

Workshop Report

Insights from the 8th Sustainable Phosphorus Summit (SPS8)

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Abstract

Phosphorus sustains global food production and is, therefore, of crucial importance to human nutrition and health. However, its mismanagement can lead to water pollution and environmental degradation in addition to low crop yields. In many parts of sub-saharan Africa, phosphorus deficiency constrains agricultural productivity and exacerbates food insecurity. Despite these challenges, phosphorus remains a fragmented topic in global and African policy. To address these issues, the 8th Sustainable Phosphorus Summit (SPS8) was convened in Africa for the first time. SPS8 took place in Accra, Ghana, between 30th September and 3rd October 2025. The Summit was an international collaboration, with co-conveners from the Council for Scientific and Industrial Research (CSIR) – Ghana, the Forum for Agricultural Research in Africa (FARA), The UK Centre for Ecology & Hydrology West Africa Office, Lancaster University and Rothamsted Research. In this paper, we give a detailed overview of the key messages and insights that emerged from highlight talks, lectures, working groups and field trips. We also discuss and reflect on the challenges of delivering an inclusive summit, from designing solutions to benefit-sharing. SPS8 demonstrates that inclusive, cross-sector knowledge-exchange events are crucial to support and enable phosphorus sustainability on the continent of Africa and globally and to enable the next generation of interdisciplinary phosphorus researchers.

Keywords

Africa, food security, water quality, soil fertility, collaboration, inclusivity

Date and place

30th September - 3rd October 2025, Accra, Ghana.

Participation

The Summit was an international collaboration, with co-conveners from the Council for Scientific and Industrial Research (CSIR) – Ghana, the Forum for Agricultural Research in Africa (FARA), The UK Centre for Ecology & Hydrology West Africa Office, Lancaster University and Rothamsted Research. The Summit was sponsored by the Development Bank Ghana, University of Southern Denmark, Ragn-Sells, the Science and Technologies for Phosphorus Sustainability (STEPS) Center, the African Plant Nutrition Institute, the Global Environment Facility through the uPcycle Project and the Volta River Authority. The Summit welcomed ca. 120 in-person attendees and ranged from 302-538 online participants. In-person delegates represented a range of sectors, including industry, UN bodies, governments, independent and industry-focused research institutes, academia, education, indigenous people's groups and development banks.

The event was a successful culmination of many months of collaborative work (Manzeke-Kangara et al. 2025) with partners, stakeholders and experts from 38 organisations and 20 countries represented in organising committees alone. The organising team comprised 36 members of an International Expert Working Group (IEWG) including three Co-Chairs, nine members of the Local Organising Committee (LOC) and eleven members of the International Coordination Team (ICT). The IEWG coordinated the drafting of the programme and managed the peer review process for speakers and the LOC designed the opening programme, provided on-the-ground expertise and managed sponsorships, field trips and side events. The ICT managed conference organisation, budgeting, communications and coordinated all other committees and delegates.

Introduction

Phosphorus is essential for crop and livestock production and underpins global food security. Adequate phosphorus availability to plants supports root development, energy transfer, nutrient uptake and yield across cropping systems, particularly in highly weathered tropical soils where native phosphorus reserves are inherently low (Elser and Haygarth 2021, Brownlie et al. 2022). On the other hand, phosphorus mismanagement can contribute to significant environmental problems, particularly in regions with high nutrient surpluses. Over-application of phosphorus fertilisers, inappropriate field management and inadequate treatment of nutrient-rich wastewater can lead to phosphorus losses to the environment (Johnes et al. 2022). When phosphorus inputs exceed eutrophication thresholds, toxic algal blooms degrade water quality, disrupt ecosystem services, threaten human and animal health, reduce biodiversity and impact local and national economies (WWQA Ecosystems 2023). Decomposing algal biomass can create hypoxic 'dead zones', as observed in the Baltic Sea, Gulf of Mexico and Chesapeake Bay, while methane emissions exacerbate climate change (Beaulieu et al. 2019).

While excess phosphorus is an issue in many countries in the Northern Hemisphere, in much of sub-Saharan Africa, widespread soil phosphorus deficiency remains one of the

principal biophysical constraints to agricultural productivity. Although Africa hosts about 76% of the total phosphate rock reserves (U.S. Geological Survey 2024), over 75% of cultivated African soils are phosphorus-deficient, contributing directly to low yields, soil degradation and chronic food insecurity (Prochnow and Lupinetti-Cunha 2022). Economic barriers are the primary constraint to fertiliser use across sub-Saharan Africa, with smallholder farmers often struggling to access fertilisers, resulting in sub-optimal crop yields (UN Environment Programme 2009, Dawson and Hilton 2011, Chianu et al. 2012, Nziguheba et al. 2016). The finite and geographically concentrated nature of phosphate rock amplify these risks, with price volatility and supply disruptions exacerbating hunger and poverty (Blackwell et al. 2019, Brownlie et al. 2023, U.S. Geological Survey 2024). The role of conflict in disrupting soil health through nutrient management has also recently been highlighted (Medinets et al. 2025).

Addressing phosphorus deficiency through improved access to fertilisers, integrated soil fertility management and efficient nutrient stewardship is, therefore, essential for achieving sustainable agricultural intensification on the continent of Africa. To tackle this issue, the African Union signed the Nairobi Declaration in 2024, which called for a more than 3-fold increase in levels of fertiliser use from an average of 18 kg ha⁻¹ to at least an average of 54 kg ha⁻¹ by 2034 (African Union 2024). Yet, given sub-Saharan Africa's high susceptibility to erosion, rapidly growing urban wastewater flows, variability in regulatory oversight and limited access to farmer support services, scaling up phosphorus inputs could exacerbate phosphorus losses, with negative consequences for water quality and aquatic ecosystems (Manzeke-Kangara et al. 2025). The African phosphorus challenge therefore lies in designing integrated strategies that improve crop yields and enhance phosphorus use efficiency, while safeguarding freshwater ecosystems by investing in waste management and nutrient recycling systems, agronomy and soil conservation (Manzeke-Kangara et al. 2025).

Although these urgent challenges persist, intergovernmental action on phosphorus management and the development of innovative solutions for phosphorus recycling and recovery remain limited. Globally, few national policies exist that deal specifically with sustainable phosphorus management and no framework comprehensively addresses sustainable phosphorus use at the global scale, even though international commitments include multiple UNEA resolutions, the Kunming-Montreal Global Biodiversity Framework and the Sustainable Development Goals (SDGs), as in Table 1. Addressing this governance gap, ahead of the 7th United Nations Environment Assembly in December 2025 held in Nairobi, the Executive Director of UNEP called on countries to coordinate action to reverse phosphorus pollution, provide guidance on sustainable nutrient management and safeguard global food security (United Nations Environment Programme 2025).

What is a Sustainable Phosphorus Summit?

The 'Sustainable Phosphorus Summit (SPS)' is an established international, multi-stakeholder global series aimed at advancing research, dialogue and action for the

sustainable management of phosphorus across the world. The SPS is an innovative, cross-sector event which aims to catalyse transformative change, showcasing the regional context of phosphorus in its host country, while bringing these contexts to the global community. The first SPS was held in 2010 in Linköping, Sweden (Neset and Cordell 2010) and every 1-4 years after that: Tempe (USA) in 2011, Sydney (Australia) in 2012 (Global Phosphorus Research Initiative 2012), Montpellier (France) in 2014 (Hinsinger 2014), Kunming (China) in 2016 (Phosphorus Futures 2015), Brasilia (Brasil) in 2018 (Phosphorus Futures 2017) and Raleigh-Durham (USA) in 2022. In 2025, the 8th SPS was brought to Africa for the first time, recognising the urgent need for action on sustainable phosphorus management on the continent and ensuring that African voices were prominent and guided discussions towards the design of sustainable phosphorus solutions from local to global scales.

Table 1.

All relevant framework/agenda/resolution elements dealing with nutrients.

Framework / Agenda / Resolution	Element	Relevance / Contribution
Kunming–Montreal Global Biodiversity Framework (GBF) (<i>Secretariat of the Convention on Biological Diversity 2022</i>)	Goal B	Promotes sustainable use and restoration of freshwater ecosystems by addressing nutrient pollution, a major driver of biodiversity loss.
	Target 7	Supports efforts to halve excess nutrient losses by 2030 through regular monitoring of phosphorus and nitrogen.
	Target 2	Informs restoration of degraded inland waters, where reducing eutrophication is essential for ecosystem recovery.
	Target 3	Enables effective conservation of freshwater bodies by tracking eutrophication status.
	Target 8	Contributes to climate resilience via ecosystem-based approaches that maintain healthy freshwater systems.
2030 Agenda for Sustainable Development (SDGs) (<i>United Nations 2015</i>)	SDG 6.3	Provides indicators to assess nutrient pollution reductions in freshwater, central to water quality improvements.
	SDG 14	Addresses inland nutrient sources contributing to coastal eutrophication.
	SDG 15	Supports protection of freshwater biodiversity as part of terrestrial ecosystems.
	SDG 2	Promotes increased agricultural productivity and sustainable food production systems, requiring improved soil fertility and efficient nutrient use.
	SDG 12	Promotes sustainable nutrient use in agriculture and industry.
UNEA Resolutions	Resolution 5/4 – Sustainable Lake Management	These emphasise the need for improved nutrient monitoring and data tools-functions directly addressed by the FEI.

Framework / Agenda / Resolution	Element	Relevance / Contribution
	Resolution 3/10 – Water Pollution	
	Resolutions 4/14 & 4/2 – Nitrogen Management	
	Resolution 6/13	Promotes effective, inclusive solutions for strengthening water policies in the context of climate change, biodiversity loss and pollution.
UN Resolutions	UN Resolution A/HRC/RES/48/13	Supports the right to a clean, healthy and sustainable environment by tracking eutrophication threats.
	UN Decade on Ecosystem Restoration (2021–2030)	Guides restoration of nutrient-impaired freshwater ecosystems through actionable data.
Voluntary Guidelines for Sustainable Soil Management (VGSSM) (<i>Food and Agriculture Organization 2017</i>)	Nutrient stewardship principles	Promote balanced fertilisation, soil organic matter management and efficient nutrient cycling to enhance productivity while protecting ecosystems.
Nairobi Declaration on Africa Fertilizer and Soil Health Summit 2024 (<i>African Union 2024</i>)	Commitments 1 & 2	Improved access and affordability of inorganic and organic fertiliser for smallholder farmers. Targeted agronomic recommendations for specific crops, soils and climatic conditions to ensure greater efficiency and sustainable use of fertilisers.

Aims of the workshop

SPS8 focused on priority actions for achieving sustainable phosphorus management in Africa and globally, as outlined in the full programme (Spears et al. 2026). A network of experts and stakeholders co-designed Six Global Challenges (Manzeke-Kangara et al. 2025) around which the Summit was based:

1. Phosphorus is critical in supporting global food security. How can we improve the phosphorus use efficiency in food production systems?
2. Access to phosphorus is varied across the world, and we need to improve access and benefits where needed, for example, in Africa. How can we address the imbalance in phosphorus fertiliser use?
3. Phosphorus pollution of water can result in biodiversity loss and human health impacts. How can we reduce the transfer of phosphorus from land to water and manage/mitigate its effects?
4. There are complex interactions between phosphorus, nitrogen, carbon and climate. We must increase our understanding and awareness of this, developing integrated mitigation and adaptation plans.

5. Sustainable mining and recycling are essential to preserve phosphorus for future generations. We must balance the supply of new phosphorus from mining, with increased attention to varied recycling streams.
6. We need to improve our governance of phosphorus locally and globally. We need to explore new opportunities for effective governance at multiple levels to help enact the transformations required.

The Summit featured six sessions, one for each of the Six Global Challenges. Each session had a highlight talk and 4-5 short lightning talks, followed by a panel discussion. The 7th session was sponsored and organised by the African Plant Nutrition Institute (APNI) and was focused on enhancing global phosphorus efficiency along the mining-use-recovery pathway. In total, the Summit featured about 60 presentations.

SPS8 established three collaborative working groups focused on:

1. Working Group 1 (WG1): Phosphorus Action Plan for Africa, including African Sustainable Phosphorus Network (ASPNet) side event;
2. Working Group 2 (WG2): Global Phosphorus White Paper;
3. Working Group 3 (WG3): Early-Career Researcher Initiative.

On the final day, delegates were given a choice of three field trips: The Accra Compost and Recycling Plant (ACaRP), the Volta River Authority (VRA) or The Cocoa Research Institute Ghana (CRIG).

Key outcomes and discussions

Key messages presentations, working groups and field trips are detailed below.

Key messages from Keynote Lecture and Highlight talks

To contextualise the scale of the phosphorus challenge in Africa, Dr. André Bationo (Technical Advisor of the President and Chief Executive Officer at the International Fertilizer Development Center IFDC, Ghana, and former Director of Alliance for a Green Revolution in Africa AGRA-West Africa) gave a keynote lecture about the sources and sustainable management of phosphorus for food security in Africa. Dr Bationo began by highlighting that, currently, Africa has a population of ~ 1.5 billion people and spends ~ €50 billion every year on food imports to feed them. By 2050, if current trends continue, Africa will itself only be able to feed just over 10% of its population. Africa has around three quarters of the world's phosphate rock reserves, but approximately 80% of the soils in Africa are phosphorus deficient. Despite the acute phosphorus deficiency of soils, local farmers use very little phosphorus fertiliser because of high costs and problems with accessibility. The use of locally available phosphate rock could be an alternative to imported phosphorus fertilisers, as emerging from research from the International Fertilizer Development Center (IFDC). Whereas most phosphate rock is unreactive and not suitable for direct application, in a few cases, such as Minjingu (Tanzania), Tilemsi

(Mali) and Tahoua (Niger) phosphate rocks, it can be used directly. Dr Bationo concluded that various methods can be used to improve the agronomic effectiveness of phosphate rock. The most promising technologies from IFDC research are processing the rock by partial acidulation or activation by small quantities of water-soluble phosphorus. Africa's food production could be multiplied up to 6-fold by improved agricultural practices and fertiliser use.

Prof. Kwame Agyei Frimpong (Professor of soil fertility at the University of Cape Coast and senior scientist APNI, Ghana) delivered a highlight talk on the 1st Global Phosphorus Challenge (Food Security). Prof. Frimpong explained that phosphorus is viewed by the United Nations Food and Agriculture Organisation (FAO) report as the most agriculturally yield-limiting nutrient (Food and Agriculture Organization 2017) as it has no known biochemical alternatives, describing it as 'life's bottleneck'. Unlocking the potential of phosphorus supply to enhance global food security requires engaging farmers and recognising their challenges and opportunities. Theoretically over 90% of soils would be responsive to phosphorus fertiliser application, but approximately 40% of acidic, weathered soils in tropical and sub-tropical regions are phosphorus-deficient due to phosphorus fixation by aluminium and iron. In arid and semi-arid climates with alkaline soils, phosphorus availability is limited by the presence of calcium in the soil. Dr. Frimpong concluded that integrated phosphorus management approaches involving applying phosphorus-solubilising and phosphorus-accumulating bacteria, adjusting soil pH, using P efficient crops, crop rotation and intercropping and adopting the 4R nutrient stewardship approach (Right source, Right rate, Right place and Right time) can enhance P use efficiency, soil health, crop yields and improve the livelihoods of farmers and their households.

Dr. Kaushik Majumdar's (Director General at APNI, Morocco) delivered a highlight talk on the 2nd Global Phosphorus Challenge (Access to Fertilisers). Dr. Majumdar highlighted that phosphorus is one of the most yield-limiting plant nutrients in Africa, compromising the productivity of soils and that a 5-fold increase in phosphorus application will be needed to maintain food security in the Econtinent (Sattari et al. 2012). Compared to 2016, estimated elemental phosphorus application must increase by between 1.7 million tonnes and 3.4 million tonnes to feed the African population by 2050 (Magnone et al. 2022). Metadata from recent nutrient omission studies, demonstrated significant cereal yield response to phosphorus across all soil fertility levels (Njoroge et al. 2019, Zingore et al. 2022). These studies revealed over 1 t ha⁻¹ of phosphorus response in cereal crops and balanced phosphorus application improved crop yield and yield stability and increased nutrient use efficiency. Dr Majumdar concluded that removal of supply and value chain constraints, improving availability and access to phosphorus fertilisers and adoption of scientifically credible and contextually relevant agronomic solutions will be crucial for sustainable phosphorus management in Africa.

Prof. Kenneth Irvine (IHE Delft Institute for Water Education, The Netherlands) delivered a highlight talk on the 3rd Global Phosphorus Challenge (Pollution), unpacking the environmental pollution issues that phosphorus losses can cause. Dr Irvine emphasised the complexity of phosphorus management in surface waters, for lakes. The United

Nations Environment Programme coordinated World Water Quality Alliance White Paper on Embedding Lakes into the Global Sustainability (WWQA Ecosystems 2023) called for a new sustainable approach to lake management, based on ecosystem protection and restoration, emphasising the impacts of nutrients from agriculture and wastewater. In some cases, reducing phosphorus inputs to land may not be sufficient to prevent continuation of algal blooms because of unavoidable phosphorus losses from agriculture or release of phosphorus stored in sediments. In some cases, food web interactions such as harvesting small fish (which eat *Daphnia* and other crustaceans which graze on algae) can be part of management. In all cases, sufficient understanding of the ecology and food web interactions in lakes help support management actions. Prof. Irvine concluded that phosphorus management challenges will be exacerbated by climate change, which causes warming of waterbodies and increases storm rainfall events and flooding-drying cycles, both of which increase phosphorus losses from land.

Dr. Maja Arsic (Research Scientist at Commonwealth Scientific and Industrial Research Organisation, Australia) delivered a highlight talk on the 4th Global Phosphorus Challenge (Interactions), specifically on navigating phosphorus-climate-energy interactions from an Australian perspective. Dr Arsic explained that phosphorus flows remain largely embedded in linear systems of extraction, production, consumption and waste generation. There are ambitions to increase agricultural production for food, feed, fibre and fuel, while biomass loss and waste rates remain high across the value chain. Biomass or nutrient recycling practices (e.g. land application of sludges) are largely driven by industry waste management regulations, energy and cost reduction activities and supply chain climate reporting requirements. Phosphorus circularity from a food security perspective remains a secondary focus. Finally, from a solutions-orientated perspective, applying circular bioeconomy framing could support sustainable phosphorus futures. Dr. Arsic concluded that centring phosphorus at the food-energy-waste nexus is essential to connect bioresources across scales, mapping biomass flows between economic sectors and developing a complex understanding of the embedded interactions between phosphorus, climate and energy systems.

Mr. Ludwig Hermann (Secretary and Board Member of the European Sustainable Phosphorus Platform (ESPP) and Senior Researcher and Advisor at Proman Management GmbH, Austria) delivered a highlight talk on the 5th Global Phosphorus Challenge (Sustainable Mining and Recycling), highlighting innovative opportunities for phosphorus recovery. Mr Hermann highlighted that current consumption patterns in high-income countries cannot be extended to the global population without further overshooting planetary boundaries. Mr Hermann continued detailing that Ghana has a growing fertiliser market, but no commercially viable phosphate rock deposits have yet been confirmed. Meanwhile, major secondary phosphorus resources of livestock manure and human excreta remain underutilised. With only 21% of the Ghanaian population having access to basic sanitation, this leads to large nutrient losses, pollution and health risks. Systemic challenges include power shortages, unclear institutional responsibilities, insufficient maintenance capacity and chronic budget gaps. Opportunities exist for resource recovery, including wastewater and organic waste streams, which offer high-

potential opportunities for recovering phosphorus, energy, water and valuable materials. Technologies, such as biogas production, biomethane upgrading, hydrothermal carbonisation and vivianite extraction, can transform waste into economic assets. Function-based business models, cooling services, carbon credits and nutrient products can provide new revenue streams to co-finance sanitation. Mr Hermann concluded that additional opportunities lie in nutrient-removal algae ponds and valorisation of cocoa residues and beach-polluting Sargassum into energy and carbon materials.

Dr. Ning Liu (United Nations Environment Programme, Kenya; Coordinator of the Global Partnership on Nutrient Management (GPNM)) delivered a highlight talk on the 6th Global Phosphorus Challenge (Governance), addressing the lack of intergovernmental action on phosphorus sustainability. Dr Liu started by reiterating that phosphorus is vital for food security, yet poor management disrupts planetary boundaries, causing eutrophication and biodiversity loss. Lessons from global governance frameworks like the Montreal Protocol stress science-based, cooperative approaches. While nitrogen dominates current efforts, phosphorus governance is gaining traction. Dr Ning presented the GPNM, coordinated by UNEP, which promotes optimised nutrient use and collaboration amongst governments, civil society and the private sector. The GPNM has secured funding for projects on nutrient cycles and nitrogen management, supporting voluntary national action plans and capacity building. Dr Liu then mentioned UNEA resolutions (4/14 and 5/2) which emphasise sustainable nitrogen management through improved coordination, data sharing and integrated policies. Phosphorus is mentioned, but concrete actions on the global policy stage remain limited. To address this, the UNEP Executive Director's report to the Seventh Session of UNEA urged Member States to establish a global platform for collaborative action and stronger focus on phosphorus. Finally, Dr Liu concluded that strategic recommendations include coordinated global efforts, region-specific strategies, enhanced monitoring and integration with the UN Sustainable Development Goals to ensure sustainable food systems and ecosystem health.

Key messages from African Plant Nutrition Institute's session

The African Plant Nutrition Institute (APNI) sponsored and organised a session entitled 'Enhancing Global Phosphorus Efficiency Along the Mining-Use-Recovery Pathway' (African Plant Nutrition Institute 2025). The session was focused on strategies to enhance sustainable phosphorus use across Africa and covered three key themes:

1. precision plant nutrition;
2. soil health for improved livelihoods and
3. climate & weather-smart plant nutrition for resilience.

Speakers highlighted innovative strategies to improve phosphorus efficiency, including: advanced ore-body modelling for selective extraction, sensor-based ore sorting, water recycling and desalination. The 4R Nutrient Stewardship principles, soil management, crop breeding innovations and site-specific strategies were also presented as effective ways to enhance phosphorus use efficiency, sustaining food security.

Key Solidarity Messages

Seven organisations (UN Environment Programme, APNI, Obafemi Awolowo University, FARA, Soil Science Society of Ghana, Development Bank Ghana, CSIR, Table 2) sent endorsements for SPS8, in the form of a recorded video which was played at the Summit (Youtube 2025). The most frequently mentioned reason for supporting SPS8 was for it to be a platform to foster collaboration, partnerships, knowledge-sharing, innovation and capacity-building in the phosphorus sustainability field. Multiple organisations also mentioned the importance of SPS8 being held in Africa to kick-start the writing of a roadmap for sustainable phosphorus management in Africa, to address the phosphorus deficit in African soils affecting crop yields and building on the continental consensus on sustainably increasing fertiliser use in Africa. Ultimately, organisations supported SPS8 as an initiative to build scientific consensus and strengthen strategic partnerships for developing inclusive and scalable solutions towards sustainable phosphorus management in Africa and globally, as well as to support phosphorus policy integration into wider national and international governmental policies.

Key Working Group outcomes

Working groups participants represented a cross-sector global cohort with an African majority (i.e. > 50% participants) in WG1 and WG3. Each working group had about 25-30 participants and 2-3 facilitators. The key objectives and outcomes of each working group are summarised in Fig. 1.

Table 2.

Detailed Solidarity Messages for SPS8 (uPcycle Lakes Project 2025).

Name	Role and Organisation	Message
Doreen Lynn Robinson	Deputy Director of the UN Environment Programme Ecosystems Division, Kenya	Remarked that SPS8 was a great opportunity to enhance action towards sustainable phosphorus management in Africa and globally. She also emphasised UNEP's commitment to tackling nutrient pollution, which demands globally coordinated solutions-orientated actions. Doreen also announced that, at the UNEA meeting in December 2025, UNEP's Executive Director would share a report on the importance of sustainable nutrient management for wide ranging benefits, including soil health and food security, resource recovery and green energy generation, water security and climate resilience. Finally, Doreen highlighted that fragmented governance on phosphorus sustainability should be tackled by embedding it into broader environmental and development agendas through the Global Partnership on Nutrient Management (GPNM) and that SPS8 served as a platform to foster collaboration, innovation and capacity-building to build inclusive and scalable solutions.
Dr. Kaushik Majumdar	Director General at APNI, Morocco	Emphasised the timeliness of holding an SPS in Africa, for two main reasons: the extreme phosphorus deficit in African soils affecting crop yield and the continental consensus on sustainably increasing fertiliser use in Africa to build soil health.

Name	Role and Organisation	Message
		Dr. Majumdar further highlighted the need to increase fertiliser use in line with the Africa Fertiliser and Soil Health 10-year Action Plan, endorsed by member states of the African Union, in order to support agricultural transformation across the African continent.
Prof. Vincent Aduramigba-Modupe	Professor on Soil Fertility Modelling at Obafemi Awolowo University, Ibadan and Institute of Agricultural Research and Training, Nigeria	Works as Visiting Scientist at the West Africa Soil Hub (WASH), which supports the National Government in West Africa by working on five key areas: soil information system, farmer experimentation, capacity building and lab and financing. Prof. Aduramigba-Modupe highlighted the commitment of the WASH to support the SPS8 initiative and ensure that phosphorus policy is integrated into national governments.
Dr. Aggrey Agumya	Executive Director of FARA, Ghana	Highlighted FARA's apex role in agricultural research and innovation in Africa and its technical support for the African Union Commission and African Union Development Agency Network for Agricultural Research and Innovation. Dr. Agumya welcomed SPS8 to build on the momentum of the 2024 African Union Nairobi Declaration on Fertiliser and Soil Health, which is expected to unlock investment and foster innovation, policies and partnerships in soils, including addressing phosphorus challenges. Dr. Agumya concluded by affirming FARA's commitment to take forward the outcomes of SPS8, including a long-term roadmap for sustainable phosphorus management in Africa and a mechanism for strengthening collaborations amongst stakeholders.
Dr. Edward Yeboah	President of the Soil Science Society of Ghana, Ghana	Explained that the Soil Science Society of Ghana works to advise governments on soil use and management and orientate flagship programmes in Ghana. Dr. Yeboah highlighted the importance of holding an SPS in Africa to address widespread phosphorus deficiency and soil acidification across the African continent, in order to improve food security. Finally, Dr. Yeboah remarked that the Society's commitment to ensure partnerships would be established to advance phosphorus research in Africa and beyond.
John Kwame Mensah Zigah	Deputy CEO at Development Bank Ghana, Ghana	Highlighted the mission of the DBG to provide long-term capital that drives inclusive and sustainable growth, aligning with the UN Sustainable Development Goals. Mr. Zigah supported SPS8 as a knowledge-sharing platform to build dialogue and commitment on priority actions for achieving sustainable phosphorus management. Moreover, he highlighted the need for securing responsible use and recycling of phosphorus for present and future generations and the DBG's commitment to advancing solutions that respect people and the planet.
Prof. Paul Bosu	Director General of the CSIR, Ghana	Underlined the critical balance of excess phosphorus polluting rivers and lakes, while lack of phosphorus damages agricultural productivity. Prof. Bosu welcomed SPS8 to create the support and knowledge base to turn these challenges into opportunities, via the creation of an action plan for Africa and the creation of an African Sustainable Phosphorus Network.

Working Group 1 (WG1): Phosphorus Action Plan for Africa facilitated by Adelaide Asante (UKCEH West Africa) and Prof. Kwame Agyei Frimpong (University of Cape Coast and APNI).

While Africa holds most of the world's phosphate rock reserves, high costs, weak distribution systems and inadequate policies limit farmers' access to fertilisers. Low

phosphorus use efficiency, coupled with poor agronomic practices and weak governance, further constrain productivity and contribute to water pollution through runoff and wastewater discharges. The objective of WG1 was to deliver a high-level phosphorus roadmap with an African perspective on the need for a global sustainable phosphorus policy.





Working Group	Objective	Key Outcomes
 Phosphorus Action Plan for Africa	Deliver a phosphorus roadmap with an African perspective on the need for a global sustainable phosphorus policy	<ul style="list-style-type: none"> • Establishment of the ASPNet • Strengthened capacity and coordination across institutions • Align efforts with the African Fertilizer and Soil Health Action Plan (AFSH-AP) and Soil Initiative for Africa (SIA)
 African Sustainable Phosphorus Network (ASPNet) side event	Launch an African Sustainable phosphorus Network and set out core activities	<ul style="list-style-type: none"> • ASPNet launched and hosted by FARA and supported by 8 other African institutions • Coordinating the Phosphorus Action Plan for Africa • Organising future first African SPS
 Global Phosphorus White Paper	Develop framework for a white paper addressing the Six Global Phosphorus Challenges	<ul style="list-style-type: none"> • Two-tiered white paper: 1) Global Policy Recommendations on Phosphorus Sustainability; 2) Translating Recommendations into Action – Example Policy Brief. • Deliver an African-focused, collaborative white paper
 Early-Career Researcher (ECR) Initiative	Identify needs, barriers and enablers to early-career development in phosphorus sustainability	<ul style="list-style-type: none"> • Development of online network of international ECRs, collaborating with ASPNet • Questionnaire for all SPS8 delegates • Future article on barriers and challenges to sustainable phosphorus management in Africa and globally

Figure 1.

Summary objectives and outcomes of the three working groups (including the ASPNet side event) held during SPS8.

Key discussion points by WG1 included deliberations focused on Africa's phosphorus management challenges, including low phosphorus use efficiency, limited access to phosphorus inputs, phosphorus transfer from land to water and how to manage or mitigate its effects, limited knowledge and understanding of interactions between the nutrient cycle and climate, weak policy frameworks and emerging environmental concerns.

Agreed outcomes included integrated soil fertility management, aligning efforts with the African Fertilizer and Soil Health Action Plan (AFSH-AP) and Soil Initiative for Africa (SIA) and the promotion of circular economy approaches for phosphorus recovery and use efficiency. WG1 also committed to strengthening of coordination, governance, data systems and capacity across institutions and, crucially, established the African Sustainable Phosphorus Network (ASPNet) to champion the Phosphorus Action Plan.

Side-Event: African Sustainable Phosphorus Network (ASPNet)- facilitated by Adelaide Asante (UKCEH West Africa), Prof. Kwame Agyei Frimpong (University of Cape Coast and APNI) and Prof. Oluwole Fatunbi (FARA).

Recognising the need for an African-led initiative to address the complexities around phosphorus sustainability challenges, prior to SPS8, several consultative meetings were held with continental phosphorus actors and stakeholders representing research, academia, policy, development and industry, to discuss the creation of an African Sustainable Phosphorus Network. The objective of the side-event was to launch the ASPNet and set out the network's core activities.

Key discussion points included reviewing the draft framework of the ASPNet prepared by the Local Organising Committee of SPS8 and discussing the sustainability plans of the network as well as governance and institutional hosting. The committee discussed how ASPNet would align with existing initiatives, especially the Soil Initiative of Africa (SIA) and the Africa Fertilizer and Soil Health Action Plan (AFSH-AP), networks like Africa Chapter of the Global Soil Platform (AfGSP), African Phosphorus Platform for Food Security (APPFS), Soil Science Society of Africa and other willing organisations.

The main outcome of the discussions was the launch of the ASPNet on 2 October 2025, during SPS8. The ASPNet will be a collaborative Platform for Phosphorus Ecosystem Health in Africa and will be hosted by FARA with support from the UKCEH West Africa Office and with participation from other African institutions. The ASPNet will coordinate the drafting and finalisation of the Phosphorus Action Plan for Africa; set up an online portal for resources, collaboration and engagement; organise webinars and thematic dialogues, including the first African Sustainable Phosphorus Summit. ASPNet membership shall be open to individuals and organisations who share its objectives, including academics, water managers, extension agents and agricultural advisors, farmers and farmer organisations, fertiliser industry representatives, waste management and circular economy innovators, policy-makers and government officials, regional and international organisations, students and early-career professionals.

Working Group 2 (WG2): Global Phosphorus White Paper - facilitated by Dr. Will Brownlie and Issy Lewis (UKCEH) and Dr. Dana Cordell (University Technology Sydney).

Phosphorus sustainability is lacking in the global policy agenda. Recognising this, WG2 set out to develop a white paper on global phosphorus sustainability, which would synthesise knowledge gaps, address the six global challenges around which the summit was designed and propose opportunities for policy development (Brownlie and et al 2026).

Key discussion points included clarifying the purpose, audience and structure of the white paper. Topics discussed included identifying the most critical recommendations for policy-makers in relation to the Six Global Challenges and what level of contextual detail would be necessary to support these recommendations.

The main outcomes included the commitment of the WG members to proceed with a two-tiered white paper: (1) Global Policy Recommendations on Phosphorus Sustainability (finance and incentives, circular economy, communication and education, research and monitoring, integration with global goals) and (2) Translating Recommendations into an Action Example Policy Brief. An African-focused complementary white paper will also be delivered, with collaboration from other working groups. The group also produced a preliminary list of around 20 policy recommendations, under five broad themes:

- Finance and Incentives: Conditional farm loans, carbon–P credits and subsidies for recycling and infrastructure;
- Circular Economy: Quotas for recycled P, investment in biogas and wastewater systems and service-based nutrient delivery models;
- Communication and Education: Targeted messaging for high- and low-use regions, strengthened extension services and open data platforms;
- Research and Monitoring: Long-term legacy P monitoring, system mapping and better attribution of pollution sources;
- Integration with Global Goals: Align phosphorus policy with SDGs 2, 6, 12, 13 and 15 and with UNEA and KM- GBF frameworks.

Working Group 3 (WG3): Early-Career Researcher Initiative - facilitated by Dr. Malika Mezeli (Lancaster University), Associate Prof. Kasper Reitzel (University of Southern Denmark) and Dr. Muneta Grace Manzeke-Kangara (Rothamsted Research).

There is an international focus on the need for sustainable phosphorus management experts; however, the current socio-political environment presents challenging conditions in which early-career researchers (ECRs) may struggle to develop as independent researchers.

To ensure this call is answered, the objective of this working group was to identify the needs, barriers and enablers that ECRs face and what is needed to address them to support the next generation of phosphorus champions. Key discussion points included identifying the interconnected needs of networking, peer-to-peer support and skills

sharing. The group initiated the draft of a collaborative scientific paper focused on challenges for funding, mobility of ECRs and challenges regarding accelerating politically defined research (Mezeli et al. 2026).

The group established an online network to share research updates and other relevant topics. In addition, the group agreed to submit a questionnaire to all SPS8 delegates and relevant networks to gather evidence on developing future opportunities for ECRs. WG3 also committed to developing a new phosphorus ECR international community and foster collaborations with the newly-established ASPNet, with a future objective to develop a paper on barriers and challenges to sustainable phosphorus management in Africa and globally.

Field Trips

The Accra Compost and Recycling Plant (ACaRP) is a sustainable waste management and organic compost production facility, integrated into nationwide waste recycling systems and dedicated to circular economy development. Participants visited the facility dedicated to waste recycling which included a waste-receiving bay, initial sorting, metal separation, composting chambers for biodegradable materials and the transformation of waste into organic compost and liquid organic fertiliser. Participants were also taken to the laboratory, where products are tested for safety and usability prior to distribution. ACaRP showcases innovative approaches to waste management and nutrient recovery.

The Volta River Authority (VRA) is Ghana's leading power utility, providing hydro, solar and thermal energy as well as sustainable management of the Volta River and Reservoir system. Participants visited the VRA office, where they were briefed on the issue of aquatic weeds infesting the Volta Lake and on nutrient pollution from waste disposal into the lake, soil losses from agriculture and industrial discharges. Aquatic weeds can impact power generation by clogging turbines and increasing downtime and can affect local communities, increasing health hazards, such as schistosomiasis, hampering transportation, restricting fishing opportunities, aquaculture production and recreation. In extreme cases, aquatic weeds can cause the VRA plant to shut down, leading to significant economic losses. VRA explained their innovative weed control strategies, involving harvesting weeds which are then transformed into organic compost through strategic partnerships, for example, with ACaRP.

The Cocoa Research Institute Ghana (CRIG) focuses on research in sustainable cocoa production and soil fertiliser management. Participants visited the Institute's cocoa plantation, product development laboratory, cocoa fermentation and drying beds and chocolate production laboratory. CRIG scientists explained the sustainable farming and nutrient management practices at the plantation and emphasised how scientific research supports Ghana's cocoa value chain, via efficient phosphorus use and nutrient recycling and sustainable agricultural practices.

Inclusivity Principles of Sustainable Phosphorus Management

Delivering sustainable phosphorus management from the local to global stages requires inclusive cross-sector action. In recognition of this and building on the uPcycle Gender Mainstreaming Plan (Lewis et al. 2025), SPS8 was designed around four sustainable phosphorus management inclusivity principles that guided its organisation, development and delivery:

1. Designing solutions, based on inclusive participation across stakeholders. The voices of all people and communities are fairly represented in the design of solutions to deliver sustainable phosphorus management, including those from marginalised groups;
2. Ensuring that benefits are shared equitably from communities to global scales. Sustainable phosphorus management ensures that its benefits reach vulnerable communities, while extending positive impacts beyond the immediate scale of intervention;
3. Building capacity across responsible industries and institutions. Capacity development is focused on the industries, institutions and regulatory bodies responsible for implementing sustainable phosphorus management measures;
4. Contributing to a global strategy to ensure sustainable food production in sub-Saharan Africa. Sustainable phosphorus management is a global responsibility essential for advancing food production sustainability and resilience, while minimising losses and damage to aquatic ecosystems, both nationally and internationally.

Inclusivity baseline of SPS8

SPS8 was organised with the first inclusivity principle ('1. Designing solutions based on inclusive participation across stakeholders') at its heart.

SPS8 delegates, including invited speakers and Summit organisers, were asked to cover the costs of their own registration, travel and accommodation in order to maximise financial support for participants from low-income countries or early career researchers. Out of 113 registered delegates, ~ 64% (73 people) paid full price for registration. Financial support was, therefore, available on offer to participants who might face financial or structural barriers to attend SPS8. Successful candidates were selected by an Early Career Researcher and Sponsorship Committee who reviewed 37 sponsorship applications. The Committee developed a structured review rubric to ensure transparency, consistency and equity in decision-making. This rubric centred on four key criteria: career stage, prioritising early-career researchers; geographic context, with emphasis on applicants from low- and lower-middle-income countries, based on World Bank country classifications; alignment of work and potential contribution to sustainable phosphorus management; and demonstrated financial need. Each application was independently scored by committee members, followed by a consensus discussion to ensure alignment with SPS8's inclusivity principles. Using this process, the Committee

awarded full sponsorship to three applicants and provided waived registration fees to 15 applicants. An additional two applicants were connected to external funding sources identified by the Committee. In total, nearly half of all applicants (49%) received some form of financial support, significantly strengthening global representation and enabling the participation of individuals whose perspectives are often under-represented in international scientific convenings.

The African Plant Nutrition Institute (APNI) strategically supported the participation of eighteen graduate students and early career researchers from African National Agricultural Research and Extension System (NARES), in addition to the speakers in the special 7th Session organised by the Institute. This investment facilitated participation of five women and 13 men from 16 African institutions at the SPS8 and was instrumental in strengthening the engagement of African scientists across career stages and enhancing capacity for phosphorus research and innovation in Africa.

To further support inclusive participation, a special Visa-on-Arrival service was made available to all delegates, managed by the UKCEH West Africa Office, to minimise burden, time constraints and other potential barriers to attendance. A total of approximately 50 Visas on Arrival were issued, counting for ~ 40% of in-person attendees. SPS8 also enabled free online participation, organised by our partners at FARA, to allow the Summit to reach wider audiences, which brought an additional 302-538 online participants.

The selection of International Expert Working Group (IEWG) co-chairs sought to encompass regional diversity (ensuring African representation), experience hosting Sustainable Phosphorus Summits and gender diversity. This resulted in membership across Ghana, North America and Australia, including two males (Mittiyah, Elser) and two females (Cordell, Oyetunde-Usman). Highlight speakers were identified from input by the broader IEWG and invited by the IEWG co-chairs by considering the following criteria: regional diversity (Africa & Middle East, South/Central/North America, Asia & Oceania, Europe), gender balance, sector (academia, industry, government, community sector), communication and story-telling abilities, experience (e.g. years, region, culture), diverse perspectives across key themes (ranging from sustainable soil management to equitable phosphorus governance), balance of fresh perspectives and new voices, involving established senior and ECRs.

Abstracts were reviewed by the IEWG co-chairs and selected, based on the following criteria: broader relevance to the six global phosphorus challenges (i.e. not simply reporting on a single trial or study), communication skills, regional diversity and gender balance. For session chairs and working group chairs, at least two were appointed in order to help ensure gender balance.

Challenges of delivering an inclusive Summit

Despite these efforts, achieving an inclusive summit was challenging. For example, five female highlight speakers were invited across the Six Global Phosphorus Challenges

themed Sessions, but only one female speaker was able to accept and present (Table 3). The most cited reason for female invited highlight speakers declining was lack of funding support to attend. Many of these invited speakers were from the non-profit sector or academia, making self-funding challenging. Bringing in 'fresh perspectives and new voices' was also a challenge because phosphorus sustainability was not a priority issue for some of these invited speakers and hence it was challenging for them to justify resourcing and attendance internally to their institutions. Reflecting these challenges in recruitment, the first two session panels were 100% male, although gender diversity was improved in later sessions. The APNI-led session faced similar challenges in including female speakers.

Food security and soil fertility, central to the phosphorus challenge, are embedded within complex historical, socio-economic and political dynamics that shape access to nutrients and the governance of agricultural resources. Reflecting these broader dynamics, participation at the Summit was largely limited to international organisations, natural science researchers, national agricultural research institutions and representatives from the fertiliser industry. Social science perspectives, including political economy, human geography and political ecology, were largely absent and farmer organisations were not represented. This imbalance highlights a risk that phosphorus governance discussions remain dominated by technical expertise, while insufficiently reflecting the socio-economic realities of nutrient management. Addressing phosphorus sustainability ultimately requires governance approaches that integrate scientific expertise with socio-economic analysis and the practical knowledge of those managing soils and nutrient flows. We hope this paper serves as a baseline against which to improve inclusivity in this important discourse.

Catalysing the SPS8 inclusivity principles

The deliverables and future activities from the Working Groups will address principles 2 to 4 as catalysing actions.

The outputs of SPS8, including the Phosphorus Action Plan for Africa and the Global Phosphorus White Paper, are going to be widely shared, spanning local to global communities, via web platforms and dissemination events. The Early-Career Researcher network will be open to collaborations with global stakeholders and strive to reach vulnerable groups. Output materials will be tailored to meet accessibility needs, including translation into multiple languages where possible. These actions will catalyse the second principle of sustainable phosphorus management ('2. Ensuring that benefits are shared equitably from communities to global scales').

Capacity-building was kick-started at SPS8, which was ultimately a knowledge-exchange and networking event. Relevant informational and capacity-building materials will be made available to relevant bodies, via the SPS8 website. The outputs of SPS8 (including the Global Phosphorus White Paper, the ECR Viewpoint article and the Phosphorus Action Plan for Africa) will serve as capacity-building materials for the purposes of knowledge exchange and awareness raising. These actions will catalyse the third

principle of sustainable phosphorus management ('3. Building capacity across responsible industries and institutions').

SPS8 championed this effort by uniting local and international participants, along with Expert Working Groups, to embrace a collective responsibility for producing food sustainably, while minimising environmental harm. The event allowed the creation of new international connections, including stakeholders and experts, as well as the launch of the African Sustainable Phosphorus Network (ASPNet) hosted by FARA with support from the UKCEH West Africa Office and with participation from other African institutions, and the establishment of a new Early-Career Researcher Initiative for Phosphorus Sustainability, with support from the University of Southern Denmark, Lancaster University and Rothamsted Research. These actions will catalyse the fourth principle of sustainable phosphorus management ('4. Contributing to a global strategy to ensure sustainable food production in sub-Saharan Africa').

Conclusions

SPS8 underlined the crucial need for inclusive collaboration across research, government, NGOs, industry and academia towards global phosphorus sustainability. The event allowed the creation of new international connections, including stakeholders and experts, as well as the launch of the African Sustainable Phosphorus Network (ASPNet) hosted by FARA with support from the UKCEH West Africa Office and with participation from other African institutions and the establishment of a new Early-Career Researcher Initiative for Phosphorus Sustainability, with support from the University of Southern Denmark, Lancaster University and Rothamsted Research. Notably, we expect the Global Phosphorus White Paper to provide information for discussions ahead of the United Nations Environment Assembly 2026. SPS8 delegates committed to follow-through on the projects started and relationships fostered during the Summit, as well as enhance cross-sector collaborations.

As exemplified by SPS8, inclusive knowledge-exchange events around phosphorus are crucial to support and enable phosphorus sustainability on the continent of Africa and globally and support the next generation of interdisciplinary phosphorus researchers. Inclusive representation at SPS8 was challenging to achieve, exemplifying that phosphorus governance discussions may overlook the socio-economic realities of nutrient management. Governance gaps and the lack of global frameworks addressing sustainable phosphorus management were also identified as a major barrier to global phosphorus sustainability, with an urgent need for global and regional frameworks to explicitly integrate phosphorus into their agendas. To ensure continuity of the SPS Summit series, SPS9 will be hosted in Japan by Dr Kazuyo Matsubae at Tohoku University. SPS9 can build on the lessons learnt from SPS8, to address specific phosphorus challenges and opportunities globally, through the lens of Japan and we hope this paper serves as a baseline against which to improve inclusivity in this important discourse.

Conflicts of interest

The authors have declared that no competing interests exist.

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