DETERMINANTS OF PARTICIPATION IN INNOVATION PLATFORMS AND ITS SUSTAINABILITY: A CASE STUDY OF SUB-SAHARAN AFRICA†

[DETERMINANTES DE LA PARTICIPACIÓN EN PLATAFORMAS DE INNOVACIÓN Y SU SOSTENIBILIDAD: UN ESTUDIO DE CASO DE ÁFRICA SUBSAHARIANA]

Adewale Adekunle[1], Adeolu Ayanwale[2] and Ayodeji Kehinde[3*]

[1] Commonwealth of Learning, 4710 Kingsway, Suite 2500, Burnaby: BC V5H 4M2: Canada, Email:wadekunle@col.org
[2]Department of Agricultural Economics, Obafemi Awolowo University, Ile Ife, Osun State, Nigeria. Email: aayanwa@oauife.edu.ng,
[3]Department of Agricultural Economics, Obafemi Awolowo University, P.M.B. 13: Ile-Ife: Osun: 220282: Nigeria. Email: kehindeayodeji8@gmail.com
**Corresponding author*

SUMMARY

Background. Innovation platforms (IP) are a set-up where a group of stakeholders that are somewhat interdependent are identified and invited to get together and interact in a forum for social learning. However, Sub-Saharan African researchers have recently paid very little attention to its participation. **Objective.** To investigate the determinants of participation in IPs and its sustainability. The study specifically outlines the socioeconomic characteristics of the farmers and identifies variables influencing farmers' participation in IPs and the sustainability of such IPs. **Methodology.** The study used a multistage sampling technique to collect its data. The data were analyzed using the Double hurdle count model. **Results.** The results of the first hurdle indicate that the decision to participate in IPs is significantly influenced by factors such as gender, age, household size, years of farming experience, number of female working-class members, young dependents, aged dependents, access to agricultural extension, and asset ownership. While the findings of the second hurdle model reveal that gender, age, marital status, years of schooling, the number of female members of the working class, the number of young dependents, the number of aged dependents, access to extension services, and asset ownership play a significant role in determining the sustainability of participation in IPs. **Implications.** The paper adds evidence for a better understanding of the determinants of participation in IPs and its sustainability**. Conclusions.** Based on these findings, it is recommended that institutional structures and programs that enhance farmers' education, the frequency of extension contacts, and farm income be implemented to sustain participation in IPs.

Key words: Determinants; Participation; Innovation platforms; Sustainability; Sub-Saharan Africa.

RESUMEN

Antecedentes. Las plataformas de innovación (PI) son una configuración en la que se identifica un grupo de partes interesadas que son algo interdependientes y se invita a reunirse e interactuar en un foro de aprendizaje social. Sin embargo, los investigadores del África Subsahariana han prestado recientemente muy poca atención a su participación. **Objetivo.** Investigar factores determinantes de la participación en las PI y su sostenibilidad. El estudio describe específicamente las características socioeconómicas de los agricultores e identifica las variables que influyen en la participación de los agricultores en los PI y la sostenibilidad de dichos PI. **Metodología.** El estudio utilizó una técnica de muestreo de etapas múltiples para recopilar sus datos. Los datos se analizaron utilizando el modelo de conteo de doble obstáculo. **Resultados.** Los resultados del primer obstáculo indican que la decisión de participar en los PI está significativamente influenciada por factores como el género, la edad, el tamaño del hogar, los años de experiencia agrícola, el número de miembros de la clase trabajadora, los dependientes jóvenes, los dependientes mayores, el acceso a la agricultura. extensión y propiedad de los bienes. Mientras que los hallazgos del segundo modelo de obstáculos revelan que el género, la edad, el estado civil, los años de escolaridad, el número de mujeres miembros de la clase trabajadora, el número de dependientes jóvenes, el número de dependientes de edad

† *Submitted October 14, 2022 – Accepted March 6, 2023.* http://doi.org/10.56369/tsaes.4583

ISSN: 1870-0462.

avanzada, el acceso a los servicios de extensión y los activos la propiedad desempeña un papel importante en la determinación de la sostenibilidad de la participación en los PI. **Implicaciones.** El documento agrega evidencia para una mejor comprensión de los determinantes de la participación en los PI y su sostenibilidad. **Conclusiones**. Con base en estos hallazgos, se recomienda que se implementen estructuras y programas institucionales que mejoren la educación de los agricultores, la frecuencia de los contactos de extensión y sus ingresos para sostener la participación en los PI.
Palabras clave: Determinantes; Participación; Plataformas de innovación; Sustentabilidad; Africa Sub-sahariana.

INTRODUCTION

In Sub-Saharan Africa, particularly in West Africa, smallholder agricultural productivity is still poor in comparison to agricultural productivity in other regions, and the availability of food per person is relatively static (Pretty *et al*., 2011; Hounkonnou *et al*., 2012). An increasing corpus of literature acknowledges that African farmers lack opportunities and that, to connect them to improved services and achieve development goals, it is necessary to reform institutional structures beyond the farm level (Salami *et al*., 2017). Smallholder farmers in Africa work hard to increase their agricultural production, food security, and income. However, African smallholder farmers must constantly modify their production systems due to frequent and abrupt changes in their production conditions, which calls for continuous innovation (Nederlof *et al*., 2011; World Bank, 2012). The establishment of innovation platforms (IPs) is one method that can assist African farmers in keeping pace with this ongoing innovation process (Cullen *et al*., 2014). There has been a noticeable transition in recent years from technology-focused to system-oriented approaches to innovation (Klerkx *et al*., 2012; Schut *et al*., 2016). One illustration is the increased focus on the Agricultural Innovation Systems (AIS) idea, which reframes innovation as emerging through the interaction of numerous people. An AIS is described as a network of businesses, organizations, and people working to commercialize radical innovations for goods, processes, and organizational structures, as well as the institutions and laws that influence how various actors communicate, share, access, exchange, and use knowledge (Hall *et al*., 2006). According to this concept, innovation encompasses social and institutional changes as well as new technologies.

Research and development organizations in SSA are increasingly experimenting with Innovation Platforms (IPs) as a tool to promote innovation by offering a social space for learning, experimentation, and negotiation among stakeholders as they work to operationalize the AIS concept (Schut *et al*., 2016). An IP is a place for learning and change, according to ILRI (2012). There is a diverse set of people involved—farmers, traders, food processors, researchers, government officials, etc.—who frequently represent the views of organizations. The members gather to diagnose issues, spot opportunities, and devise strategies for achieving their objectives. An IP is described in this paper as a setting where numerous actors or stakeholders with important interests can come together to solve issues through social learning. It emphasizes linkages between actors, knowledge flows, and incentive mechanisms. This paradigm holds that innovation of all types, whether technical or institutional, follows a non-linear process, and that the 'system' capacity depends on the 'density and quality of relationships' between the innovation-producing and using individuals, as well as supporting institutions (Altenburg *et al*., 2008). Although innovation systems thinking is intuitively attractive, many find the concepts abstract and struggle to find practical and implementable ways of intervening to improve innovation capacity. Above all, IPs represent a possible solution (Homann-Kee Tui *et al*., 2013; Schut *et al*., 2015). Furthermore, IPs are a strategic instrument to improve collaboration for agricultural development in developing countries, even though they frequently focus on marginalized poor stakeholders (Swaans *et al*., 2014; Van Paassen *et al*., 2014; Schut *et al*., 2016).

Thus, IPs are more open than committees, which are frequently established with a set of members to address a specific issue. As a discussion forum that operates without the requirement for a defined legal framework, IPs also free institutions from institutional limitations (van Paassen *et al*., 2014). Accordingly, they are more flexible as conversational tools than consortia, which frequently call for a binding legal agreement between the parties involved. In this sense, IPs have been promoted by various stakeholders who are interested in resolving a particular challenge, be it a problem or an opportunity, as a social place for knowledge sharing and learning for innovation (Adekunle *et al*. 2013). To do this, multi-stakeholder processes supported by IPs enable bottom-up searches for solutions to local bottlenecks (Pamuk *et al*., 2014). Multi-stakeholder procedures are used to identify obstacles, explore possibilities, look for solutions, and to spark collaboration and collective action (Sanyang *et al*.,

2016). IPs have a greater potential to identify innovations appropriate for a particular context than mono-stakeholder groups of individuals with common backgrounds and experiences because they ideally engage multiple types of stakeholders with distinct backgrounds and experiences for a common interest (Horton *et al*., 2010). The priorities for innovation differ among IPs because each IP establishes its own priorities based on local preferences, possibilities, and limits. According to Horton *et al*. (2010), Pamuk *et al*. (2014), Sanyang *et al*. (2016), and Sartas *et al* (2017), the success of IPs may be correlated with pre-existing social capital levels and the compatibility of innovations with local conditions.

An ideal and sustainable IP is determined by local preferences and draws stakeholders through an already-existing degree of social capital and a bottom-up participatory process (Sanyang *et al*., 2016). They may plan and carry out activities as a platform or manage the actions of specific members. IP can function either at the operational or strategic level. The strategic platform, which was established at a higher level to determine strategic orientations, alternatives, and axes, is in charge of the operational platforms, which are situated at the grassroots level. The operational IP's responsibilities include joint diagnostics with various ground actors, validation of technological options through demonstrations, validation of mechanisms for accessing various services, such as credit, information, and market, support for farmers' organizations, and facilitation of interactions between farmers through cross-visits, exchange days, and field days, as well as facilitation of interactions between ground actors for experience sharing and learning, build actors' capacity (farmers, processors, traders, etc.). The strategic platforms' roles include enlisting facilitators (researchers, extensionists, and NGO professionals) to improve IP support, facilitating experience sharing between facilitators to enforce mutual learning, creating institutional support for IP, negotiating better market access for IP members, and facilitating mechanisms to access various services, such as credits, markets, and technical supports. The platform enables acts that none of the participants could have accomplished independently. A platform is likely to need facilitation and may go through a drawn-out initial phase of mutual learning and role-defining before it can get down to business because of its complicated membership and potential for conflict (Misaki *et al*., 2018). As a result, IP offers a favorable setting for interaction and the performance of connected stakeholders' tasks in the innovation process (Adekunle *et al*., 2010).

Several studies (Jiggins *et al*., 2016; Schut *et al*., 2016; Sparrow and Traoré, 2018) have investigated the impact and outcomes of IPs as well as their role in promoting agricultural development. Innovation platforms have been considered to address issues facing smallholder farmers and sustainably raise the standard of living for rural dwellers (ISPC, 2015; Maru *et al*., 2018). Additionally, previous studies on agricultural intervention using IPs have demonstrated the potential benefit of this participatory strategy in terms of influence on the outcomes for the livelihood of rural smallholder farmers in Africa (World bank 2012; Mapila *et al*. 2012; Schut *et al* 2015). According to empirical studies, agricultural innovation systems have a positive impact on rural people's capacity to increase production by better utilizing their natural resource base (Gildemacher *et al*., 2009); improving food security and nutrition (Morris *et al*., 2007); diversifying their sources of income; and protect the environment (UN, 2008) in an African context. Furthermore, other studies have looked at the contribution of IPs to improved nutrition, food security, and poverty reduction (Wellard *et al*. 2013). The effect of innovation platforms (IPs) on food consumption and the reduction of rural poverty in central Africa was also assessed by Pamuk *et al*. (2015). Similarly, Ahimbisibwe *et al* (2020) analyzed the effects on household welfare of a platform for agricultural innovation in Uganda. Although numerous studies have demonstrated that IPs can encourage farmers´ innovation and enhance their standard of living (Kilelu *et al*., 2013; Lema *et al*., 2016), numerous studies have also highlighted flaws in the IP method. For instance, IPs might unintentionally strengthen existing power dynamics (Cullen *et al*., 2014). Similar to this, IPs can legitimize the influence of vested interests, which may result in less-than-optimal results (Hounkonnou *et al*., 2018; Schut *et al*., 2016). Others have claimed that IPs may not be adaptable enough to be guided by iterative learning procedures to handle developing challenges and have a limited ability to remove structural impediments (Kilelu *et al*., 2013; Klerkx *et al*., 2010). However, the effectiveness of IPs in achieving innovation outcomes depends on the context and is determined by the level of facilitation, the make-up of the stakeholders, and the power dynamics within IPs (Davies *et al*., 2018; Lamers *et al*., 2017; Cullen *et al*., 2014; Hounkonnou *et al*., 2012). Consequently, there is still much to learn about how a multi-stakeholder platform works and how it might affect how it develops (Lundy *et al* 2013; van Paassen *et al* 2013; Dror *et al* 2016). Rajalahti *et al*. (2008) suggest that because IPs are relatively new phenomenon in development, farmers' participation in IPs as well as

its sustainability can be used as an indicator of how well they are working to improve welfare.

There is, however, little knowledge of what drives farmers to engage in IPs and the elements that support or discourage active engagement that is, sustainability. The mobilization of pertinent actors to address critical issues and maintain their participation is hampered by this knowledge gap. Understanding the interests of participants in IPs is crucial because it enables IPs to find the right actors and design policies that take into account the variety of interests present in IPs in order to maintain sustainability. Opening up spaces for involvement does not guarantee that those who engage will be eager to do so (Adeyemo and Kehinde, 2019; Kehinde and Kehinde, 2020). Farmers generally show little enthusiasm for or cooperation with many initiatives (Mulema and Muzar, 2015; Adeyemo and Kehinde, 2020). If farmers are reasonably satisfied that taking part will result in the desired benefits, they are more likely to participate in collective action. Even if participants invest time and effort in participating, they may become discouraged in participatory programs and believe that nothing ever changes. Additionally, participatory approaches fail to acknowledge how individuals varied, shifting, and multifaceted identities influence their decision of whether and how to engage in IPs (Cleaver, 2001; Matilda *et al*., 2020). Finding the potential influences on farmers' participation in IPs is crucial. Most studies on IPs are based on impact evaluation. What currently lacks in the literature is how do we sustain farmers' participation in IPs? In actuality, the involvement of farmers in IPs has not yet been properly investigated. There is little research on IP involvement that has used rigorous analytical techniques to overcome problems with causal effect estimation, like selection bias in IP participation (Ahimbisibwe *et al*., 2020). Many of them used weak quantitative techniques like probit regression modeling and cost-benefit analysis (Cadilhon, 2013; Martey *et al*., 2014; Iromini *et al*., 2021), hence they continue to be an unsolved mystery (Kilelu *et al*., 2013). To address the issues of selection biases, this study uses a double hurdle count model with a control function. Therefore, this paper offers the results of an empirical study whose objective is to evaluate IP participation and its sustainability. The study specifically outlines the socioeconomic characteristics of the farmers and identifies variables influencing farmers' participation in IPs and the sustainability of such IPs. In order to solve the sustainability concerns of IPs' participation, the criteria that have been recorded will serve as a basis. By describing the reasons that induce actors to join in IPs and the circumstances under which involvement is maintained, this paper contributes to the field of IPs, which is still comparatively understudied. For policymakers establishing IPs intervention programs and ensuring its successful participation, the paper also has practical significance. The study will also act as a guide for the implementation of IPs in other parts of Africa in the future.

The rest of the paper is structured as follows. The next section provides a description of the study's data and methodology. Section three summarizes and discusses the empirical findings, and Section four concludes by outlining the implications for policy.

MATERIALS AND METHODS

Study area

The SSA CP tested the effectiveness of multi-stakeholder approaches in deriving impact in greater quanta in three Pilot Learning Sites (PLS) across sub-Saharan Africa. These sites are areas that have been benchmarked as representative locations for different regions in Africa. The areas are *Kano-Katsina-Maradi* which is the representative site for West Africa, The *Lake Kivu* area is the representative site for East and Central Africa, and the *Zimbabwe-Mozambique-Malawi* axis is the representative site for Southern Africa.

The data presented here comes from the Kano, Katsina, and Maradi (KKM) PLS, which spans a region with 18.3 million people across 83,900 square kilometers in Nigeria and the Niger Republic. The SSA CP used the Innovation Platform (IP) as the foundation for implementing the Integrated Agricultural Research for Development. The Innovation Platform is a physical and/or virtual forum that brings together all potential innovation actors, spanning the value chain and beyond, who are necessary for the generation of innovation for a commodity or system of focus, for constant interaction and joint learning on the development of innovation within the commodity chain, or value web of the system, for constant interaction and joint learning on the development of innovation within the communication network (Adekunle, 2005). The IP thus brings all these actors to play to enable them to easily deliver the three capitals – Human, Financial, and Social necessary for innovation and consequently the derivation of socioeconomic benefits. The first KKM PLS meeting, held in Kano in March 2005 (CORAF, 2005), marked the beginning of the process of IP establishment in the KKM. At this meeting, a Pilot Learning Team (PLT) was established to address priority issues identified in KKM communities. The PLT was composed of individuals

from many different scientific fields (biophysical and social) and organizations (national agricultural research institutes, universities, CGIAR Centres, advanced research institutes, extension agencies, NGOs, community-based and farmers' organizations, and the private sector).

The PLT established a team under the direction of IITA to conduct a validation study for limits and potential entrance sites in all three KKM agroecological zones (CORAF, 2005). To examine the situation on four levels—community, area, state, and region—this committee was put together from a variety of institutions, including research, extension, nongovernmental organizations (NGOs), and the private sector. The majority (90%) of the time was to be spent at the local level of the community, and they worked in 20 villages chosen to be representative of the PLS utilizing participatory approaches.

Studies of a similar nature have been out in various PLS in East, Central, and Southern Africa. This report addresses the PLS component of the SSA CP now being implemented in Western Africa. The project is located on the Nigerian and Niger Republican Kano-Katsina-Maradi axis. Three Task Forces (TFs) make up the project, namely:

(i) The Northern Guinea Savanna, which focuses on improving land productivity in the Northern Guinea Savanna zone through a multi-stakeholder approach integrating technical options, policy, and market access.

(ii) The Sudan Savanna TF, with the focus on ‘sustainable agricultural intensification and integrated natural resource management in the Sudan Savanna in West Africa.’

(iii) The Sahel Savanna Task Force, whose mission is to ‘improve rural livelihoods of rural population through intensification, access to markets, and sustainable management of natural resources in the Sahel agro-ecological zone’.

The approved research entry points for each of the three TFs are:

(i) Identification and promotion of suitable integrated pest management (IPM), indigenous knowledge systems (IKS), and crop production and storage technologies.

(ii) Promotion of suitable labor-saving technologies, such as traction and processing equipment.

(iii) Integrated management of soil fertility.

(iv) Crop-livestock production that is integrated.

(v) Promoting the right crop varieties, such as those that are early maturing, drought tolerant, and pest resistant.

(vi) Making use of the right technologies to develop irrigation potential (FARA, 2006).

The objectives of the TFs' projects are created and incorporated into a framework that is supposed to appropriately encapsulate the IAR4D's core idea. The implementation of the IAR4D is organized inside an IP system, as was mentioned in the introduction, and this system guided the choice of project sites based on the unique characteristics of the farming systems of each TF.

Sample selection

A total of 1800 households in the KKM PLS provided the data for this study. The survey was conducted by TFs as a part of the SSA CP, which was coordinated by FARA and sponsored by the governments of Italy and Norway as well as the European Union (EU) and the UK Department for International Development (DfID). The three main functional areas of the TFs in the KKM PLS were represented in the sample frame, which was derived from a number of districts. A random sample of district wards, a random sample of villages within each ward, and a random sample of households in each selected village were used to choose representative households in each district. Finally, a household was retained in the sample if it belonged to one of the 180 villages selected within the clean, conventional, or IP/action sites. Clean villages were villages with no presence of the government or governmental agencies or projects; conventional villages were villages where there are ongoing programs using conventional approaches while IP Action sites had Innovation Platforms established where learning using ODL/ICT was used to complement financial and social/agribusiness capital. Financial capital came usually from banks and other financial institutions participating in the activities of the Platform as Platform members while social/agribusiness capital ranges from seeds, fertilizer, agrochemical, processing, storage, bulking, transportation, marketing, policy, research, to extension, came from a wide range of partners providing those specialized services. They were also participating as members of the Platform.

Data analysis

This study examined the determinants of participation in IPs and its sustainability in West Africa using 1800 households. Firstly, the data were examined using descriptive statistics in order to better understand the socioeconomic characteristics of the farmers. The data were subsequently analyzed using the double hurdle count model to address the issues of unobserved heterogeneity and possible endogeneity.

Double hurdle count model

Determinants of farmers' participation in IP and sustainability in IPs were investigated using the Hurdle Poisson (HP) model. The decision to join an IP was used as a proxy for farmers' participation in IPs and the number of meetings attended by the farmers was used as a proxy for sustainability in participation in IPs. The model was selected because of the nature of the data. The dependent variable in the second hurdle is a zero-inflated and over-dispersed count variable. HP model consists of a binary choice model such as the probit model to determine factors affecting farmers' participation in IPs and Zero-Truncated Poisson (ZTP) model to determine the factors affecting sustainability in participation in IPs. They are not, however, estimated at the same time. When modeling dichotomous or binary outcome variables, binary probit regression is commonly used. Studies previously conducted have shown that the standard Poisson regression was frequently used to determine the intensity of participation (Winkelmann, 2008; Cameron and Trivedi, 2013; Ehiakpor *et al*., 2020).

However, the fundamental constraint of the common Poisson regression model is that the conditional expectation and conditional variance must be equal, or equi-dispersion, $E(y/\mu) = v(y/\mu) = \mu$. Unfortunately, this is not always the case. Over-dispersion is the term used to describe the situation where the conditional variance exceeds the conditional expectation. While under-dispersion is the situation where the conditional variance is less than the conditional expectation. Additionally, the count data set contains instances of excess zeros. This means that the estimation of standard Poisson regression may be erroneous if we do not take the type of count data into consideration (Greene, 2002; Erdman *et al*., 2008; Ehiakpor *et al*., 2020).

However, when we look at the sample data that was used in this study, we see that every farmer showed up for at least two of the scheduled sessions, which means that the sample data is indicative of non-zero results in this study. It could result in a skewed estimation, if the zero-truncation data feature is not considered (Lord *et al*., 2005). Therefore, the bias brought on by non-zero outcomes can be corrected by using a zero-truncated Poisson model (Ehiakpor *et al*., 2020). According to Long and Freese (2014), the standard Poisson regression model serves as the foundation for the zero-truncated Poisson model, which is a variant of that model:

$$Pr(y_j k/x_j) = \frac{exp(-\mu_j)\mu_j{}^{y_j}}{y_j} \quad (1)$$

where for a given x_j, the likelihood of observing zero outcomes is $Pr(y_j k/) = \frac{exp(-\mu_j)\mu_j{}^{y_j}}{y_j} pr(y_j = 0/x_j) = exp(-\mu_j)$ while the likelihood of observing non-zero outcomes is denoted as $pr(y_j = 0/x_j) = 1 - exp(-\mu_j)$

The conditional probability equation has the following form:

$$Pr(A/B) = \frac{Pr(AB)}{Pr(B)} \quad (2)$$

The conditional probability equation could be written as follows when we observed a certain count data, such as $y_j = K$, and granted that k is a non-zero value:

$$Pr(y_j = k|y_j > 0, x_j) = \frac{Pr(y_j = K \& y_j > 0|x_j)}{Pr(y_j > 0|x_j)} \quad (3)$$

The zero-truncated Poisson model can also be stated in terms of empirical equations as:

$$Pr(y_j > 0|x_j) = \beta x_j + \mu_j \quad (4)$$

Where $x_j$is the independent variables, μ_j signifies the error term, and β is the parameter that needs to be estimated. Based on the reviewed literature, the explanatory variables are chosen. Information were gathered by the researchers and processed using social science package software (SPSS) version 23 and using STATA software (ver. 17, College Station, TX).

RESULTS AND DISCUSSION

Socio-economics characteristics of the farmers

Table 1 provides a description of the socioeconomic characteristics of the farmers in the studied area.

Table 1. Descriptive statistics of sampled farmer.

Variables	Description	Mean	SD
Gender	1 = if farmer is male	0.88	0.32
Age	Age of the farmer in years	46.83	15.01
Marital Status	1 = if farmer is married	0.51	0.34
Education	Number of years spent in school	3.69	2.63
Household size	The number of persons in a household (count)	8.06	6.31
Farming experience	Number of years in farming	29.01	19.37
Male working-class members	The number of male persons between 16 to 58 in a household (count)	2.11	1.36
Female working-class members	The number of female persons between 16 to 58 in a household (count)	2.09	1.36
Young dependents	The number of persons below 16 in a household (count)	4.16	2.96
Aged dependents	The number of persons above 59 in a household (count)	1.05	0.46
Agricultural extension	1 = if farmer is visited by extension agent	0.76	0.52
IP participants	1 = if farmer is a participant of an IP	0.68	0.31
Numbers of meetings	Number of meetings attended by the farmers	14.76	9.56
Asset ownership	Asset owned by the farmers in Naira	143105	28498
Income	The monthly income of the farmer	13296	9773

Regarding IP participation, the age of the farmers is crucial. The average age of the respondents in the study area is 46 years. This demonstrates that a typical farmer in the study area is still in his or her economically and professionally active years. This finding corroborates the findings of Adeyemo and Kehinde (2020). The majority (88%) of the farmers are male. This indicates that men are more active and involved in IPs activities in West Africa. This finding corroborates the findings of Adeyemi *et al*. (2020). About 51% of the farmers are married. This reaffirms the fact that agricultural activities are primarily a family business run by the farm households in which their respective spouses assist in the farming operation thereby reducing labor costs. This could be the reason for their participation in IPs. The average years of education in the study is approximately 4 years. This implies that literate farmers are not involved in agricultural production in West Africa. This could hinder their participation in IPs. The farmers, in the study area, have an average of 29 years of farming experience. This study revealed that farmers in the study area, have many years of experience in farming and therefore could aid their participation in IPs. This finding corroborates the findings of Kehinde (2021). The average size of households in the study area is 8 persons. This suggests that the farmers in the study area have a sizeable household, which could act as a buffer against labor shortages on the farm. About 76% of the respondents are visited by extension agents in the last production season. The majority (68%) of the respondents are participants in agricultural IPs. IPs allow interactions among farmers in terms of information dissemination. The average number of meetings attended by farmers in IPs is 15. This could sustain their participation IPs. The average monthly income in study is ₦11531. The value of asset owned by the farmers is ₦143105. This could aid the farmers' participation in IPs.

Factors affecting farmers' participation in IPs and its sustainability

The double hurdle Poisson regression results are presented in Table 2. The independent variables were checked using the variance inflation factor for multicollinearity prior to the estimation of the double hurdle count model (VIF). The result, 4.97, shows that multicollinearity between the independent variables considered by the model is not an issue.

The results of the hurdle model are presented in two parts. The first hurdle shows the results of determinants of participation in IPs, while the second hurdle shows the result of factors that influence participation sustainability. In the first hurdle, the log-likelihood was significant (P=0.000), suggesting that the regressors have strong explanatory power. This shows that the entire model is well fit and significant at 1%. According to the results of the first hurdle, gender, age, household size, years of farming experience, number of female working-class members, number of young dependents, number of aged dependents, access to agricultural extension, Location_kano, and asset ownership have a significant impact on whether farmers participate in IPs or not. However, age and household size have a negative and significant impact on the decision to

Table 2. Determinants of participation and sustained participation in Ips using Zero truncated Poisson regression model.

Variable	First hurdle (participation in IPs)	Second hurdle (continued memberships in IPs)
	Coefficient (Z)	Coefficient (Z)
Gender	2.065**(2.47)	4.884***(7.03)
Age	-0.284***(-3.14)	-.0124**(-2.06)
Marital status	0.442(1.59)	0.890***(4.70)
Years of education	0.554(0.93)	0.366***(7.00)
Household size	-0.148*(-1.94)	0.907(0.07)
Years of farming experience	0.184***(2.99)	0.531(1.47)
Male working-class members	-0.157(-0.81)	0.126(0.55)
Female working-class members	1.326***(2.68)	0.432**(2.34)
Young dependents	0.625*(1.86)	0.914***(7.73)
Aged dependents	0.774**(2.07)	0.405**(2.01)
Income	0.141(0.09)	0.166(0.69)
Agricultural extension service	1.433*(1.74)	1.196***(3.33)
Asset ownership	0.604***(8.24)	-0.521***(-6.59)
Location_Kano	0.517***(3.00)	0.587***(3.60)
Location_Kastina	0.291(0.96)	0.212(0.43)
Location_Maradi	0.347(0.65)	0.202(0.92)
VIF	4.97	-
IMR	-	0.429(0.34)
Constant	4.815***(3.95)	2.906***(3.92)
LRChi^2	2374.15	2299.08
Loglikelihood	-1433.816	-1040.943
Prob>Chi^2	0.0000	0.0000
Likelihood ratio test of alpha Chibar2(01)		
Prob>chibar2	-	0.832

*** significant at 1%, ** significant at 5%

participate in IPs. This means that young farmers with small household sizes are more likely to participate in IPs. Gender, on the other hand, has a positive and significant effect on the decision to participate in IPs. This suggests that male farmers are more likely to participate in IPs. Years of farming experience has a positive and significant effect on the decision to participate in IPs. This suggests that experienced farmers are more likely to participate in IPs. The number of female working-class members has a positive and significant effect on the decision to participate in IPs. This suggests that farmers with a lot of female working-class members in the households are more likely to participate in IPs. The number of young dependents in the households has a positive and significant effect on the decision to participate in IPs. This suggests that farmers with a lot of young dependents are more likely to participate in IPs. The number of aged dependents has a positive and significant effect on the decision to participate in IPs. This suggests that households with a lot of aged dependents are more likely to participate in IPs. The access to agricultural extension services has a positive and significant effect on the decision to participate in IPs. This suggests that farmers with access to agricultural extension services are more likely to participate in IPs. The asset ownership has a positive and significant effect on the decision to participate in IPs. This suggests that farmers that owns asset are more likely to participate in IPs. The coefficient of district dummy for farmers located in kano has a positive and significant effect on the decision to participate in IPs. This suggests that farmers located in kano are more likely to participate in IPs.

An inverse Mills ratio was utilized as a covariate in the model to account for selection bias in the second hurdle. The fact that the IMR is not statistically significant indicates that selection bias was a concern. Therefore, it is justified to use a double hurdle model to estimate the factors that determine participation and its sustainability. Also, the likelihood ratio test of alpha substantially does not reject the null hypothesis that the errors do not display overdispersion in the second hurdle. As a

result, the zero truncated Poisson regression model could not be dismissed in favor of the zero truncated NB regression. As a result, when compared to the zero truncated NB regression model, the zero truncated Poisson model provides an unbiased and consistent estimate. The findings of the second hurdle model reveal that gender, age, marital status, years of schooling, the number of female members of the working class, the number of young dependents, the number of aged dependents, access to extension services, location_kano and asset ownership play a significant role in determining the sustainability of participation in IPs. As a result, the age of farmers has a negative and significant impact on the sustainability of participation in IPs. The result suggests that an increase in the age of farmers decreases the sustainability of participation in IPs. Similarly, asset ownership has a negative and significant impact on the sustainability of participation in IPs. The result suggests that an increase in farmers' assets decreases the sustainability of participation in IPs. Gender, on the other hand, has a positive and significant impact on the sustainability of participation in IPs. The result suggests that being a male farmer increases the sustainability of participation in IPs. Marital status positively and significantly affects the sustainability of participation in IPs. This implies that being a married farmer increases the sustainability of participation in IPs. Years of education positively and significantly affect the sustainability of participation in IPs. The result suggests that an increase in years of farmers' education increases the sustainability of participation in IPs. The number of female working-class members has a positive and significant impact on the sustainability of participation in IPs. The result suggests that increase in the number of female working-class members increases the sustainability of participation in IPs. The sustainability of participation in IPs is positively and significantly impacted by the number of young dependents in the household. The findings imply that as the number of young dependents increases, so does IP participation sustainability. The number of aged dependents in the household significantly and positively affects the sustainability of participation in IPs. The result suggests that increase in the number of aged dependents increases the sustainability of participation in IPs. Similarly, access to extension service positively and significantly affect the sustainability of participation in IPs. This implies that farmers with access to extension services participate in IPs. Location_kano positively and significantly affect the sustainability of participation in IPs. This suggests that contact with farmers located in kano increases the sustainability of participation in IPs.

The farmers' decision to participate in IPs is influenced by their gender. Abebaw and Hailes (2013) and Balgah (2016) supports the findings, that families headed by males are more likely to participate in IPs than households headed by women since men often perform fewer reproductive tasks. However, the farmer's age has a negative effect on their decision to participate in IPs. This is in line with what Awotide *et al*. (2015) discovered in rural Nigeria. This is due to the perception that younger farmers are strong risk-takers than older farmers, making them more open to change such as participation in IPs rather than participation in cooperatives. Ito *et al*. (2012) also supported the idea that aged farmers typically choose to withdraw themselves from IPs, particularly when the expenses of membership outweigh the benefits. Furthermore, the size of the household has a negative impact on IP involvement. This finding contradicts with previous studies from Mojo *et al*. (2015) and Bernard and Spielman (2009), among others. Farmers' participation in IPs is positively impacted by the farmers' years of farming experience. This is probably because as the farmer gets older in farm work, he accumulates more human capital in the form of experience and increased household members which when re-invested into the farming business will increase yield. Consequently, he will then need a trustworthy route to secure the right income from the sale of his product, which will push him to join IPs. This result is consistent with that of Tesfamariam (2012), who discovered that the number of years spent working as a farmer and in a cooperative had a positive impact on participation in IPs. According to studies conducted in Ethiopia, involvement in an agricultural group is influenced positively by a farmer's experience (Bernard *et al*., 2008; Bernard and Spielman, 2009; Abebaw and Haile, 2013). In a household, the proportion of female workers, children, and elderly dependents has a positive impact on participation in IPs. This can be explained by the fact that consumption pressure from these set of household members may push farmers to join an IP. The results support studies by Bernard and Spielman (2009) and Mojo *et al* (2015).

All things being equal, farmers that have adequate access to extension services are more likely to join IPs, according to Ma *et al*. (2018), Abdul-Rahaman and Abdulai (2018) and Kehinde and Ogundeji (2022). This may be explained by the fact that the government and other partners' extension workers frequently persuade farmers to join IPs and embrace new production technology since some new inputs, such as seedlings and information on their use, are shared through IPs. This agrees with Nugussie (2010), who contends that exposure to training and

visits is crucial to raising rural people's awareness of the benefit of participating in IPs. Farmer assets have a mixed impact on their involvement in IPs. For instance, the farmers' assets have a positive influence on the ability to participate in IPs. This is consistent with previous research by Asante *et al*. (2011), Bagher (2011), Francesconi and Heerink (2011), Abebaw and Haile (2013), and Mojo *et al* (2015). Contrarily, the level of participation in IPs is negatively influenced by the farmers' assets. This agrees with previous studies such as Karli *et al*. (2006) and Verhofstadt and Maertens (2014). Participation in IPs and marital status had a statistically significant positive relationship. An agricultural organization's membership was found to be significantly influenced by marital status in a study conducted in Poland (Banaszak, 2008), which may be explained by the fact that pressure from the household may push farmers to joining IPs. Years of education were found to have a positive impact on the decision to participate in IPs in this study, which may be explained by the fact that education enables farmers to comprehend the overall advantages of joining IPs. Findings from studies by Weber and Musshoff (2012), Verhofstadt and Maertens (2015), and Mojo, Fischer, and Degefa (2015) are in agreement with this finding. Conversely, education makes it easier to learn new information, such as market and input pricing, which seems to support the notion that farmers are more willing to join IPs (Ma *et al*., 2018; Mojo *et al*., 2017). The positive relationship between farmers located in kano and participation in Ips could be attributed to the fact that the farmers in kano understand the benefits of IPs.

Policy implication

This paper adds evidence for a better understanding of the determinants of participation in IPs and its sustainability.

CONCLUSIONS

This study investigated the factors that affect IP participation and its sustainability. A multistage sampling technique was used to obtain the data for the study. The data were analyzed using the Double hurdle count model. According to the results of the first hurdle, gender, age, household size, years of farming experience, number of female working-class members, number of young dependents, number of aged dependents, access to agricultural extension, Location_kano, and asset ownership have a significant impact on whether farmers participate in IPs or not. While the findings of the second hurdle model reveal that gender, age, marital status, years of schooling, the number of female members of the working class, the number of young dependents, the number of aged dependents, access to extension services, location_kano and asset ownership play a significant role in determining the sustainability of participation in IPs. This study concluded that raising farmers' income, education, and frequency of extension contacts will result in more active and sustainable participation in IPs. Therefore, we recommend governments to set up efficient programs and institutional frameworks that enhance farmer knowledge, the frequency of extension contacts, and income to enhance farmer participation in IPs. Second, in order to maximize participation and maintain the platform's sustainability, IP facilitators need to educate and target younger farmers. Finally, the IPs must be targeted at poor farmers as asset ownership discourages the likelihood to sustain participation in IPs. Farmers can escape extreme poverty and enhance their revenue by increasing their participation in IPs. Future studies, though, must investigate the characteristics of people who stop participating in IPs.

Acknowledgments
We are very grateful to the farmers who sat patiently for hours providing responses to the questionnaire. We also appreciate the anonymous reviewers whose valuable comments helped improve the manuscript.

Funding. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest. The authors declare that there are no known competing financial or personal interests associated with this publication.

Compliance with ethical standards. The research presents original data that are not submitted to other journals at the same time. Besides, the research was conducted according to the established procedures of the Obafemi Awolowo University, Ile-Ife, Nigeria. This study was ethically approved by the Postgraduate Committee of Obafemi Awolowo University, Ile-Ife, Nigeria. **Statement of informed consent.** Verbal and written informed consent were obtained from the respondents for their anonymized information to be published in this article. All participants were fully informed of the objective of the study.

Data availability. Data are available with the corresponding author at: (kehindeayodeji8@gmail.com) upon reasonable request.

Author contribution statement (CRediT). A. A. Adekunle - conceptualization, methodology, writing – review & editing. **A. D. Kehinde** – formal analysis, methodology, validation, writing – review & editing. **A.B. Ayanwale** – conceptualization, project administration.

REFERENCES

Adekunle, A.A., Ayanwale, A.B., Fatunbi, A.O., Olarinde, L.O., Oladunni, O., Nokoe, S., Binam, J.N., Kamara, A.Y., Maman, K.N., Dangbegnon, C. and Emechebe., 2014. Unlocking the Potential of Integrated Agricultural Research for Development in the Savanna of West Africa. Forum for Agricultural Research in Africa (FARA), Accra, Ghana.

Adekunle, A.A., Ellis-Jones, J., Ajibefun, I., Nyikal, R.A., Bangali, S., Fatunbi, A.O., and Angé, A., 2013. Agricultural innovation in sub-Saharan Africa: Experiences from multiple stakeholder approaches. Accra, Ghana: Forum for Agricultural Research in Africa (FARA), Accra, Ghana.

Adekunle, A.A., Fatunbi, A.O. and Jones, M.P., 2010. How to set up an Innovation Platform. A concept guide for the Sub-Saharan African Challenge Program (SSA CP). Forum for Agricultural Research in Africa (FARA), Accra, Ghana. Available at: https://vtechworks.lib.vt.edu/handle/10919/70141.

Adeyemi E.B., Adeyemo R., Kehinde A.D. And Famuyini C.A., 2020. Effects of Fadama III User Group Participation on Food Security of Rural Households in Benue State, Nigeria. *Ife Journal of Agriculture*, 32(3), pp. 85-97. https://ija.oauife.edu.ng/index.php/ija/article/view/585/470

Adeyemo R. and Kehinde A.D., 2019. Community-Based Organisation and Land Management Practices in Cassava Based Small Holder Farming System in Osun State. *Agricultura*, 111-112 (3-4), pp. 270-281. https://journals.usamvcluj.ro/index.php/agricultura/article/view/13533

Adeyemo, R. and Kehinde, A.D., 2020. Membership in association, Gender and Adoption of Land-enhancing Technologies among Arable Farmers in Ogun State, Nigeria. *Agricultural Science and Technology*, 12 (2), pp. 189-201. http://doi.org/10.15547/ast.2020.02.031

Adeyemo, R. and Kehinde, A.D., 2021. Community Driven Development: The case of FADAMA II Cooperatives in Alleviating Poverty in a Developing Country. *Contemporary Agriculture*, 70 (1-2), pp. 46-53. https://doi.org/10.2478/contagri-2021-0009

Ahimbisibwe, B.P., Morton, J.F., Feleke, S., Alene, A., Abdoulaye, T., Wellard, K., Mungatana, E., Bua, A., Asfaw, S. and Manyong, V., 2020. Household welfare impacts of an agricultural innovation platform in Uganda. *Food and Energy Security*, 9, pp. e225. https://doi.org/10.1002/fes3.225

Cadilhon, J.J., 2013. The functions of facilitation in multi-stakeholder learning: Lessons learned from capacity development on value chains management in innovation platforms in Burkina Faso and Ghana. *Knowledge Management for Development Journal*, 9, pp. 174–181. https://hdl.handle.net/10568/34328

Chave, M., Ozier-Lafontaine, H., Noel, Y. and Noël, Y., 2012. Towards agricultural innovation systems: Designing an operational interface. *Outlook on Agriculture*, 41(2), pp. 81–86. https://doi.org/10.5367/oa.2012.0090

Cleaver, F., 2001. Institutions, agency and the limitations of participatory approaches to development, in B. Cooke and U. Kothari, eds, Participation: The New Tyranny, Zed Books, London, pp. 36–50.

Critchley, W., Verburg, M. and Veldhuize, L. V., 2006. Facilitating Multi-Stakeholder Partnerships: Lessons from PROLINNOVA, IIRR/Leusden: PROLINNOVA International Secretariat, ETC EcoCulture, Silang, Cavite, Philippines.

Cullen, B., Tucker, J., Snyder, K., Lema, Z., and Duncan, A., 2014. An analysis of power dynamics within innovation platforms for natural resource management. *Innovation and Development*, 4, pp. 259–275. https://doi.org/10.1080/2157930X.2014.921274

Davies, J., Maru, Y., Hall, A., Abdourhamane, I.K., Adegbidi, A., Carberry, P., Dorai, K., Ennin, S.A., Etwire, P.M., and McMillan, L., 2018. Understanding innovation platform effectiveness through experiences from west and Central Africa. *Agricultural Systems*, 165, pp. 321–334. https://doi.org/10.1016/j.agsy.2016.12.014

Dror, I., Cadilhon, J.J., Schut, M., Misiko, M. and Maheshwari, S., 2016. Innovation Platforms for Agricultural Development. Evaluating the Mature Innovation Platforms Landscape. London, UK: Routledge.

Gildemacher, P., Maina, P., Nyongosa, M., Kinyae, P., Woldegiorgis, G., Lema, Y., Damene, B., Tafesse, S., Kakuhenzire, R., Kashaja, I., Musoke, C., Mudiope, J., Kahiu, I. and Oriz, O., 2009. Participatory analysis of the potato knowledge and information system in Ethiopia, Kenya and Uganda. In Sanginga, PC, Waters-Bayers, A, Kaaria, S, Njuki, J, and Wettasinha, C (Eds.) *Innovation Africa: Enriching farmers' livelihoods.* Earthscan: London. PP 153 – 165.

Hall, A., Janssen, W., Pehu, E. and Rajalahti, R., 2006. Enhancing Agricultural Innovation: How to Go beyond the Strengthening of Research Systems. World Bank, Washington DC.

Homann-Kee Tui, S., Adekunle, A., Lundy, M., Tucker, J., Birachi, E., Schut, M., Klerkx, L., Ballantyne, P., Duncan, A. and Cadilhon, J., 2013. What are innovation platforms? In*: Innovation Platforms Practice Brief* 1. ILRI, Nairobi, Kenya, pp. 1–7.

Horton, D., Akello, B., Aliguma, L., Bernet, T., Devaux, A., Lemaga, B., Magala, D., Mayanja, S., Sekitto, I., Thiele, G. and Velasco, C., 2010. Developing capacity for agricultural market chain innovation: experience with the 'PMCA' in Uganda. *Journal of International Development, 22*(3), pp. 367-389. https://doi.org/10.1002/jid.1694

Hounkonnou, D., Brouwers, J., van Huis, A., Jiggins, J., Kossou, D., R¨oling, N., Sakyi- Dawson, O. and Traor´e, M., 2018. Triggering regime change: a comparative analysis of the performance of innovation platforms that attempted to change the institutional context for nine agricultural domains in West Africa. *Agricultural Systems*, 165, pp. 296–309. https://doi.org/10.1016/j.agsy.2016.08.009

Hounkonnou, D., Kossou, D., Kuyper, T.W., Leeuwis, C., Nederlof, E.S., R¨oling, N., Sakyi- Dawson, O., Traor´e, M. and van Huis, A., 2012. An innovation systems approach to institutional change: smallholder development in West Africa. *Agricultural Systems*, 108, pp. 74–83. https://doi.org/10.1016/j.agsy.2016.09.012

ILRI., 2012. What are Innovation Platforms? *Proceedings from the International Livestock Research Institute (ILRI) Internal Meeting on Innovation Platforms, Nairobi, 6-7 December 2012*, ILRI, Nairobi. Kenya.

Iromini, O, Amujoyegbe, B, Kehinde, A.D. and Bamire, A.S., 2021. Adoption of Cassava-Legume Intensification Options among Farmers in Innovation Platform of Humidtropics Programme in Southwestern Nigeria. *Journal of Agronomy, Technology and Engineering Management*, 4(5), pp. 649-663. https://www.fimek.edu.rs/downloads/casopisi/jatem/issue/v4_5/3._Iromini_et_al_2021_4(5),_649-663.pdf

ISPC., 2015. Strategic study of good practice in AR4D partnership. CGIAR Independent Science and Partnership Council. 111pp.

Jiggins, J., Hounkonnou, D., Sakyi-Dawson, O., Kossou, D., Traore, M., Roling, N. and Van Huis, A., 2016. Innovation platforms and projects to support smallholder development – experiences from Sub-Saharan Africa. *Cahiers Agricultures*, 25, pp. 64002. https://doi.org/10.1051/cagri/2016051

Kehinde, A.D. 2021. Agricultural cooperatives and improved technologies adoption among smallholder farmers in cocoa-based farming systems of Southwestern Nigeria. *International Journal of Agricultural Management and Development*, 11(4), pp. 467-483. https://ijamad.rasht.iau.ir/article_687362.html

Kehinde, A.D. and Kehinde, M.A., 2020. The Impact of Credit Access and Cooperative Membership on Food Security of Rural Households in South-Western Nigeria.

Journal of Agribusiness and Rural Development, 57(3), pp. 255-268. https://doi.org/10.17306/J.JARD.2020.01337

Kehinde, A.D. and Ogundeji, A.A., 2022. The simultaneous impact of access to credit and cooperative services on cocoa productivity in South-western Nigeria. *Agriculture and Food Security*, 11, pp. 1-17. https://doi.org/10.1186/s40066-021-00351-4

Kilelu, C.W., Klerkx, L. and Leeuwis, C., 2013. Unravelling the role of innovation platforms in supporting co-evolution of innovation: contributions and tensions in a smallholder dairy development programme. *Agricultural Systems*, 118, pp. 65–77. https://doi.org/10.1016/j.agsy.2013.03.003

Klerkx, L., Aarts, N. and Leeuwis, C., 2010. Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. *Agricultural Systems*, *103*(6), pp. 390-400. https://doi.org/10.1016/j.agsy.2010.03.012

Klerkx, L., van Mierlo, B. and Leeuwis, C., 2012. Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In: Darnhofer, I., Gibbon, D., Dedieu, B. (Eds.), Farming Systems Research into the 21st Century: The New Dynamic. Springer, Dordrecht.

Lamers, D., Schut, M., Klerkx, L. and Van Asten, P., 2017. Compositional dynamics of multilevel innovation platforms in agricultural research for development. *Science and Public Policy*, 44, pp. 739–752. https://doi.org/10.1093/scipol/scx009

Lema, Z., Mulema, A.A., Le Borgne, E. and Duncan, A., 2016. Innovation platforms for improved natural resource management and sustainable intensification in the Ethiopian highlands. In: Dror, I., Cadilhon, J.J., Schut, M., Misiko, M., Maheshwari, S.H. (Eds.), Innovation Platforms for Agricultural Development: Evaluating the Mature Innovation Platforms Landscape. Routledge, New York, pp. 117–132.

Lundy, M., Le Borgne, E., Birachi, E., Cullen, B., Boogaard, B., Adekunle, A. and Victor, M., 2013. Monitoring innovation platforms. Innovation Platforms Practice Brief no. 5. International Livestock Research Institute (ILRI), Nairobi. https://cgspace.cgiar.org/handle/10568/34159

Magreta, R., Zingore, S. and Magombo, T., 2010. Analysis of effective market linkages in promoting investments in natural resource management in the rice-based farming system in Malawi: A case of Nkhate irrigation scheme. In: *ISDA 2010*, pp. 12-p. CIRAD-INRA-SupAgro.

Mapila, M. A., Kirsten, J. F. and Meyer, F., 2012. The impact of agricultural innovation system interventions on rural livelihoods in Malawi. *Development Southern Africa*, *29*, pp. 303- 315. https://doi.org/10.1080/0376835X.2012.675699

Martey, E., Etwire, P. M., Wiredu, A. N., and Dogbe, W., 2014. Factors influencing willingness to participate in the multi-stakeholder platform by smallholder farmers in Northern Ghana: implication for research and development. *Agricultural and Food Economics*, *2*, pp. 1-15. https://doi.org/10.1186/s40100-014-0011-4

Maru, Y., Sparrow, A., Stirzaker, R. and Davies, J., 2018. Integrated agricultural research for development (IAR4D) from a theory of change perspective. *Agricultural Systems*, 165, pp. 310–320. https://doi.org/10.1016/j.agsy.2016.09.012

Matilda A. Ouma, C.A., Onyango, J., Ombati, M. and Mango, N.,2020. Innovation platform for improving rice marketing decisions among smallholder farmers in Homa-Bay County, Kenya, *Cogent Food & Agriculture*, 6, pp.1832399. https://doi.org/10.1080/23311932.2020.1832399

Misaki, E., Apiola, M., Gaiani, S. and Tedre, M., 2018. Challenges facing sub-Saharan small-scale farmers in accessing farming information through mobile phones: A systematic literature review. *Electronic Journal of Information Systems in Developing Countries*, 84(4), e12034. https://doi.org/10.1002/isd2.12034

Morris, M.L., Kelly, V., Kopicki, R.J. and Byerlee, D., 2007. *Fertilizer use in African agriculture: Lessons learned and good practice guidelines*. World Bank: Washington 18 D.C.

Mulema, A. A. and Mazur, R. E., 2015. Motivation and participation in multi-stakeholder innovation platforms in the Great Lakes Region of Africa fair and organic value chain's view project Africa RISING view project motivation and participation in multi-stakeholder innovation platforms in the Great Lakes Region of Africa. *Community Development Journal*, 51, pp. 212-228. https://doi.org/10.1093/cdj/bsu068

Nederlof, S., Wongtschowski, M. and van der Lee, F. (Eds) 2011. *Putting Heads Together. Agricultural Innovation Platform in Practice*. Amsterdam, the Netherlands: KIT Publishers.

Ngwenya, H. and Hagmann, J., 2011. Making innovation systems work in practice: experiences in integrating innovation, social learning and knowledge in innovation platforms. *Knowledge Management for Development Journal*, 7, pp. 109–124. https://doi.org/10.1080/19474199.2011.593867

Pamuk, H., Bulte, E. and Adekunle, A.A., 2014. Do decentralized innovation systems promote agricultural technology adoption; Experimental evidence from Africa. *Food Policy*, 44, pp. 227–236. https://doi.org/10.1016/j.foodpol.2013.09.015

Pamuk, H., Bulte, E., Adekunle, A. and Diagne, A. 2015. Decentralized innovation systems and poverty reduction: Experimental evidence from Central Africa. *European Review of Agricultural Economics*, 42, pp. 99–127. https://doi.org/10.1093/erae/jbu007

Pretty, J., Toulmin, C., and Williams, S., 2011. Sustainable intensification in African agriculture. *International Journal of Agricultural Sustainability*, 9, pp. 5–24. https://doi.org/10.3763/ijas.2010.0583

Rajalahti, R., Janssen, W. and Pehu, E. 2008. Agricultural innovation systems: From diagnostics toward operational practices. Washington, DC: Agriculture & Rural Development Department, World Bank.

Salami, A., Kamara, A.B. and Brixiova, Z., 2017. Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities. African Development Bank, Tunis, Tunisia.

Sanyang, S., Taonda, S.J.B., Kuiseu, J., Coulibaly, N.T. and Konaté, L., 2016. A paradigm shift in African agricultural research for development: The role of innovation platforms. *International Journal of Agricultural Sustainability* 14, pp.187–213. https://doi.org/10.1080/14735903.2015.1070065

Sartas, M., Schut, M. and Leeuwis, C., 2017. Learning System for Agricultural Research for Development (LESARD): Documenting, reporting, and analysis of performance factors in multi-stakeholder processes. In *Sustainable Intensification in Smallholder Agriculture: An Integrated Systems Research Approach* (Eds I. Öborn, B. Vanlauwe, M. Phillips, R. Thomas, W. Brooijmans and K. Atta-Krah). London, UK: Earthscan.

Schut, M., Klerkx, L., Sartas, M., Lamers, D., McCampbell, M., Ogbonna, I., Kaushik, P., Atta-Krah, K. and Leeuwis, C., 2016. Innovation platforms: experiences with their institutional embedding in agricultural research for development. *Experimental Agriculture*, 52, pp. 537–561. https://doi.org/10.1017/S0014479718000200

Sparrow, A. D., and Traoré, A. 2018. Limits to the applicability of the innovation platform approach for agricultural development in West Africa: Socio-economic factors constrain stakeholder engagement and confidence. *Agricultural Systems*, 165, 335–343. https://doi.org/10.1016/j.agsy.2017.05.014

Swaans, K., Boogaard, B., Bendapudi, R., Taye, H., Hendrickx, S. and Klerkx, L., 2014. Operationalizing inclusive innovation: Lessons from innovation platforms in livestock value chains in India and Mozambique. *Innovation and Development*, 4, pp. 239–257. https://doi.org/10.1080/2157930X.2014.925246

Tambo, J. A. and Wünscher, T., 2017. Enhancing resilience to climate shocks through farmer innovation: evidence from northern Ghana. *Regional Environmental Change*, *17*, pp. 1505-1514. https://doi.org/10.1007/s10113-017-1113-9

UN (United Nations). 2008. 'Innovation for sustainable development: Local case studies from Africa.' Division for sustainable development. United Nations: New York.

Van Paassen, A., Klerkx, L., Adu-Acheampong, R., Adjei-Nsiah, S. and Zannoue, E., 2014. Agricultural innovation platforms in West Africa. How does strategic institutional entrepreneurship unfold in different value chain contexts? *Outlook on Agriculture*, 43, pp. 193–200. https://doi.org/10.5367/oa.2014.0

Van Paassen, A., Klerkx, L., Adu-Acheampong, R., Adjei-Nsiah, S., Ouologuem, B., Zannou, E., Vissoh, P., Soumano, L., Dembele, F. and Traore, M., 2013. Choice-making in facilitation of agricultural innovation platforms in different contexts in West Africa: experiences from Benin, Ghana and Mali. *Knowledge Management for Development Journal*, 9, pp. 79-94. https://km4djournal.org/index.php/km4dj/article/view/156/257

Wellard, K., Rafanomezana, J., Nyirenda, M., Okotel, M. and Subbey, V., 2013. A review of community extension ap proaches to innovation for improved livelihoods in Ghana, Uganda and Malawi. *The Journal of Agricultural Education and Extension*, 19, pp. 21-35. https://doi.org/10.1080/1389224X.2012.714712

World Bank. 2012. Agricultural innovation systems: An investment sourcebook. The World Bank. 658 pp.