



7-9 November 2017, Accra, Ghana

Pan Africa Chemistry Network Congress 2017: Sustainable Agriculture

 #PanAfricaChem

Congress Report

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Sustainable Agriculture; How the Chemical Sciences Can Contribute to Food Security for a Growing Population

AICC, Accra, Ghana, 7th-9th November 2017

Tuesday 7th November 2017

	Opening Ceremony
10.30	David Phillips, Past-President, Royal Society of Chemistry Jerome Gallin, Agilent Technologies David Kofi Essumang, The Ghana Chemical Society (GCS)
11.45	Conference photograph
	SESSION 1: Chemistry for Crop Protection <i>Chair: David Kofi Essumang, University of Cape Coast, Ghana</i>
12.00	Using natural products to invent new chemicals for crop protection <i>John M Clough, Syngenta, UK</i>
12.30	LUNCH
13.30	Agilent Technologies in Africa <i>Jerome Gallin, Agilent Technologies, France</i>
14.00	Semiochemicals released from Cowpea [<i>Vigna unguiculata</i> (L.) Walp.] upon Herbivory feeding and their potentials in integrated pest management <i>Samuel Osafo Acquah, KNUST, Ghana</i>
14.20	Levels of some organochlorine pesticides in Cowpea (<i>Vigna Unguiculata</i> (L.) Walp) from South-South and South-West Nigeria <i>Emmanuel Odion, University of Benin, Nigeria</i>
14.40	COFFEE BREAK
15.40	Enhancing African Science through Partnership <i>Helen Driver, Royal Society of Chemistry, UK</i>
16.00	Anti-microbial secondary metabolites from Kenyan plants with crop protection potential <i>Jacob Midiwo, University of Nairobi, Kenya</i>
16.30	Flash Presentations: 1. Identification of host plant attractants for mango stone weevil management in Ghana <i>Dorcas Osei-Safo, University of Ghana, Ghana</i> 2. Bioassay-guided isolation of active phytochemicals against <i>Tuta absoluta</i> (Meyrick) from <i>Caesalpinia</i> species (Leguminosae) <i>Flaure Rosette Essoung Ehawa, University of Yaounde I, Cameroon</i> 3. Natural fungicide from Prekese <i>James Korang, CSIR Forestry Research Institute of Ghana, Ghana</i>
17.00	PANEL DISCUSSION – all speakers from this session
17.30	Poster Session and Drinks Reception for all delegates

Wednesday 8th November 2017

	SESSION 2: Sustainable Agriculture for Economic Development: The Case of Cocoa <i>Chair: John Clough, Syngenta, UK</i>
9.00	Spectrophotometric analysis of caffeine in five different dried Cocoa (<i>Theobroma cacao</i>) beans and Cocoa powder samples found in Ido markets, Ibadan, Nigeria <i>Dupe Abiona, The Polytechnic, Ibadan, Nigeria</i>
9.20	Pesticide use in cocoa farming in Ghana: Implications for sustainability, food and environmental safety <i>Enock Dankyi, University of Ghana, Ghana</i>
9.50	Role of chemical science in cocoa industry in Nigeria: Successes, challenges and the way forward <i>Paul E Aikpokpodion, Cocoa Research Institute of Nigeria, Nigeria</i>
10.20	COFFEE BREAK
10.50	The Role of Chemistry in the Development of the Cocoa Industry in Ghana <i>Samuel Tetteh Lowor, Cocoa Research Institute of Ghana, Ghana</i>
11.20	Aiding the development of a sustainable cocoa production system in West Africa <i>Fiona Lahive, University of Reading, UK</i>
11.50	Flash Presentations: 1. Effect of sources of N - fortified organic based potassium fertilizer on soil, seedling growth and stem nutrient uptake of TC - 4 hybrid Cocoa in Nigeria <i>Olorunfemi Sunday Ojo Akanbi, Cocoa Research Institute of Nigeria, Ibadan</i>
12.10	Human exposure assessment of Ochratoxin a through the consumption of cocoa beans from four cocoa regions of Ghana and the potential public health risk <i>Ray Voegborlo, KNUST, Ghana</i>
12.30	Technologies for managing major crop protection issues in cocoa and other African crops <i>Adrian Arnold, International Pesticide Application Research Consortium (IPARC) and ACIS R&D Ltd, UK</i>
13.00	PANEL DISCUSSION – all speakers from this session
13:30	LUNCH
	SESSION 3: Future Farming <i>Chair: David Phillips, Past-President, Royal Society of Chemistry</i>
14.30	The practical application of science & technology to boost Cocoa productivity; community & family income <i>Kingsley Adade, Syngenta Agro Ag, Ghana</i>
15.00	An integrated approach to siting grain storage facilities to reduce transportation cost in developing countries <i>Emmanuel Essien, University of Ghana, Ghana</i>
15.20	Agricultural mechanization as a means of making agriculture more sustainable <i>Mahama Aliu Aduna, University of Ghana, Ghana</i>
15.50	COFFEE BREAK
16.20	Improving your research communication skills through AuthorAID <i>Ravi Murugesan, INASP, India</i>
16.50	Effect of storage on lutein levels in smooth cayenne (<i>Ananas comosus</i>) grown in Kenya <i>Hudson Nyambaka, Kenyatta University, Kenya</i>
17.10	Flash Presentations:

	<ol style="list-style-type: none"> 1. Cultivation vs. wild harvesting of <i>Cryptolepis sanguinolenta</i>, a medicinal plant used in the treatment of malaria <i>Naalamle Amissah, University of Ghana, Ghana</i> 2. Emerging technologies in food production: Edible insects as food and feed <i>John Masani Nduko, Egerton University, Kenya</i> 3. Land use conflict between farmers and herdsman – implication for agricultural and rural development in Nigeria <i>Michael Adedotun, Michael Adedotun Oke Foundation, Nigeria</i>
17.40	Optimized production of selected indigenous fruit trees for food and nutrition security in the Lake Victoria Basin, Eastern Africa <i>Francis Omuja, Natural Chemotherapeutics Research Institute, Uganda</i>
18.00	PANEL DISCUSSION – all speakers from this session
	Congress Dinner at the National Theatre of Ghana

Thursday 9th November 2017

	SESSION 4: Crop and Soil Nutrition <i>Chair: Johannes Awudza, KNUST, Ghana</i>
9.00	Optimizing site specific fertilizer recommendations for maize production in transition zone of Ghana <i>Olufisayo Onawumi, Forestry Research Institute of Nigeria, Nigeria</i>
9.20	Putting nitrogen fixation to work for smallholder farmers in northern Ghana <i>Samuel Adjei-Nsiah, International Institute of Tropical Agriculture, Ghana</i>
9.50	Food security for a growing population in Ghana – the role of The Soil Research Institute <i>Emmanuel Dugan, CSIR, Soil Research Institute, Ghana</i>
10.10	COFFEE BREAK
11.30	Flash Presentations <ol style="list-style-type: none"> 1. Quantification of copper sorption in soils as influenced by soil characteristics using a laboratory column leaching technique <i>Mandela Alema, CSIR Soil Research Institute, Ghana</i> 2. Preparation of organic fertiliser from malted sorghum mash and pig manure for sustainable agriculture in northern Ghana <i>Emmanuel Oyelude, University for Development Studies, Ghana</i> 3. Synergistic use of arbuscular mycorrhiza fungi and organic fertilizer for improving <i>Amaranthus cruentus</i> cultivated under different soil moisture regimes <i>Adebisi Adekanmbi, Obafemi Awolowo University, Nigeria</i>
12.00	AGORA and Research4life: reducing the knowledge gap by providing access to critical scientific research <i>Kristin Kolshus, Food and Agriculture Organization of the United Nations, Africa</i>
12.20	PANEL DISCUSSION – all speakers from this session
13.20	Lunch
14.20	Analytical Skills Training – in partnership with GSK <i>Ray Voegborlo, KNUST, Ghana</i>
14.40	Farming for the Future: the role of smart agriculture <i>Prof Hans Adu-Dapaah, CSIR-Crops Research Institute</i>
15.10	Closing Ceremony and Poster Prize Awards

Congress Report

Please note – the abstract book and some speakers presentations can be found here:

<http://www.rsc.org/events/detail/28432/pan-africa-chemistry-network-congress-2017-sustainable-agriculture-how-the-chemical-sciences-can-contribute-to-food-security-for-a-growing-population>

Tuesday 7th November 2017:

Opening session:

The Chair for the opening ceremony was Prof Steve Amissah, Provost of College of Agriculture and Natural Resources, Kwame Nkrumah University of Science and Technology (KNUST), Ghana.

In his welcome address, Prof David Philips, former President of the Royal Society of Chemistry and a member of the Pan Africa Chemistry Network (PACN) Advisory Board said:

- The Royal Society of Chemistry and the PACN is an influential voice for the chemical sciences worldwide and in Africa, though three core roles:
 - a provider of high-quality chemical science knowledge,
 - the UK's professional body for chemistry, and
 - an influential voice for the chemical sciences.
- One of the ways the Royal Society of Chemistry do this is by bringing together networks of people with a common goal; the Pan Africa Chemistry Network is a fantastic example of this
- There are speakers from eight different countries attending this year's PACN Congress, including the UK, Kenya, Nigeria, Cameroon and Ghana and delegates from Europe, Asia and across Africa
- The first PACN Congress in Ghana was in 2011 and this event is a continuation of that event.
- Goal 2 of the UN Sustainable Development Goals seeks to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. This Congress will contribute to this vital conversation
- Since 2011, the world's population suffering from extreme hunger has reduced from 930 million to 732 million and the contribution of chemical sciences in agricultural sustainability continues to be discussed
- Ghana and other African countries have free access to the Royal Society of Chemistry journal archives and e-books. Institutions should register through the [PACN website](#).
- By 2020, the Royal Society of Chemistry, in partnership with GSK, will have trained 400 African scientists on the use and maintenance of analytical equipment, including GCMS and LCMS.

Jerome Gallin from Agilent Technologies said Agilent technologies was proud to be part of this year's Congress as a sponsor. He indicated that there was a lot of instrumental support that Agilent can offer to

scientists in all sectors. Agilent have a network of distributors, including 76 Agilent-trained service engineers, across Africa who can provide support. Many of these distributors attended the Congress, including those from Ethiopia, South Africa, Ghana, Nigeria and Burkina Faso.

Jerome also highlighted their partnership with LCGC's CHROMacademy to give University staff and students free access to learning resources across a wide range of analytical techniques: www.chromacademy.com/Agilent-uni.html

Prof David Kofi Essumang, President of The Ghana Chemical Society (GCS) said that chemistry plays a key role in food security. He also emphasised that natural products chemistry should replace synthetic chemistry in the control of agricultural pests since that is causing harm to humans. He also indicated that collaboration between chemists and agriculturists is vital to solve problems of food security.

SESSION 1: Chemistry for Crop Protection

Chaired by Prof David Kofi Essumang from the University of Cape Coast, Ghana

Plenary Presentation

In his plenary presentation on using natural products to invent new chemicals for crop protection, Dr John Clough from Syngenta made the following remarks:

- Chemicals used in agriculture for crop protection are mainly insecticides, herbicides and fungicides
- Sales of agro chemicals to Africa and the Middle East were relatively small compared to the rest of the world of ~\$2,200m (~4.5% of the global market)
- He talked about research into new bioactive natural products that can be used as leads for synthesis from actinomycetes and fungi collected from China
- Some potent bioactive compounds discovered so far are
 - Leptospemore, Bicyclopyrone, Phosphonothrixin, Strobilurins and Oudemansins
- Evolution of ideas have led to azoxystrobin, the world's biggest agricultural fungicide (2016 sales of ~\$1300m)
- Nature is an excellent source of biologically-active compounds. Although natural product research is slow and uncertain, it can lead to novel and highly successful products.
- Natural products are special by definition because nature has the 'machinery' to make them.

Oral Presentations

Jerome Gallin from Agilent Technologies talked on Agilent Technologies in Africa. In his presentation, he introduced the brand new Ultivo Triple Quad LC/MS instrument.

He said it is:

- designed for the user, easy to maintain, compact in size, robust, reliable and accurate; an ideal tool for the food and environmental industry

Dr Samuel Osafo-Aquaah from KNUST, Ghana presented on semio-chemicals released from cowpea *Vigna unguiculata* (L) Walp upon herbivory feeding and their potentials in integrated pest management.

He emphasized that there is the need for green food production ensures pollution prevention and the use of push-pull technology to transform Ghana's agricultural sector as it will reduce

- Waste, materials, hazard, risk, energy and cost

Emmanuel Odion from the University of Benin, Nigeria presented on the levels of some organochlorine pesticides in cowpea (*vigna unguiculata* (L) Walp) from south-south and south-west Nigeria.

The aim of his study was to study and quantify organochlorine pesticide (OCP) residues in cowpeas obtained from local food markets. There were significant concentrations of fresh DDT and endosulfan determined although OCPs have been banned in Nigeria. For example, 56% of samples proved positive for o,p'-DDT, which could be concern for the long term health of local population. Further research is required to establish how these OCPs got into the cowpeas (during growth or storage), and what the impact of these chemicals can be on human health. This talk led to a lively discussion around the potential impacts of these findings, and the additional research required.

Dr Helen Driver from the Royal Society of Chemistry introduced the Royal Society of Chemistry and the Pan Africa Chemistry Network to delegates in her presentation entitled "*Enhancing African Science through partnership*". She talked about the advantages of being part of the PACN and the benefits of membership of the RSC. The aims of the PACN are:

- To enhance and improve the skills and knowledge of the chemical science community
- To integrate African chemistry into the global science community by enabling exchange of ideas and by facilitating collaboration
- To support the community to deliver solutions of global challenges; environment, energy, food, health and water
- To be the long-term partner of choice for Africa, to advance excellence in the chemical sciences to improve lives of people around the world now and in the future.

Some of the advantages she mentioned were:

- Funding available, including: [International Exchange Awards](#) with the Royal Society for UK scientists with sub-Saharan Africa (up to £12,000 available for two years); Royal Society of

Chemistry [Scientific Meeting Fund](#) (up to £2,000); [Researcher Mobility Grants](#) (£7,500 over 2 years).

- Access to the Royal Society of Chemistry [journals archive and eBook access](#)
- Opportunity to apply to attend [analytical science training courses in Africa](#)

Helen encouraged delegates who were not members of the RSC to register and become members to enjoy the benefits. So far, there are 750 members in Africa, (out of a total 54,000 members spread over 110 countries).

She also highlighted that the Royal Society of Chemistry offers funding for research for members through the [Research Fund](#). Members can apply for up to £4,000 to purchase chemicals and/or equipment for your research project. Those working in less well-funded institutes, those in developing countries and early career researchers are prioritised.

Full details of the PACN are here: www.rsc.org/pacn

Prof Jacob Midiwo from the University of Nairobi, Kenya spoke on antimicrobial secondary metabolites from Kenyan plants with crop protection potential. In his presentation, he spoke about the bioactivities of extracts from *Alibizia schimperiana*, *Thespesia garckeana*, *Abrus Schimperi* and *Clerodendrum eriophyllum* against bacteria, plasmodium and fungi and concluded that these plant extracts could be explored further for use as agricultural pesticides because they have shown highly potent bioactivities.

Flash presentations

Flash presentations were done by Dorcas Osei-Sarfo from the University of Ghana on the topic, identification of host plant attractants for mango stone weevil management in Ghana, Faure Rosette Essoung Ehawa from the University of Yaounde I, Cameroon on Bioassay-guided isolation of active phytochemicals against *Tuta absoluta* (Meyrick) from *Caesalpinia* species (Leguminosae) and James Korang on natural fungicide from Prekese.

Panel discussions

Panel discussions followed the flash presentations with all speakers for that session being asked questions. There was a particularly involved discussion about the future research needed to further investigate the significance of the OCPs found in the cowpeas in Nigeria.

Poster Presentations

All delegates were invited to view the posters on display and talk to the presenters.

Wednesday 8th November 2017

SESSION 2 'Sustainable Agriculture for Economic Development: The Case of Cocoa'

Chaired by Dr John Clough from Syngenta, UK.

Oral presentation

Dupe Abiona from the Polytechnic, Ibadan, Nigeria spoke on the topic '*Spectroscopic analysis of Caffeine in five different dried cocoa (Theobroma cacao) beans and Cocoa powder samples found in Ido markets, Ibadan, Nigeria*'.

The aim of the study was to determine the concentrations of caffeine in both dried cocoa beans and cocoa powder. She reported that the caffeine content in dried and fermented cocoa beans as well as its powder are below permissible levels and are therefore safe for human consumption, but should be limited for children and pregnant women.

Plenary presentations

Enock Dankyi from the University of Ghana, spoke on pesticide use in cocoa farming in Ghana. He said neonicotinoids were pesticides of choice for the cocoa industry as they have high selectivity. Studies show that neonicotinoid residues are very low in the beans but high in the shells and since the beans are consumed rather than the shells, neonicotinoids pose no risk to consumers. Their use is controlled as they are thought to be detrimental to bee health and are banned in Europe. He also raised the issue about cocoa smuggled into Ghana from elsewhere may not be subject to the same restrictions and analytical science is key to identifying any potentially harmful pesticides used.

Paul Aikpokpodion from the Cocoa Research Institute of Nigeria presented on the title 'role of chemical science in the cocoa industry in Nigeria'. In his study, Paul determined the levels of OCPs, Ops, PAH and heavy metals (Cu and Pb) in cocoa beans and found all parameters within permissible levels, making the beans safe for human consumption. The limits set by the EU are the most commonly used parameters to establish safe levels of pesticides and other contaminants.

Samuel Lowor from Cocoa Research Institute of Ghana (CRIG), talked about the role of chemistry in the development of the cocoa industry in Ghana. He said that CRIG are responsible for allowed pesticides, and residue limits, as well as testing new chemicals for use. He also discussed the development of new and improved varieties, and that different varieties of pest and disease resistant cocoa were being planted. Typically, 27 seed gardens were currently in operation in six regions with four parent varieties being used. In all these trials, much effort has been put in to maintain Ghana's premium cocoa flavour. He also discussed how Ghana is now producing its own chocolate and benefiting from the value added products.

Fiona Lahive from the University of Reading, UK, presented on aiding the development of a sustainable cocoa production system in West Africa. She indicated that some of the limits to cocoa production include:

1. Pests and diseases
2. Mistletoes
3. Lack of access to credit
4. Ageing farms in need of rehabilitation
5. Ageing farmers
6. Variations in agronomic practices
7. Limited use of improved beans

The best farms produce ~2 tonnes dried beans per hectare, but many farms fall short of this. However, there is great potential for improvement and reasons for optimism. The International Cocoa Quarantine Centre (ICQC), hosted by the University of Reading, UK, supports the continuing breeding efforts required to maintain sustainable cocoa production in the face of increasing pressures from pests and diseases, current low yields, and the uncertainties posed by global climate change, whilst addressing the increasing need for environmental and social responsibility. www.icgd.reading.ac.uk/icqc/

She also indicated that levels of CO₂ and temperature could have varying effects on the production of cocoa and the fat content of the beans, and said simple interventions such as plastic or organic mulching has positive impact of levels of soil moisture and improves the establishment of cocoa. Also, growing cocoa under shade can reduce environmental stress such as high temperature and vapour pressure deficit.

Flash presentation

Olorunfemi Sunday Ojo Akanbi from the Cocoa Research Institute of Nigeria made a flash presentation on the topic '*Effect of N-fortified organic based potassium on soil seedling growth and stem nutrient uptake of TC-4 hybrid cocoa in Nigeria*'. In his study, he found that although all the fertilizer varieties contributed to plant growth, the N-rich OPBA fertilizer performed better.

Oral presentation

Ray Voegborlo from KNUST, Ghana discussed human exposure assessment of ochratoxin A through the consumption of cocoa beans from four cocoa regions of Ghana and the potential health risk. ochratoxin A is a mycotoxin produced by *Aspergillus* and is found in a range of foods, including during the fermentation of cocoa. He said that although ochratoxin A hasn't yet become a problem in the Ghanaian cocoa industry, there was the need to determine its levels so that it doesn't become a problem in the future. If cocoa exports are found to contain high levels of ochratoxin A, then they could be rejected by the international market.

Plenary presentation

Adrian Arnold from IPARC and ACIS R&D Ltd, UK, spoke on technologies for managing crop protection issues in cocoa and other African crops and the importance of collaboration; regulation, research needs, farmer practices, consumer and environmental safety must work together. He said that rational pesticide use (RPU) is a concept that describes the targeted careful use of pesticides as part of an integrated pest management (IPM) system; 'What to apply? When to apply? How to apply?' He added that unpruned cocoa trees and variable cone nozzles caused poor spraying effects. Narrow cone disc-core was recommended for effective spraying of cocoa. He discussed the publication 'Pesticide Use in Cocoa' from the International Cocoa Organisation, (ICCO); www.icco.org/about-us/icco-news/292-new-pesticide-use-in-cocoa-manual-now-available.html.

Adrian discussed the and the neo-nicotinoid insecticide (NNI) controversy and effects on bee populations, however he indicated that contrary to the thought that cocoa was mainly pollinated by bees, it turned out that cocoa was pollinated by tiny insects called midges (Diptera, Ceratopogonidae). More research is required to establish the impacts of NNIs on midge populations.

Panel Discussions

Panel discussions followed the last presentations with all speakers for that session involved.

SESSION 3: 'Future Farming'

Chaired by Prof David Phillips, Past President, Royal Society of Chemistry, UK

Plenary presentations

Kingsley Adade from Syngenta, Ghana spoke on the practical application of science and technology to boost cocoa productivity; community and family income. In his presentation, he said that Ghana was currently producing about 835 000 metric tonnes of cocoa per year. He enumerated the 5A's to the success of small holder cocoa farmers in terms of pesticide use as:

- Awareness, Access, Aggregation, Affordability and Availability

He also mentioned that Syngenta had a tool kit for cocoa production that tackles crop protection, application, fertilizer and good agricultural practices.

Mahama Aliu Aduna from the University of Ghana spoke on agricultural mechanization as a means of making agriculture more sustainable. In his presentation, he talked about inadequate farm machinery in Ghana and hence low agricultural productivity. He compared tractor population and tractor per 1000ha

cultivated land in Ghana to countries like the USA to emphasise on the inadequacy of machinery in Ghana for mechanised agriculture. He also touched on tractor operations and maintenance, climate smart mechanization and post-harvest practices and discouraged the use of disc plough for tilling, as it can destroy the fertile soil for cultivation.

Ravi Murugesan from [INASP](#), spoke on 'Improving your research communication skills through AuthorAID'. AuthorAID offers support for authors from developing nations and provides free online training courses in proposal, research grant and publication writing. They also offer:

- Mentoring support
- Networking and collaboration
- Embedding research and proposal writing skills within institutions
- Addressing gender inequality in academic institutions.

He said the topics covered in the online courses include; literature reviews, research and publication ethics, targeting relevant and trustworthy journals, writing research papers, understanding the publishing process and how to communicate research to different audiences. AuthorAID has a programme with CSIR in Ghana to embed skills and training for their researchers. www.authoraid.info/

Oral presentations

Emmanuel Essien from the University of Ghana spoke on the topic 'An integrated approach to siting grain storage facilities to reduce transportation cost in developing countries'. The aim of his work was to develop an integrated approach to siting grain storage facilities. He said the problems that the agriculture sector was facing were:

- Sustainability – seasonality of agriculture, climate shocks and pricing

He employed the use of mathematical models to help site grain storage facilities in Ghana to prevent or reduce post-harvest losses.

Hudson Nyambaka from Kenyatta University, Kenya talked on the effect of storage on lutein levels in smooth cayenne (*Annana comosus*) grown in Kenya. He said consumption of pineapples is linked to reductions in the risk of major non-communicative diseases such as cancer and heart disease by protecting cells from damage through free radicals. The studies focused on:

- Promotion through assessment of levels and processing
- Bioavailability through intervention and lab procedures
- Processing and storage and their effects on carotenoids

From his research, he concluded that storage of pineapples for further ripening, increases carotenoids and enhances the quality of the fruit.

Flash presentations

There were three flash presentations by Naalamle Amissah for the University of Ghana, John Masani Nduko from Egerton University, Kenya and Michael Adedotun from Nigeria.

Naalamle presented on cultivation vs wild harvesting of *Cryptolepis sanguinolenta*, a medicinal plant used in the treatment of malaria. In her study, she explored the:

- Assessment of molecular diversity and concentration of cryptolepine
- Optimum management practices
- Propagation Protocols.
- Effectiveness of bioactive compounds

She also studied the concentration of cryptolepine in roots and stems of *Cryptolepis sanguinolenta* collections from the Eastern, Volta, Brong Ahafo and Ashanti Regions of Ghana.

John Nduko in his presentation on '*Emerging Technologies in food production: Edible insects as food and feed*', talked about the use of locusts and grasshoppers as food since they are rich in proteins and oils. He discussed ways that these insects can be used in different food products to increase nutrition in populations.

Michael Adedotun presented on the land use conflict between farmers and herdsmen and its implications on agricultural and rural development. He said that these conflicts have led to the death of farmers and herdsmen and had the potential to hinder agricultural productivity and create food security issues as well as bring about security challenges.

Panel discussions

Panel discussions followed the flash presentations

Congress dinner

The Congress dinner was held at the National Theatre of Ghana and the delegates enjoyed an evening of Ghanaian music, dancing and food.

Thursday 9th November 2017:

SESSION 4: 'Crop and Soil Nutrition'

Chaired by Prof. Johannes Awudza from KNUST, Ghana

Oral presentations

Dr Olufisayo Onawumi from the Forestry Research Institute of Nigeria talked on 'Optimizing site-specific fertilizer recommendations for maize production in the transition zone of Ghana'. The motivation for this work was to meet the demand of maize for the growing population. The aim of the study was to estimate

the influence of site-specific inorganic fertilizer rates and its integration with poultry manure (PM) on nutrient uptake, biomass and maize yield. The work was carried out on two maize genotypes: Obatampa (open-pollinated variety) and Mamaba (hybrid maize). The results showed that both maize varieties gave high yields under $N_{60}P_{10}K_{20}$ + PM (2.5 t/ha). Also, the combined application of site-specific fertilizer rate and organic fertilizer improved the hybrid maize yield compared to using the inorganic fertilizer alone. The sources of funding for this work were AGRA and OFRA.

Emmanuel Dugan followed with a talk on *'Food security for a growing population in Ghana – the role of The Soil Research Institute'*. The motivation was improving food security in Ghana. The aim was to develop soil fertility mapping for Ghana. The speaker said that their institute is encouraging farmers in Ghana to analyze their soils before planting. Knowledge of the soil characteristics will inform farmers of their fertilizer need and by that, they increase yield and make more money.

Plenary presentation

The next speaker, Dr Samuel Adjei-Nsiah, from International Institute of Tropical Agriculture, Ghana, who spoke on *'Putting nitrogen fixation to work for smallholder farmers in northern Ghana: Progress and achievements'*. The motivation was to improve household nutrition and income. The main objective of the N2Africa project was to increase biological nitrogen fixation and productivity of grain legumes for African smallholder farmers in order to contribute to enhanced soil fertility.

The key element mentioned for sustainable implementation of the project was a private partnership, especially with NGOs. This project received funding from Bill and Melinda Gate Foundation. He was happy to mention that through the N2Africa project, the Government of Ghana, has approved a subsidy for phosphorus fertilizer for grain legumes cultivation in Ghana.

Flash presentations

The first flash presentation was by Mandela Alema, from CSIR Soil Research Institute, Ghana, on *'Quantification of copper sorption in soils as influenced by soil characteristics using a laboratory column leaching technique'*. The study showed copper sorption to increase with increasing soil organic matter and therefore recommended clean-up of industrial effluents using large column leaching apparatus.

The next flash presentation was by Emmanuel Oyelude, from University for Development Studies, Ghana, who spoke on *'Preparation of organic fertilizer from malted sorghum mash and pig manure for sustainable agriculture in northern Ghana'*. The motivation of work was to find alternative fertilizer for smallholder farmers in the northern part of Ghana. The objective was to prepare organic fertilizer from malted sorghum mash which is abundant in the area. Co-composting with pig manure resulted in fertilizers which showed germination indices greater than 100 %.

The last flash presenter, Adebisi Adekanmbi from Obafemi Awolowo University, Nigeria spoke on '*Synergistic use of arbuscular mycorrhiza (AM) fungi and organic fertilizer for improving *Amaranthus cruentus* cultivated under different soil moisture regimes*'. She concluded that the addition of the AM fungi and 5 t ha⁻¹ organic fertilizers to the soil optimally improved the growth and yield of *A. cruentus* in water stress conditions.

Oral presentation

Kristin Kolshus of the UN Food and Agriculture Organization (UN FAO) brought to light the work of the FAO in Africa in terms of providing free or low-cost access to current scientific literature and data in agriculture and related sciences. One channel in which they operate is Research4Life: AGORA, HINARI, OARE and ARDI. Research institutions across Africa are eligible to receive free, or low cost, access to a huge variety of published resources - www.research4life.org. Kristin encouraged everyone to speak to their institution to ensure they are registered.

Plenary presentations

Prof. Ray Voegborlo from KNUST, Ghana spoke about the partnership between the Royal Society of Chemistry and GSK to enhance analytical skills across Africa. They are running a 5 year programme, and will train over 400 scientists in key analytical techniques by 2020. Prof Ray is one of the Local Trainers in Ghana who, alongside Dr Genevieve Adukpo from Cape Coast, will ensure that this training programme is sustainable into the future to benefit Ghanaian and African science. He also discussed the challenges that KNUST faced with their equipment, particularly the problem of intermittent power supply to the lab. KNUST have overcome this problem, by installing solar panels and back up batteries. This equipment now supports the whole analytical laboratory and has enabled KNUST to become a host for the PACN GCMS training, alongside the courses in Kenya, Ethiopia and Nigeria. For more information, or to apply to attend the GCMS or LCMS courses, please go to:

<http://www.rsc.org/campaigns/m/rp/pacn-gsk/partnership/>

The final presentation was given by Prof. Hans Adu-Dapaah from CSIR Crop Research Institute, Ghana on '*Farming for the Future: the role of smart agriculture*'. His motivation was the challenges such as galamsey gold mining, drought, flood and climate change, which affect food production. He aimed at introducing sustainable smart farming techniques to increase yield and profit. Some of the initiatives introduced in Ghana by the CSIR Crop Research Institute include improved farming systems, integrated crop and livestock management, new high yielding hybrids (maize, rice, cowpea, groundnut), disease resistant varieties (groundnut, bambara, cassava, cocoyam, pepper), new planting materials (yam), precision agriculture and integrated agriculture. He made mention that all these initiatives fit into the Government of Ghana Flagship projects such as "Planting for Food and Jobs".

Closing Session

The Poster Prizes were awarded as follows:

Prize	Prize winner	
PACN Prize 1 st	Francis Asiam <i>KNUST, Ghana</i>	Collection, distribution, extraction and characterisation of vegetable oils from 40 varieties of high yielding <i>Allanblackia parviflora</i> in Ghana
PACN Prize 2 nd	Eugenia Ayebea Asamoah <i>KNUST, Ghana</i>	Development of Rabbit Meat Sausages
PACN Prize 3 rd	Ray Voegborlo <i>KNUST, Ghana</i>	Human Exposure Assessment of Ochratoxin A through consumption of cocoa beans
Agilent supported prize	Nkechinyere Isienyi <i>Forestry Research Institute, Nigeria</i>	Impact of heavy metal on soil near Lapite dumpsite in Ibadan, Nigeria
Syngenta supported prize	Flaure Essoung <i>ICIPE, Kenya</i>	Welwitschianol A and B: Two cyclohexene derivatives and other insecticidal constituents of <i>Caesalpinia welwitschiana</i>

The session was closed with acknowledgement of individuals who helped in the organization of the programme: the Royal Society of Chemistry is very grateful to the Local Organising Committee, the team of students who helped run the meeting and the support from KNUST, the University of Ghana and the Ghanaian Chemical Society.

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Following the Congress, Ravi Murugesan from INASP ran a two-day AuthorAID-PACN Research Writing Workshop at the Centre for African Wetlands, University of Ghana. He was assisted by Albert Allotey and Gloria Djagbletey from CSIR, Ghana and the workshop was attended by 26 scientists from Ghana and Nigeria.

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The delegates of the PACN Congress 2017

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With input from the Chairs of each Scientific Session

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