OPEN ACCESS Int. J. Agr. Ext. 11 (01) 2023. 01-13 DOI: 10.33687/ijae.011.01.4342

Check for updates

Available Online at EScience Press

International Journal of Agricultural Extension

ISSN: 2311-6110 (Online), 2311-8547 (Print)

https://esciencepress.net/journals/IJAE

THE INFLUENCE OF MULTI-STAKEHOLDER NETWORKS ON THE UPTAKE OF SYSTEM OF RICE INTENSIFICATION AMONG SMALLHOLDER RICE FARMERS IN WESTERN KENYA

[a]Matilda A. Ouma*, [b]Luke O. Ouma, [c]Justus M. Ombati, [c]Christopher A. Onyango

[a] School of Agricultural and Food Sciences, Jaramogi Oginga Odinga University of Science and Technology, P.O. Box 210-40601, Bondo, Kenya.

[b] Biostatistics Research Group, Population Health Sciences institute, Newcastle University, United Kingdom.

[c] Department of Agricultural Education and Extension, Egerton University, P.O. Box 536 –20115, Egerton, Njoro, Kenya.

ARTICLE INFO

Article History

Received: October 19, 2022

Revised: February 03, 2023

Accepted: March 11, 2023

Keywords

Innovation platforms

Technology uptake

Capacity building

Participatory learning

Rice

ABSTRACT

Multi-stakeholder platforms are useful in driving technology uptake by bringing together stakeholders in a value chain for joint agenda-setting and learning to address a common goal. In this paper, we analyze how multi-stakeholder networks unfold in an innovation platform for networking and capacity building to drive the uptake of the system of rice intensification (SRI) in Oluch irrigation scheme in western Kenya. An innovation platform (IP) was launched at Oluch irrigation scheme in Kenya to enhance networking among stakeholders and facilitate capacity building among farmers. We performed a network analysis to understand the patterns of knowledge exchange among stakeholders in the IP. We further explore the association between innovation platform characteristics and the uptake of SRI practices using regression analyses, correlation analyses and chi-square-tests. Our findings reveal that there was a substantial increase in the uptake of SRI that was largely driven by strategic networks. Extensionists and farmer groups emerged as the most important actors while farmer-to-farmer networks are still nascent in promoting SRI than expected but growing. We conclude by describing the describe a theory of change developed and experienced in the IP. While multi-stakeholder networks may be important drivers of technology uptake, there is a need for careful analysis of strategic networks within the IP that are core to achieving IP goals such as uptake of the technology and ensuring sustainability of the IP.

Corresponding Author: Matilda A. Ouma

Email: ouma.ondijo@gmail.com

INTRODUCTION

Agricultural productivity across most food grain value chains in sub-Saharan Africa (SSA) is accosted by multiple competing constraints (Jayne *et al*., 2010; Kim *et al*., 2021; Nchuchuwe and Adejuwon, 2012; Obasanjo, 2013) that often demand the action or involvement of multiple stakeholders nearly at the same time (Ouma, Ombati *et al*., 2020; Verdier-Chouchane and Boly, 2017). For instance, while a narrow focus on production constraints may realize increased production is not sufficient when market forces are not favorable for good returns to the farmer, thus still dwarfing the concerted efforts to improve the livelihoods of farmers overall.

In recent years, there has been increased interest and calls for multi-stakeholder engagement across different value chains to support new technologies tailored to improving agricultural productivity and livelihoods among smallholder farmers (Sartas *et al.*, 2018). Notably, there is a growing body of evidence that multi-stakeholder networks (also innovation platforms, IPs) can spearhead the adoption of agricultural innovations in SSA (Homann-Kee *et al*., 2013; Mulema and Mazur, 2016; Pamuk and Van Rijn, 2019; Schut *et al*., 2019). The IP is a forum to enable a cluster of stakeholders (individuals and organizations) from varied sectors, and interests groups to exchange knowledge, resources, and ideas and take joint action in addressing a common goal for economic or social benefit (Cullen *et al*., 2014; Homann-Kee *et al*., 2013). This is contrary to the traditional approach of addressing broader technology adoption and adaptation objectives through actions taken in isolation by a single stakeholder without regard to interacting forces as is the case of the typical introduction of technology by government mainstream (agricultural extensionists) agricultural extension agents.

Of the several technologies for improving rice productivity proposed across Asia and Africa, the system of rice intensification (SRI) has emerged as highly favourable for Africa, especially among smallholder farmers (Kaloi *et al*., 2021). To date, several studies have now documented the benefits of SRI in Kenya and across SSA (Kaloi *et al*., 2020; Katambara *et al*., 2013; Mati *et al*., 2012; Ndiiri *et al*., 2013; Omwenga *et al*., 2014) and the constraints to its widespread adoption (Kaloi *et al*., 2021; Ouma *et al*., 2020). In countries such as Kenya, SRI has been shown to improve yield and gross revenue by at least 30% (Kaloi *et al*., 2020; Ndiiri *et al*., 2013) and marketing decisions among farmers (Ouma *et al*., 2020). Nevertheless, the country is still grappling with the adoption of such promising technologies to improve rice productivity. Importantly, there is limited evidence of efforts to explore alternative strategies to reintroduce SRI to farmers.

In this work, we conjecture that the IP promise in achieving the desired local impact in many settings in SSA (Dabire *et al*., 2017) can be leveraged to address the lag in uptake and adaptation of SRI among small-scale rice farmers in Kenya. We assert that we may address the lag in SRI uptake by implementing a multi-stakeholder involvement approach. One motivation for multi-stakeholder networks is the varied scope of challenges behind the lag in the adoption of agricultural innovations which are now well understood, including the availability of sufficient information about the technology; access to extension services; farmer education levels; income levels; access to credit and gender-related constraints (Kasirye, 2010; Llewellyn and Brown, 2020; Muzari *et al*., 2012; Udimal *et al*., 2017).

The objective of this paper is to analyse multi-stakeholder networks in a setting where an innovation platform for networking and capacity building was established to spearhead the uptake of SRI in Oluch irrigation scheme in western Kenya. Especially, we are interested in two questions: what is the influence of multi-stakeholder networks on the uptake of SRI in Oluch irrigation scheme? We conclude with a discussion of findings, some policy considerations, and future directions for research.

METHODS

Study setting & study design

Our study was undertaken at Oluch irrigation scheme of Rangwe Sub-County in Homabay county. In this setting, subsistence farming among smallholder farmers is dominant.

The suitability of this scheme was that; SRI had previously been introduced but failed to take root and secondly, the scheme largely experiences low agricultural productivity despite the great potential offered by the irrigation infrastructure. This scheme covers an area of approximately 1300 hectares, but only about half of these are under irrigation.

Our study employed an action research design enabling participatory learning processes based on a logically linked cyclical pattern of identifying an issue, collecting baseline measures, introducing and implementing change and re-measuring (Brydon-Miller and Coghlan, 2014; Pretty, 1995; Zuber-Skerrit and Fletcher, 2007). This was relevant for this study because the study identified the research problem in collaboration with smallholder farmers, gathered baseline data to have an in-depth understanding of the status quo, and took action (establishing networks and knowledge exchange among stakeholders) to promote productivity among smallholder rice farmers.

We established an innovation platform (IP) to facilitate networking among stakeholders and promote the uptake of SRI. A summary of the IP participants is shown in Table 1 below.

Table 1. Summary of stakeholders in the IP and their roles.

Stakeholder	Roles/responsibilities
Farmers	Rice farming
Irrigation water users association (IWUA)	Farmer group that manages irrigation water use
Irrigation project implementing team (KOSFIP)	Support the platform on legal aspects of water use
Ministry of Agriculture - County agricultural extension	Technical and advisory services
Input suppliers	Provision of farm Inputs
Traders	the market for rice production and by-products
Processors	Milling of rice
Research institutions	New technology, provision of certified seed, pest and disease control
Local administration	Mobilization of the community, security of the scheme and policy implementation

Data collection

First, a baseline study of 101 farmers was undertaken before the launching of the innovation platform to establish the current level of uptake of SRI, and existing challenges impeding uptake (Ouma *et al*., 2020). For the selection of the sample, a purposive sampling procedure was adopted. Secondly, an innovation platform was initiated to facilitate the action learning process and use of SRI.

The IP was established at an inaugural workshop involving all key stakeholders in the value chain including farmers, irrigation project implementing team, local administration, input suppliers, government service providers, traders, private millers, non-governmental organizations, private organizations and technical personnel. The IP recruited 24 farmers and 17 different stakeholders. Each stakeholder mapped out their roles, interests, objectives and benefits they aim to gain and to other stakeholders. Thereafter, SRI demonstration plots were established for learning, from which the 24 farmers gained skills to return and implement the technology in their farms and equally train farmers within their respective blocks. The IP initiated in 2016 lasted until 2019. At the end of the study duration, a survey of farmers was undertaken to establish the level of uptake of specific SRI practices, yield and gross revenue. Focus group discussions were undertaken to understand the benefits accrued to every stakeholder at the end of the study and discuss the findings of the end-line survey. Two genders separated FGDs each consisting of 12 participants were conducted targeting rice farmers who had participated in the IP and non-IP participants. This was meant to capture information on levels of uptake of SRI practices and use and the benefits derived. Observation checklists were used to observe the implementation of SRI practices after the IP intervention and the changes brought about by it. In addition, a checklist of reflective questions was used as a tool to gather IP participants' experiences before and after the IP intervention.

Statistical analysis

Data were analyzed using descriptive and inferential statistics. All statistical analyses were performed in R software (version 4.2.1, R Core Team, Vienna, Austria). Comparison of proportions was performed using Z-tests; chi-square tests were used to assess associations between categorical variables. The joint impact of multiple variables on a continuous outcome was assessed using linear regression models. A network analysis of multi-stakeholder networks within the IP launched in the study area was undertaken using the *graph* package (Csardi and Nepusz, 2006). Only quantitative data obtained from the FGDs is analysed in this study, while the qualitative data are analysed elsewhere. All statistical tests were performed at the 5% level of significance.

RESULTS

Uptake of SRI

Figure 1 shows a comparison of the uptake of key SRI practices before the launch of an IP at Oluch irrigation scheme, and the end of the IP. There was a significant increase in the uptake of all practices. Nonetheless, we observe skewed uptake of practices, i.e., certain practices were more likely to be adopted than others.

For instance, our observations and survey of IP-trained farmers showed that at least 90% of farmers embrace line planting and 70% embraced plating young healthy seedlings at the end of the study. On the other hand, mechanization ranked lowest among the five practices, but this can be attributed to the fact that many smallholder farmers in these resource-poor settings do not necessarily have the requisite capital to purchase equipment. Instead, many often rely on the pooling of resources to help achieve such objectives.

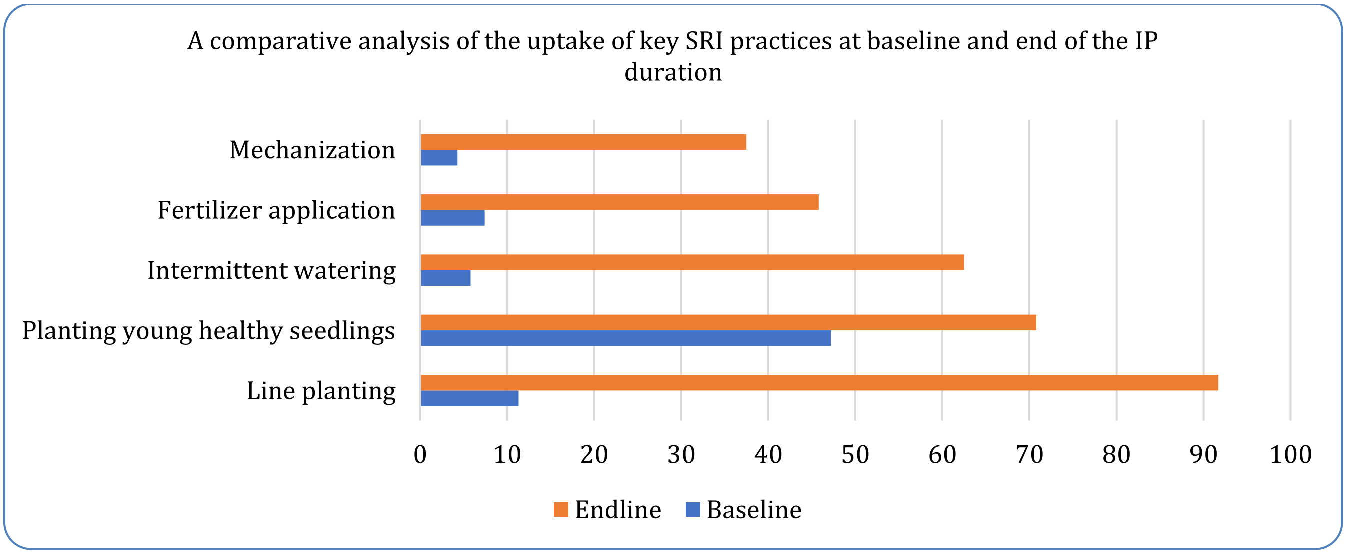
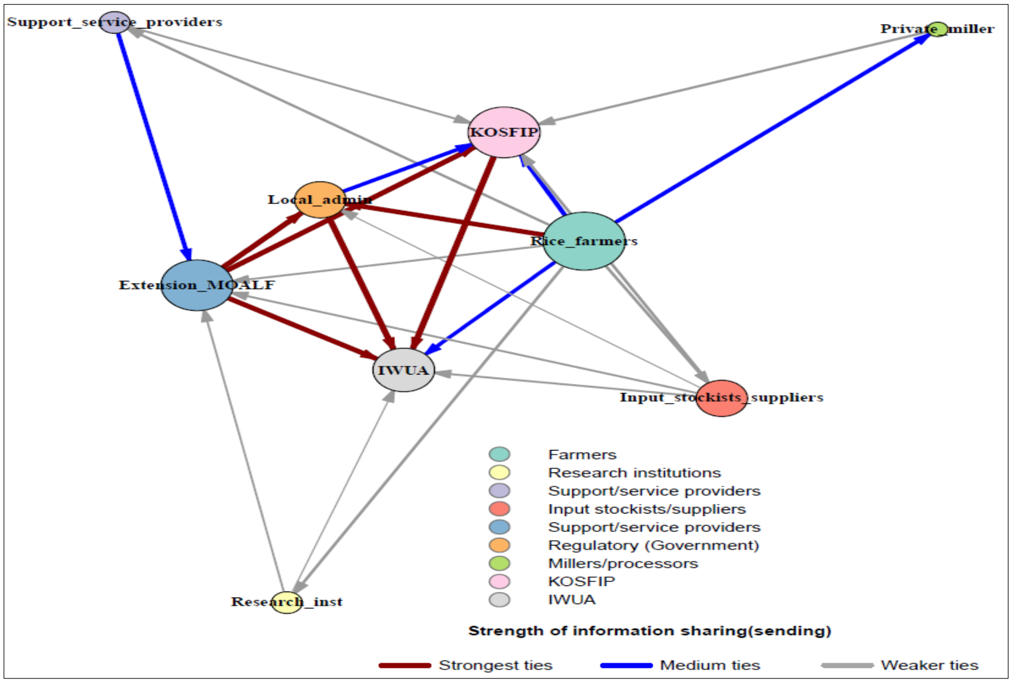


Figure 1. A comparative analysis of the uptake of key SRI practices at baseline and end of the IP duration.

Multi-stakeholder networks and SRI uptake

To determine how multi-stakeholder networks effectively promote SRI uptake at Oluch irrigation scheme, we present a network visualization of information-sharing patterns as acknowledged by the stakeholders within the IP. For clarity, we present two network graphs where: the first (Figure 2) depicts sending of information from a given stakeholder X to another stakeholder Y in the IP and the second (Figure 3) depicts how stakeholder X receives information from, thus both depictions mirror a feedback loop.

The network ties linking stakeholders are weighted based on the strength between any two stakeholders. The size of the nodes represents the number of interactions with other stakeholders. First, we observe variable strengths in the ties between the stakeholders within the innovation platform. This is an indication of different levels of interaction among the stakeholders. In Figure 2 the strongest ties link five stakeholders: rice farmers, extension officers, IWUA (an umbrella body of farmers), KOSFIP (government project implementer and local administration. Almost similar results are observed in Figure 3. The proximity of stakeholders in the network map is an indicator of their close level of interaction. The five stakeholders with the strongest ties linking them are those who are 'key' primary stakeholders who are located within or close to the irrigation scheme like farmers. The observed higher degree of interaction is because each of these stakeholders is either i) the main link between rice farmers and other non-farmer stakeholders OR ii) the first point of contact for non-farmer stakeholders seeking to engage with the smallholder farmers. For instance, research institutions, support/service providers and millers/processors are further away in the network confirming the usual practice that they are commonly brought aboard the platform by a stakeholder who has very strong direct links with the farmers or the umbrella body of farmers, IWUA (for example, extension officers or KOSFIP). The results in Figure 2 show weak ties between farmers and other stakeholders. These findings demonstrate that although various stakeholders share a significant amount of information with farmers, these stakeholders receive information from farmers only to a limited extent. This perhaps suggests limited learning from farmers by stakeholders.



. Figure 2. Strength of multi-stakeholder information sharing (sending) in the IP.

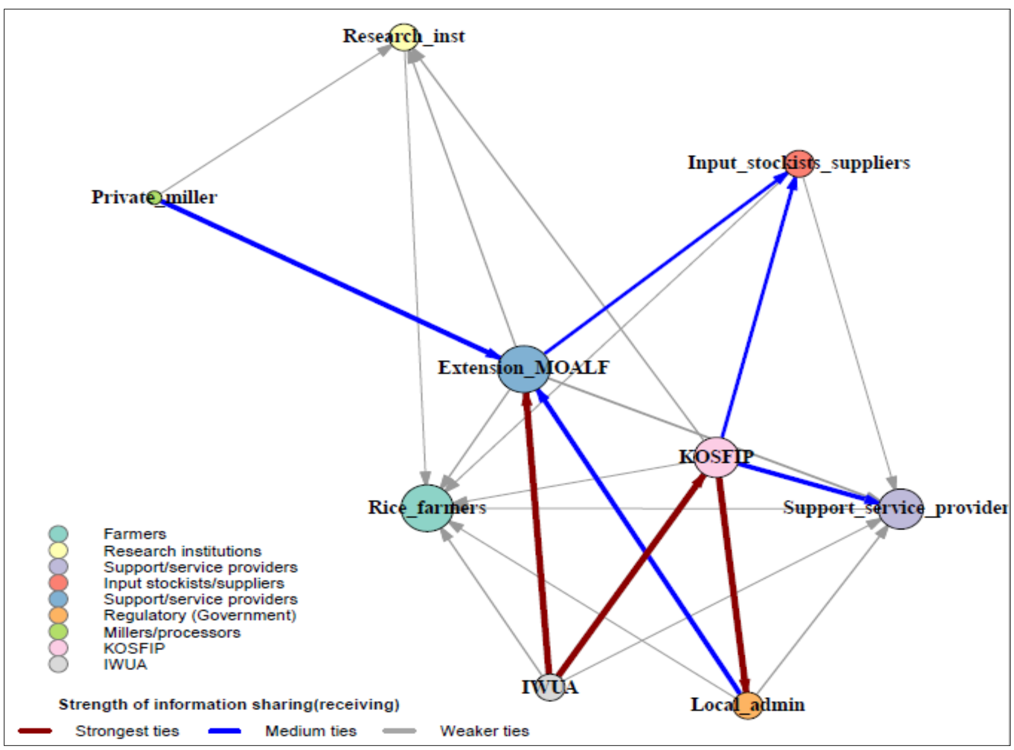


Figure 3. Strength of multi-stakeholder information sharing (receiving) in the IP.

Analysis of information sharing among stakeholders

To establish information sharing between the 24 farmers about platform and stakeholder representatives, all IP participants responded to a basic question, on a Likert scale, how do they rate the degree of information sharing between them. Each member rated their engagement with all other members of the IP. The results presented in Table 2 show summary statistics for information sharing. Here, sending information refers to a participant's conception of how they share information with the other member/stakeholder while receiving information refers to the same participants' conception of how the other member/participant shares information with them on the platform.

Table 2. Summary of statistics for the level of information sharing among stakeholders.

Stakeholder classification	Receiving information		Sending information	
	Mean	SD	Mean	SD
Farmers (all)	7.0	1.7	2.8	1.3
Research institutions	2.6	1.0	4.3	2.5
Support/service providers	2.8	1.1	4.6	2.6
Input stockists/suppliers)	2.9	1.3	5.1	2.7
Note: information sharing was rated on a scale of 1-10				

Table 2 show that farmers received the most information compared to all other stakeholders in the platform. This is unsurprising because farmers are the primary stakeholders on this platform and the IP exists solely to promote their uptake of SRI practices and improve rice productivity. Information sharing from farmers to other stakeholders was quite low. This implies that while all efforts are geared toward imparting knowledge to farmers, there was limited feedback from the stakeholders from whom it was received. Further, we explored farmers information sharing characteristics – whether information sharing was different amongst farmers, and between farmers and other non-farmer stakeholders. The degree of information sharing was categorized as low, moderate, and high to depict the various levels of interaction. Table 3 below assesses for a difference in proportions across different degrees of information sharing.

Table 3. Information sharing patterns between farmers and stakeholders in the IP.

Information flow	Farmer – farmer (%)			Non-farmer stakeholder – farmer (%)			Test for difference in proportions
	Low	Moderate	High	Low	Moderate	High	
Sending information	81.2	18.1	0.7	1.2	53.9	44.9	P-value < 0.001
Receiving information	78.6	21	0.4	70.8	27.2	2	P-value = .0287

The findings in Table 3 show strong evidence of variation in how farmers share information. Farmers learn less from each other compared to their learning and interaction with a non-farmer stakeholder on the platform. This observation could be attributed to the fact that farmers have cited inadequate knowledge and skills on SRI practices at the baseline survey, were more confident to learn from experts who were now within their proximity as a result of the IP. However, it is anticipated that with sufficient learning, farmers' level of confidence will have increased. In Table 4 and Table 5, we characterize knowledge exchange among farmers. Specifically, we analyse to what degree farmers learn from each other, from other stakeholders, and to what degree others receive information from them. We observe that overall information sharing among farmers is still very low as less than 1 percent send or receive information from one another. Similarly, the characteristics of sharing also indicate this scenario as 67 to 70 percent of the farmers hardly share information.

At least 20 percent of farmers share information to a moderate level, while most of the farmers share information only to a low degree. This observation potentially indicates the likelihood that farmers are more inclined to receive information from non-farmer stakeholders or that most of them are less confident in sharing specific famer-related information with their colleagues that they suppose non-farmer stakeholders would best handle.

Table 4. Knowledge exchange between farmers and other stakeholders.

Degree of sending information	Farmer to farmer (%)	Another stakeholder to the farmer (%)	Overall	Test for difference in proportions
Low degree	81.2	1.2	33.5	Test statistic = 486.1934 P-value <0.001
Moderate	18.1	53.9	39.5	
High degree	0.7	44.9	27.0	

Table 5. Farmer knowledge reception from other stakeholders.

Degree of receiving information	Farmer to farmer (%)	Another stakeholder and farmer (%)	Overall (%)	Test for difference in proportions
Low degree	78.6	70.8	74.0	Test statistic = 7.1016 P-value = 0.028702
Moderate	21.0	27.2	24.7	
High degree	0.4	2.0	1.3	

Table 6 summarizes the information-sharing characteristics among non-farmer stakeholders in the IP. In principle, we perceived that even non-farmer stakeholders would largely benefit from one another and develop synergies. The findings reveal that most non-farmer stakeholders only interacted to a low degree overall. This may be expected because many of the non-farmer stakeholders rarely engage in knowledge exchange or forums for collective action to support the farmer (i.e., absence of common ground), For instance, the link between researchers and input suppliers, and traders were non-existent before the IP. More often, many of the stakeholders individually reach or engage farmers directly through their farmer groups or extensionists.

A positive note of the observed results in Table 6 is that stakeholders are keen to initiate collaborative networks on how they can benefit each other in the value chain given the evidence of some higher interactions. Relating these findings (Table 6) to the afore-described network maps (figure 2 and 3), it emerges that there are core stakeholders such as extension officers, government project implementers (KOSFIP), farmer groups (IWUA) that in greater liaison with other stakeholders.

Table 6. Information sharing patterns between non-farmer stakeholders.

Degree of sharing information	Sending	Receiving	Overall	Test for difference in proportions
Low degree	69.9	66.2	68.0	Test statistic = 0.7762 P-value = 0.6783
Moderate	12.5	16.2	14.3	
High degree	17.6	17.6	17.6	

IP variables and SRI uptake

We further explored innovation platform variables and characteristics that are associated with the uptake of SRI. Figure shows a correlation plot of several IP variables. Importantly, we focus on how uptake correlates with high interaction with stakeholders and other IP variables. The findings show that high interaction in the innovation platform is a key driver for the uptake of SRI and strong links with certain institutions like KOSFIP and IWUA were highly associated with increased uptake of the SRI practices. However, it is important to acknowledge that certain associations often acknowledged to emerge after a time lag.

In *Table* 7, we model the uptake of SRI as a function of the IP characteristics and the number of high interactions they developed based on our assessment. We observe that there is evidence of a strong association between high interactions with research institutions, input suppliers, extension officers, farmer groups (IWUA), KOSFIP, and private millers and the uptake of SRI. These findings imply that farmers who had stronger interactions with different research institutions in the platform were also better adopters of SRI practice, p-value (0.0485) at the 5% level of significance. Both extension officers from MOAL&F and research institutions are involved with technology dissemination and therefore farmers who interact more closely with these stakeholders are likely to be more knowledgeable than their colleagues on the implementation of different SRI practices, hence increased uptake overall. Previously, Grootaert and colleagues have demonstrated that the number of organizations farmers are affiliated with and the intensity of farmers' participation in those organizations increases the intensity of adoption and play a notable role in increasing innovation (Grootaert *et al.*, 2004). Earlier in this paper, we have shown in the network maps that IWUA and KOSFIP are key stakeholders in the IP and have the highest number of strong interactions with most non-farmer stakeholders therefore it is unsurprising that they are critical in uptake.

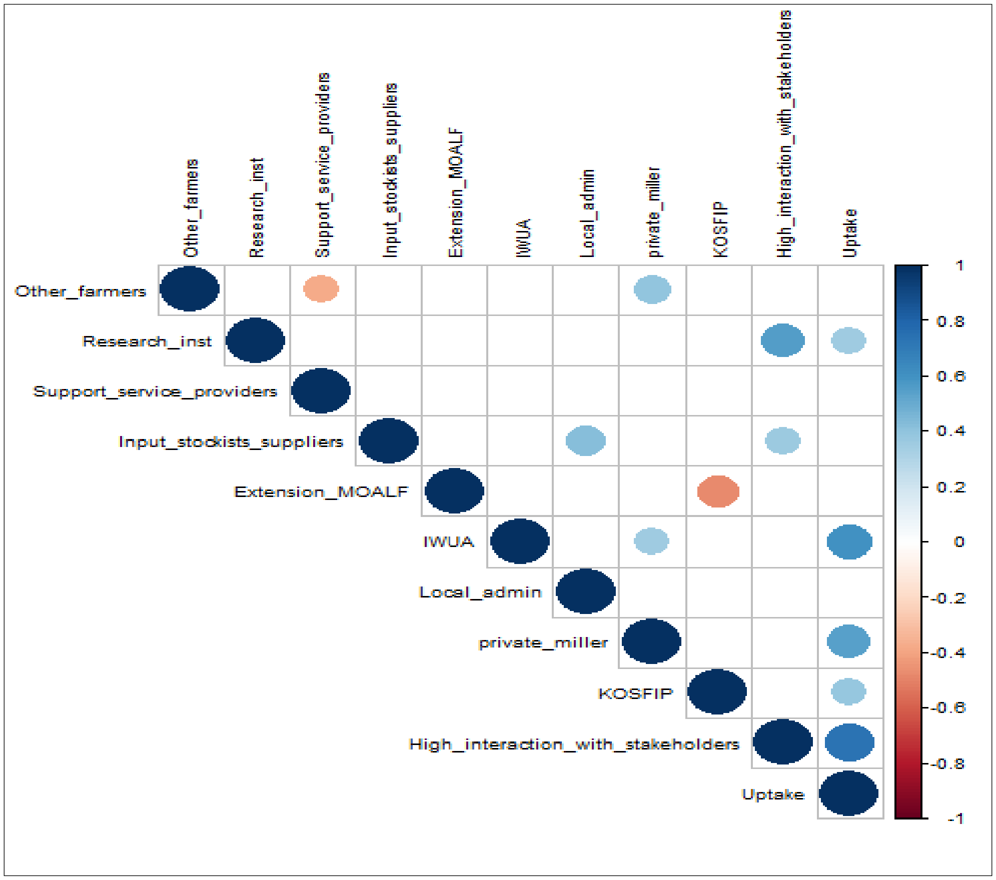


Figure 4. Correlation of SRI Uptake and Innovation Platform Variables.

Although farmer-farmer interactions were a promoted concept in the IP, we do not observe a strong link between farmer-to-farmer learning and SRI uptake. However, this does not negate its importance but perhaps suggests that farmers relied more on knowledge from other stakeholders. Stronger interactions between some farmers and private millers leading to increased uptake can be explained by the fact that they are likely to be more focused towards improving their rice productivity for commercialization purposes. As such, they are likely to be keen to have greater uptake of SRI practices to improve their productivity. Overall, increased SRI uptake among farmers was associated with a higher degree of information sharing with several different multi-stakeholders in the platform. This is an important finding as it shows that the intended outcome from the established platform is not driven by only a few stakeholders, but by different actors in the value chain. Although not accounted for in this model, other individual farmers' characteristics are useful in explaining the variability in the uptake of SRI.

Finally, besides increased uptake of SRI practices and increased riced productivity and acreage under rice, the facilitated innovation platform achieved so-called 'unintended outcomes'–where farmers and stakeholders accrued positive benefits not envisioned at the planning stages. For instance, there is a growth in networks, informed decision-making through joint learning, and knowledge of the value of IPs. Farmer-to-farmer extension capacity was significantly increased and new stakeholder partnerships formed that were previously inexistent. Ouma *et al.* (2020) have previously explored the role of the IP in improving marketing decisions among farmers at Oluch irrigation scheme (Ouma, Onyango *et al*., 2020).

Table 7. Linear regression results showing IP variables as predictors of SRI uptake.

Explanatory variables	Estimate	Std. Error	t-statistic	Pr(>|t|)
(Intercept)	-3.4558	0.6315	-5.4723	0.0001 ***
Other farmers	0.0022	0.0690	0.0321	0.9749
Research institutions	0.0978	0.0449	2.1770	0.0485*
Support service providers	0.0839	0.0506	1.6563	0.1216
Input stockists/suppliers	0.0661	0.0312	2.1164	0.0542*
The extension (MOALF)	0.1013	0.0199	5.0873	0.0002***
IWUA	0.0951	0.0186	5.1127	0.0002***
Local admin	0.0481	0.0361	1.3316	0.2059
Private millers	0.0877	0.0203	4.3264	0.0008***
KOSFIP	0.1022	0.0211	4.8348	0.0003***
Number of high interactions with stakeholders	0.0117	0.0157	0.7493	0.467

Theory of Change developed and experienced in IP

The model in Figure 5 characterizes the change process as facilitated by the IP. The importance of this framework is that it details what farmers learnt and employed, how they learnt interactively and collaboratively and how they changed their perceptions about SRI practices. Similarly, through knowledge exchange, other rice farmers not primarily participating in the IP equally embraced SRI practices to improve their rice production and subsequently improved livelihoods. Given the previously discussed findings, we see that smallholder farmers explored the existing opportunities to address the challenges that constrained their production. This then agrees with other authors who argue that the inclusion of various types of stakeholders strengthens networks and interaction between stakeholders leading to enhanced efficiency and effectiveness of agriculture and rural development (ARD) efforts (Mugittu and Jube, 2011). To enhance learning and interaction, frequent networking forums were held including informal meetings, field days, and farm visits besides the main facilitation workshops. Often, farmers who emerged as SRI champions within the IP organized these forums that provided the space for sharing knowledge and experiences even amongst farmers themselves and thereby developing strategies to spur rice productivity. In assessing the networks, the linkage between theory and practice, randomly selected blocks and SRI plots were visited by IP stakeholders including the SRI Champions. The visits heightened interactions and enabled participants to share experiences, learn and nurture new knowledge for enhancing innovative capacities for SRI uptake. Field observations made were both impressive and surprising. Of particular interest were the farmers who had 'distanced' and 're-designed' the SRI technological codes to suit their circumstances. Change developed and experienced in the facilitated IP shows that the action learning approach is better implemented with this focus on learning for innovation rather than the spread of 'best bet' technologies.

DISCUSSION

To enhance rice productivity among smallholder farmers in Kenya, Innovative agricultural technologies like SRI are highly relevant to improve productivity and subsequently improved livelihoods. This study leverages a well-known and useful vehicle in agricultural research for development called innovation platforms to promote the uptake of SRI in a rural setting in western Kenya. In this paper, we sought to analyze multi-stakeholder networking within an IP and how this is associated with the uptake of the SRI technology.

The results demonstrated that the involvement of different stakeholders at different levels, joint agenda setting and reflection can lead to desired outcomes such as improved SRI uptake in our study. Principally, we show that specific multi-stakeholder networks are more crucial than others in driving the IP agenda. While some of this may be somewhat expected.

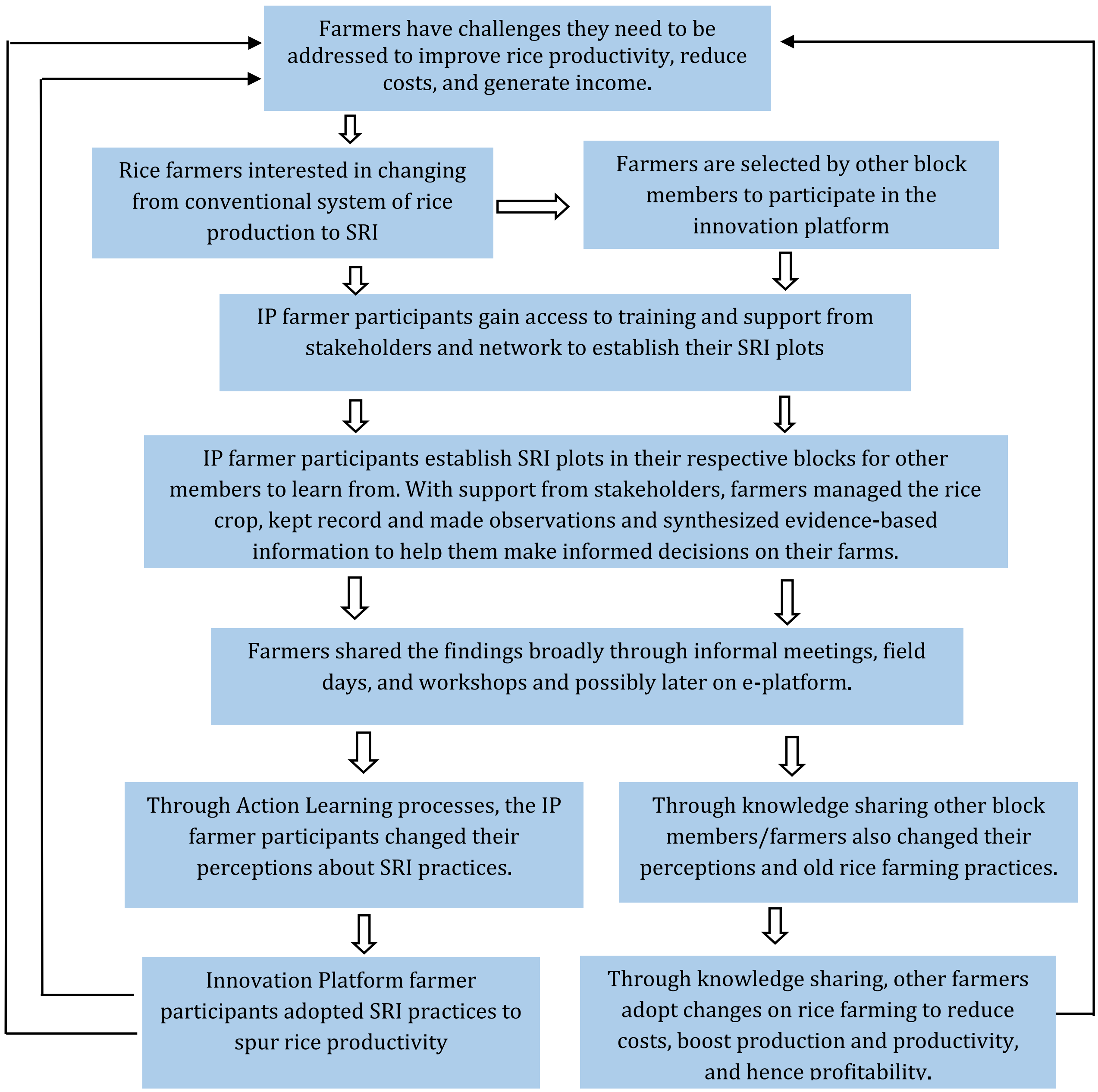


Figure 5. A Model reflecting the Theory of Change developed and experienced in the Innovation Platform.

Further, we established that high interaction between farmers and stakeholders and close links with specific stakeholders tended to spur the realization of the intended benefits of the IP. For instance, extension officers, government administration, the umbrella body of farmers (cooperative) and irrigation project implementers were important stakeholders involved in supporting rice farmers throughout the value chain and a link with all other non-farmer stakeholders. Subsequently, these are key stakeholders when considering the sustainability efforts of the established innovation platform.

Our results also showed that variability in interactions among different stakeholders, which is common in agricultural innovation systems because of their level of integration and different levels of motivation and capacity (Sartas *et al*., 2018). On the other front, different levels of interaction could be ascribed to a limited understanding of the IP concept, lack of commitment, lack of resources and unfulfilled expectations of tangible immediate benefits (Mulema and Mazur, 2016). Overall, the study revealed a statistically significant influence of Innovation Platform intervention on the uptake of SRI practices.

It is important to emphasize that the mere bringing together of multiple stakeholders does not automatically translate to successful technology uptake. Some authors contend that organising IP meetings at different stages is equally not optimal (Lamers *et al*., 2017). In our study, several aspects of the design and implementation of the innovation platform fostered enhanced stakeholder networks within the IP and subsequently achievement of the desired outcome. First, the joint workshops, (firstly an inaugural workshop on challenges of production in the region (see Ouma *et al*., (2020) and then a joint agenda-setting workshop) served to set the pace for the success of the IP. Consequently, we may have a participatory diffusion of knowledge through networks (Lamers *et al*., 2017).

Secondly, our IP Each stakeholder was tasked to outline their interests and thirdly collective action initiatives, for instance, developing SRI demonstration plots jointly with national-level stakeholders (researchers) and community-level stakeholders (farmers (groups), and extensionists) who often act in isolation trigger multilevel interaction and develop trust. Similar results have been reported in other IPs (Pamuk *et al*., 2015; Pamuk and Van Rijn, 2019; Schut *et al*., 2018). Principally, stakeholders can acknowledge in this joint learning space (IP), the interrelationship among constraints facing farmers and are motivated to create synergies if they are non-existent. Resultantly, we saw new networks that were previously non-existent in that local value chain.

It is expected that our findings may not exactly translate to other settings of interest although they serve as an important reference point for future research focusing on technology adoption among smallholder rice farmers. As such, some authors have argued for sequenced and strategic engagement of stakeholders based on their interests, the needs of the IP and the stage of the innovation process (Lamers *et al*., 2017). A few reasons can be fronted for this. First, it is also important to realise that technologies such as SRI while accosted by many common challenges in several settings where its adoption has been studied (Kaloi *et al*., 2021; Katambara *et al*., 2013; Ouma *et al*., 2020; Udimal *et al*., 2017) there are important region-specific differences and other factors such as farmer dynamics, government policy environment, research community support that will differ from case to case. Secondly, IP diversity (Pamuk and Van Rijn, 2019) and compositional dynamics of IPs (Lamers et al., 2017) are known to play an important role in technology adoption but these are often different across different value chains or settings.

CONCLUSION

In conclusion, to achieve successful technology adoption among smallholder farmers, there is a need for networks among multiple actors but the emphasis should be laid to understand strategic networks within the IP that highly contribute to achieving the desired outcome of the IP.

REFERENCES

Brydon-Miller, M. and Coghlan, D. 2014. The big picture: Implications and imperatives for the action research community from the SAGE Encyclopedia of Action Research. Action Research, 12(2): 224–233.

Csardi, G. and Nepusz, T. 2006. The igraph software package for complex network research. International journal of complex systems, 1695.

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(2): 259–275.

Dabire, D., Andrieu, N., Djamen, P., Coulibaly, K., Posthumus, H., Diallo, A. M., Karambiri, M., Douzet, J. M. and Triomphe, B. 2017. Operationalizing an Innovation Platform Approach for Community-Based Participatory Research on Conservation Agriculture in Burkina Faso. Experimental Agriculture, 53(3): 460–479.

Homann-Kee, T. S., Adekunle, A., Lundy, M., Tucker, J., Birachi, E., Schut, M., Klerkx, L., Ballantyne, P. G., Duncan, A. J., Cadilhon, J. and Mundy, P. 2013. What are innovation platforms? In Innovation Platform Practice: Vol. Brief 1.

Jayne, T. S., Mather, D. and Mghenyi, E. 2010. Principal Challenges Confronting Smallholder Agriculture in

Sub-Saharan Africa. World Development, 38(10): 1384–1398.

Kaloi, F. K., Hezron, N. I., Charles, N. O. and Lucy, K. N. 2020. Comparing productivity of rice under system of rice intensification and conventional flooding: A switching regression approach. African Journal of Agricultural Research, 16(10): 1355–1363.

Kaloi, F. K., Isaboke, H. N., Onyari, C. N., & Njeru, L. K. 2021. Determinants Influencing the Adoption of Rice Intensification System among Smallholders in Mwea Irrigation Scheme, Kenya. Advances in Agriculture, 1624334:1-8.

Kasirye, I. 2010. Constraints to Agricultural Technology Adoption in Uganda: Evidence from the 2005/06-2009/10 Uganda National Panel Survey (2010). In Poverty, Price Volatility, Efficiency and the Impacts of Population Shifts. http://ageconsearch.umn.edu/bitstream/160629/2/Chapter 4.pdfo2/Chapter 4.pdf

Katambara, Z., Kahimba, F. C., Mahoo, H. F., Mbungu, W. B., Mhenga, F., Reuben, P., Maugo, M., & Nyarubamba, A. (2013). Adopting the system of rice intensification (SRI) in Tanzania: A review. Agricultural Sciences, 04(08), 369–375. https://doi.org/10.4236/as.2013.48053

Kim, D. G., Grieco, E., Bombelli, A., Hickman, J. E., & Sanz-Cobena, A. 2021. Challenges and opportunities for enhancing food security and greenhouse gas mitigation in smallholder farming in sub-Saharan Africa. A review. Food Security, 13(2): 457–476.

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(6): 739–752.

Llewellyn, R. S., & Brown, B. 2020. Predicting Adoption of Innovations by Farmers: What is Different in Smallholder Agriculture? Applied Economic Perspectives and Policy, 42(1): 100–112.

Mati, B., Nyamai, M., Home, P. G., Odongo, B., Wanjogu, R., & Thuranira, E. G. 2012. Improving land and water productivity in basin rice cultivation in Kenya through System of Rice Intensification (SRI). Agricultural Engineering International: CIGR Journal, 14(2): 1–9.

Mugittu, V. F., and Jube, J. T. 2011. Putting heads together: Agricultural innovation platforms in practice Diagnostic innovation and livestock (DIAL): Towards a more effective and sustainable application of antibiotics in livestock farming View project Research Into Use View project. https://www.researchgate.net/publication/318877795

Mulema, A. A., and Mazur, R. E. 2016. Motivation and participation in multi-stakeholder innovation platforms in the Great Lakes Region of Africa. Community Development Journal, 51(2): 212–228.

Muzari, W., Gatsi, W. and Muvhunzi, S. 2012. The Impacts of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa: A Review. Journal of Sustainable Development, 5(8): 69–77.

Nchuchuwe, F. F. and Adejuwon, K. D. 2012. The challenges of agriculture and rural development in Africa: the case of Nigeria. International Journal of Academic Research in Progressive Education and Development, 1(3): 45–61.

Ndiiri, J. A., Mati, B. M., Home, P. G., Odongo, B. and Uphoff, N. 2013. Adoption, constraints and economic returns of paddy rice under thesystem of rice intensification in Mwea, Kenya. Agricultural Water Management, 129: 44– 55.

Obasanjo, O. 2013. The challenges of agricultural production and food security in Africa. Routledge.

Omwenga, K. G., Mati, B. M., and Home, P. G. 2014. Determination of the effect of the system of rice intensification (SRI) on rice yields and water saving in Mwea Irrigation Scheme, Kenya. Journal of Water Resource and Protection, 6(10):895-901.

Ouma, M. A., Ombati, J. M. and Onyango, C. A. 2020. Challenges and Coping Strategies in the Uptake of the System of Rice Intensification Practices in Oluch Irrigation Scheme, Homa-Bay County, Kenya. Journal of Experimental Agriculture International, 42(12): 13–25.

Ouma, M. A., Onyango, C. A., Ombati, J. M. and Mango, N. 2020. Innovation platform for improving rice marketing decisions among smallholder farmers in Homa-Bay County, Kenya. Cogent Food and Agriculture, 6(1): 1832399.

Pamuk, H., Bulte, E., Adekunle, A., and Diagne, A. 2015. Decentralised innovation systems and poverty reduction: Experimental evidence from Central Africa. European Review of Agricultural Economics, 42(1): 99–127.

Pamuk, H., & Van Rijn, F. 2019. The Impact of Innovation Platform Diversity in Agricultural Network

Formation and Technology Adoption: Evidence from Sub-Saharan Africa. Journal of Development Studies, 55(6): 1240–1252.

Pretty, J. (1995). Participatory learning for sustainable agriculture. World Development, 23(8): 1247–1263.

Sartas, M., Schut, M., Hermans, F., Asten, P. van, & Leeuwis, C. (2018). Effects of multi-stakeholder platforms on multi-stakeholder innovation networks: Implications for research for development interventions targeting innovations at scale. PLOS ONE, 13(6), e0197993.

Schut, M., Kamanda, J., Gramzow, A., Dubois, T., Stoian, D., Andersson, J. A., Dror, I., Sartas, M., Mur, R., Kassam, S., Brouwer, H., Devaux, A., Velasco, C., Flor, R. J. O. Y., Gummert, M., Buizer, D., McDougall, C., Davis, K., Tui, S. H. K., and Lundy, M. 2019. Innovation platforms in agricultural research for development. Experimental Agriculture, 55(4): 575–596.

Schut, M., Klerkx, L., Kamanda, J., Sartas, M., & Leeuwis, C. (2018). Innovation platforms: Synopsis of innovation platforms in agricultural research and development. In Encyclopedia of Food Security and Sustainability (pp. 510–515).

Udimal, T. B., Jincai, Z., Mensah, O. S., and Caesar, A. E. 2017. Factors influencing the agricultural technology adoption: The case of improved rice varieties (Nerica) in the Northern Region, Ghana. Journal of Economics and Sustainable Development, 8(8): 137–148.

Verdier-Chouchane, A., and Boly, A. 2017. Introduction: Challenges to Africa's Agricultural Transformation. African Development Review, 29(S2): 75–77.

Zuber-Skerrit, O. and Fletcher, M. 2007. The quality of an action research thesis in the social sciences. Quality Assurance in Education, 15(4): 413–436.

Publisher's note: EScience Press remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.