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Geochemistry and Health Kenyan Stakeholder workshops 2022

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Workshop attendees group photo, Uasin Gishu, Kenya

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Foreword

This report summarises an exchange visit carried out by the British Geological Survey (BGS) to disseminate soil geochemical and public health data collated over the previous five years with partners from the University of Eldoret and Moi University to relevant stakeholders. A series of workshops provided a platform for the co-design of digital tool applications to ensure accessible data and to identify end-users with appropriate heads of agricultural and public health offices from 20 County governments. Workshop hubs were held in Kisii, Kisumu, and Eldoret between 23rd June and 3rd July 2022.

The research was presented directly to stakeholders from 12 counties in western Kenya, with representatives from the remaining eight counties unable to attend in person. Additional stakeholders attended from various public sectors and private industries. The knowledge exchange visit covered a number of purposes for feedback via workshops, with specific organisations and to plan for ongoing project work across the research consortia. This work was supported from a number of sources (i) BGS-NERC grant (NE/R000069/1) entitled Geoscience for Sustainable Futures 2019-2022 and BGS Centre for Environmental Geochemistry programmes for financial support; (ii) a Royal Society grant (ICA\R1\1910770) entitled Dynamics of Environmental Geochemistry and Health in a Lake-wide Basin; (iii) a British Academy grant (WW21100104) entitled Early Career Researcher development in Africa through writing and mentoring workshops, and (iv) the NERC BGS National Capability International programme ‘Geoscience to tackle global environmental challenges’.

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We would like to thank the many people who assisted in the collection of samples who made this research possible, including the Public Health Officers from each county administrative area who assisted in community engagement and in particular the field and laboratory staff from the University of Eldoret (UoE), Moi University (Moi U) and BGS. David Samoie, Doreen Meso, Charles Owano, Job Isaboke, Melvine Otieno (UoE), Esilaba Anabwani, Amimo Anabwani (Moi U), Nicholas Porter, Sophia Dowell, Amanda Gardner, Elliott Hamilton, Mark Kalra, Tom Barlow (BGS).

Contents

FIGURES

TABLES

Summary

This report describes a knowledge exchange visit to Kenya by BGS with partners at the University of Eldoret and Moi University leading on the dissemination of consortia data outputs and outcomes via coordinated workshops for leaders in agricultural and public health invited from each of 20 County governments (50+ attendees across three hubs), with additional practitioners familiar with the research-to-government-to-industry interaction in attendance. The geochemistry and public health data resulted from a comprehensive programme of data collection between 2016 and 2019 to inform the geochemical spatial influence on agricultural practices and for future use of a geochemical predictive model in determining the geospatial influence on non-communicable diseases (e.g. cancer, micronutrient deficiency). Additional focussed meetings with key stakeholders were undertaken to improve data uptake and outcomes, including the Kenyan Marine and Fisheries Research Institute, Kenyan Agricultural and Livestock Research Organisation and Kenya Forestry Research Institute. Background for the project collation of the data can be found at: https://www.bgs.ac.uk/geology-projects/geochemistry-and-health/

1 Introduction

This report outlines an exchange visit undertaken by the British Geological Survey (BGS) to partners at the University of Eldoret and Moi University in western Kenya between 23rd June and 3rd July 2022. This research exchange consisted of meetings and workshops aimed at maximising the efficiency of information dissemination, grant proposal development/planning /closeout and supporting the preparation of an international conference (SEGH 2022) with Kenyan partners.

Three workshops were conducted with the aim of delivering ODA (BGS-NERC grant NE/R000069/1) data as published by Watts *et al* (2019, 2020, 2021a, 2021b) to agricultural and public health stakeholders in three hub counties (Kisii, Kisumu and Uasin Gishu) to fully cover the geographical extent of western Kenya. Feedback obtained from these meetings will also assist the design of digital tools using this data in the new National Capability International programme at BGS for use in Food Systems and Health, as well as for delivery of a geochemistry model to define soil erosion transfers from land-to-lake catchments to inform land and lake management practices in alignment with a Royal Society International Collaboration grant. Data presented at the workshops included the development of localised food composition tables which improve the accuracy of estimates for dietary intake and risk of deficiency for micronutrients, particularly where information is limited for localised preferences for food items and assumed at a national level periodically for the study locations (Watts *et al* 2019). Soil geochemical prediction maps created using machine learning and random forest algorithms to inform intervention strategies at scale (western Kenya), including direct supplementation, fortification of drinking water, agronomic strategies, phytofortification or promotion of nutritional diversity to address challenges presented by the United Nations Strategic Development Goals (SDG). This data will be invaluable to multidisciplinary efforts to investigate geospatial controls on human and animal health. Furthermore, biomonitoring data representing health status was presented with wider ramifications to geochemical pathways for micronutrients and potentially harmful elements, with consequences for public health and ecosystem health. Watts *et al* (2020, 2021a) provided an endpoint assessment of health in presenting urinary elemental data from dietary or environmental pathways, as a means of assessing population status for excess exposure or deficiency of supply to inform intervention strategies. At each workshop we reported these data to establish a dialogue with relevant stakeholders on how to best present data in an accessible manner, co-designing future delivery methods and mobilising their participation in our future research activities.

Additional meetings with the Kenya Agricultural and Livestock Research Organization (KALRO) in Nairobi, the Kenya Marine and Fisheries Research Institute (KMFRI) in Kisumu and the Kenya Forestry Research Institute (KEFRI) in Maseno provided us the opportunity to share research findings, update on current progress (Humphrey et al 2022) and plan future Royal Society (ICA\R1\1910770) and BGS National Capability International project activities. Finally, the exchange presented the opportunity to host a hybrid meeting (in-person and Zoom) to close out a British Academy writing skills grant (WW21100104) for African Early Career Researchers (ECRs) – the culmination of a series of online writing workshops since July 2021 to 50+ ECRs from seven African countries.

2 Geochemistry and Health Stakeholder Workshops

2.1 WORKSHOP AGENDA

The agenda for each geochemistry and health Kenyan stakeholder workshop meeting can be found in Appendix 1. In brief, each workshop was opened by Prof Osano with an introduction from each attendee followed by a short presentation by Dr Menya introducing the origin of the geochemistry and public health research collaboration in relation to esophageal squamous cell carcinoma (ESCC) incidence rate and the hypothesis that there may be a geochemically controlled spatial influence on health conditions in the Eastern Rift Valley. Subsequently, Prof

Osano introduced the context of the environmental sampling campaign for the geochemical and health surveys conducted between 2016 and 2019 and dietary source apportionment data (Watts et al 2019). Next, Dr Humphrey presented the soil geochemistry predictive tool and provided a demonstration of how to use and access the data (Watts et al 2021b). The final data dissemination task was led by Dr Watts, who presented published drinking water and urine data (Watts et al 2020, 2021a) with a public health context and identifying the challenges in interpreting biomonitoring and environmental data.

The second half of the meeting consisted of breakout sessions with two groups: Group 1: Agriculture-Environment (led by Prof. Osano, with Dr Humphrey) and Group 2: Public Health data (led by Dr Menya, with Dr Watts). In these interactive sessions stakeholders were asked to consider the following questions: (i) What do they think of the data – appropriate format?; (ii) How could it be used to demonstrate impact? (iii) How could the data be used + by whom?; and (iv) Future recommendations. These questions led to dynamic, collaborative conversations and stakeholders were asked to summarise their thoughts, opinions and observations on post-it notes and attach them to each question which was presented on a poster (Figures 2 and 3). Finally, each group presented their findings to all stakeholders with a general discussion and closeout.

Details regarding the location, date, number of attendees and represented counties can be found in Table 1. Figure 1(a-c) shows the workshop attendees in Kisii, Kisumu and Uasin Gishu, respectively.

Table 1 Geochemistry and Health Kenyan Stakeholder workshop attendee information

County	Date	Number of Attendees	Represented Counties
Kisii (Magharibi Garden Hotel)	27th June 2022	19	Bomet, Homa Bay, Migori, Nyamira, Kisii
Kisumu (Acacia Premier Hotel)	28th June 2022	9	Busia, Kakamega, Kisumu, Vihiga
Uasin Gishu (Noble Hotel, Eldoret)	30th June 2022	22	Bungoma, Elgeyo-Marakwet, Nandi, Trans-Nzoia, Uasin Gishu

s

Figure 1 Workshop attendees in Kisii (A), Kisumu (B), and Uasin Gishu (C), Kenya

2.2 AGRICULTURE FEEDBACK

Following the conclusion of the final meeting all of the post-it notes generated by the agricultural break-out groups from each meeting were arranged into relevant themes, Figure 2 summarises these observations, clearer images are available in Appendix 2.

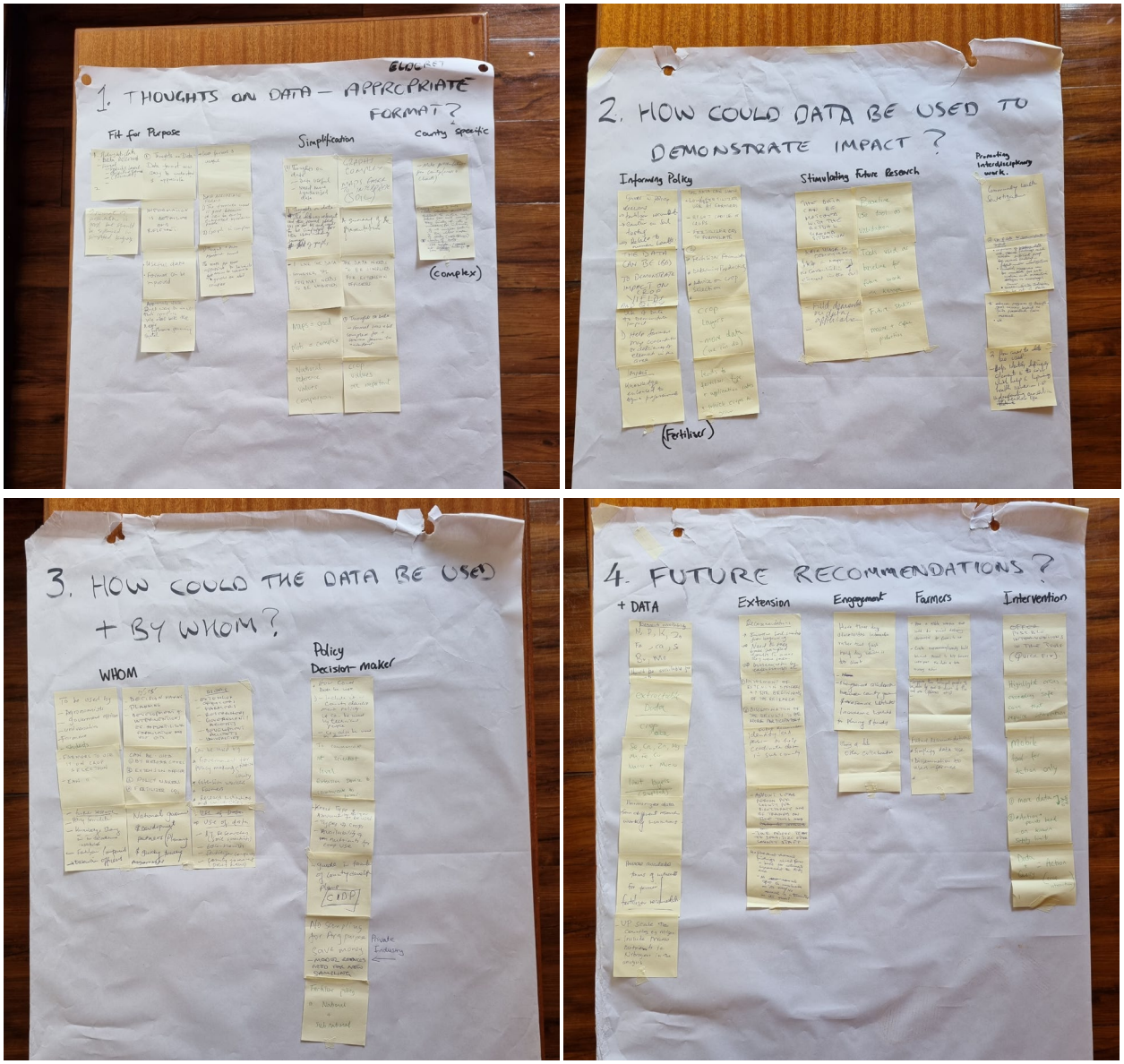


Figure 2 Workshop feedback from all agricultural groups (Kisii, Kisumu, and Uasin Gishu)

2.2.1 Thoughts on data- appropriate format?

2.2.1.1 FIT FOR PURPOSE

In general, the agricultural stakeholders concluded that the predictive soil map was useful and that the data was presented in a relevant format. It was stated that the maps can easily be interpreted by technical people and were, therefore, fit for purpose. However, it was highlighted that the language used could be simplified for non-academics.

2.2.1.2 SIMPLIFICATION

The theme of simplification was expanded upon considerably within the sessions, however, this was particularly pertinent to the graphs presented on public health by Dr Watts with most of the agricultural stakeholders identifying that maps were the best means of displaying soil data at this scale. Interestingly, several comments were identifying the need for the data to be simplified

for ‘common users’, for example, farmers and extension officers. However, this was not the case for all stakeholders, showcasing the diverse ability of attendees across the counties in western Kenya, with some requiring a greater degree of complexity and detail from the datasets.

2.2.1.3 County specific

In contrast to the call for a simplified version of the maps and graphs which were presented with all counties in a single plot, some users wanted county specific soil data. Whilst this does reduce the number of data points an individual would be assessing it does vastly increase the complexity of data presentation. It does help to demonstrate the flexibility of the datasets and the way in which they are presented depending on the end user requirements and technical ability.

2.2.2 How could data be used to demonstrate impact?

2.2.2.1 Informing policy

The most commonly identified theme by the agricultural stakeholders was the ability of the tool to inform policy. Specifically, impact could be realised by informing targeted fertiliser combinations and recommendations which could have drastic effects on yields and nutritional quality of crops – benefiting crop health/yield and human consumption-health. It was anticipated that these data could also assist in crop selection and tailored fertiliser application rates.

2.2.2.2 Stimulating Future research

Agricultural stakeholders were enthused by the prospect of using the soil prediction tool as a means to (i) stimulate future research; (ii) validate studies using the tool as a baseline; and (iii) use the tool within the university sector as a teaching aid. The capacity of the datasets and tool to stimulate future research outcomes was a common theme, particularly with the Open Access approach to the release of data. A number of ideas were discussed for future research and possible funding proposal ideas. These points highlight the benefit of engaging with relevant stakeholders during the conception and completion of the predictive geochemistry tool, with the presentation of the public health tool likely to stimulate interdisciplinary research.

2.2.2.3 Promoting interdisciplinary research

A key consideration when establishing the stakeholder engagement meetings was to connect local agricultural and soil specialists with public health officials. One of the major outcomes demonstrating the impact of the meetings was the realisation that agricultural and public health workers need to develop sustainable interdisciplinary research programmes. Stakeholders identified that this data could be used to develop the ‘understanding [of] our soils for healthier life’. It was noted that there were some Counties regularly discussing interdisciplinary studies, albeit not a common activity and that the multi-disciplinarity of the consortia research group has provided a case study to follow to encourage future inter-connectivity of environment and health research.

2.2.3 How could the data be used and by whom?

2.2.3.1 Policy decision making

Stakeholders primarily identified that the data could be used by policymakers to improve farming practises by incorporating the data into County Integrated Development Plans (CIDP). Furthermore, they identified the need for scientists to engage with extension services and for the extension services to communicate specific actions to farmers. Stakeholders recognised the ability to develop subnational fertiliser policy based on this data with additional layers of data that could be presented within the tool. An interesting observation made by an individual from private industry noted that the tool reduced the need for companies to conduct their own soil survey activities for future agricultural purposes as they could use the tool, thereby saving them considerable expense or at least targeting more carefully expensive laboratory testing resource.

2.2.3.2 WHOM

Four groups of individuals were identified as potential users of the data presented; (i) Officials (government officers, decision-makers, policymakers, development partners); (ii) Academics: universities, researchers, soil/plant scientists, agronomists, students; (iii) Private Sector (fertiliser companies, industrial-scale farmers); and (iv) General public: subsistence farmers

2.2.4 Future recommendations

2.2.4.1 ADDITIONAL DATA

The most requested future recommendation from agricultural stakeholders was the procurement of additional data. The additional data included soil data, in particular soil extractable/ plant available concentration layers, including nitrogen and the concentration of nutrients in staple crops (maize, beans etc). An additional minor recommendation was to extend the scope of our research to cover all the counties within western Kenya or provide coverage for the whole of Kenya – even Africa was mentioned! Whilst these comments are welcomed and indicate the need for such work it is beyond the scope of our project. However, the highly detailed quality measurements performed in western Kenya to support the geochemical prediction model could be used to train larger scale predictive modelling tools that rely on less accurate/precise data tools, such as near infra-red spectroscopy that are significantly cheaper than traditional high quality wet chemistry techniques such as inductively coupled plasma mass spectrometry.

2.2.4.2 EXTENSION AND ENGAGEMENT

Despite the project teams' approach to interdisciplinary research and engagement with local officials prior to commencing sample collection, several stakeholders believed that more extension officers should have been involved in the research from the beginning. They recommended that an individual at the sub-county level should be appointed to coordinate data releases. This presents logistical and financial challenges that cannot be addressed by the research team retrospectively – in general, it was agreed that with some tweaks to datasets, the County officials will be empowered by this new information to interpret and inform sub-county level officials. It was noted that Universities in Kenya often have an Outreach office for what was termed 'Research Flow Back', which appeared to be an efficient approach to enhance the research-to-community dissemination, sometimes limited by officials. Moreover, some stakeholders would have wished for more time for the workshops to discuss the data and further measures. It was determined that information packs would be helpful as a follow-up within a few months and then in 12 months, a follow-up workshop using a virtual or in person format to gather lessons learnt from data dissemination to practitioners and communities.

2.2.4.3 FARMERS

Whilst the data tool presented was originally designed to inform experts to subsequently advise farmers on agricultural soil amendments, several comments in Figure 2 express an interest in providing a mobile tool for use by members of the general public. However, this would require many aspects of the data to be simplified and specific action limits set within the tool for recommendations on fertiliser and crop selection. For example, soil elemental concentrations presented as low too high for simplification will require a definition of what is high and low for each element. This may also need to be connected with counties' epidemiological data that highlights the prevalent elemental deficiencies among the inhabitants of the respective counties.

2.2.4.4 INTERVENTION

Currently, the webtool has a user-driven filter section that can identify regions with specific attributes as requested by the user. However, many stakeholders recommended that the tool could incorporate specific intervention limits and 'quick fixes' for farmers based on the soil properties. For example, use a zinc fortified fertiliser in regions where Zn availability is below a set limit. These action limits based on measured samples and accepted agriculture practices could significantly strengthen the impact of this research.

2.3 PUBLIC HEALTH FEEDBACK

Following the conclusion of the final meeting, all of the post-it notes generated by the public health break-out groups from each meeting were arranged into related themes. Figure 3 summarises these observations, clearer images are available in Appendix 2.

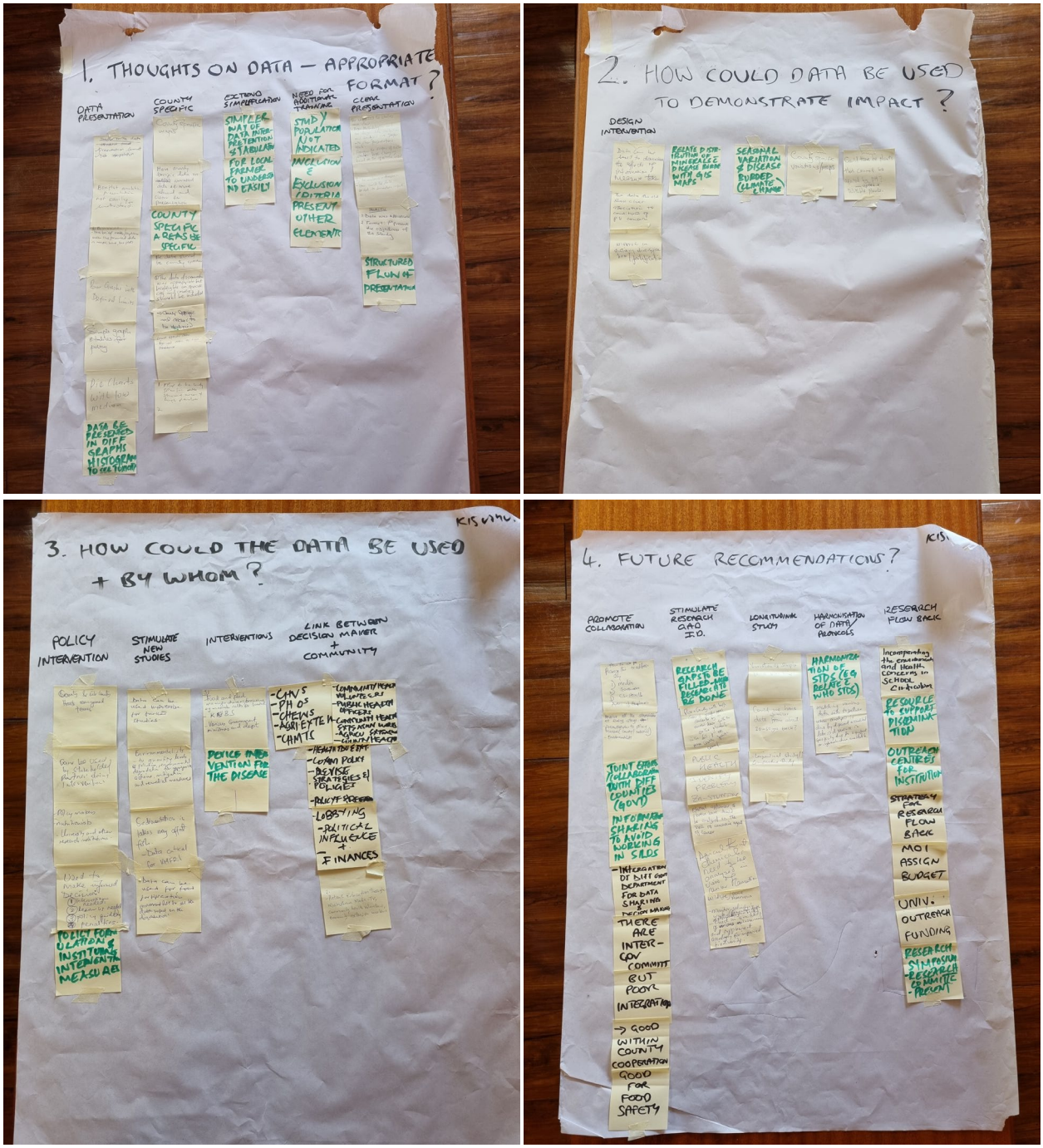


Figure 3 Workshop feedback from all public health groups (Kisii, Kisumu, and Uasin Gishu)

2.3.1 Thoughts on data- appropriate format?

2.3.1.1 DATA PRESENTATION & COUNTY SPECIFIC

In contrast to the agricultural breakout groups, the public health stakeholders commented on the challenges of interpreting the urinary biomonitoring data citing that the boxplots conveyed a level of complexity that exceeded their understanding. Alternative plots including pie charts and

histograms were recommended – this was more a point on stylistic presentation of data in a familiar format. Additionally, public health stakeholders identified that the presentation of data at county level was useful, with context against the wider cohort of 20 counties. However, due to the different land areas and population densities the number of observations per county varies significantly and there is a risk of over interrupting limited results – Dr Watts used examples for drinking water supplies and urine biomonitoring data to demonstrate the potential caveats in over interpreting datasets at an increased level of detail, taking into account potential uncertainty of data.

2.3.1.2 NEED FOR APPROPRIATE TRAINING, SIMPLIFICATION

The remaining observations made by public health stakeholders can be summarised by the need for additional training. Specific calls for tabulating data, presenting other elements, metadata and study objectives were all made available to stakeholders in the presentations and publications, however, they were not fully comprehended – likely due to not being read in advance or even in the information pack provided. A follow-up meeting or survey may determine whether the investment in time from individuals has satisfied their desire for information and understanding. A difference in understanding and technical ability between the agricultural and public health attendees was noted.

2.3.2 How could data be used to demonstrate impact?

2.3.2.1 INTERVENTION

The public health attendees believed that the data presented could be used to plan intervention strategies and assess the extent of specific measures taken.

2.3.3 How could the data be used and by whom?

2.3.3.1 POLICY INTERVENTION

Policy formulation and intervention measures were commonly identified as uses of the public health data presented during the workshops. The primary users of this data were identified as policymakers, health management teams, nutritionists, universities and research institutions.

2.3.3.2 STIMULATE NEW STUDIES

The concept that this data can be used to hypothesise future research correlates well with the observations made by the agricultural stakeholders. However, the public health stakeholders were unable to postulate a hypothesis for further research based on the data we presented. This identifies a training need for this sector specifically the need to appraise the public health sector on the application of the biomonitoring data to estimate health status for some prevalent non-communicable diseases. The few health practitioners with medical training understood the concept of using biomonitoring data and could perhaps help the county officials in using such methodologies to inform interventions – possibly via the University outreach centres.

2.3.3.3 LINK BETWEEN DECISION MAKER AND COMMUNITY

The breakout groups were able to identify a need for this data and several agencies capable of disseminating public health research including Community Health Volunteers (CHV), Public Health Officers (PHOs)- whom we worked with closely during sample collection, Community Health Extension Workers (CHEWs) and County Health Management Teams (CHMTs).

2.3.4 Future recommendations

2.3.4.1 PROMOTE COLLABORATION & HARMONISATION OF DATA/PROTOCOLS

The majority of public health work conducted in Kenya is assessed at a county level with individual agencies conducting similar assessments and research across separate counties without collaboration. This limitation to the current working practices in Kenya was identified by the public health stakeholders. It was identified that there needs to be a greater level of cooperation and integration between counties. Furthermore, the harmonisation of data and

protocols will facilitate collaboration between researchers and stakeholder institutions for a number of applications– health and agricultural interventions (e.g supplementation of essential nutrients) or identifying exposure to hazards (metals).

2.3.4.2 STIMULATE RESEARCH GAP IDENTIFICATION

The public health attendees identified that this data can be used to stimulate future research. Officials from Bungoma county noted that soils within their administrative boundaries had low total Zn concentrations and based on their knowledge of high incidence rates of Zn deficiencies in Bungoma future research collaboration between public health and agricultural research would be beneficial for lasting impact.

2.3.4.3 RESEARCH FLOW BACK

It was noted that resources to support dissemination should be incorporated into research grants to feedback findings to local populations. Therefore, engaging with outreach centres and having a defined strategy for research flow back is vital for future projects.

3 Additional Meetings

3.1 KENYA AGRICULTURAL AND LIVESTOCK RESEARCH ORGANIZATION (KALRO), NAIROBI 24TH JUNE 2022S

On the 24th of June 2022, the travelling contingency from the BGS; consisting of Dr Michael Watts and Dr Olivier Humphrey accompanied by two students from the University of Eldoret, Ms Maureene Ondayo and Mr Job Isaboke, were invited to the KALRO headquarters by Dr Esther Gikonyo (soil fertility and plant nutrition scientist) and other seven registered attendees to discuss the research activities undertaken in western Kenya. Following introductions Dr Watts presented the scope of activities and research outcomes BGS has conducted since 2016. Subsequently, Dr Humphrey gave two presentations, the first titled '*A Machine Learning Approach To Geostatistics In Kenya'* which consisted of an explanation of the methodology used to create the soil geochemistry predictive maps and tool with a demonstration of the key features. Following this presentation, there was an enthusiastic and forensic question and answer session with good engagement from specialised spatial scientists in attendance. They were stimulated to utilise the data for themselves and immediately thought of new studies that could be undertaken informed by or using the dataset.

The second presentation '*Dynamics of Environmental Geochemistry and Health in a Lake-wide Basin*' highlighted the current outcomes and future activities of a Royal Society grant (ICA\R1\1910770). Here the results of Humphrey *et al* (2022) were summarised highlighting the dynamic nature of soil erosion rates in the Winam Gulf catchment with the greatest risk of soil erosion occurring between February and April. Furthermore, the research presented provides a risk-based assessment for identifying soil erosion hotspots that should be the focus of future investigations. Finally, the current progress and sampling strategy for the next phase of work within this grant was presented. The aim of which is to use deconvolutional Bayesian (un)mixing models for assessing sediment source apportionment within the Winam Gulf basin as detailed in Blake et al (2018) to inform land and lake management – in particular loss of physical soil, micronutrients and transfer of macronutrients to the aquatic environment. Furthermore, Mr Job Isaboke engaged in productive conversations with senior agronomists at KALRO regarding future activities.

3.2 KENYA MARINE AND FISHERIES RESEARCH INSTITUTE (KMFRI), KISUMU 29TH JUNE 2022

The Kenya Marine and Fisheries Research Institute (KMFRI) is a named partner on the Royal Society grant and we were able to feedback to field assistants the results of their efforts and future activities to staff involved in the project. Dr Chrisphine Nyamweya (Asst. Director KMFRI) hosted our visit in which we delivered the *'Dynamics of Environmental Geochemistry and Health in a Lake-wide Basin*' presentation and discussed activities with eight attendees. One of the

attendees, Dr Hilda Nyaboke Mogaka (Research scientist), has been in communication regarding the potential of a future collaborative project between KMFRI, BGS and researchers from Kings College London within the Winam Gulf to combine expertise from all parties. Figure 4 shows a tweet issued by KMFRI highlighting our visit.

Figure 4 KMFRI Tweet publicising our research visit

3.3 KENYA FORESTRY RESEARCH INSTITUE (KEFRI), MASENO 29TH JUNE 2022

Following the close of the second Geochemistry and Health Kenyan Stakeholder workshop in Kisumu Dr Christopher Aura (KMFRI) and Prof Odipo Osano (UoE) managed to arrange a meeting with the Kenya Forestry Research Institute (KEFRI) to discuss current activities relating to the Royal Society grant. During our visit, we met Dr. John Millan Otuoma - Lake Victoria Eco-Region, Fanuel O. Wesonga (Senior Forester) and Stella Gatama (Social Scientist). During this meeting, we were able to present an overview of our existing work and identify them as potential partners to help disseminate our findings to relevant local stakeholders. In particular, assistance via social science to communicate data findings at a community level to realise impact via stimulation to changes in behaviour to reduce soil erosion.

3.4 BRITISH ACADEMY EARLY CAREER RESEARCH WRITING WORKSHOP, UOE 1ST JULY 2022

A British Academy grant (WW21100104) entitled 'Early Career Researcher development in Africa through writing and mentoring workshops' was aimed at providing a series of workshops for 50+ African early career researchers (ECRs) from seven countries (Kenya, Nigeria, Senegal, Niger, Djibouti, Malawi, Zambia +India) including humanities and social sciences. The interdisciplinary nature of the virtual workshops from July 2021 encouraged ECRs to develop networks within their own region and internationally. In this hybrid meeting (in-person and Zoom) Prof Odipo Osano, Prof Akinade Olatunji (University of Ibadan, Nigeria) and Dr Michael Watts closed out the yearlong grant highlighting a series of outputs that were produced as a result of this project including from Nigeria alone: >5 manuscripts to be submitted for peer-review and >8 blogs to be published on the Society for Environmental Geochemistry and Health website, with similar numbers expected from Kenya through to late 2022. Additional information can be found here: https://segh.net/ba-writing-workshop

4 Conclusions and Outlook

The primary objective of the research exchange was to feedback data as published by Watts et al (2019, 2020, 2021a, 2021b) and engage with agricultural and public health stakeholders in western Kenya to plan future activities e.g. refinement of data dissemination and uptake, research experimentation and data collection. The BGS, UoE and Moi university hosted three workshops across western Kenya engaging with 51 attendees. Following presentations from project leads we held breakout groups for both agricultural and public health stakeholders with focused discussions on the following questions: (i) What do they think of the data – appropriate format?; (ii) How could it be used to demonstrate impact? (iii) How could the data be used + by whom?; and (iv) Future recommendations. Common themes were identified relating to what additional data is required on how best to present the data in order to influence policy and drive new research. We were also able to identify a need for additional training in how to interpret the data presented. The outlook for ongoing and stimulation of future projects is promising both with the research consortia and independently of. During this research exchange, we managed to successfully close out existing grants and make meaningful advancements planning critical future activities whilst engaging with new partners to assist in the dissemination and practical use of data to effect outcome and impact via changes in practices and behaviour which can contribute to global public good.

Overall, the exchange visit strengthened existing partnerships after a difficult pandemic period and created new contacts to strengthen ongoing and future research activities between BGS, UoE, KMFRI, KALRO and KEFRI with exciting prospects on the horizon.

Appendix 1 Workshop Agenda

Geochemistry and Health Kenyan Stakeholder workshops June/July 2022

AGENDA

Opening from Professor Odipo Osano and Dr Diana Menya 20 mins

Diana Menya

Explain public health context – initial rationale for esophageal squamous cell carcinoma (ESCC) and thoughts behind spatial influence on health conditions.

Odipo Osano

Overall context of information – sampling regime for geochemical and health survey – links to ESCC work.

Specific information

Olivier Humphrey

Present soil geochemistry predictive tool and provide a demonstration. *A Machine Learning Approach To Geostatistics In Kenya* (25 min)

Michael Watts

Present drinking water and urine data. *Geochemistry and public health data for western Kenya: Drinking water and urinary biomonitoring* (15min)

Total 90 min or so to allow for questions or further demonstration of data

Comfort Break (10 min)

Breakout groups (60 min)

Group 1: Agriculture-Environment – led by Prof. Osano, with Dr Humphrey

Group 2: Public Health data – led by Dr Menya, with Dr Watts

Questions to consider:

-What do they think of the data – appropriate format?

-How could it be used to demonstrate impact?

-If it can be used now, how and by whom?

-Future recommendations

Feedback (30 min)

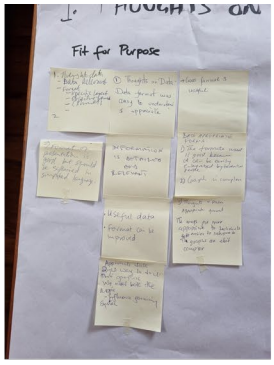
volunteer rapporteurs from each group.

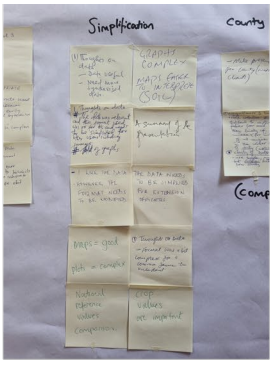
15 min summary and AOB

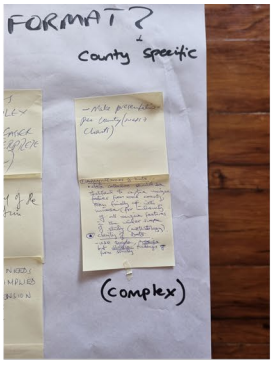
Appendix 2 Workshop data

Agricultural group feedback from workshops

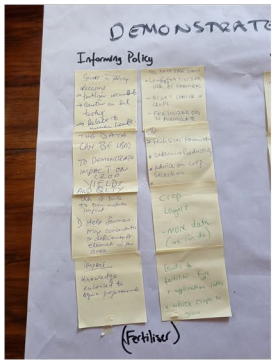
Thoughts on data-appropriate format?

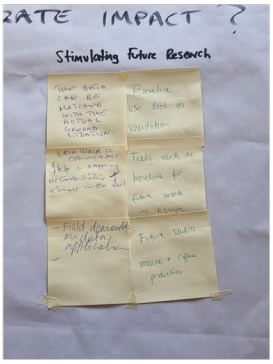


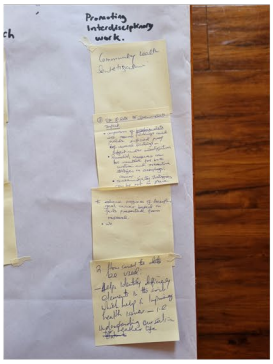




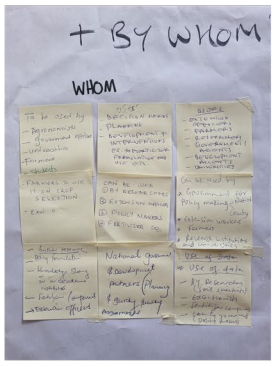
How could data be used to demonstrate impact?

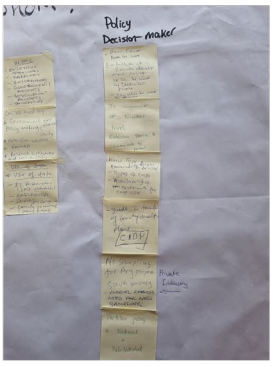




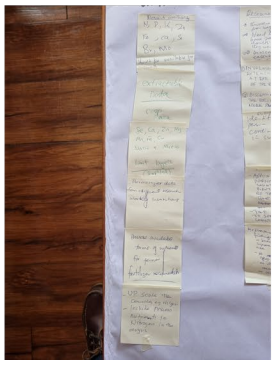


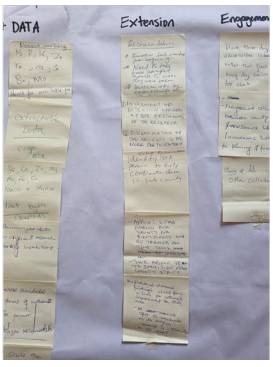
How could the data be used and by whom?

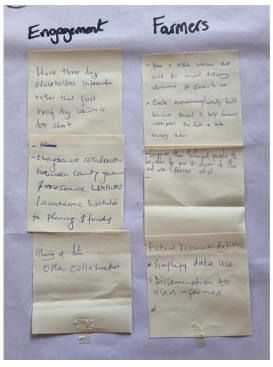


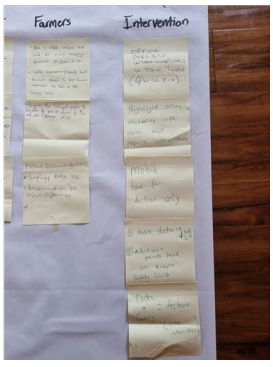


Future recommendations



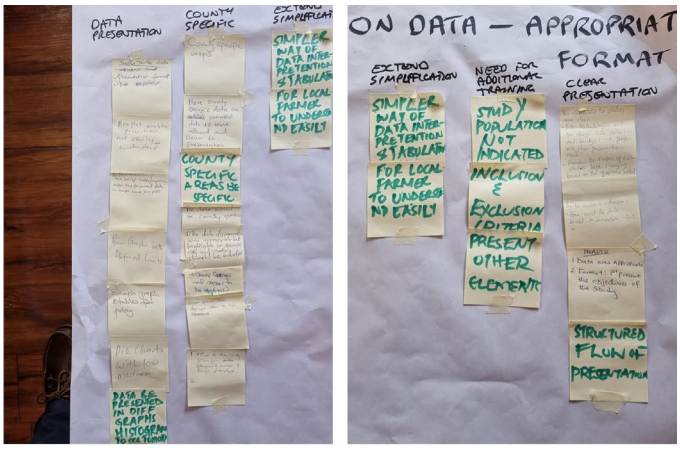




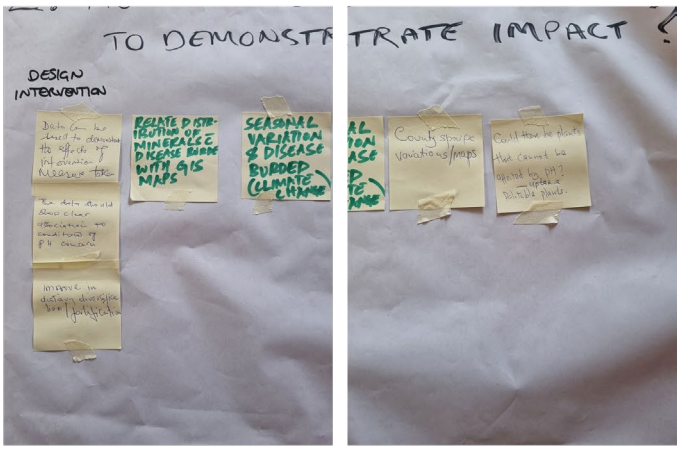


Public health group feedback from workshops

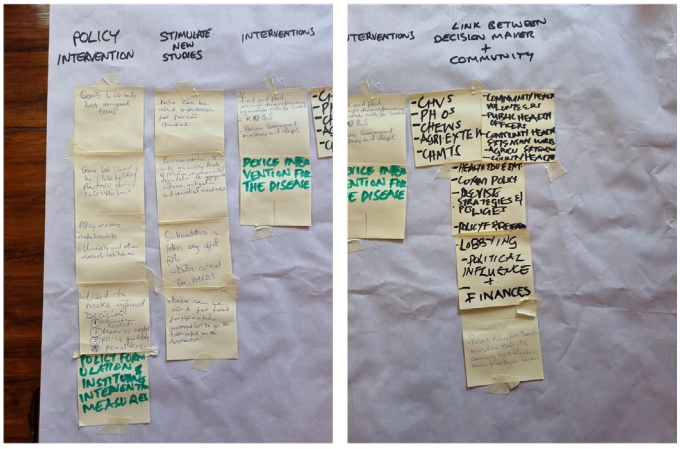
Thoughts on data-appropriate format?



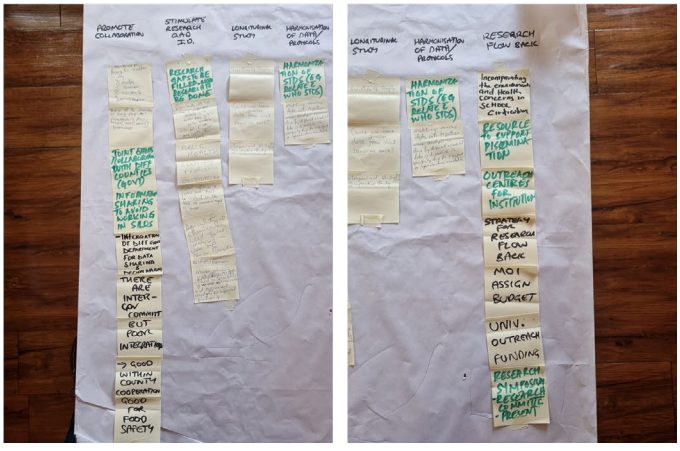
How could data be used to demonstrate impact?



How could the data be used and by whom?



Future recommendations



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