markers were not created to be quantitative indicators, which means that tagging a project with the Rio marker does not necessarily mean that the whole project was devoted to adaptation (rather, it was most likely only part of it). However, they still represent the best available solution for providing an overview of the composition of foreign aid flows.

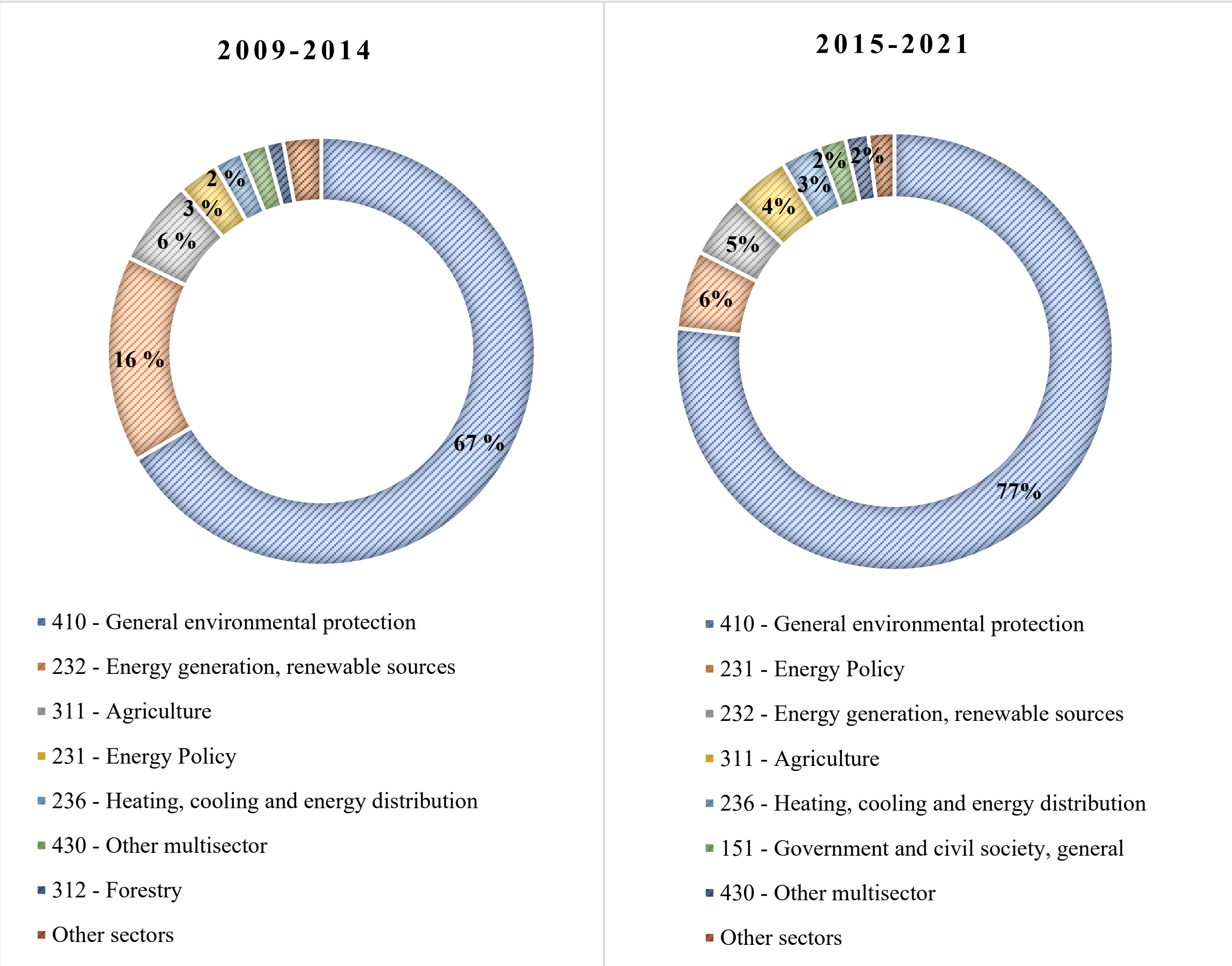
Source: OECD-DAC Rio Markers for Climate Handbook

5.2. Climate aid by sector

Before discussing the most relevant CSA sectors, it may be worth looking at the distribution of total bilateral (and earmarked) aid across all sectors in order to identify which ones have contributed the most over time, with regard to adaptation and mitigation targets (either as the principal or significant objective). Figure 6 and Figure 7 show the percentage of total bilateral (and earmarked) funding tagged with the Rio markers 'mitigation' and 'adaptation', respectively, being allocated to different sectors over the two periods of time 2009-2014 and 2015-2021 (with principal and significant objectives).

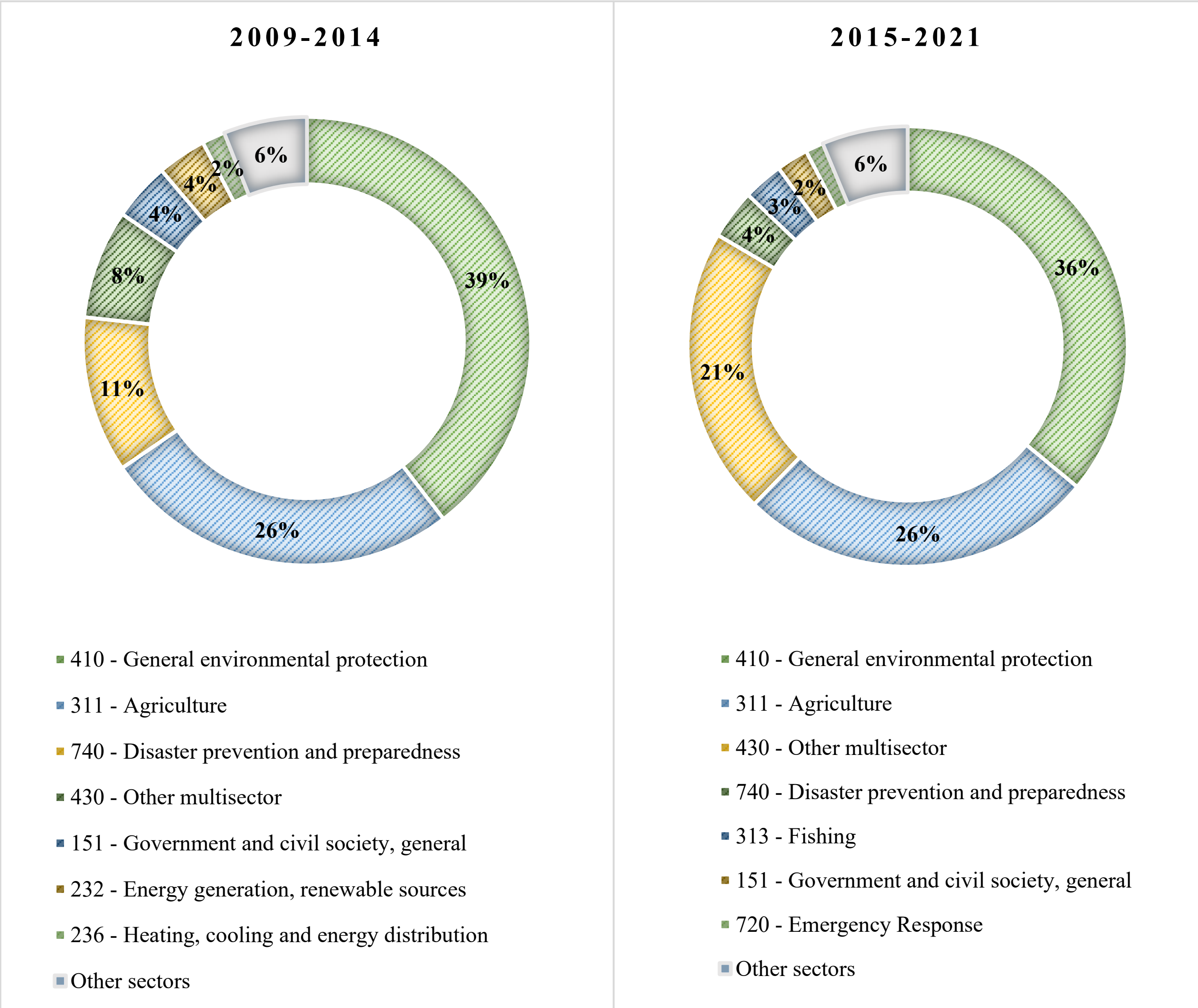
Unsurprisingly, the OECD-DAC sector 410 "General Environmental Protection" has been the main beneficiary of aid, for both mitigation and adaptation targets. However, there are some important differences that are worth mentioning. Whilst its relevance has increased over the two periods, from 67% to 77% with regard to projects targeting mitigation (as principal or significant objective), it has slightly decreased over the two sub-periods for adaptation, falling from 39% to 36%. Its contribution appears to have been more substantial when targeting mitigation, but relatively less sizable when it comes to adaptation. The other most relevant sectors, having mitigation as either a principal or a significant objective, are those that are closely related to the energy sector (policy, renewable, distribution, etc.)

Figure 6: Total bilateral and earmarked aid by sectors: Mitigation



Different trends have been experienced by the agricultural sector (OECD-DAC 311): although it represents a small percentage of the aid targeting mitigation (between roughly 4% and 6%), it has consistently attracted the second largest share for climate aid adaptation (26% in both periods). As for the rest of the sectors, the share of DAC 430 ("Other multisector") increased from 8% to 21%, whilst the percentage for DAC 740 ("Disaster prevention and preparedness") decreased from 11% to roughly 4%.

Figure 7: Total bilateral and earmarked aid by sectors: Adaptation



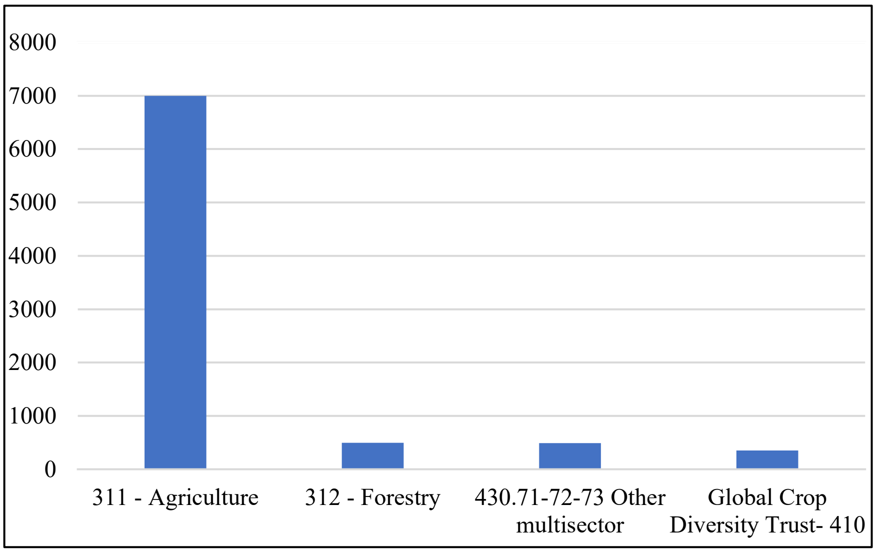
5.3. Sectors targeted by CSA finance

We start the core of our analysis by identifying the sectors that, in our view, are most relevant for the CSA finance (namely DAC 311.Agriculture, 312.Forestry; non-sectoral specific activities under 'Other multisector' in DAC 430.71-72-73; and the Global Crop Diversity Trust in DAC sector 410).

These sectors/activities attract very different amounts of bilateral (and earmarked) development assistance flows, as shown in Figure 8, which reports the total amount (in million Norwegian kroner) of flows allocated over the period 2009-2021 across these selected sectors. In this context, agriculture represents the largest share among these, accounting for nearly 83% of the resources, with the other sectors accounting for the remaining 17%.[46]

[46] We did not include in the analysis the NICFI (Norway's International Climate and Finance initiative), which falls into DAC 410.General environmental protection. This fund defines a much broader spectrum of activities that are relevant for environmental policies, but not strictly related, overall, to climate-smart agriculture

Figure 8: Bilateral and earmarked ODA (in million Norwegian kroner) for 2009-2021 in CSA-relevant sectors



Again, this represents a partial picture, as we are not considering multilateral aid (as core contributions), which might have been sizable, not only for agriculture but also for the forestry sector. Figure 9 and Figure 10 show, instead, the percentages of policy objectives across the selected sectors, marked with the Rio markers “adaptation” and “mitigation”, respectively. The focus is not on the amount of received funds in absolute terms, but rather on their relative distribution by the type of objective (none/significant/main) within the selected sectors. This is important as it enables a comparison of the different composition of flows across sectors, based on the policy objectives in the context of the CSA finance within the timespan 2009-2021, regardless of the different amounts received. This may be relevant and policy-informative for the purpose of this report, as it can show how resources are distributed and to what extent they contribute to climate aid.

As for Figure 9, Agriculture has nearly 54% of the funded projects targeting adaptation as either a significant or a main objective. Within the forestry sector, most projects (83%) do not target adaptation (policy objective=0), with only 12% of these being marked with significant objective (policy objective=1), and 6% with principal objective. Within the sub-sectors DAC 430.71-72-73, a very high proportion of disbursements target adaptation as the principal objective (around 45%), whilst 31% refer to it as a significant objective. The GCDT only includes projects that have adaptation as either a significant (96%) or a principal (4%) policy objective.

Figure 10 reports the distribution of total bilateral assistance within each sector, by policy objectives, with respect to the mitigation target. In this case, agriculture appears to contribute relatively less, with 65% of projects having “none” as the policy marker. On the contrary, within the Forestry sector, 83% of funds are devoted to projects having either a “significant” or a “principal” policy objective. The rest of the activities (DAC 430.71-72-73 and GCDT) do not target mitigation for the period covered in the analysis.

Figure 9: CSA & Adaptation over relevant sectors (2009-2021)

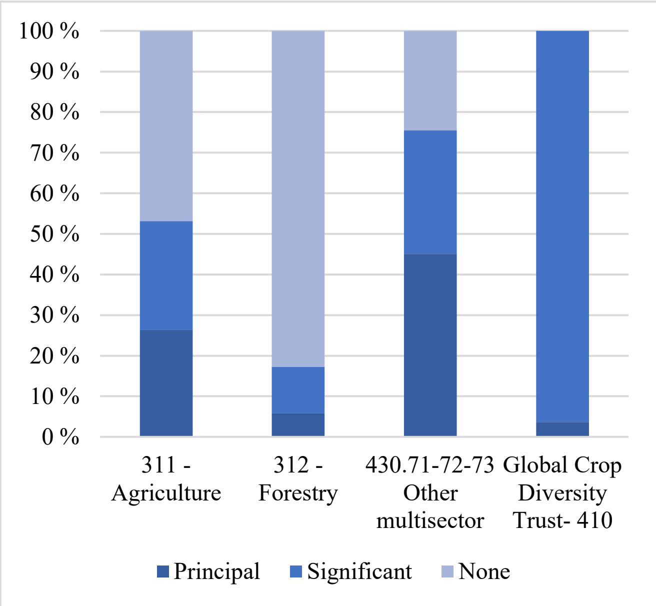
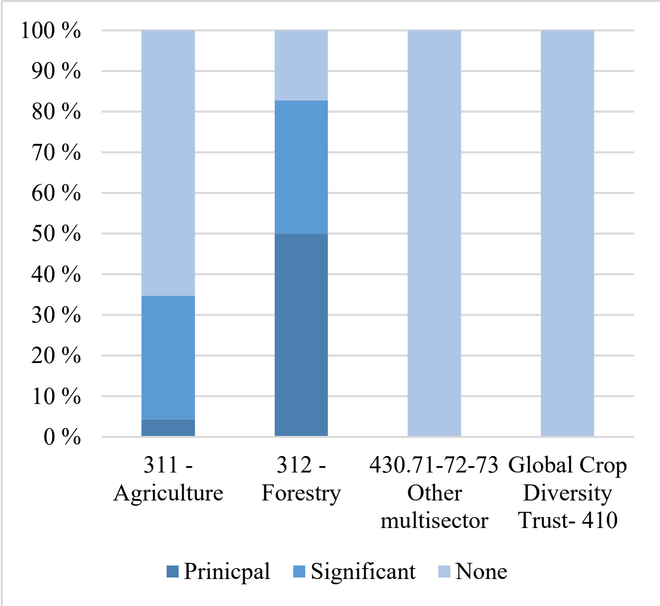


Figure 10: CSA & Mitigation over relevant sectors (2009-2021)



So far, we have provided a static analysis, showing the total funds being allocated over the period 2009-2021. However, it might be interesting to adopt a more dynamic perspective and look at the evolution of CSA finance over time. Figures 11 and 12 show the percentage of disbursements (over the relevant CSA sectors) by policy objectives.[47] A similar trend can be seen in both figures between 2012 and 2015: an increasing share of resources targeting adaptation and mitigation as either significant or principal policy objective, followed by a gradual but ongoing reduction since 2016, mainly with regard to mitigation. One of the possible reasons for the pattern observed during the period 2012-2015 could be linked to the agricultural sector, as this was targeted by the Norwegian strategy for food security (in a climate context) that aimed to promote growth in food production in a changing climate, which was initiated in late 2012 and terminated in 2015.[48]

Once again, the selected CSA-relevant sectors appear to have contributed proportionally more to the adaptation target than to the mitigation target, especially with regard to the policy objective "principal". Conversely, a higher proportion of projects within these sectors are tagged with "significant" than with "principal" policy objectives, with regard to the mitigation policy target.

[47] In doing so, for each year, we add together the bilateral development assistance flows received by each CSA sector, by the type of policy objective (0, 1, 2)

[48] https://www.regjeringen.no/en/dokumenter/food_security/id726999/

Figure 11: Adaptation – all CSA-relevant sectors over time

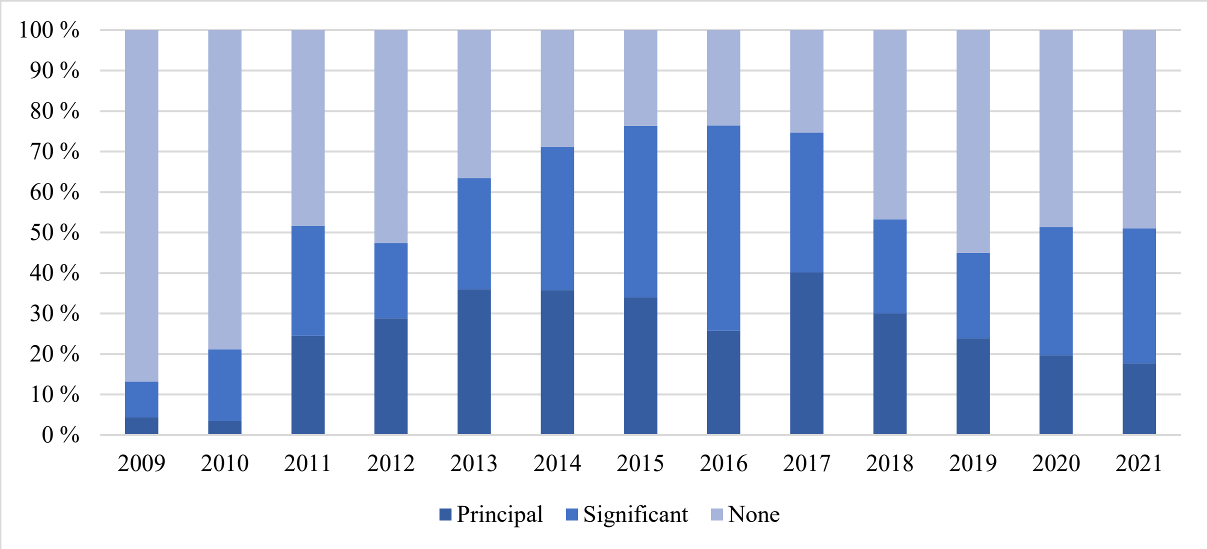
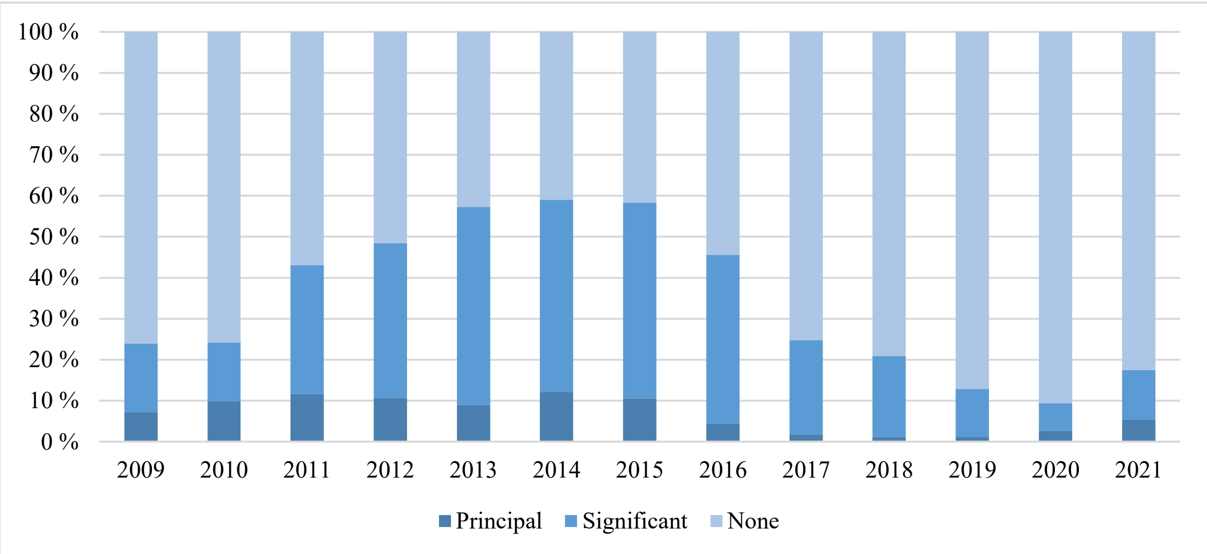


Figure 12: Mitigation – all CSA-relevant sectors over time



5.4. The role of agriculture in the CSA aid

In this section, a more thorough analysis is conducted with respect to agriculture (DAC 311), as this represents the most relevant sector in the context of CSA finance, as previously shown in Figure 8. This may, in fact, contribute to reducing GHG emissions, increasing carbon sequestration (mitigation), and/or increasing the resilience to climate change, via, for example, climate-resilient crops, etc. It is worth looking at this sector in connection to CSA in a more dynamic perspective, by analysing the allocation of resources for each objective (none, principal and significant) for both Rio markers (adaptation and mitigation). Interestingly, the trend of the distribution of policy objectives over time (see Figures 13 and 14) resembles the general aggregated trend for all CSA-relevant sectors, as shown in Figures 11 and 12, which reinforces the hypothesis of the crucial role played by agriculture in explaining the trend of bilateral CSA aid. In the context of mitigation, CSA has mainly been driven by projects with a significant policy objective, whilst a more balanced picture emerges with regard to adaptation, in line with the global trends of climate aid.

Figure 13: Agriculture & adaptation over time

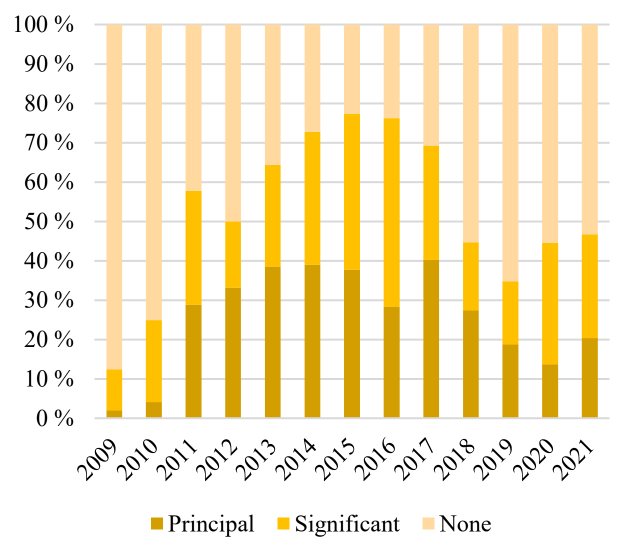


Figure 14: Agriculture & mitigation over time

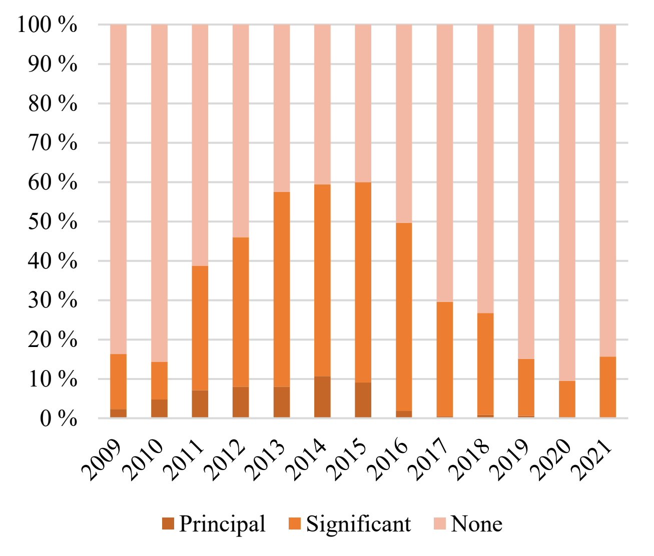


Table 2 presents the volume of bilateral aid flows reported by Norway in the agriculture sector for both adaptation and mitigation, by the policy objectives 1 and 2. An upward trend has been observed between 2012 and 2015 for both climate change targets, followed by a substantial volume reduction (especially for mitigation), and a more recent increase for both mitigation and adaptation.

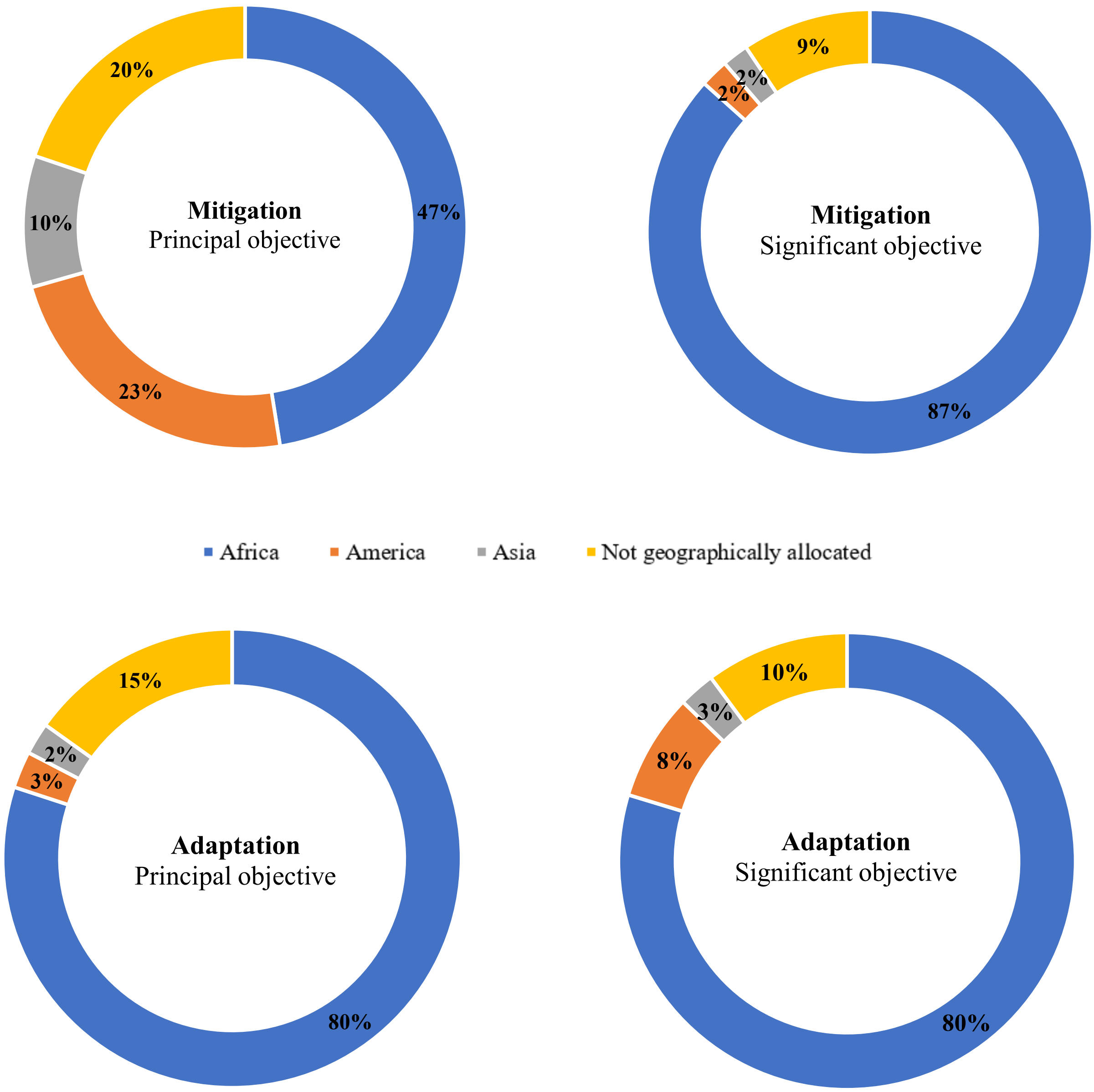
Table 2: Norwegian bilateral and earmarked aid targeting climate change adaptation and mitigation in the agriculture sector (million Norwegian kroner), 2009-2021

311 – Agriculture (in million Norwegian kroner)				
	Adaptation Policy objective		**Mitigation** Policy objective	
year	**Significant**	**Principal**	**Significant**	**Principal**
2009	52	10	70	12
2010	96	19	44	22
2011	138	137	150	34
2012	94	184	212	45
2013	236	351	451	73
2014	239	278	346	76
2015	263	250	338	60
2016	214	127	214	8
2017	154	214	155	3
2018	82	130	123	4
2019	94	110	85	3
2020	206	92	61	2
2021	230	177	136	1

5.6. Geographies

The final part of this descriptive analysis is dedicated to investigating the regional allocation of CSA finance in the agriculture sector.[49]

Figure 15: Climate change mitigation and adaptation in agriculture, by world regions (2009-2021)



[49] Data per region was extracted for each year in the period 2009-2021, and then aggregated in a single figure for the period 2009-2021 for each of the regions, and calculated as a proportion

Figure 15 shows that **mitigation** as a principal (or main) objective in the agriculture sector mainly targeted Africa, with 47% (with the South of Sahara region and Malawi being the biggest recipients), followed by America with 23% (Brazil, Nicaragua, Mexico), unspecified developing countries with roughly 20%, and Asia with almost 10% (mainly disbursed to Nepal and Indonesia). As for **mitigation** flows with a significant policy objective, 87% of the aid was reported for Africa (with Malawi, Ethiopia, Zambia and the South of Sahara region being the biggest recipient countries/areas), followed by other unspecified developing countries ("not geographically allocated") with 9%, America with 2% (mainly concentrated in Nicaragua), and Asia with 2% (mostly driven by Afghanistan, Nepal and Vietnam).

Similarly, as for climate change **adaptation** finance in the agriculture sector, the aid disbursements with a principal policy objective targeted Africa as the main recipient region, accounting for 80% (with Malawi, Zambia, the South of Sahara region, Mali and Ethiopia being the biggest recipients), followed by other unspecified developing countries (15%). The remaining 5% targeted America (with Nicaragua as the biggest recipient) and Asia (with Asia regional, India, Nepal, Bangladesh and Vietnam as the main recipients). A similar picture is observed with regard to the flows targeting adaptation as a significant objective, which once again were targeted towards Africa (mainly Malawi, Ethiopia, Zambia, Tanzania and Mozambique), accounting for roughly 80%, followed by other unspecified developing countries (nearly 10%), America with 8% (dominated by Nicaragua, the Caribbean and Central American region, and Brazil), and Asia with 3% (with Nepal and Afghanistan as the biggest recipients).

The analysis of the geographical allocation of CSA bilateral finance within the agriculture sector suggests that Africa, which is considered one of the most (if not the most) vulnerable regions in the world, both in terms of development and climate change, has been prioritised and well targeted by Norway over the years. On a global scale, there has been evidence of inefficiency of donors to correctly target the most vulnerable countries. In 2019, middle-income countries were the main beneficiaries of climate change adaptation funding allocable to individual countries, "with 42% of the US$13 million going to lower-middle-income countries (LMICs), and 35% to upper-middle-income (UMICs). Only 23% went to low-income countries. In 2019 only 25% of bilateral ODA for adaptation was allocated to countries with the highest level of vulnerability to climate change" (Dwyer et al., 2021, p. 5). This seems to suggest a weak correlation between climate change adaptation finance and recipient countries' vulnerability to climate change. This is relevant, as this could imply that bilateral allocation of climate adaptation aid is not strongly influenced by the vulnerability of the recipient countries.

5.7. An international comparison

Although the focus of the analysis is on Norway, it is interesting to look at it in comparison to the rest of the OECD-DAC donors. This is important, as it may highlight potential similarities or differences between donors in the context of CSA finance in the **agriculture sector**.[50] To further facilitate the comparison of the trends, all values are expressed as constant 2019 million US dollars and are taken from the OECD Credit Reporting System (CRS) for the period 2010-2019.[51]

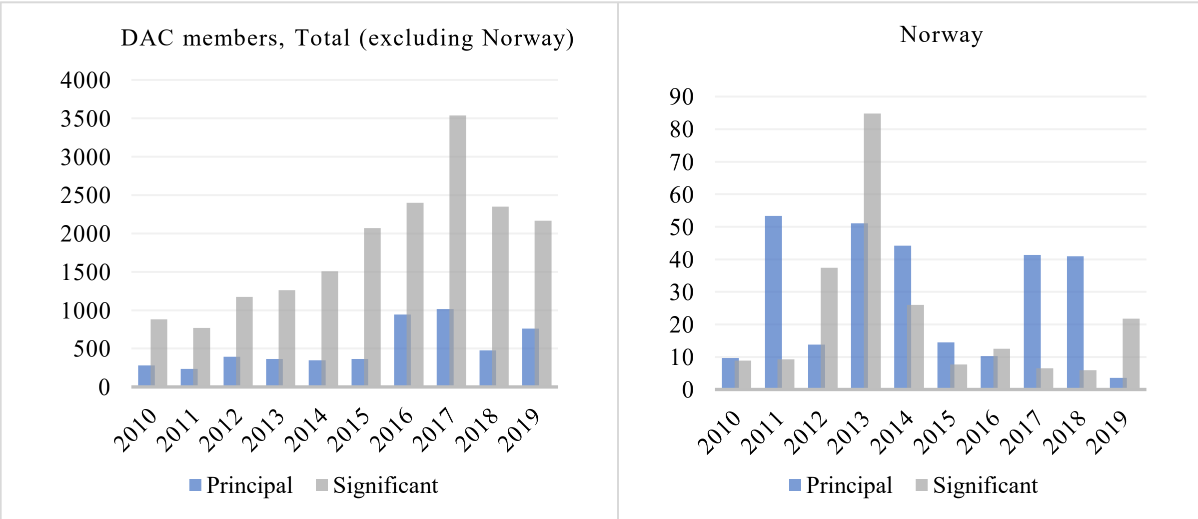
[50] Sector 311: III.1.a. Agriculture, Total

[51] https://stats.oecd.org/Index.aspx?DataSetCode=RIOMARKERS

The OECD-DAC donor countries are Australia, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States. However, Norway was excluded when presenting the aggregated statistics for the DAC donors, to avoid double counting

Figures 16 and 17 present the volume of bilateral aid targeting climate change "adaptation" and "mitigation", respectively, in the agriculture sector for Norway and the rest of the OECD donor countries for the period 2010-2019. Certain aspects must be taken into consideration for Figure 16: the flows targeting **adaptation** as a significant policy objective reached their peak for the rest of the OECD DAC donors in 2017, which was followed by a contraction, whilst a more erratic trend has been observed in the case of Norway, where the peak was reached earlier, in 2013, followed by an ongoing reduction until 2018. If we look instead at the flows targeting adaptation as a principal (or main) policy objective for the rest of the OECD DAC donors, they were systematically lower than the ones marked as "significant" (the blue bars are always smaller than the grey ones), indicating that climate aid for adaptation was mainly driven by flows devoted to projects having a significant policy objective, rather than a principal one. If we, instead, focus on Norway, a different picture emerges: the flows disbursed for projects within agriculture targeting adaptation as a principal objective were, in many instances, higher than the ones with "significant" policy objectives (grey bars).

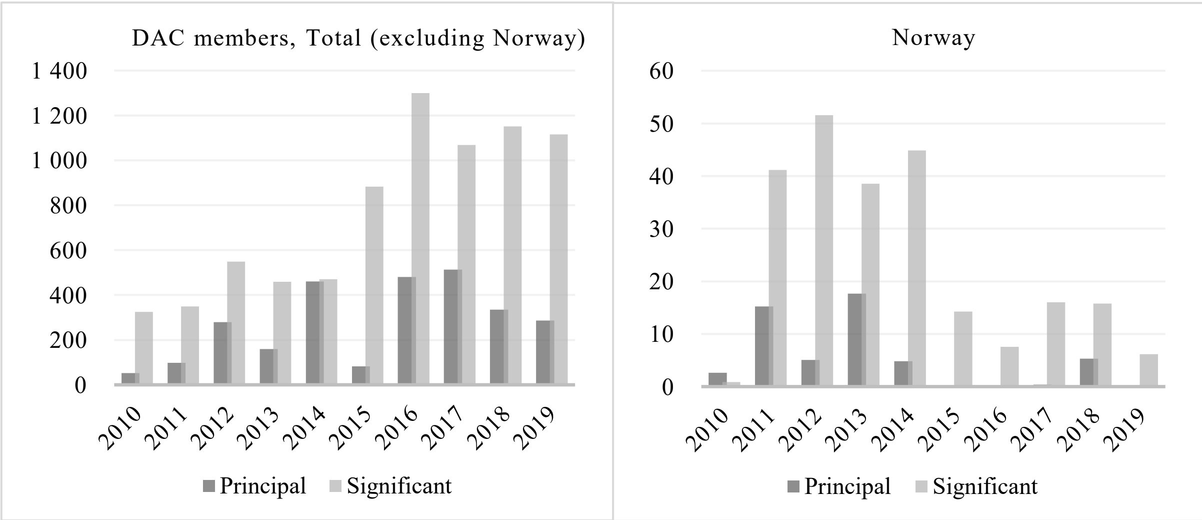
Figure 16: Climate change **adaptation**. An international comparison, 2010-2019 (constant prices, 2019 million US dollars)



Notes: The left side panel refers to the volume of climate aid for adaptation in the agriculture sector for the OECD-DAC donors (excluding Norway), whilst the right-side panel refers to the volume disbursed by Norway. All values are in constant prices, 2019 US million dollars.

In Figure 17, a systematic higher level of resources devoted to **mitigation** as a "significant" policy objective can be observed for both OECD-DAC donors (except for 2014) and Norway. However, whilst there was an upward overall trend for these flows targeting mitigation with a significant policy objective for the rest of the OECD DAC donors, the opposite was experienced by Norway, which committed more disbursements over the period 2011-2014, followed by a substantial reduction afterwards.

Figure 17: Climate change **mitigation**. An international comparison, 2010-2019 (constant prices, 2019 US million dollars)



Notes: The left side panel refers to the volume of climate aid for mitigation in the agriculture sector for the OECD-DAC donors (excluding Norway), whilst the right-side panel refers to the volume disbursed by Norway. All values are in constant price, 2019 US million dollars.

Again, this international comparison did not focus on the differences in the volumes of ODA flows disbursed for climate-smart agriculture (as we are comparing a single country versus a macro-aggregate of countries), but rather on the more general trends that have been observed and that might have diverged over time. In addition, as more data will become available, it would be interesting to look at how CSA finance has evolved in the aftermath of Covid-19, as a global exogenous shock of this proportion might have severely affected donors' budget capacity and prioritisations.

6. What else matters?

Before concluding, it is worth discussing some open points that deserve attention.

- The **role of the stakeholders** involved in facilitating the uptake of the CSA practices: *states and district agriculture departments*, *extension offices, agriculture and climate research institutions, NGOs, donor agencies, private sector, farmers* and *value chain actors* are all **key actors**. The alignment of stakeholders' priorities in the choice of CSA practices is a crucial factor for speeding up its adoption and enabling its success. Therefore, mismatching in priorities among stakeholders can be a major element of concern. A recent interesting study focused on the "*participatory prioritisation framework*" in the context of CSA adoption (with regard to productivity, income, resilience and emissions) in the region of Maharashtra (India).[52] This concerned 74 actors: 40% were local farmers, 25% were government officials, 25% were development organisations, and 10% were from the private

[52] Khatri-Chhetri et al. (2019)

sector. Based on the stakeholders' response, a CSA-PI (Performance Index) was created (with a scale between 1 and 5). Based on this assessment:

- the favourite technologies were irrigation and water management interventions, followed by technologies for crop nutrient management, improved and resilient seed varieties, and agro-forestry management;
- **technical feasibility, cost structure** and **synergy with government programmes** seem to be the elements that influence the overall implementation feasibility (i.e. high productivity-high implementation feasibility (drip irrigation, agro-forestry, etc.), and high income-high implementation feasibility (micro-irrigation technologies, climate-smart housing for livestock)). However, there are also some good CSA tools that have low implementation feasibility despite their very good adaptation performance;
- interestingly, the most preferred CSA practices were the ones not implemented by most of the farmers (see barriers);
- subsidies for technology and provision of credit to the farmers are stated as being the main crucial factors by stakeholders, along with capacity building and market (insurance schemes);
- stakeholders identify governments, the private sector and NGOs as crucial players in promoting CSA practices/technologies;
- productivity and income (Pillar 1) were also the preferred targets for the stakeholders in enabling CSA practices.

- As for the **role of private sector,** it deserves a special mention, given its role as potential enabler in the diffusion of the CSA.[53] Many have advocated for a stronger collaboration and creation of partnership between public and private sectors, with the aim to unlock and unfold the potential of CSA and agricultural education system as well. "*There is [a] need to strengthen cooperation between the private sector (agribusiness) and public education to enhance [the] relevance of the training programs, to build links between students and potential employers and source funding*" (World Bank and Government of Zimbabwe, 2019: 56). Incentives and trust in public institutions might be relevant in this context, combined with a wider access to finance for smallholder farmers, as opportunities and business can grow for the private investors only when farmers can access finance and cease to be unbanked.[54]

- A much-debated topic gravitates around the **role of interdependencies among the SDGs**. Indeed, many of the pursued sustainable development goals are interlinked and directly connected to each other, and even more so in the CSA context (e.g. SDG 1: No poverty; SDG 2: Zero Hunger; SDG 5: Gender equality; SDG 8: Decent work and Economic growth; SDG 12: Responsible consumption and production; and SDG 13: Climate action), even if they pertain to different dimensions and areas of intervention.[55] However, failing to account for these interdependencies risks undermining " the ability of government and organizations

[53] Makuwerere (2020)
[54] https://www.casaprogramme.com/wp-content/uploads/2021/10/Private-finance-investment-opportunities-in-climate-smart-agriculture-technologies.pdf
[55] According to Obersteiner et al. (2016), policies focusing on SDG 12 are the most effective at limiting the presence of trade-offs in terms of environmental outcomes and food prices

to maximize the long-term moves towards sustainability".[56] Indeed, the achievement of one SDG may be functional and conducive to the success of the others. After all, adaptation aid is a subset of development aid, and development generally tends to increase resilience. By providing both *adaptation aid* and *development aid*, donors may be providing a package of assistance that serves both climate and general development purposes (Weiler et al., 2018).

7. Concluding remarks

Climate change represents one of the biggest environmental, social and economic challenges of our time. Its implications are massive, and it is a responsibility of us all, with no exception. Countries from all over the world have been called out to cooperate and coordinate action plans, with the aim of providing effective solutions to climate change. Common problems require common efforts and solutions, so that the burden of the costs involved might be shared and free-riding might be discouraged. Some economies tend to be more vulnerable to climate change, given their geography and their livelihood, and mostly relying on land use and agriculture. Climate change, food security and food systems are crucial and closely interlinked concepts, which have gained considerable attention, especially in the context of developing assistance.

The climate-smart agriculture (CSA) approach has been identified as a viable solution in order to ensure mitigation, adaptation and food security, as it can target, in principle, all three dimensions of sustainability (environmental, economic and social). Its success is, however, contingent on the presence of certain crucial elements. It must be:

- **responsive** to ecological stressors and social-political economic factors creating vulnerability;
- **adaptive** to the biophysical shock and the stressors it relates to;
- **focused** on those who are poorest and/or marginalised (inclusive);
- **context-specific** (one size does not fit all);
- **respectful** of cultural heritage and aim to preserve the cultural background;
- **transformative** (addressing systemic barriers).

An important element that has emerged from the systematic review of the literature as a crucial success factor for CSA practices is the complementarity between the specific adaptive capacity (targeted by the CSA) and the generic adaptive capacity. The latter can be targeted and shaped by other policies and interventions (both in the context of domestic policies and development assistance), and refers, for instance, to financial access, education, technological diffusion and social capital (which has the potential to close the information gap when it comes to new CSA technologies).

This report has provided a review of the most common CSA practices, their main features, the major drivers and the relative barriers. It has also offered a descriptive analysis of the CSA bilateral/earmarked development assistance provided by Norway, with a special focus on the agricultural sector. What has emerged is the important role played by agriculture in climate change adaptation, with a special focus on Africa, although it has contributed to a less degree to mitigation over the period 2009-2021. It will

[56] See https://www.cell.com/action/showPdf?pii=S2590-3322%2820%2930008-7

be interesting to look at the evolution of climate aid in the context of CSA over the coming years, and the effect of the pandemic on the donors' capacity and prioritisations.

Although it was possible to evaluate the objectives of the projects, nothing could be analytically inferred from the database concerning the **actual outcomes** (ex-post evaluation), given the lack of quantitative data to gauge the effects of these interventions in the CSA context. Therefore, this represents a major limitation of the descriptive analysis of this report. Besides, based on the literature review, long-term effects of CSA practices have not been systematically evaluated, and a major knowledge gap seems to exist. The evaluation of both **short** and **long-term** CSA interventions is required in order to adjust interventions that have underperformed or, vice versa, to promote and potentially scale those that have been successful. It may also help in understanding whether climate-smart agriculture could serve as an alternative mechanism for the structural transformation and economic growth in developing countries.

Another crucial point is how policy objectives related to mitigation and adaptation interact with other major policy targets, such as gender inequality, which has been proven to be influential in CSA practices. Although this was not the focus of the report, it represents an important element that can contribute to a better understanding of the synergies and the trade-offs that exist among the different sustainable development targets.

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