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Science-policy interfaces for sustainable climate-smart agriculture uptake: lessons learnt from national science-policy dialogue platforms in West Africa

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ABSTRACT

Connecting science with policy has always been challenging for both scientists and policymakers. In Ghana, Mali and Senegal, multi-stakeholder national science-policy dialogue platforms on climate-smart agriculture (CSA) were setup to use scientific evidence to create awareness of climate change impacts on agriculture and advocate for the mainstreaming of climate change and CSA into agricultural development plans. Based on the platforms' operations and achievements, we used semi-structured questionnaire interviews and reviewed technical reports produced by the platforms to analyse how their modes of operation and achievements improve understanding of the science-policy interfaces between agricultural and climate change decision making. Results showed that these platforms constitute an innovative approach to effectively engaging decision-makers and sustainably mainstreaming climate change into development plans. Effective science-policy interaction requires: (a) institutionalizing dialogue platforms by embedding them within national institutions, which improves their credibility, relevance and legitimacy among policymakers; (b) two-way communication, which contributes substantially to the co-development of solutions that address climate change vulnerabilities and impacts; and (c) relevant communication products and packaging of evidence that aligns with country priorities, which facilitates its uptake in policy-making processes. We conclude with a framework of sustainable operation for such platforms based on lessons learnt in the three countries.

KEYWORDS

Climate change; policy; institution; partnership; knowledge; capacity building; climate-smart agriculture; West Africa

1. Introduction

With current trends of population growth in West Africa, increased demand for food is a primary challenge. When one takes into account the effects of climate change on food production, such as higher temperatures, shifting seasons, more frequent and extreme weather events including flooding and drought (Jalloh, Nelson, Thomas, Zougmoré, & Roy-Macauley, 2013), that challenge grows even more daunting. Agriculture as the major source of livelihood for a majority of West Africans is being seriously impacted, and this is a major threat to farmers in the region. Addressing the negative impacts of climate change on agriculture will require adaptation and

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mitigation efforts in line with the Malabo Declaration regarding the commitment to enhancing the resilience of livelihoods and production systems to climate variability and related risks (NEPAD, 2014). These efforts will also contribute to achieving the Sustainable Development Goals on climate action and zero hunger. The concept of climate-smart agriculture (CSA) is based on these development priorities and aims at sustainably improving food security, reducing climate-related risks and mitigating climate change (FAO, 2010).

Given the cross-sectoral nature of climate change impacts, improving the adaptive capacity of people would require an inter-disciplinary approach for climate-smart technologies, policies and institutions, which can constitute the backbone of informed development of agricultural programs, plans and strategies (Dinesh et al., 2018). Indeed, meeting the challenges associated with climate change and its impacts on agriculture and food security is unlikely without transforming the ways researchers, policymakers, farmers, civil society, and the private sector all interact. With the new challenges posed by climate change, a multitude of development actors have emerged in West Africa, yet the coordination, communication and exchange of information on the subject remain weak (Totin, Roncoli, Traore, Somda, & Zougmoré, 2017). For effective, timely and informed decision-making, actors need advice and insights on the multiple issues underlying their decisions. Policy and institutional support has been shown to be crucial for the introduction and accelerated adoption of technologies such as climate-smart agriculture (Lipper et al., 2014) and conservation agriculture (Kassam et al., 2014). Nevertheless, such insights are sometimes slow to materialize because of a lack of appropriate strategies to sustainably establish a fruitful dialogue between researchers and decision-makers (Schut et al., 2015). Often, the lack of opportunities for meetings between stakeholders and inadequate methods for disseminating research results make it difficult for decision makers to utilise effectively the information that does exist. To address this problem, establishment of multi-stakeholder science-policy dialogue platforms is one method whereby interactions among stakeholders can be fostered, to strengthen the development of climate change policies that can benefit the agricultural sector (Schut et al., 2016). These science-policy dialogue platforms, analogous to agricultural innovation platforms, can be at the village, national, regional or global levels. As a multi-stakeholder platform, they represent the larger socioecological system within which a particular agricultural innovation operates (Van Rooyen, Ramshaw, Moyo, Stirzaker, & Bjornlund, 2017). The mode of operation of agricultural policy dialogue and innovation platforms is seen in their interaction, negotiation and collective action towards a common goal (Schut et al., 2015).

In West Africa, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) of the CGIAR (formerly 'Consultative Group for International Agricultural Research') has since 2012 supported the creation of national science-policy dialogue platforms on climate-smart agriculture (NSPDP-CSA) in Mali, Ghana and Senegal (Partey, Zougmoré, Ouedraogo, & Campbell, 2018). These platforms, made up of different stakeholders within the agricultural sector, were established to use scientific evidence in order to create awareness on climate change impacts on agriculture and make recommendations on the mainstreaming of climate change and CSA into agricultural development plans. The platforms were also expected to influence the environmental sectors within the respective countries. Since their establishment, there is limited information as to how the modes of operation and achievements of the NSPDP-CSA improve our understanding of the science-policy interfaces of agricultural and climate change decision making. The aim of this study is to use the evidence from the operations and achievements of the CCAFS platforms to make recommendations for effective and sustainable science-policy interaction on climate change and CSA. To achieve this, we first determined the different activities implemented by the platforms under various national contexts and their contribution to national priorities on climate change, agriculture and food security. Second, we assessed the different forms of interaction that were at play between science and policy in the operation of the platforms, by analysing their visibility among policy actors as well as knowledge generation and communication strategies linked to decision-making processes on the mainstreaming of CSA and climate change into agricultural policies and development plans.

2. Methodology

2.1. Analytical framework

Science-policy interface (SPI) is a well-researched area in the environmental and agricultural sciences. With

respect to the many environmental issues that require inter- and transdisciplinary approaches, SPI is considered an effective way in which to take into account a variety of knowledge types, views and interests of scientists, policy actors and other decision makers (Lopez-Rodriguez, Castro, Castro, Jorreto, & Cabello, 2015). In the literature, the interface between science and policy has been conceptualized in several ways. Funtowicz and Strand (2007) characterized policy engagement strategies that may be adopted by scientists as modern, precautionary, consensus, demarcation and extended participation models. These are described in Table 1, and each is context-specific with distinct advantages and disadvantages. Dilling and Lemos (2011) and Landry, Amara, and Lamari (2001) also address the different ways by which knowledge may be produced and disseminated for effective science-policy interaction. They categorized these into three different models of science creation: the science-push model, the demand-pull model, and the co-production model (Figure 1).

The science-push model assumes that decision-makers will make use of scientific knowledge because of their needs. Scientific production is driven by the pursuit of knowledge by the researcher rather than the policymaker (Dilling & Lemos, 2011), although the advances in the findings of research are considered a major determinant of the utilization of knowledge by the policymaker (Landry et al., 2001). For the demand-pull model, Landry et al. (2001) indicate that through searching for solutions to problems, policymakers may ask researchers to conduct specific scientific research. Sarewitz and Pielke (2007) note that the demand-pull model may sometimes lead to users of knowledge requesting scientific information that may be difficult to produce. Nevertheless, knowledge produced through the demand-pull model generally comes with higher expectations of uptake, even if this is not straightforward. The coproduction model combines the science-push and demand-pull models: knowledge is co-produced through frequent iteration and interaction between the scientific community and potential users (Dilling & Lemos, 2011).

The development of knowledge products at the interface of science and policy must be credible, salient and legitimate for there to be effective science-policy interaction that yields expected outcomes (Cash et al., 2003). Credibility refers to the trustworthiness, standard, technical adequacy and scientific plausibility of scientists and information delivered in the policy process (Van Enst, Driessen, & Runhaar, 2014). Salience is the relevance of the scientific information generated to policy processes; and legitimacy refers to the degree to which knowledge developed and used in the policy process is fair and

Table 1. Models of science-policy interactions used in the analysis.

Model	Explanation
Modern model	This is based on the assertion that science informs policy by producing objective, valid and reliable knowledge (Funtowicz & Strand, 2007). This is followed by sorting values and prioritization for the formulation of the most applicable policy. Under conditions of uncertainty, this model may likely underestimate risks and lead to the politicization of science (Udovyk, 2014).
Precautionary model	This model is particularly relevant for the management of risks. It recommends taking action when the likely benefits outweigh the cost of delays. Although characterized by divergent views, the model has been used in the Rio Declaration on Environment and Development, and the exploration of approaches to Bisphenol A management in the EU (Udovyk, 2014).
Consensus model	This model acknowledges the multiple avenues or voices by which science speaks to policy which can be often conflicting, truths to power seen as a rescue of the modern model from conflicting certainties. Important elements in the model include scientific dialogue, creation of inter-subjective knowledge in intergovernmental expert panels, and the search for robust findings (Udovyk, 2014; Wardekker et al., 2008).
Demarcation model	This model assumes that individuals and institutions generating science may alter the conclusions or content of their findings based on their interests and values. As such, advice provided cannot be guaranteed to be objective and neutral which might abuse science when used as evidence in the policy process. For this reason, the demarcation between the providers of scientific information and users is recommended as a means of protecting science from potential 'political' interferences that may undermine its integrity. This demarcation is meant to ensure that political accountability rests with policy makers and is not shifted, inappropriately, to scientists (Funtowicz & Strand, 2007).
Extended participation model	This model challenges the approach of the modern model. It recommends the consideration of all knowledge systems in science-policy interactions. Instead of considering science as the sole legitimate provider of knowledge, the model suggests a more participatory approach to the management and generation of advisory services based on science. In brief, the extended participation model recommends that science should be one part of the 'relevant knowledge' or should be brought in as evidence for a decision or policy process (Funtowicz & Strand, 2007; Udovyk, 2014).

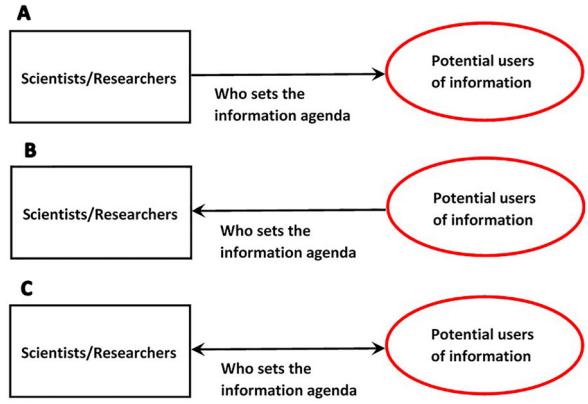

Figure 1. Models of science creation. A, science push; B, demand pull; C, coproduction model (Dilling & Lemos, 2011).

respectful of varying values and beliefs of stakeholders and their political acceptability (Cash et al., 2003; Koetz, Farrell, & Bridgewater, 2012; Van Enst et al., 2014). Several other conditions and recommendations for effective science-policy interfaces have also been highlighted in the literature, including ensuring long-term dialogue, mutual learning, and institutional support (Gorg et al., 2016; Marshall et al., 2017).

2.2. Methodology for analysis of platforms' modes of operation and achievements

To advance knowledge on how the modes of operation and achievements of the NSPDP-CSA improve our understanding of the science-policy interfaces of agricultural and climate change decision making, we first employed the three analytical categories defined by Cash et al. (2003) to determine how the platform was considered credible, salient and legitimate, in relation to their mandate of influencing policy decision-making processes. To do this, firstly we considered the platforms as institutions whose implementation successes and failures may be attributed in part, to their recognition and operational strategies (Koerts et al., 2011; Koetz et al., 2012). By institutions we do not mean the norms, clusters of rights, rules, and decision-making procedures that give rise to social practice, assign roles to participants, and guide interactions (Young et al., 2014). Instead, we consider institutions to be any organization, establishment, foundation, or the like, devoted to the promotion of a particular cause or program, especially one of public character (Koetz et al., 2012). Second, we related the platforms' engagement with policy-makers to the theoretical models of science-policy interactions described by Funtowicz and Strand (2007) and Udovyk (2014). The models briefly described in Table 1 have been used by several researchers to study science-policy interfaced regarding complex issues such as climate change (Funtowicz & Strand, 2007). The models help determine engagement strategies and communication pathways that applied to the platforms being considered here. We used context-specific actions, achievements and knowledge products of the platforms to illustrate these, in a way that is consistent with our interpretation of CSA (FAO, 2010).

Finally, we related knowledge generation strategies of the platforms to the three different models of science creation described by Dilling and Lemos (2011) and Landry et al. (2001): science push, demand pull, and the co-production (Figure 1).

Information collection regarding the platforms' operational and communication strategies, the knowledge products developed, and their activities and achievements, was carried out using semi-structured questionnaire interviews structured around these areas (Dinesh et al., 2018; Fowler, 2013). In some cases where answers needed further clarifications, we followed up with additional open-ended questionings to bring further insights on the targeted aspects of the platform work. The structure and questions of the questionnaire that was used for the interviews are detailed in Appendix 1. Respondents per country were representatives of institutions and included the chair, vice-chair and secretary of each platform and three decision-makers in the government ministries of agriculture, research and environment. While the chair, vice-chair and secretary were directly targeted as respondents, the representatives of the three

government ministries (agriculture, research and environment) were selected based mainly on their position (mainly heads of departments). The information collected from each respondent was triangulated with that from other respondents. For instance, we cross-checked, with some expected beneficiaries, the existence and delivery of the platforms' knowledge products. We also visited their websites to verify that the knowledge products and that the platforms' events to promote them are published. In addition, we conducted an inventory and reading of various information sources produced by the platforms, including working papers, policy briefs, Info notes, journal papers, video and radio documents, etc. (Table 4). Indeed, the numerous reports and knowledge products developed by the platforms (Table 4) were powerful means to cross-check the results achieved and the coherence of views expressed by the respondents vis-à-vis the platforms' operation, activities and achievements. In total, some 28 knowledge documents for Ghana, 24 for Mali and 28 for Senegal were used as sources of information. These documents mainly report activities, results and achievements by the platforms in the form of working papers, policy briefs, Info notes, journal papers, video documents, etc. (Appendix 2). While of a qualitative nature, the information and opinions collected from respondents were important for providing a good understanding of the perspectives and experiences of the actors involved and of the wider interest in these national platforms (Sarewitz & Pielke, 2007).

3. Results

The operations and achievements of the NSPDP-CSA were analysed vis-à-vis three determinants: (1) their mandate of influencing policy decision-making; (2) knowledge generation for effective science-policy interaction; and (3) engagement and communication pathways for effective science-policy interaction.

3.1. Mandate of the platforms for influencing policy decision-making

We analysed the credibility, legitimacy and saliency of the platforms as institutions carrying out the mandate of producing and sharing scientific knowledge that may influence science-policy interaction for decision-making (Cash et al., 2003).

In view of the cross-cutting nature and multi-stakeholder complexities of climate change issues, it is crucial that the platforms be legitimized. As noted above, legitimacy relates to the ways in which knowledge is respectful of varying values and beliefs of stakeholders and their political acceptability (Cash et al., 2003; Koetz et al., 2012; Van Enst et al., 2014). To help achieve this, the platforms were set up using participatory approaches (Figure 2). This allowed for the development of multi-stakeholder entities with cognitive diversity that had interest in climate-smart agriculture decision-making processes (Joyce, 2003). The setup of the country platforms started with a regional workshop in Dakar, Senegal with representatives from Ghana and Mali as well as Senegal. These representatives were from six key sectors: environment, agriculture, research, academia, farmers and civil society organizations. The goal of the workshop was to have high-level representation of decision makers and policy advisors from different sectors allied with discussions about the relevance of putting in place a specific national science-policy dialogue platform for each of the three countries, and if such a platform already existed in a given country, what specific actions would be needed to make it operational. As such, and besides specific goals to be pursued by the platforms, they were also expected to help fill some gaps within the existing National Climate Change Committees (NCCC) in the countries. For example, although the thematic groups defined within the Malian NCCC addressed national climate change priority areas, they had not been able to generate information products that could inform decisions by policymakers (Sogoba, Ba, Zougmoré, & Samaké, 2014). It was envisaged that in this case, the NSPDP-CSA could contribute in this regard. Following the regional workshop, participatory in-country meetings led to the definition of composition, leadership, vision, mission and operating strategies of the platforms. Considered to be complementary to existing initiatives and knowledge networks for combating climate change, most stakeholders recommended the establishment of a core of up to ten national organizations that could then be expanded via the gradual engagement of other actors. The country core teams also decided to designate an institutional focal point to coordinate and facilitate platform operations. The object was to select the most appropriate organization that could expand each country's NCCC with respect to agriculture and food security. The focal organizations selected for each platform were the National Agriculture Directorate (DA) in Senegal, the Animal Research Institute under the Council for Scientific and Industrial Research (CSIR-ARI) in Ghana,

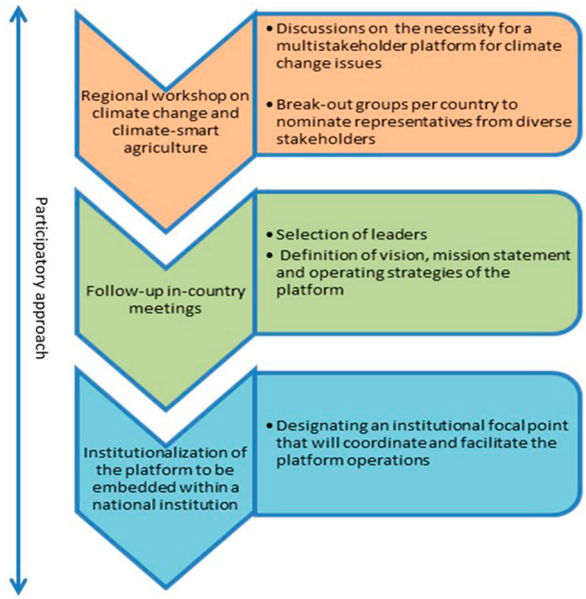

Figure 2. Process of setting up national science-policy dialogue platforms on climate-smart agriculture in Ghana, Mali and Senegal.

and the Environment and Sustainable Development Agency (AEDD) in Mali. Figure 3 shows the general composition of the platform in Ghana.

Several characteristics of the three country platforms are shown in Table 2, including information on number of members, representing organizations and website links. While the country platforms are generally embedded within different national institutions, the core leadership for all of them consisted of a chairperson, vice chair, secretary, accountant, monitoring and evaluation officer and a communications officer. To reinforce legitimacy at the country level, the leadership was balanced among different organizations with shared responsibilities. For instance, in Ghana, while the chairperson is from the Council for Scientific and Industrial Research (CSIR), the vice chairperson is from the Ministry of Food and Agriculture (MoFA). In Mali, the chairperson is from the agriculture sector (DNA) while the vice-chair is from the environment sector (AEDD).

The participatory and inclusive organization and implementation of the platforms also contributed to their credibility among national stakeholders. By credibility, Van Enst et al. (2014) means the trustworthiness, standard, technical adequacy and scientific plausibility of scientists and information delivered in the policy process. Indeed, trustworthiness and credibility was enhanced through organization and coordination by the platforms of major policy initiatives, which led to awareness-raising and engagement of high-level policymakers; examples include the development of a national CSA action plan in Ghana, and organization in Senegal of a high-level policy event on climate change mainstreaming into the presidential plan for an emerging Senegal by 2030, attended by parliamentarians, mayors and permanent secretaries.

From the interviews conducted in Ghana, Mali and Senegal, it was evident that the platforms were registered as not-for-profit organizations and had embedded themselves within existing national institutions as affiliate organizations (Table 2). In Senegal, a ministerial decree was published in 2015 by the Minister of Agriculture and Rural Equipment to formally institutionalize the platform as a sub-component of the NCCC. The decree provided guidance on membership, organizational structure and operating mode of the platform. Under the overall coordination of the platform's chairperson based at the Directorate of Agriculture (DA), five work streams were constituted and assigned to specific institutions: (i) state technical services and decentralized structures, led by the DA; (ii) policy decision makers, led by the Environment Committee of parliament; (iii) research, led by the University of Dakar, the Senegalese Institute for Agricultural Research (ISRA), the National Agency of Civil Aviation and Meteorology (ANACIM); (iv) civil society,

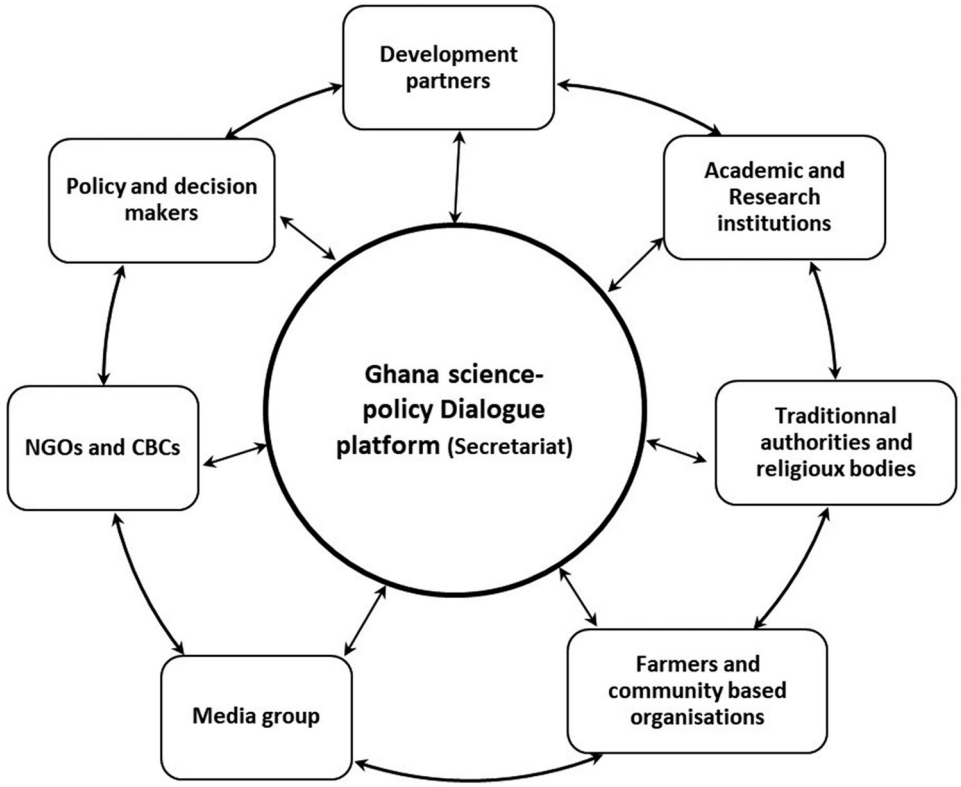

Figure 3. Composition of the Ghana national science-policy dialogue platform on climate change, agriculture and food security.

Table 2. Descriptive characteristics of the national science-policy dialogue platforms from 2012–2017.

	Ghana	Mali	Senegal
Nature of the platform	Not-for-profit	Not-for-profit	Not-for-profit
Legalization form	Certificate from the Register General	Administrative decision	Ministerial decision
Coordinating organization/ embeddedness	Council for Scientific and Industrial Research- Animal Research Institute (CSIR-ARI)	National Directorate of Agriculture (DNA)	Agriculture Directorate (DA)
Vice chair organization	Ministry of Food and Agriculture (MoFA)	Environment and Sustainable Development Agency (AEDD)	National Agency of Civil Aviation and Meteorology (ANACIM)
Webpage or website for knowledge sharing	http://www.csir-stepri.org/?item=269	http://c-casamali.org	www.ccasa-senegal.org

led by the national umbrella organization of producer organizations (CNCR); and (v) media, led by a monthly newspaper on agriculture (Agropasteur). Seen as a sub-component of the National Climate Change Committee, the platform is entrusted by the government to handle all aspects of agriculture and food security vis-à-vis climate change in Senegal. This demonstrates the credibility of the platform as a sustainable provider of scientific information that can guide decision making on climate change issues. In Mali, the formal creation of the platform was acted upon through an administrative decision in February 2013 by the Environmental Agency for Sustainable Development (AEDD). Formed by the government of Mali in 2010, AEDD was mandated to integrate climate change and coordinate government adaptation and mitigation actions in Mali (Andrieu et al., 2017). Given its position in the climate change institutional landscape of Mali, AEDD was designated as the focal point of the platform, with the National Directorate of Agriculture (DNA) playing the role of chair. A civil society organization (AMEDD) is also providing technical support to

AEDD to implement the platform's activities, thereby increasing the trustworthiness and technical adequacy of the platform. Overall, the platform is regarded as providing vital impetus to the thematic group on 'adaptation to climate change including risks and disasters' of the National Climate Change Committee (Sogoba et al., 2014). In Ghana, the platform was officially launched in November 2012 and formally registered in March 2015 as a not-for-profit entity with a certificate from the Register General of Ghana to commence business. In terms of leadership, while the chairperson is from the Council for Scientific and Industrial Research (CSIR), the vice chairperson is from the Ministry of Food and Agriculture (MoFA). Since its launch and registration, the Ghana platform has gained the reputation for climate change and CSA advocacy among government institutions such as the MoFA, CSIR, the Environmental Protection Agency, parliamentarians, NGOs, development organizations such as the Food and Agricultural Organization of the United Nations (FAO), and research centres of the CGIAR consortium such as the International Centre for Tropical Agriculture (CIAT), whose activities in Ghana have involved the platform.

Generally, respondents considered the decision to register and embed the platforms within national institutions as important for improving their recognition and visibility among policy decision-makers. Besides recognition by policymakers, interviewees within the platform confirmed that institutionalization of the platforms was key to benefiting from funding support from donor organizations who place strong emphasis on the credibility and legitimacy of organizations before granting funding support. For instance, the platforms in Ghana and Senegal obtained funding from FAO and the West Africa Agricultural Productivity Program (WAAPP), respectively, for various activities on CSA based on evidence of their affiliation to national institutions and the knowledge products on climate change and CSA that they have been able to produce. Decision-makers interviewed also confirmed that registering and embedding the NSPDP-CSA into already functioning and recognized institutions facilitated the building up of confidence in their mission, research methodology and results while also contributing to their sustainability. Apart from CCAFS, the platforms' activities are funded through bilateral sources, including FAO, USAID, WAAPP, and collaboration with other CGIAR centres.

With respect to salience, the processes by which relevant knowledge products are developed commence with the inclusive identification of priorities and the planning of yearly activities. Our survey results as summarized in Table 3, revealed that the core teams within the platforms meet to lead the development of yearly work plans which are then validated by platform members, with various activities implemented under the coordination of the secretariat within the group. Regular meetings (on average once a month) are organized to review progress of activities. In addition, capacity training workshops are organized for knowledge sharing and learning around specific climate change topics and policy studies defined by the platform. Indeed, given the diversity and field of specializations of the different stakeholders within the platforms, it was necessary that their capacities be built to enable them to engage policymakers effectively in addressing knowledge gaps on climate change, while also becoming aware of evidence-based CSA solutions. This is a core requirement for effective science-policy interactions (Totin et al., 2017). Numerous awareness-raising meetings were organized on various topics of interest for the countries; examples include the importance of climate information for decision-making on climate risk management, the concept of CSA and what it entails for countries' climate change strategies and policies, public debates on national TV about national adaptation plans, and high-level policy events with policy and decision-makers. Some of these awareness-raising initiatives have used capitalization documents developed by the platforms. For instance, Ghana produced four working papers, Mali three and Senegal three, which all address topics covering doubts and uncertainties among policymakers (Table 4). Platform members also attended and contributed to global-level events such as the UNFCCC' Conference of Parties and the global CSA alliance meetings. For instance, at the COP in Warsaw, a learning workshop on 'Agriculture in National Adaptation Plans (NAP)' gathered representatives from 12 countries, including platform members from Ghana and Mali. They developed a NAP analytical framework and a policy brief with recommendations on solutions to successful national adaptation plans (Kissinger et al., 2014).

3.2. Knowledge generation

We relate knowledge generation strategies of the platforms to the three different models of science creation (Figure 1). From the interviews, the platforms revealed that the main approaches for defining activities focused at generating knowledge and informing and

Table 3. Survey results of the country platforms and their operations from 2012–2017.

	Ghana	Mali	Senegal	Average
Number of organizations members of the core team	11	9	7	9
Total number of organizations members of the platform	40	20	30	30
Total number of persons members of the platform	65	30	100	65
Ratio of females in the platform (%)	25	25	30	26.6
Number of regular meetings	30	27	29	28.6
Number of planning meetings	5	5	5	5
Number of capacity strengthening workshops	20	21	18	19.6
Number of donor funding received	2	0	3	1.6
Number of global meetings attended	7	4	8	6.3
Number of people surveyed	6	6	6	6

engaging policy decision makers. Respondents confirmed that knowing which national agricultural policy, plan, program or strategy to target for climate change and/or CSA mainstreaming was challenging. To do this, they use desktop reviews and also organize meetings with decision-makers (mostly high-level government officials and heads of government departments) within the ministries of agriculture and in some instances with parliamentarians in their network, to develop a compendium of existing and proposed national policies, plans, programs and strategies in the agricultural sector that are being drafted, finalized, validated or approved by parliament. In addition, the platforms utilise both primary and secondary research information to characterize the agricultural sectors of the countries, and review information on climate change vulnerabilities, impacts on agriculture and food security, and existing adaptation strategies. In doing this, they also develop a compendium of available CSA options that can help farmers build adaptive capacity to climate change and variability. The costs and benefits of adopting specific CSA options are also evaluated and explained.

Deciding on which agricultural policy or development plan to prioritize for CSA mainstreaming has depended on what decision makers deem as most urgent and relevant. The platforms therefore have worked in collaboration with policymakers in the identification and implementation of solutions. With this approach, platform members gain awareness of the variety of directions in which their research findings can affect policy, while policy decision-makers can recognize areas where more applied research may be required. The platforms consider this manner of working and co-creating knowledge with decision-makers as central for improving the uptake of policy recommendations. In Mali, for instance, the adoption of the two-way communication approach resulted from a diagnostic study that analysed and shed light on the current situation of actors and organizations, barriers and opportunities for an operational dialogue between national climate change stakeholders (Sogoba et al., 2014). Recommendations from the study contributed to improving inter-institutional dialogue and well-informed decision-making on climate change.

All scientific evidences on climate change vulnerabilities, impacts on agriculture, adaptation strategies and CSA options are published as easily accessible communication products such as working papers, policy briefs, and Info Notes, which come in both paper print and electronic forms (Table 4).

Table 4. Knowledge products generated and policy processes contributed to by the science-policy dialogue platforms from 2012–2017.

	Ghana	Mali	Senegal
Publications			
Number of working papers	4	3	3
Number of Info Notes	4	2	3
Number of Flyers/ brochures	3	2	5
Number of blogs	4	6	5
Number of journal papers	0	1	0
Number of videos	5 videos	4 videos	7 videos
Other products	3 proceedings, 2 reports	2 radio programs	0
Contributions to policies processes			
Policy processes influenced	3	2	3
Contributed processes of national/sub-national policies/ plans	National CSA investment framework, Livestock policy action plan, District-climate change action plans & budgets	CSA for climate resilient communities' project in Mali, CSA mainstreamed into Mali GCF calls.	PRACAS, PSE, National agriculture action plan

CSA: Climate-Smart Agriculture, PRACAS: Programme d'Accélération de la Cadence de l'Agriculture Sénégalaise; PSE: Plan Sénégal Emergent; GCF: Green Climate Funds.

3.3. Engagement and communication pathways for effective science-policy interaction

We analysed the platforms' engagement and communication pathways based on the theoretical models of science-policy interactions outlined in Table 1. The communication within the platforms and with other national and regional stakeholders was crucial to effective science-policy interaction. This was concretized through different mechanisms, including the following: (1) the platform teams organized regular meetings not only to prioritize yearly work plans and monitor progress on implementation of planned activities but also to discuss and validate work plans, terms of reference, and results of commissioned studies; (2) various capacity training workshops organized for knowledge sharing and learning around specific climate change topics and policy studies selected by the platform; (3) the use of knowledge communication products for high-level policy engagements to advocate and inform policy changes and decision-making on climate change, agriculture and food security; and (4) the widespread dissemination of knowledge and information through media and websites. The Senegal platform has a dedicated website for information sharing about activities and research output (http://ccasa-senegal.org/). The other platforms have created dedicated web pages within the focal entity's website (Table 2). Examples of the effectiveness of these communication pathways are outlined below.

3.4 Examples of the platforms' activities and achievements

In this section we provide specific examples regarding some of the lessons learnt from the platforms and how they can help to inform policy decision making. In most cases, the achievements discussed are a result of the combination of the three determinants noted above: mandate, knowledge generation, and engagement and communication. Information reported here was obtained from reviews of technical reports developed by the platforms and triangulated through interviews with the chairpersons and secretary members of each platform.

3.4.1 Ghana

In the quest to identify agricultural policy initiatives for CSA mainstreaming, the platform in January 2014 organized a high-level national policy event which saw the attendance of government ministers, members of parliament, national research directors, academics and other high-level policymakers. The aim of the event was to make parliamentarians and high-level policymakers aware of the vulnerability of Ghana's agriculture and food systems to climate change, and to recommend policy and budgetary support for actions to adapt Ghana's agriculture and food systems to climate change.

During this event, the platform used various communication products such as policy briefs, booklets and working papers capturing topics on climate change impacts on agriculture in Ghana and CSA to lead intellectual and policy discussions. Knowledge shared by the platform on evidenced-based climate change impacts and implications for food security in Ghana highlighted the urgent need to give climate change full consideration in all agricultural development policies and plans. Decision-makers including parliamentarians from the Committee on the Environment agreed to support the mainstreaming of climate change into agricultural investments initiatives in Ghana (https://ccafs.cgiar.org/blog/). The final statement by parliamentarians also included support for research on CSA to benefit the most vulnerable populations (Essegbey, Totin, Karbo, Traoré, & Zougmoré, 2016). In addition, the policy discussions led by the Ministry of Food and Agriculture requested that the platform lead the development of Ghana's first National CSA Action Plan, targeted at ensuring the ground-level operationalization of the eight program areas of the agriculture and food security focus areas of Ghana's National Climate Change Policy (NCCP). The NCCP was developed by a multi-stakeholder group to affirm Ghana's ambition to mitigate risks posed by climate change (Essegbey, Nutsukpo, Karbo, & Zougmoré, 2015). In collaboration with the Ministry of Food and Agriculture (MoFA), in 2015 the platform developed and launched the country CSA action plan (2016–2020). Specific strategies were formulated in the CSA action plan to contribute to developing climate-resilient agriculture and food systems for all agro-ecological zones, as well as the human resource capacity required for a climate-resilient agriculture promotion in Ghana. Its development was made possible through the active engagement of various public and private entities in Ghana through dialogue and knowledge exchanges. The methodology for developing the national CSA action plan comprised desk research, data collection through

interviews and participatory workshops and small group meetings. Today, the CSA action plan is recognized by all stakeholders as a ground operation policy document for agricultural development in Ghana. A financial plan for the implementation of the action plan is currently being developed by the platform in close collaboration with various stakeholders such as the ministries of agriculture, environment, finance, local government and rural development.

3.4.2 Mali

Pursuant to the Paris Agreement, the Government of Mali identified the potential for its agricultural sectors to deliver adaptation-mitigation synergies, as well as economic, environmental and social co-benefits. CSA is therefore identified in the Nationally Determined Contributions (NDC) of Mali as one viable strategy to help meet its adaptation and mitigation goals. In view of this, the government is taking major steps to demonstrate its intentions to mainstream CSA by looking at ways to prioritize CSA options, and develop bankable proposals that can help solicit funds from climate finance initiatives such as the Green Climate Fund (GCF) for implementation of its NDC. In addition, intensions of the Economic Community of West African States (ECOWAS) to improve on the deficiencies of the National Agricultural Investment Plans (NAIPs) of member-states by integrating CSA in the NAIPs has called for urgent action by the Government of Mali to review its NAIPs for CSA mainstreaming. While this is critical for the Malian agricultural sector, there were considerable challenges in identifying, valuing and prioritizing bundles of climate-smart options for investment. Bringing together experts with the intellectual capacity to help integrate CSA into the NDCs and NAIPs was regarded as a viable response to these challenges.

In recognition of its composition, the platform was called upon to undertake a critical stocktaking of ongoing and promising CSA practices in Mali. A series of workshops was then organized by the platform with the participation of key national and international stakeholders for the co-development and prioritization of two CSA portfolios and related action plans for the Malian Sudanese zone. They identified CSA practices that potentially increase productivity, resilience, and mitigation, while also being profitable for farmers and society (Sogoba et al., 2014). This initiative resulted in the implementation of prioritized practices in research and development programs in Mali. In response to the request by the Ministry of Agriculture and the Parliament, the platform is presently playing an instrumental role in the CSA mainstreaming process (Andrieu et al., 2017). As a step forward, the platform was able to use these prioritized CSA options to collaborate with selected government departments in developing a US$ 1 million bankable proposal that has been submitted to the GCF. Successful fund acquisition will contribute to leveraging local funding sources to successfully meet the financial requirements for NDC implementation and to support the sustainable operation of the platform.

3.4.3 Senegal

In Senegal, the platform engaged with policymakers using workshops as means of sharing knowledge on the climate change implications for the agricultural sector and rural sector development programs. Platform members were asked to conduct an in-depth analysis of the level of climate change mainstreaming into activities defined in the country's major Program for Accelerated Agricultural Development (PRACAS). The PRACAS is the agricultural component of the presidential plan for an emerging Senegal by 2035 (PSE). Recommendations from the analysis were discussed during a high-level policy event organized in 2016 with attendance of national elected officials such as Parliamentarians, members of the Social, Environmental and Economic Council (https://www.Integration_cc_au_senegal). Following the event, the recommendations have been integrated into the PRACAS. In recognition of the immense contribution of the platform to CSA promotion in Senegal, the platform received a state-funding support of about US$ 200,000 in 2016, which has allowed the downscaling of the national platform into 13 district-level platforms. Given the national scale focus of this paper, activities of the district-level platforms are not addressed here and are described elsewhere (e.g. Totin et al., 2017).

4. Discussion

With CSA becoming a prominent approach for tackling climate change issues in the agriculture and food security sectors, and with countries now being committed to reducing their greenhouse gas emissions through their NDCs, the platforms were expected to be the springboards for the mainstreaming of climate change and CSA into countries agricultural development strategies, plans and policies (Robinson & Crane, 2016).

What have been the elements of success? First, the results provide clear indications that institutionalizing the platforms and embedding them within existing national institutions was important for improving their credibility, saliency and legitimacy within the three countries. The national platforms were recognized as crucial entities regarding climate change matters for the agriculture sector because of their composition and institutional affiliation. In the literature, lack of recognition is considered a major barrier to influencing policy at the science-policy interface (Weichselgartner & Kasperson, 2010). As policymakers consider the appeals and advices of advocacy groups, they appraise the legitimacy and credibility of such groups. By embedding the NSPDP-CSA into functioning and recognized institutions, it allowed policymakers to have confidence in the platforms' mission, research methodology and results. Besides recognition by policymakers, institutionalization of the platforms was key to accessing funding support for their sustainable operation, as has been the case for the platforms in Senegal and Ghana. This institutionalization is crucial when the platforms are addressing cross-sectoral issues. The Mali platform is an illustrative case, with the development of a bankable proposal on CSA promotion, which was submitted to GCF (Andrieu et al., 2017). Moreover, it appeared that most platforms adopted a reasonably balanced chairmanship between the agriculture and environment sectors, and the overall coordination and facilitation of the platform activities by a core team encompassing public and private stakeholders. Balanced leadership certainly facilitated the institutionalization of the national platforms and their embeddedness within existing national climate change organizational frameworks. When institutionalized, platforms have the capacity and power to shape the kinds of questions to be asked, the kinds of knowledge to generate, the kinds of analyses to make and communicate, and the kinds of policy options to consider (Robinson & Crane, 2016).

Second, the adoption of a two-way communication approach contributed to effective interaction between the platforms and policymakers. Traditionally, the interactions between scientists and policy actors have been based on a one-way approach, involving the scientists as the producers of knowledge and the policymakers as the users (Lopez-Rodriguez et al., 2015). Under this model, expert scientific advice is believed to make a direct contribution to the increased effectiveness and rationalization of political action. This linear thinking may not support effective policy-oriented research plans because it considers science and policy decision-making as separate domains, with science perceived as a uniquely neutral provider of objective knowledge (Young et al., 2014). From the results obtained here, it was evident that the platforms' activities were grounded in a more concerted process, with two-way communication approaches that allow scientists and policymakers to work together towards identifying agricultural priorities and proposing consensual solutions (Burnside-Lawry, Franquet, Wairiu, Holland, & Chand, 2017; Wardekker, van der Sluijs, Janssen, Kloprogge, & Petersen, 2008). In this way, scientists gain awareness of the variety of ways in which research can impact policy, and policymakers understand better the issues around which more applied research is required (Lopez-Rodriguez et al., 2015). The science-policy dialogue platforms were formed to demonstrate this culture of communication: bringing together groups of actors, including research and policy actors who share common interests, knowledge and experiences through a collaborative interaction that strengthens trust and mutual understanding (Vermeulen et al., 2012). The rationale was to facilitate sustainable interactions to provide knowledge and advice that may influence decision making in the longer term, not necessarily in the shorter term (Pieczka & Escobar, 2012; Young et al., 2014). In the development of the CSA action plan for Ghana and the CSA prioritization framework for Mali, this two-way communication was useful for scientists and policymakers in the development of a better understanding as to why CSA must be mainstreamed into agricultural policies and development plans to meet security and development goals in each country.

Third, the development of credible, relevant and salient communication products was key in the engagement of the platform with policymakers. As shown from the country examples, the platforms developed easily accessible and readable materials with evidenced-based information on climate change impacts and CSA options, which were used by policymakers. With climate change becoming topical on the agenda of global concerns, the need for robust science to inform policy design has increased (Dilling & Lemos, 2011). In the context of this paper, demonstrating evidence of climate change impacts and the potential of CSA to contribute to climate change adaptation and mitigation was evident in the platforms' engagement with policymakers. In addition, packaging scientific evidence on climate change and CSA and aligning them with

country priorities was crucial for the uptake of proposed solutions. In part, the platforms' participation in national, regional and global events on climate change and CSA, as well as their own internal knowledge sharing and capacity enhancement, may have contributed to their ability to produce relevant and timely knowledge products found usable by policymakers.

Generally, knowledge creation seemed to have combined the strengths of the science-push, demand-pull and co-production models described by Dilling and Lemos (2011). In the event leading up to the development of the CSA action plan in Ghana, for example, the platform shared knowledge on climate change and its implications for food security in Ghana. The communication products used in the discussion were developed exclusively by the platform for use by decision-makers. This followed the science-push approach. However, the documentation of the CSA options which guided the development of the CSA action plan benefitted from the contributions of heads of agricultural departments at the Ministry of Agriculture, who make critical decisions concerning agricultural policies in Ghana. In the case of Mali, stocktaking of CSA options was recommended by policymakers which followed the demand-pull model, while the prioritization of CSA options had the involvement of policymakers.

From these lessons learnt from the operation and achievements of these three platforms, we synthesized a general framework of sustainable operation of the platforms to informing policy and decision makings on CSA (Figure 4). It suggests the different steps and relationships by which the platforms were able to operate to identify countries' needs of knowledge and information, generate knowledge and scientific evidence on promising CSA options, and engage and communicate for effective science-policy interaction and policy advocacy.

Indeed, through regular interactions and networking among members, the platforms helped identify countries' priorities and needs for successful climate change adaptation and mitigation actions. The ultimate vision was to contribute to enabling millions of farmers to adapt to a changing climate while boosting food security under low-emissions development. As platforms on CSA, it was important that the platforms could provide evidence and knowledge on promising agricultural innovations that deliver on the three pillars of CSA: productivity/food security, adaptation and mitigation. All scientific evidence on climate

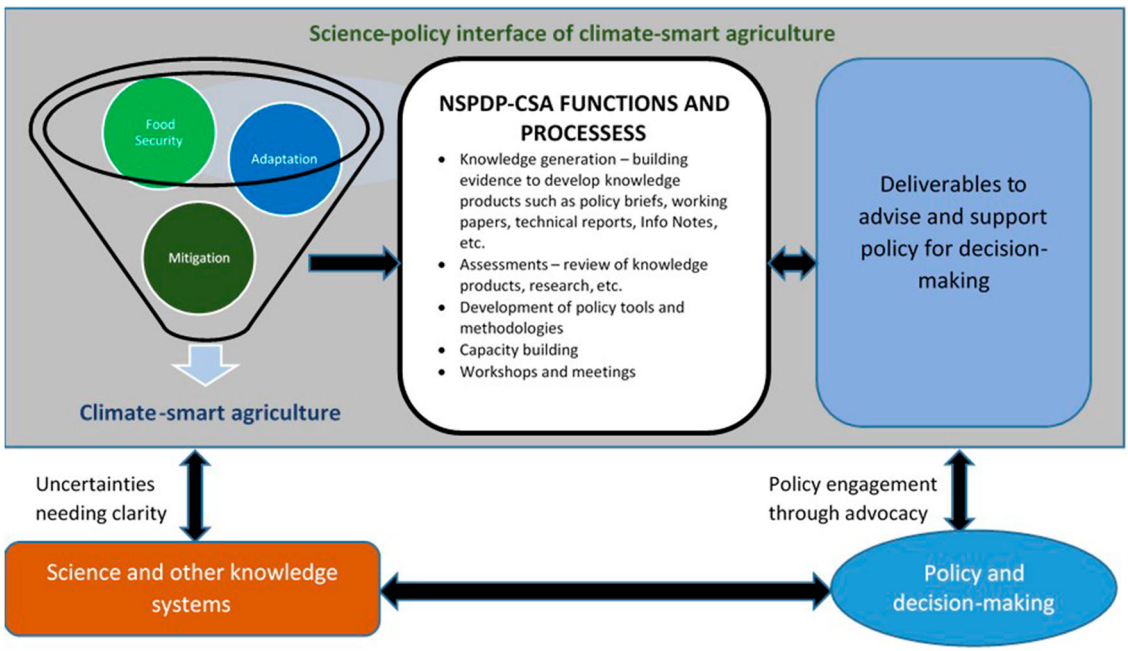

Figure 4. A framework for the operation of the National Science-Policy Dialogue Platforms on Climate-Smart Agriculture (NSPDP-CSA) in Senegal, Mali, and Ghana.

change and CSA options are published by the platforms as easily accessible communication products that are shared and discussed with policymakers. By engaging with policymakers in the co-development of solutions, these national platforms demonstrate elements of both the modern and then consensus model of science-policy interaction (Udovyk, 2014). Our results indicate that science can successfully influence policy through analyzing and understanding local contexts, when embedded in a suitable framework (Figure 4).

5. Conclusions

Five years' experience shows clearly that national science-policy dialogue platforms can be an innovative approach for engaging policymakers for climate change and CSA mainstreaming into agricultural development policies and plans in Ghana, Mali and Senegal. Through effective interaction with policymakers, the Ghana platform was able to lead the development of a national CSA action plan in collaboration with the Ministry of Agriculture, targeted at ensuring the ground-level operationalization of the eight program areas of the agriculture and food security focus areas of Ghana's NCCP. In Senegal, the platform contributed to mainstreaming climate change into two key national policies (PRACAS and PSE). In Mali, the platform contributed to stocktaking and prioritization of CSA options which are contributing to the development of a CSA investment plan and guiding the mainstreaming of CSA into the nationally determined contributions and national agricultural investment plans of Mali. This study also demonstrated that institutionalizing such platforms by embedding them into national institutions sustainably improves their credibility, saliency and legitimacy among policy actors. For effective science-policy interaction, two-way communication may have a considerable advantage in the co-development of solutions that address climate change vulnerabilities and impacts. In addition, our results show that relevant communication products that bring together evidence aligned with country priorities can facilitate ready uptake of proposed solutions. A framework of operation for the platforms was suggested based on lessons learnt from the three countries' experiences and achievements. Further studies on the barriers and boundary structures around the platforms are needed, to develop an innovative advocacy group on agriculture that can be a model for other sectors.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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