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Pan Africa Chemistry Network Congress 2017: Sustainable Agriculture

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Welcome address from Royal Society of Chemistry

Dear Colleagues,

On behalf of the Scientific Committee and the Royal Society of Chemistry, we are delighted to welcome you all to the 2017 Pan Africa Chemistry Network (PACN) Congress on Sustainable Agriculture.

The Royal Society of Chemistry's Pan Africa Chemistry Network seeks to create a self-sustaining science base in Africa, to solve local challenges and to contribute to global knowledge in the chemical sciences and related disciplines. This Congress is part of our efforts to bring leading scientists together to discuss current research, enhance communication and create collaboration opportunities.

We are delighted to be partnering with Agilent Technologies and Syngenta for this Congress, and we look forward to hearing from Jerome Gallin, John Clough and Kingsley Adade about their activities to support scientific advances in this crucial topic.

There are many organisations that are supporting the African science community, and we are very pleased to be welcoming colleagues from INASP, Research4Life and the British Council to this Congress. We encourage you all to learn how different organisations can support your science. For example, INASP's AuthorAID programme supports researchers in low and middle income countries to communicate their work, and we are pleased to be co-hosting a workshop with them this week to support communication skills for scientists.

The Sustainable Development Goals (SDGs) are a set of 17 aspirational "Global Goals", spearheaded by the United Nations, through a deliberative process involving its 193 Member States, as well as global civil society. Goal 2 is to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" and efforts to combat hunger and malnutrition have advanced significantly since 2000. Ending hunger, food insecurity and malnutrition for all, however, will require continued and focused efforts, especially in Asia and Africa. For example, 793 million people are undernourished globally (2016), down from 930 million people in 2014.

At this Congress we will discuss the contribution that the chemical sciences can make towards solving the challenge of sustainable agriculture and food security.

We are delighted to be bringing the PACN Congress to West Africa, and to Ghana and we owe great thanks to the team from KNUST and the University of Ghana who made this Congress possible. We would also like to thank the members of the Scientific Committee across the world, in helping to deliver what we expect to be an exciting and thought-provoking Congress.

Again, it is our pleasure to welcome you all to this Congress and thanks to the many people who have made this event possible.

Prof Johannes Awudza
Kwame Nkrumah University of Science and Technology, Ghana

Dr Helen Driver
Royal Society of Chemistry, UK

Prof David Phillips
Past-President of the Royal Society of Chemistry, UK

Organising and scientific committees

Johannes Awudza
(Chair) KNUST, Ghana

Anthony Adimado
KNUST, Ghana

Professor Afoakwa
University of Ghana, Ghana

Nathaniel Boadi
KNUST, Ghana

Mary Chama
University of Ghana, Ghana

John Clough
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University of Ghana, Ghana

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University of Ghana, Ghana

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Imperial College London, UK

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James Hutton Institute, UK

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Natural Environment Research Council (NERC), UK

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University of Ghana, UK

The Royal Society of Chemistry

We are the world's leading chemistry community, advancing excellence in the chemical sciences. With over 54,000 members and an international publishing and knowledge business we are the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world.

A not-for-profit organisation with a heritage that spans 175 years, we have an ambitious international vision for the future. Around the world, we invest in educating future generations of scientists. We raise and maintain standards. We partner with industry and academia, promoting collaboration and innovation. We advise governments on policy. And we promote the talent, information and ideas that lead to great advances in science.

In a complex and changing world, chemistry and the chemical sciences are essential. They are vital in our everyday lives and will be vital in helping the world respond to some of its biggest challenges. We are committed to promoting, supporting and celebrating inclusion and diversity. We understand that the success of our community depends on our ability to nurture the talent of the best people regardless of who they are or their background.

We're working to shape the future of the chemical sciences – for the benefit of science and humanity.

www.rsc.org

Pan Africa Chemistry Network

The Pan Africa Chemistry Network (PACN) was set up by the Royal Society of Chemistry in 2007 to promote a sustainable science base across Africa, to solve local challenges and contribute to global knowledge. Our aims are to:

- enhance collaboration between scientists, governments, universities and industry
- support the scientific community to attract students to scientific careers and promote public appreciation of the role of chemical science in Africa's future
- strengthen and build capacity within the African science base

We work closely with colleagues across Africa, especially in Ethiopia, Ghana, Kenya and Nigeria to support and enhance the chemical sciences. Although our work is focussed on activities in these 4 countries, we welcome scientists from across Africa to be part of this network.

We have members of staff at the University of Nairobi and Addis Ababa University who support our work in Africa. This on-the-ground experience and expertise enables us to deliver a range of activities to support African science, for example, training courses in analytical chemistry, networking events, international travel grants and a range of scientific conferences.

www.rsc.org/pacn

For updates please join our newsletter rsc.li/africanews

Biographies

Samuel Adjei-Nsiah

Samuel Adjei-Nsiah is a trained Agronomist and holds a PhD in Production Ecology and Resource Conservation from Wageningen University in the Netherlands. He has several years of experience in integrated soil fertility management in smallholder farming systems in Ghana. Samuel has also worked on tropical legumes and has rich experience in nitrogen fixation in grain legumes. His present research is in the realm of smallholder agricultural development and focuses on sustainable intensification in cereal-based farming systems in the Guinea savannas of West Africa. He has professional skills in facilitating agricultural innovation platforms and multi-stakeholder processes.

Hans Adu-Dapaoh

Rev. Prof. Hans Adu-Dapaah started his industrious research career as a Post-doc at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. He joined the CSIR-Crops Research Institute in 1993 and by dint of hard work rose through the ranks to become Chief Research Scientist in 2006. He has developed a number of technologies which have improved the livelihoods of resource-poor farmers. These include the release of 12 improved groundnut varieties, 14 improved cowpea varieties, 6 improved soybean varieties and 4 improved French beans. These varieties are high yielding, resistant to pests, diseases and, drought with enhanced nutrition and consumer-preferred qualities. Rev. Prof. Hans Adu-Dapaah has documented most of his research work in internationally acclaimed peer reviewed journals, edited conference proceedings, books, production guides and technical reports. He has to his credit over 180 publications. He has also refereed over 80 scientific papers in a number of local and international journals. He is a member of the Editorial Board, Ghana J of Agricultural Science and Editorial Advisory Board member, Agricultural and Food Science J. of Ghana.

Rev. Prof. Hans Adu-Dapaah has contributed towards building human resource capacity locally and internationally. He has mentored 35 young Scientists. He has supervised research projects of 30 PhD/M.Phil students, 30 undergraduate students from KNUST, UGL, UCC UEW Mampong campus & Wageningen University, Netherlands. Rev. Prof. Hans Adu-Dapaah has served as External Examiner for 25 PhD /MPhil/MSc students. As a Resource Person he has trained a number of Technical& management level personnel in a number of public and private organizations locally and internationally.

He was elected Fellow of the Ghana Academy of Arts and Sciences in 2014.

Rev. Hans Adu-Dapaah's hard work has not gone unnoticed in both local and international circles. He is deservedly a proud recipient of over 15 career awards. These include the following:

- 2000 Outstanding Scientists of the 21st Century Diploma Award & International Scientist of 2001 Diploma awards by International Biographical Center, Cambridge, England.
- Recipient of 500 Leaders of Influence Awards by American Biographical Institute Inc 10th Edition.
- National Best Agricultural Researcher Award 2005 at the National Farmers Day, Navrongo.
- National Best Scientist (Presidential) Gold Award at First Ghana Science Congress, August 2011.

Mary Anti Chama

Dr. Mary Anti Chama is a Senior Lecturer at the Department of Chemistry, University of Ghana. She holds a BSc. (Hons) and Ph.D in Chemistry. Her research area is in Plant Natural Product mainly from Ghanaian medicinal source. She has worked on Isolation, structure elucidation and biological activities of Scoparia dulcis and some dichapetalum species. She is currently also involved in in silico studies and has worked as a research fellow at the Centre for Molecular Informatics in the Department of Chemistry, University of Cambridge, United Kingdom under Dr. Andreas Bender, researching into in silico studies towards understanding the mode of action of the dichapetalins.

Adrian Arnold

1972-77 National Institute of Agricultural Engineering, Silsoe, UK

1977-90 International Pesticide Application Research Centre (IPARC)

Imperial College at Silwood Park, Ascot, UK. Application equipment R&D; Pest management.

1990-94 Cocoa Research Institute of Ghana (CRIG), Technical Cooperation Officer, seconded from IPARC, scientific instrumentation with particular interest in spraying equipment.

1994- Director of ACIS R&D Ltd., developing instrumentation e.g. for production of biopesticides (MycoHarvester) and motorised insect traps. Collaborative work on equipment to monitor pesticide dust drift.

Johannes A M Awudza

Prof Johannes A. M. Awudza is an Associate Professor of Chemistry at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi. He obtained his B.Sc. (Hons) (1980) and M.Phil. (1987) in chemistry from KNUST, Kumasi, Ghana and his Ph.D. in polymerization catalysis from the then University of Manchester Institute of Science and Technology (UMIST), now part of the new unified University of Manchester, U.K., in 2000.

He has been a faculty member at the Department of Chemistry, KNUST since 1986. He has held a number of positions at KNUST including Head of the Department of Chemistry, Member, College and Faculty Boards at the College of Science, Member of the University's Academic Board and Chairman, University Safety Committee. He was instrumental in the establishment of the M.Phil. programme in polymer science and technology at KNUST. He has been a fellow of the Brew-Hammond Energy Centre of KNUST since its inception.

Prof Awudza is a chartered chemist, fellow of the Royal Society of Chemistry (FRSC), UK and an affiliate member of International Union of Pure and Applied Chemistry (IUPAC). He is the representative of the Royal Society of Chemistry (RSC) in Ghana and a member of the International Advisory Board of the Pan-African Chemistry Network (PACN). He was instrumental in the establishment of the PACN hub at KNUST and chairs the committee which organizes annual international GC-MS training workshops at KNUST with support from the RSC and GlaxoSmithKline (GSK).

He has been a consultant to the International Centre for Science and High Technology – United Nations Industrial Development Organization (ICS – UNIDO), Trieste, Italy on biofuels and chemicals from bio-based materials and carried out research on same at the University of Messina, Sicily, Italy in 2008. He was also a member of the teams that worked on the UK's Department for International Development (DFID) funded projects on street vended foods and the community development project "Boafo Ye Na".

Prof Awudza's current research areas include renewable energy with focus on development of nano-materials for solar cells and development of next generation biofuels, catalysis in polymer synthesis, development of alternative materials for water treatment, development of biodegradable polymers and plastic waste management.

He has been an academic visitor to the School of Chemistry and School of Materials of the University of Manchester, UK, since 2007, working with the late Prof Peter J. T. Tait on polymerization catalysis and Prof Paul O'Brien, FRS, CBE, on the development of nanomaterials for solar cells. He is currently the KNUST project leader for a consortium working on a DFID-Royal Society funded project on the development of nanomaterials for solar cells. The consortium is made up of Prof Paul O'Brien (School of Chemistry and School of Materials, University of Manchester, UK), Prof Johannes A. M. Awudza (Department of Chemistry, KNUST), Prof Neerish Revaprasadu (Department of Chemistry, University of Zululand, South Africa) and Prof Peter Ndifon (Department of Chemistry, University of Yaounde I, Cameroon).

Kingsley Baffoe Adade

Kingsley Baffoe Adade is the Field Technical Expert of Syngenta in Ghana. He holds a Bachelor of Science degree in Agriculture and a Master of Philosophy degree in Biotechnology from the Kwame Nkrumah University of Science and Technology.

He is an author of two scientific papers and has over seven years' experience of transferring science and technology to small holder farmers in the cocoa industry in boosting their yields through farmer education

He worked as an Assistant Research Officer with the Cocoa Research Institute of Ghana a subsidiary of the Ghana Cocoa Board. He later joined ECOM as a project and district supervisor responsible for the Hershey learn to grow program in Ghana. He was involved in training over 1400 small holder cocoa farmers in the Assin Foso district with the primary focus of improving livelihoods through increase in productivity.

He currently works with Syngenta as the Field Technical Expert responsible of transforming the proprietary science of Syngenta to meaningful valued grower solutions.

Anthony A Adimado

A professor of chemistry at the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana; and a Fellow of the Ghana Academy of Arts and Sciences and the sole awardee for the 23rd set of the Distinguished Friend of Council of the West African Examinations Council (WAEC), in March 2016.

He has held various positions as Head of Chemistry Department, Dean of School of Graduate Studies, Dean of International Programmes, all at the KNUST. He also consults on tertiary education issues for the National Council of Tertiary Education (NCTE), the National Accreditation Board (NAB) and the National Board for Professional and Technician Examination (NABPTEX) and the Ministry of Education in Ghana. He holds a BSc (Chemistry degree from the KNUST and a PhD degree in Chemistry from the University of Ibadan, Nigeria. He recently led a team of experts in assessing the preparedness of the ten (10) Polytechnics in Ghana for their conversion into Technical Universities in 2016.

John Clough

John Clough is an organic chemist and a Syngenta Fellow in Syngenta's Chemistry Department at its Jealott's Hill International Research Centre near Bracknell in Berkshire. His primary interests are the discovery of new chemicals for crop protection, especially using bioactive natural products as leads.

John conducted his PhD research on the characterization and synthesis of poly-Z-carotenoids with Professor Gerry Pattenden, FRS, at the University of Nottingham. He joined Syngenta (then ICI Plant Protection Division) in 1979. Since that time, he has contributed to many fungicide and herbicide research projects, especially those aimed at the generation of new leads. In 1983, he initiated the strobilurin fungicide project, which he then led for more than 10 years. During this time, azoxystrobin was discovered, a product which is now the world's largest agricultural fungicide. In 2011, he was awarded the RSC's "Creativity in Industry Prize" for his contribution to this work.

John has been actively involved with the RSC Pan Africa Chemistry Network since 2008 and is a member of the PACN Advisory Board. He was Vice President of the Organic Division Council of the RSC for the three years 2012-15 and Chairman of the RSC Heterocyclic and Synthesis Group for the two years 2008-09. He is an Honorary Professor and a member of the Industrial Advisory Board in the School of Chemistry at the University of Birmingham. He is an Honorary Professor in the School of Chemistry at the University of Nottingham.

Enock Dhankyi

Enock holds a PhD degree in Chemistry from the University of Ghana where he works as a lecturer. He is a young researcher having completed his PhD in the past two years. His major research interest is in the development of methods for environmental applications with emphasis on emerging pollutants in the sub-Saharan African environment. His current research focuses on behaviour, fate, metabolism and effects of pesticides and other xenobiotics in the environment and in crop production.

Helen Driver

Helen graduated from Loughborough University, UK with a BSc in Medicinal and Pharmaceutical Chemistry, which included a year with GSK in Harlow, UK.

She moved to the University of Bath to study for her PhD with Prof Barry Potter. This was focussed on the design and synthesis of compounds with anti-prostate cancer activity. She completed her PhD in 2008 and took up a role with the UK's Engineering and Physical Sciences Research Council (EPSRC). In 2011, she moved to India as the Deputy Director of Research Councils UK India, based at the British High Commission in New Delhi. In 2014 she moved back to the UK to join the Royal Society of Chemistry.

She leads the Royal Society of Chemistry activities in Africa, including the Pan Africa Chemistry Network and the Analytical Training Partnership with GSK.

Paul Ehimare Aikpokpodion

Dr Paul Ehimare Aikpokpodion was born on the 26th November, 1970 at Idi-Ayunre Ibadan, Nigeria. He is a research scientist at the Cocoa Research Institute of Nigeria where he is currently serving as the Head of Research Station at Mambilla substation, Kusuku in Taraba State. He earned HND in Science Laboratory Technology (Chemistry Option) from Moshood Abiola Polytechnic Nigeria; B. Sc in Pure Chemistry from Olabisi Onabanjo University, Ago-Iwoye, Nigeria; PGD in Industrial Chemistry, M. Tech. in Analytical Chemistry and Ph. D in Environmental Chemistry from Federal University of Technology Akure, Nigeria. He joined Cocoa Research Institute of Nigeria in year 2002. As an experienced laboratory analyst, he has been a consultant to Nigerian Institute of Science Laboratory Technologist in training Laboratory Technologists on fertilizer analysis. He has also served as consultant to European Union-TBT-ACP in training Standard Officers at the Standard Organization of Nigeria, Lagos, on laboratory sample preparation. As an experienced chemist, he has participated in several National and International projects in Nigeria. In collaboration with scientists at the Institute of Environmental Assessment and Water Research, Barcelona, Spain Dr Aikpokpodion assessed the levels of organochlorine and organophosphorus pesticide residues in cocoa beans obtained from Nigeria in year 2012. Between year 2015 and 2016, Dr Aikpokpodion had his sabbatical leave at Achievers University where he taught several undergraduate chemistry courses and supervised research projects. Some of his research findings include degradation of endosulfan in cocoa soil, evaluation of heavy metals in cocoa, translocation and bioaccumulation of heavy metals in cocoa, heavy metals contamination in agricultural soils, pesticide residues in cocoa, transport of heavy metals in cocoa soils, Polycyclic aromatic hydrocarbons in cocoa, residual effects of heavy metals on nutrient elements in cocoa, mobility of paraquat and glyphosate in agricultural soils, fermentation and polyphenols in cocoa and remediation of heavy metal contaminated soils. He has several research publications in local and foreign journals.

Jerome Gallin

Jerome Gallin became Sales Director within the Laboratory Solution Division at Agilent Technologies in 2016. He is responsible for the Chromatography, Spectroscopy and Mass Spectrometry instruments portfolio business where Agilent is not directly present and uses distributors in Europe, Middle East and Africa. This region represents 95 countries and Jerome's team manages more than 45 distributors. Approximately 20% of Jerome's business is done in Africa.

From 1999 to 2002, Jerome graduated in Organic and Analytical Chemistry from Institut Universitaire de Technologie (Orleans, France) and from the School of Applied & Molecular Sciences at Northumbria University (Newcastle, UK). In 2002, he pursued his studies at the ESTBA in Paris to specialize in Sales and Marketing. Jerome then joined a company specialized in NMR products and labelled compounds where he started as a telesales. He then held several different responsibilities and finally became the West Europe Export manager.

In 2008, Jerome joined Varian as the Africa Business Development Manager and started travelling in many Sub Saharan African countries to create links with local University Professors, Pharmaceutical & Agro-Chemical Industries to identify the difficulties of the Analytical Equipment users and find inspiration for new business opportunities. In 2009, he developed a network of local service engineers in Sub Saharan Africa in order to solve the lack of service support and user trainings. Since 2010, Varian is part of Agilent Technologies and as of today, the Agilent Technologies service network is composed of more than 80 service engineers operating from and supporting chemists from more than 25 different African countries.

Over the past 9 years, Jerome and his team have been actively supporting projects in Africa initiated by many associations such as the International Foundation for Science, BVGH, JICA, 2iE, UEMOA/UNIDO, Action10, PRISM…Earlier this year, Evrim Kilicgedik, the Eastern and Southern Africa Manager part of Jerome's team, has made the connection with RSC and since then Agilent is increasingly partnering with the Pan Africa Chemistry Network initiative by organizing user trainings, collaborating with the RSC members and sponsoring the 2017 Congress.

Kristin Kolshus

Kristin Kolshus is an Information Management Specialist at the Food and Agriculture Organization of the United Nations (FAO), Regional Office for Africa, Office for Partnerships and South-South Cooperation Division, Capacity Development Unit.
She focuses on capacity development on access to scientific information, information management, and knowledge sharing, especially through AGORA, Research4Life and AGROVOC. See http://www.fao.org/africa/en/

Fiona Lahive

Fiona Lahive is a post-doctoral researcher in the Cocoa research group at the University of Reading. She has worked with cocoa for the past seven years and obtained her PhD in cocoa physiological responses to climate in 2015. Fiona's main research interest is in the study of environmental physiology of cocoa, specifically in response to elevated CO2, soil moisture deficit and high temperature stress. She is also interested in trait identification to aid in the development of improved cocoa with greater resilience to environmental stresses.

Charles Midega

Aliu Aduna Mahama

Ing. (Dr.) Mahama, Aliu Aduna holds a Ph.D in Technical Sciences from Tashkent Institute of Engineers of Irrigation and Mechanization of Agriculture (TIIAME) USSR 1987. An Agricultural Mechanization Expert with over thirty five (35) years of practice in consultancies, teaching, research and senior level managerial experience in United Nations – FAO - IRAQ (International Consultancies), Universities (UG, UCC and University of The Gambia) and the Ministry of Food and Agriculture of Ghana. He has shown leadership in Science Organization for the development S & T and Travelled to many European (West and East), Central Asian, Far East, American and African Countries. He enjoys mentorship of young engineering scientists in Agricultural Mechanization and actively contributing to climate change issues on agriculture related to mechanization. He is a member of the country climate-smart agriculture profiling team.

Jacob O Midiwo

Prof. Jacob O Midiwo undertook his PhD studies in Organic Chemistry at the University of Maryland, College Park, USA studying fungal mycotoxins which had potential in cancer chemotherapy. He graduated from that University in 1981 and took up lectureship position at his alma mater, University of Nairobi where he has risen through the ranks to full professorship.

Prof. Midiwo has done research on the secondary metabolites of popular Kenyan medicinal plants from a range of plant families: Myrsinaceae, Polygonaceae, Papilionacea, Compositae, Rutaceae and Sapindaceae.

He has published over 60 papers in refereed international journals describing the structures and bioactivity of compounds with various bioassay models- anti-plasmodial, anti-microbiol, mosquito larvicidal, insect antifeedant effects and their capacity as anti-oxidants - in search of their potential application.

Ravi Murugesan

Ravi Murugesan is an AuthorAID trainer. He has facilitated research writing workshops and training-of-trainers workshops in 11 countries in Africa and Asia, and he has developed and facilitated online courses which have been completed by more than 4000 researchers in the developing world. Ravi earned an MS degree in electrical engineering from the University of Wisconsin-Madison and holds a certification from the Board of Editors in the Life Sciences.

Collins Obuah

Dr. Collins Obuah is a Ghanaian who completed his secondary school education with distinction in 2000 at Adisadel College at Cape Coast, Ghana. Bachelor's degree in Chemistry (Second Class Upper division) at University of Ghana in 2006. He obtained his MSc and PhD degrees from the Department of Chemistry, University of Johannesburg in 2012 and 2015. Dr. Obuah has won several awards including the prestigious SACI-Sasol post graduate medal of excellence and Lindau Nobel Laureate Meetings. He is current a lecturer at the department of chemistry, University of Ghana and for his passion for research work, he has established a research laboratory within a short time of his appointment and his is undertaking research in bio-inorganic and organometallic chemistry as well as catalysis.

Dorcas Osei-Safo

Dr. Dorcas Osei-Safo is a Senior Lecturer at the Department of Chemistry, University of Ghana (UG). Dorcas obtained her BSc degree in Chemistry with Biochemistry and her PhD in Natural Products Chemistry from UG. Her primary research area is isolation and structure elucidation of novel compounds with anticancer, antimicrobial and anticonvulsant activities, as well as activity against neglected tropical diseases. Her other research area covers the development and application of quality assurance methods for antimalarial drugs distributed for use in Ghana. Since 2015, she has developed an interest in chemical ecology by teaming up with a group of entomologists to identity suitable host plant attractants for the mango stone weevil.

Nathaniel Owusu Boadi

Dr. Nathaniel Owusu Boadi is a Senior Lecturer at the Department of Chemistry, Kwame Nkrumah University of Science and Technology, Ghana. He holds BSc. Chemistry (Hons), MSc. Environmental Chemistry and PhD. Inorganic Chemistry degrees. Dr. Boadi worked as a research fellow at the University of Manchester, United Kingdom from July 2011 to December, 2013 where he worked under Prof. Paul O'Brien, FRS, CBE, researching into novel single source routes to the synthesis of lead chalcogenide nanoparticles and thin films. His research interests include Environmental monitoring, assessment and toxicology with focus on water quality, food chemistry and food quality, food additives and contaminants, heavy metal toxicology in various environmental matrices and persistent organic pollutants in various matrices. He also researches into the synthesis of metal-organic complexes that can be used as single source precursors for the synthesis of metal chalcogenide semiconducting nanoparticles and thin films. He is currently the interim administrator for the PACN Ghana hub.

David Phillips

David Phillips was born in 1939 and educated in the north east of England and at the University of Birmingham (BSc and PhD).

He enjoyed postdoctoral experience in Austin, Texas, USA, and in Moscow, USSR, before joining the University of Southampton as a Lecturer in Physical Chemistry in 1967. He left as Reader in 1980 to become Wolfson Professor of Natural Philosophy, at The Royal Institution, subsequently becoming Acting Director 1986 and the Deputy Director 1987-89.

He then moved to become Professor of Physical Chemistry of Imperial College of Science, Technology and Medicine, University of London (now Imperial College London) in 1989, Head of Department of Chemistry 1992-2002 and Hofmann Professor of Chemistry 1999-2006. He was Dean of the Faculties of Life Sciences and Physical Sciences 2002-2005 and Senior Dean 2005-2006. He is currently Senior Science Ambassador, Schools, Professor Emeritus and Senior Research Investigator.

David Phillips gave the Christmas Lectures (jointly with John Meurig Thomas) on BBC TV in 1986-87 and many series abroad. He has broadcast for TV and radio on his research interests, popular science and the state of British science. He regularly gives 20-30 popular lectures per annum to schools and lay audiences and e-masterclasses to groups of schools in the UK and abroad. He was awarded the RSC Nyholm Lectureship and Medal in 1994-95 for services to Chemical Education, the Michael Faraday Award of the Royal Society, London for public understanding of science. He received the OBE in The Queen's Birthday Honours in June 1999 for services to science education.

He is the author of many books and research papers (some 585 in all) in the field of photochemistry and laser research. He is a past Chairman of the DfES (Department for Education and Science) sponsored 'London Gifted and Talented' consortium promoting e-learning on the Managed Learning Environment for Gifted and Talented cohort of London School students from all 33 London Boroughs.

Enyonam Sedode

Spectrophotometeric analysis of caffeine in five different dried Cocoa (Theobroma cacao) beans and Cocoa powder samples found in Ido markets, Ibadan, Nigeria,

Dupe Abiona,[2] Hassan Olabamiji[1] and Ojo Anifowose[1]

[1]The Polytechnic, Ibadan, Ibadan, Nigeria

[2]The Polytechnic, Ibadan, Ibadan, Nigeria, Nigeria

Caffeine is a psychoactive stimulant that increases alertness, elevate mood and provide temporary energy boost. It is a natural alkaloid found in varying quantities in the seeds, leaves or fruits of many plants species including cocoa. Cocoa products are widely consumed worldwide, and so many people consume cocoa beans and cocoa powder without paying attention to the caffeine content. This could have some health implications especially for people with diabetes, pregnant women, people with insomnia and so on. Therefore, this study analyzed caffeine content in five different dried fermented cocoa beans samples and five different brands of unsweetened cocoa powder purchased from different markets in Ido Local Government of Ibadan, Nigeria, to generate data and also educate consumers on it. Caffeine was carefully extracted from each product using liquid-liquid extraction method and the concentration of caffeine in each of the samples was determined spectrophotometrically. The result of the study revealed that the caffeine content of the dried fermented cocoa beans samples analyzed was lower than those of the unsweetened cocoa powder samples except one. This increase in caffeine content of the unsweetened cocoa powder product could be attributed to the degree of fermentation and extraction of other vital ingredients during the processing of the raw cocoa beans into cocoa powder. The caffeine content of the dried fermented cocoa beans analyzed ranged from 77.60mg/100g to 152.80mg/100g while those of the cocoa powder samples ranged from 137.69 to 351.18mg/100g. The European Food Safety Authority (EFSA) published their scientific opinion on the safety of caffeine, that caffeine intakes from all sources up to 400 mg per day do not raise safety concerns for adults. It is also generally agreed upon that300mg-400mg of caffeinecan be consumed daily without any adverse effects. Approximately two tablespoon of unsweetened cocoa powder is recommended per day to enjoy the health benefits of cocoa. Thus, the quantities of caffeine found in the tested samples are considered safe for healthy consumption. Nevertheless, since caffeine is an addictive substance, and should be well regulated for pregnant women, people with diabetics and other health problems, it is not also recommended for children; thus, manufacturers of cocoa products should be mandated by the regulatory body concerned to indicate caffeine presence and its quantity on package labels.

Keywords

Cocoa (Theobroma cacao) beans, Cocoa powder, Caffeine.

The practical application of science & technology to boost Cocoa productivity; community & family income

Kingsley Adade

Syngenta Agro Ag, Ghana

The challenge for global R&D companies in supporting the development of rural economies is the cascade and transformation of their proprietary science to meaningful and valued grower solutions. Across the globe millions of smallholders face significant productivity shortfalls. International donors, NGO's, Governments, National and Multi-national companies continue to try crack this conundrum, with varied degrees of success. This paper highlights some of the 'on the ground activities' pursued by both Syngenta and their partners to deploy and transform often complex science, into practical solutions for improving crop productivity and smallholder returns.

The many issues faced by developing economies with rapidly growing populations is significant. If we simply compare national statistics for education alone, we begin to appreciate just one issue national governments are faced with. Both Ghana and Côte d'Ivoire spend circa 5% - 6% of GDP on education, equating to $ 88 and $ 72 respectively per capita / annum which, as a % of national GDP, is well in line with both Switzerland and the UK. However European countries enjoy much larger economic activity, consequently their education spend per capita / year for Switzerland is $ 4 400 and UK $ 2 500. The global challenge of adequately educating people within large rural based economies, inevitably influences the rate of technology adoption. Consequently literacy levels amongst rural communities is often low and smallholder learning is best delivered through a 'show and tell' approach. However this hands-on activity, comes at a significant cost.

The sheer geographic scale of many countries leads to accessibility challenges. England extends over 130 000 km² (394 000 km of roads), compared to Côte d'Ivoire 322 000 km² (80 000 km of roads) and Ghana 238 000 km² (109 000 km of roads). This huge disparity in road access between developed and developing economies, makes the deployment of grower crop inputs and other goods and support services very difficult and costly.

A third reality is the 'bankability' of smallholder farmers around the world – most smallholder growers have little savings or access to finance / credit or banking facilities. This makes it very difficult for private sector companies to plan viable businesses, where the element of producer risk is so high.

Despite all of this complexity, Syngenta and its former legacy companies have over 50 years' experience and commitment in deploying crop protection technology in developing economies, with the explicit aim of improving the livelihoods of smallholders and their communities, through significantly increasing the returns from their crop production. In turn many developing economies governments such as Ghana, have for many years recognised the challenge, dedicating resources and significant investment to reaching out to growers and rural communities, e.g. providing specialised crop advice; field spraying and many training initiatives. A fine example is the Ghana cocoa sector that is managed by the Ghana Cocoa Board (COCOBOD), which uses its subsidiaries CRIG (Cocoa Research Institute of Ghana) and CHED (Cocoa Health and Extension Division) to transfer technology to farmers.

Syngenta has a significant commitment to smallholder engagement across Africa and the rest of the world. In order to independently measure the difference we are making on the ground, Syngenta set out six commitments to make a measurable impact on Resource efficiency; Rejuvenating ecosystems and Revitalizing rural communities. These are tracked through our Good Growth Plan platform and independently audited, where we have networks of reference farms in place. This approach has been enlightening and we see tangible improvements being made on the ground. In Cote D'Ivoire for cocoa, this concept has seen grower productivity rise by at least 28 %, when adopting a Syngenta crop protocol and stewardship approach, returning on average $ 4 for every extra $ 1 invested in the adoption of Syngenta crop protection technology and application advice.

In Ghana, Syngenta has for the past three years run extensive 'field demonstrations' in cocoa producing areas and more in-depth replicated cocoa trials. These replicated trials compare general farm practice to a Syngenta-driven programme implemented and managed on the ground by our partner Agro Eco. For the cropping season 2016/17 their comparative work conducted across three growing districts resulted in an average farm yield of 392 kg / ha of dried cocoa beans, compared to a Syngenta programme delivering 632.4 kg / ha, simply through the adoption of good agricultural practices, when managing the cocoa plantation and timely use of the appropriate crop protection products for pest and disease control. Taking into account all production costs for the respective practices, the Syngenta farmers were left with an additional $ 436 / ha.

The balance of this paper will highlight some of the grower and community based activities we deploy with our partners, to transform the livelihoods of smallholder cocoa growers and their fragile communities.

Land use conflict between farmers and herdsmen – implication for agricultural and rural development in Nigeria

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Farmers and Herdsmen are having a lot of conflict in areas of land matter. This is due to the inadequacy of grazing resources and the effect of this is noted on the household welfare, loss of material resources, Agricultural produce and reduce income. This presentation study the different conflict suggest ways of ending such, as creating awareness of land use regulations among farmers and herdsmen's, provision of grazing land, extension services to teach farmers and herdsmen on conflict coping mechanisms, educating the farmers and herdsmen's for peaceful co-existence an mutual benefit, viable NGOs on farmers-herdsmen conflict management, especially in areas of awareness, education prevention, support livestock- centered live hoods including cattle herding, and conflict mitigation.Finanly conflict management framework is required to curb the danger posed by farmer – herdsmen conflict and Traditional and local leaders should be well involved in finding solutions to farmer herdsmen.

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Synergistic use of arbuscular mycorrhiza fungi and organic fertilizer for improving amaranthus cruentus cultivated under different soil moisture regimes

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Organic-based fertilizers enhance food systems sustainability, aid adaptation of plants in drought conditions[1] and also sustain the soil nutrient balance for increased crop yields[2]. A pot experiment was conducted to assess the influence of two arbuscular mycorrhiza (AM) fungi and organic fertilizer (OF) on the growth and yield of *Amaranthus cruentus* under varying soil moisture regimes. Viable spores of AM fungi, namely *Glomus clarum* and *Glomus deserticola*, obtained from the Department of Agronomy, University of Ibadan, Ibadan, Nigeria were propagated and organic fertilizer made from market wastes was procured from a local market. The experiment consisted of 36 treatments [(*G. clarum*, *G. deserticola* and no AM), organic fertilizer at different rates (0, 5 and 10 t ha^{-1}) and varied water regimes (25, 50, 75 and 100% field capacity (FC))]. Each of the treatment was replicated thrice and factorially arranged in a completely randomized design to give a total of 108 pots. Highest mean plant height of 64.83 ± 11.64 cm was obtained with 10 t ha^{-1} OF and *G. clarum* at 100% FC. However, highest stem girth of 3.50 ± 0.00 cm and leaf area of 98.51 ± 13.19 cm^2 were obtained with 10 t ha^{-1} OF and *G. deserticola* at 100% FC. Also, the treatments (10 t ha^{-1} OF and *G. clarum*) produced the highest vegetative yield of 73.23 g 3 kg^{-1} soil (48.82 t ha^{-1}) which was significantly ($F_{72,107}$ = 67.43; $p < 0.05$) different from 27.20 g 3 kg^{-1} soil (18.13 t ha^{-1}) at 100% FC than the control pots. There was however no significant differences in the yield obtained with 5 t ha^{-1} and 10 t ha^{-1} OF, and with AM fungi when water levels were compared. However, treatments with 10 t ha^{-1} of OF with *G. deserticola* with 75% FC were significantly higher than the control at 100% FC, a higher moisture level. The repeat experiment without further application of AM and OF treatments gave lower and comparable values. We concluded that the addition of AM fungi in combination with 5 t ha^{-1} of organic fertilizer to soil optimally improved the growth and yield of *A. cruentus* in water stress conditions.

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Putting nitrogen fixation to work for smallholder farmers in northern Ghana: Progress and achievements

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Productivity of African smallholder farming systems must increase to address the food and nutritional security needs of the ever increasing human population on the continent. A key component of all approaches to enhancing agricultural productivity and achieving food and nutritional security is the integration of grain legumes in the farming systems to enhance soil fertility and to reap the benefit of integrated crop-livestock systems. Grain legumes play a key role in farming systems sustainability. Grain legumes are able to capture the infinite resource of atmospheric nitrogen gas into a form that can be utilized by plants through their symbiosis with a specific group of bacteria collectively called rhizobia. While the protein-rich grains directly addresses food and nutritional needs of the poor, the crop residues of grain legumes are high quality feed for livestock and add nitrogen to the soil, enriching infertile soils and stimulating productivity of crops grown in rotation. The main objective of N2Africa project is to increase biological nitrogen fixation and productivity of grain legumes for African smallholder farmers in order to contribute to enhanced soil fertility, improved household nutrition and increased cash income. To achieve this objective, N2Africa forms strategic partnerships with actors along the grain legume value chain to build long term systems for sustainable supply of inputs, access to remunerative markets and capacity building. This paper highlights some progress and achievements of the project over the past four years.

Role of chemical science in cocoa industry in Nigeria: Successes, challenges and the way forward

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Nigeria is one of the major cocoa producing nations of the world. Cocoa as a cash crop is the main source of foreign earnings in Nigeria. The role of chemical science in cocoa production and utilization cannot be overemphasized due to its relevance in each component of cocoa value chain. Without the application of chemistry, sustainability and profitability of the cocoa industry will be a mirage. In Nigeria, chemists validate the claims of agrochemical manufacturers during product analysis. Due to the chemical nature of all agrochemicals used on cocoa, they are not restricted to the point of application. Rather, they are mobile within the plant tissues and end up as pesticide residues in cocoa beans. Consequently, the European set up maximum residue limits for various approved agrochemicals in order to prevent indiscriminate use of pesticides which could pose health threat to the consumers. Over the years, chemists at the Cocoa Research Institute of Nigeria have carried out studies to evaluate pesticides residues and other contaminants in cocoa beans to ensure they are not rejected by EU at the international market. Evaluation of heavy metal contamination and health risk assessment in imported chocolates was also made to ascertain the safety of children who consume chocolate in Nigeria. Our studies also cut across remediation of Cu and Pb contaminated cocoa soils with a view to reducing heavy metal contamination in cocoa beans through bio-translocation and bio-accumulation. Results have shown that, application of Cu based fungicides is the main factor that determines the level of Cu residues in cocoa beans. Pb residue in cocoa beans in Nigeria is dependent on the concentration of exchangeable Pb in soils on which cocoa is grown. Residue of polycyclic aromatic hydrocarbons in cocoa beans was very low which implies the safety of the beans. The level of copper in many cocoa plantations in Nigeria was moderately high due to long term application of copper-based fungicides. However, the level of Cu in Nigerian cocoa beans are still within copper maximum residue limits. The traces of Dichlorodiphenyltrichloroethane (DDT) and its metabolites, α and β endosulfan and diazinon in cocoa beans from some regions within the country was an indication that a few farmers still used some pesticides long after they were banned. However, the outcome of the recent survey of pesticides residues in cocoa beans showed no detectable banned pesticides which suggests that, the previous training on pesticide application yielded positive result among farmers. In a green house study, soils contaminated with Cu and Pb have been successfully remediated using immobilization technique with phosphate rock. The various findings obtained from research on cocoa quality have created platform for training and sensitization of cocoa farmers in Nigeria on the right attitude towards pesticide use which ultimately increased the quality of Nigerian cocoa beans at the international market. Some the challenges in Nigerian cocoa industry includes: Land tenure system, aging farmers, lack of cocoa board to coordinate the activities of cocoa farmers, deforestation, inadequate financial returns for farmers in cocoa business, use of copper-based fungicides, resistance of certain pests to pesticides application, inadequate credit and input support from the government. Inadequate analytical facility is the main challenge of chemists in Nigeria. The way forward is for agrochemical manufacturers to synthesize highly biodegradable pesticides which are human and environmentally friendly. Improvement of farmers' standard of living through adequate compensation for quality cocoa beans. Collaboration between industries and scientists.

Keywords

Cocoa, pesticide residues, agrochemicals, cocoa industry, chocolate

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

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The study was conducted in the nursery to investigate comparative effects of rates and sources of N - fortified organic based potassium fertilizer on soil, seedling growth and stem nutrient uptake of newly released cocoa hybrid in Nigeria. The fertilizer treatments consisted of, Cocoa pod husk (CPH), Oil palm bunch ash (OPBA) and cocoa pod husk ash (CPHA) and Urea (N). The organic materials are fortified with Nitrogen based fertilizer in two combination ratios of 50:50 and 75:25 (organic to urea fertilizer) and applied at a rate of 5, 10 and 15kgN/ha. The experiment was laid out in completely Randomized Design (CRD) in three replications. Samples were collected before and after the experiment. The soil samples were processed and subjected to laboratory analysis to determine the P^H, P, K, N, K, Ca, Mg. etc. Cocoa stem dry matter accumulation and nutrient uptake were also determined. The results showed that all the fertilizer materials irrespective of sources and rates significantly ($P < 0.05$) increased soil nutrients, seedling growth, dry matter accumulation and nutrient uptake of hybrid cocoa stem relative to the control. However, OPBA amended with N - rich fertilizer at both combination ratios of 50:50 and 75:25 applied at 10kgNha^{-1} performed better than fertilizer types and combination ratios.

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Cultivation vs. wild harvesting of *Cryptolepis sanguinolenta*, a medicinal plant used in the treatment of malaria

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A significant proportion of the African population living in both rural and urban areas, depend to a large extent on medicinal plants to meet their health care needs (Cunningham, 1993). Unfortunately, increasing numbers of these medicinal plants are under treat of extinction resulting from forest clearings for farming and over-collection from wild sources.

A multi-disciplinary research collaboration between local and international partners has led to the development of domestication protocols for the cultivation of *Cryptolepis sanguinolenta*, an important medicinal plant whose roots are used in the treatment of malaria (Amissah et al., 2016). *C. sanguinolenta*is native to Africa with restricted distribution in the West and Central African sub-region from Senegal to Angola (Jansen and Schmelzer, 2010). This multidisciplinary research approach has led to the development of propagation and cultivation protocols establishing that neither the active ingredient (cryptolepine) levels nor efficacy is compromised during the domestication of *C. sanguinolenta* plants. Findings from our research would empower smallholder farmers who also double as plant collectors, to benefit from establishing *C. sanguinolenta* as a cash crop, hence improving their economic status.

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Technologies for managing major crop protection issues in cocoa and other African crops

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A number of recent, high profile, multi-author, scientific and policy papers have raised the profile of food security and the need for sustainable yet improved pest management practices ("sustainable intensification"). At the same time, the spectrum of plant protection products available to farmers is changing rapidly: with regulatory pressures removing not only older active substances from the market, but also jeopardising relatively new groups such as insecticides that may endanger pollinators. Farmers and pest managers are being confronted with the need to apply chemicals and other biologically-based control agents that are often more costly to produce and may have substantially different properties to established chemical products.

We here describe some of our work developing various techniques associated with responsible pesticide use, with an emphasis on methods that target pest control effects. For more than 60 years, IPARC scientists have focused on optimising application methods suitable for small-holder farmers and other problems in tropical pest management. An overview of sustainable intensification in the cocoa crop is described in the *Cocoa Pesticides Manual* (published free online by the ICCO), which describes the need for improved pesticide selection, timing and application – driven by the '3 Rs' (residues, resistance, resurgence).

Concerns about the impact of fipronil and certain neonicotinoid insecticides on pollinators are having a considerable impact in temperate crop agrochemical markets, but for crops such as cocoa, the role of pollinators and the impact of insecticides sprays on them, remains poorly understood. ACIS R&D developed the small insect sampler used by COCOAPOP and other projects for assessment of pollinator populations in cocoa and similar crops.

Over the past two decades we have also worked on enabling technologies for the effective exploitation of microbial control agents (MCA) such as entomopathogenic fungus spores. The 'MycoHarvester' has proved to be an important tool for the production of formulations of the mycoinsecticide based on *Metarhizium acridum* for biological control of locusts in Africa; it has also been used for other beneficial fungi such as *Trichoderma* spp. for managing *Phytophthora* and *Moniliophthora* diseases in cocoa. Further development of the MycoHarvester continues with the latest MH6 version released in 2017.

Using natural products to invent new chemicals for crop protection

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This presentation will describe the way in which Syngenta uses natural products for the discovery of new herbicides, insecticides and fungicides.

Natural products with biological activity are very useful in the crop protection industry. Such compounds can be used as commercial products, either directly or after synthetic modification, if they have suitable biological and physical properties. They are also useful for the validation of new modes of action. However, from a business point of view, natural products have been of most value as a source of inspiration for synthesis, an approach which leads ultimately to novel and fully synthetic commercial products. The most important examples are the insecticidal pyrethroids and the fungicidal strobilurins, with global sales worth more than $2 billion and $3 billion per annum, respectively.

The natural products shown in the figure below have all formed the basis of research projects in Syngenta and its parent companies. Some of these, and other projects, will be presented as short case studies, and lessons for future projects will be drawn.

Pesticide use in cocoa farming in Ghana: Implications for sustainability, food and environmental safety

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Cocoa is the third highest foreign exchange earner for Ghana and contributes about 25% of the country's gross domestic product (GDP). As it pertains to most tropical climates, pests and diseases pose a significant challenge to food production and contribute to substantial yield loses. In Ghana, most farmers believe that commercially viable cocoa yields cannot be sustained without pesticide application and therefore use liberally as the primary form of pest control. In this regard, the Government of Ghana, which exercises significant control over the cocoa industry has instituted a "free" pesticide application policy for cocoa farmers. This policy has led to considerable increases in yield and associated economic benefits such as higher incomes and improved livelihoods among smallholder farmers. However, the policy offers low incentives for food and environmental safety concerns. This is largely due to intensive application rates, misuse and abuse, encouraged by easy access to chemicals from cocoa authorities. In this paper, we present results based on studies on neonicotinoids in cocoa farming. We demonstrate the application of QuEChERS, a simple extraction technique in assessing residue levels in soils and cocoa beans. Our studies show widespread exposure and elevated levels of pesticides in soils and cocoa beans, with implications not only for food and environmental safety, but also, long-term sustainability of the cocoa industry, food security, government revenues and smallholder livelihoods. We conclude that, greater efficiency in pesticide application is required in increasing food safety and minimizing environmental impacts to ensure high yields and long-term sustainability of cocoa production in Ghana. We suggest the need for a trans-disciplinary approach to achieve this outcome.

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The Royal Society of Chemistry: Advancing the Chemical Sciences in Africa

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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. Our 54,000 members come from over 110 countries and all areas of science, academia and industry. A not-for-profit organisation with a 176-year heritage and an ambitious vision for Africa.

We have over 750 members in Africa, with 4 Local Sections and a network of Local Representatives. We want to enable African scientists to work together and with colleagues from other continents to find sustainable solutions to local and global problems.

Through the Pan Africa Chemistry Network (PACN) we are already making a difference. The PACN seeks to create a self-sustaining science base in Africa, to solve local challenges and contribute to global knowledge in the chemical sciences and related disciplines.

The Pam Africa Chemistry Network aims:

- 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 to 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

Together with our partners we have invested over £2.5 million in the PACN since 2008 and we have collaborated with more than 35 different organisations on events and activities.

In this talk we will be discussing ways that we can support you, your career and your research. This will include; access to the RSC Journal Archive and eBooks; RSC membership; funding opportunities for African science and career support. I will also be discussing international collaboration and funding opportunities available.

To keep up to date with activities in Africa, please join the mailing list: rsc.li/africanews

Pan Africa Chemistry Network: www.rsc.org/pacn

Archives for Africa: www.rsc.org/Membership/Networking/PanAfrica/Archives.asp

Twitter: #PanAfricaChem

Food security for a growing population in Ghana – the role of The Soil Research Institute

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A key dynamic entity without which life on this earth would have ended long time ago, is the soil. The soil provides for all man's needs particularly food, vegetation and other ecosystem benefits. Thus, ensuring sound soil health as well as sustainable ways to improve its resilience and quality is a pre-requisite for food security. Towards this, the CSIR-Soil Research Institute of Ghana is mandated to generate scientific information for planning, development and management of the soil resources for increased and sustainable agriculture, industry and environmental sanity. The Institute contributes to soil protection; soil mapping; mapping and monitoring of soil organic matter (SOM); soil mechanization and water management; fertilizer management; quality laboratory analytical services; soil erosion control; climate change mitigation adaptation strategies; as well as response of inoculated soybean to phosphorus and nitrogen fertilizers. Among other services, mapping and monitoring of SOM is seen as vital for improving food security in Ghana. This is because the declining trend in SOM levels is one of the key constraints on soil fertility. SOM plays a vital ecosystem role in determining nutrient turnover, soil fertility, water-holding capacity and susceptibility to land degradation. A decline in the amount of organic matter results in a decrease in the effective cation exchange capacity (ECEC) and attendance loss of Ca and Mg in soils. Moreover, Soil functions and processes in the root zone become significantly impaired when SOM levels fall below one percent (< 1%). Nevertheless, in sub-Saharan Africa with special focus on Ghana, SOM content of most agricultural soils managed by smallholders and resource-poor farmers is lower than 0.1 percent (< 0.1%), resulting in meagre yields and little response to fertilizers. Hence the apparent food/nutritional insecurity, poverty, hunger and land degradation in the country. SOM levels must therefore be restored to improve food security and the soil's resilience in agricultural systems. Efforts to restore SOM content in Ghana require well designed monitoring and mapping programmes, which the SRI is currently embarking upon.

An integrated Approach to siting grain storage facilities to reduce transportation cost in developing countries

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Networks of grain storage facilities in developing countries are primarily sited to allow farmers to easily store their commodities. The seasonal nature of agriculture in these countries however creates significant downtime for these facilities thereby impacting their sustainability. There is therefore an increasing need to design these networks of facilities to allow for concurrent use by other stakeholders to minimize the downtimes. This work developed and illustrated an integrated approach of designing such efficient networks of storage facilities as it relates to non-primary stakeholders. This integrated approach looks at how other stakeholders like exporters can take advantage of the same network to boost the sustainability of the network. It essentially uses transportation, Pseudo P-median and forecasting models to design efficient networks and also compute the efficiency of these networks. The approach was used to compute the efficiency of the government of Ghana's network of storage facilities as it relates to exporters at the sea and air ports. The simulations showed that if exporters at the airports choose to use the existing network of storage facilities as temporal storage space, they will incur a transportation cost 33% higher than if they were operating in a network designed purposely for them. This figure however reduces to 21% in the long term. Exporters that use the sea port will also incur transportation cost 58% higher than they would in a network designed purposely for them. This value also decreases to 19% which is still high thereby serving as a deterrent. The integrated approach provides an avenue for decision makers to evaluate the suitability of any proposed network of facilities for non-primary stakeholders as well as design efficient networks.

Bioassay-guided isolation of active phytochemicals against Tuta absoluta (Meyrick) from Caesalpinia species (Leguminosae)

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Tuta absoluta Meyrick originated in South America and is now one of the most important insect pests of Solanaceae in different parts of the world, including Africa. Its control has relied primarily on chemical insecticides, which are associated with several problems including resistance development and negative ecological effects. These have led to the search for more eco-friendly methods of control of the pest, such as mass trapping with sex pheromone and search for phytochemicals that show subtle anti-pest properties. In the present study, the effects of phytochemicals of different polarity associated with *Caesalpinia welwitschiana* and *C. bonduc* (Leguminosae-Fabaceae) leaves and liana on second instar larvae of *T. absoluta* were screened. The methanolic extract of *C. welwitschiana* leaves was most active with LD_{50} = 598.9 ppm. Bioassay-guided isolation of active compounds from the most active extract using column chromatographic and preparative HPLC led to the identification of fifteen compounds including two new cyclohexene derivatives. The structures of the compounds were established using spectroscopic techniques, including MS, IR, UV, 1 and 2D- NMR (COSY, HMQC, HMBC and NOESY), and in the case of the known compounds, also by comparison with reported data. This study is the first report of cyclohexene derivatives in *Caesalpinia* genus. Some of the isolated compounds were tested on second instar larvae of *T. absoluta*. Each of the isolated showed moderate to high larvicidal activity with LD_{50} < 7.5 ppm, comparable to that of azadirachtin (LD_{50} = 7.8 ppm). The results of the study show potential of the phytochemicals of the plants in the management of *T. absoluta.*

Brief introduction to FAO's goals, priorities and regional initiatives in Africa

Kristin Kolshus

Food and Agriculture Organization of the United Nations, Africa

Brief introduction to FAO's goals, priorities and Regional Initiatives in Africa; 47 countries in the region. Work of the Information and Data Access Services Team, providing access to current scientific literature and data in agriculture and related sciences. One channel is Research4Life, a public-private partnership of the WHO, FAO, UNEP, WIPO, Cornell and Yale Universities, the International Association of Scientific, Technical & Medical Publishers and individual international scientific publishers. The goal of Research4Life is to reduce the knowledge gap between high-income countries and low- and middle-income countries by providing affordable access to critical scientific research. HINARI, AGORA, OARE and ARDI are providing researchers in low- and middle-income countries with free or low-cost online access to leading journals and books in the fields of health, agriculture, environment, and applied sciences. See http://www.research4life.org/

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Natural fungicide from Prekese

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The global effort to achieve international food security is hampered by food loss through pest infection. Recently in Ghana, over 50,000 hectres of maize was devastated by the fall army-worm. For years, means of controlling these pests is the application of synthetic pesticides which are expensive, with serious side effects and also affect non-target organisms. Natural extracts are cheap and environmental friendly method of controlling these pests. Fortunately, many plants in the tropics have pesticidal properties but very little research is done to determine the kinds of pest that they can control. *Tetrapleura tetraptera* (prekese) is one of such plant. Prekese is best known for its many health benefits to humans, however, little is know about its fungicidal properties. This work reports the ability ethanolic extract of Prekese Seed to effectively inhibits the activities of both the Aspergillus flavus and Fusarium moniliforme fungi.

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Aiding the development of a sustainable cocoa production system in West Africa

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Cocoa is one of the most important tropical perennial crops which is grown for its beans used in the production of chocolate. Approximately 3.9 million tonnes of cocoa are produced annually of which approximately 70% is grown in West Africa where the main producers are Côte d'Ivoire, Ghana, Nigeria and Cameroon.

Cocoa is largely cultivated in West Africa by smallholder farmers. In a recent study of 96 cocoa farmers in Ghana, average farm size was found to be 1.3 ha. Cocoa farming comes with a range of challenges to production. The survey identified control of pests and diseases, and a lack of access to credit to invest in their farms as the two greatest challenges from the farmer's point of view. Other issues limiting production which were highlighted by the survey included a lack of rehabilitation on aging farms and the need for the development and provision of improved planting material to farmers. Access to good planting material depends on the supply of high yielding and disease resistant cocoa varieties. The International Cocoa Quarantine Centre (ICQC,R), based at the University of Reading, contains a collection of over 400 cocoa accessions which are maintained under disease free conditions. ICQC,R provides cocoa germplasm for research and breeding activities around the world without the risk of transferring pests and diseases from one growing region to another and therefore provides a fundamental step in ensuring that farmers continue to receive improved planting material.

One of the most intractable problems facing subsistence farmers is their ability to adapt to the challenges to cocoa production brought about by the effects of climate change. Higher temperatures and greater variation in rainfall patterns are predicted to occur in West Africa during the next 50 years and these are likely to have significant negative effects on establishment and productivity of cocoa, and alter pest and disease relations. However, research on young and mature cocoa trees have indicated that growth under elevated CO_2 will increase photosynthesis, growth and water use efficiency, and so help to alleviate some of the negative effects of soil water deficit. Current research at University of Reading is focused on the identification on physiological traits which confer resilience to reduced soil moisture, with the aim of supplying this information for incorporation into cocoa breeding programs. Farm management practices also have an essential role in sustainable cocoa production under climate change. Irrigation is frequently used in many crop systems, however it has not been widely adopted in West Africa due to practical limitations and cost restrictions. As an alternative, simple measures such as plastic or organic mulching has been shown to have a positive effect on soil moisture levels and improve establishment of cacao. Growing cacao under shade can also help alleviate environmental stress such as high temperature and vapour pressure deficit.

The role of chemistry in the development of the cocoa industry in Ghana

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The role chemistry plays in the development of the cocoa industry in Ghana cannot be over-emphasized. Chemistry as a discipline is involved in various aspects of the cocoa industry in Ghana. The objective of this paper is to provide an overview of the role of chemistry in the development of the cocoa sector in Ghana. Cocoa consumption is promoted due to its nutritional and health benefits. The foundation of the awareness of nutritional and health importance of cocoa is chemistry. Quality monitoring for Quality Assurance in cocoa produced for the international market is one of the major activities undertaken by the industry. This involves routine monitoring of pH, level of fermentation using the cut test and fermentation index, fat, total sugars, protein, and polyphenol content. Studies on the fermentation of the cocoa bean has established numerous scientific facts concerning chemical changes that take place during the process. This has helped in producing cocoa beans with good colour and flavour desirable for chocolate production. This has also helped to achieve a premium price for Ghana's cocoa. Another major activity carried out by the cocoa industry using chemistry is monitoring of tested and approved agrochemical residues in cocoa, soil and water bodies in the cocoa growing areas using GC-MS. This is particularly important for environmental safety and sustainability and also to avoid rejection of Ghana's cocoa beans abroad due to high amounts of residues or heavy metals. Development of improved varieties that are resistant to major biotic and abiotic stresses is one of the major goals of the cocoa industry. Chemistry plays a role in unravelling the biochemical basis of resistance to diseases and pests especially black pod disease, cocoa swollen shoot virus disease and capsids. Climate Change has become a major challenge of cocoa cultivation in recent years. Chemistry is used to understand the basis of drought tolerance and is also used to select promising cocoa genotypes for adaptation to climate change. In order to add value to cocoa and its by-products, new products are developed from them. Chemistry is very significant in determining chemical composition and safety of these new products from cocoa for human consumption. Realising the great role of chemistry and its potential in developing the cocoa industry in Ghana there is a need to invest in new tools and build more capacity to fully harness its promise.

Keywords

By-products, Chemistry, Cocoa industry, Residues, Stress, Quality monitoring

Quantification of copper sorption in soils as influenced by soil characteristics using a laboratory column leaching technique

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The fate of copper in soils has major implications on agriculture and the environmente. Considering the inherent toxicity of copper in agricultural soils largely due to copper based formulations, decisions on containment of potential Cu toxicity require an understanding of its behaviour in the soil. Two experiments arranged in a Randomized Complete Block Design (RCBD), with four replications, were carried out separately, to assess the distribution of Cu. The treatments were 0.00, 12.33, 18.50 and 24.70 g/m^2. Two different soils, Gleyic Arenosol (Nta series) and Eutric/Dysteric Gleysol (Temang series) were used for the studies. The study showed Cu sorption to increase with increasing soil organic matter (SOM) content. Whilst the correlation between Cation Exchange Capacity (CEC) and Cu sorption was positive in the Gleyic Arenosol, it was negative in the Eutric/Dysteric Gleysol. The clay content did not show any regular pattern with Cu sorption. Copper sorption increased with increasing pH in both soil types. Gleyic Arenosol adsorbed more Cu than the Eutric/Dysteric Gleysol at all levels of Cu application. The results showed the annual Cu movement in the soil to be 4.17 and 4.58 cm y^{-1} for the Gleyic Arenosol and Eutric/Dysteric Gleysol respectively. Continuous application of Cu may have serious groundwater implications especially under low pH and SOM. Industries processing heavy metals are encouraged to set up large column leaching apparatus to clean industrial effluents before disposing them.

Keywords

Copper, sorption, Cation Exchange Capacity, Heavy Metals, Soil Organic Matter

Agricultural mechanization as a means of making agriculture more sustainable

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In an attempt to define agricultural mechanization, the factors of drudgery, environment and sustainability that are based on systems and institutions come immediately into mind. All these factors are firstly considered individually, jointly and programmed into policy before implementation. Most modernized agriculture exhibition anywhere in the world today bears strong reference to the level of use of modern technology or mechanize practice in a complete value chain. Sustainability of agriculture can also be measured in comparison partly or fully with other countries that are already developed in this area. The benefit of Agricultural modernization is also generally linked up with food security, industrial growth, export, youth participation, health, entertainment etc.

Any national agricultural policy will aim at modernising agriculture for a rapid increase in agricultural production as a first step. The implementation will involve making available appropriate agricultural technologies that are consistent with environmental conservation practices, taking safety measures that will ensure economic growth. This policy has to be multidisciplinary in content with agricultural mechanization, Institutions (modernisation / removal of drudgery in agriculture) and infrastructure playing leading role.

Sustainable Agricultural through Mechanization has been one of the main pillars of any accelerated agricultural growth and has a direct correlation with the economy of using technology in agriculture. Therefore, this paper looked at the strategic factors in their perspectives in agricultural development. Measures that need to be taken to ensure that farmers also have access to a level of mechanization technology appropriate to their circumstances for agricultural sustainable production are also discussed for policy makers and professionals.

Key Words

Agricultural Mechanization, Drudgery, Assessment, Infrastructure, Strategy

Anti-microbial secondary metabolites from Kenyan plants with crop protection potential

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Research on certain medicinal plants of Kenya has revealed certain anti-fungal and anti-bacterial compounds which make the plants applicable for crop protection. The Leguminosae, Albizia schimperiana and other *Albizia* species, contain budmunchiamines, spermine alkaloids that have strong antimicrobial activity against *C*. *neoformans*, *E. coli* and *A. fumigatus*, M. *intracellulare* and methycillin resistant *Staphylococcus*. The Malvaceae, *Thespesia garckeana* contains derivatives of the diterpenoid, gossypol which are quite effective against the microbe *Enterococcus faecium*. It also showed strong activity against *C. glabrata.* The Verbenaceae, Clerodendrum bears abietane diterpenoids that show good activity against *C.glabrata, S. aureus, E. coli, P. aureginosa* and *M. intrcellulare.* The Fabaceae , *Abrus schimperi* also contains , armophaquinone and pendulone which exhibit reasonable activity against *Staphylococcus aereus*. These sources of secondary metabolites show clearly that higher plants can be sources of biodegradable, anti-microbial active compounds that can be used or transformed into entities that are usable for crop protection in the field or storage.

Human urine and its derived products as fertilizers for crop production

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Poor and degraded soils limit agricultural productivity among many smallholder farmers in sub-Saharan Africa. Many of these smallholder farmers rarely apply chemical commercial fertilizers at the recommended rates because of high fertilizer costs and lack of credit.[1] The use of human-excreta derived materials as potentially new fertilizer sources is being considered as a viable option to supply nutrients to farmers' fields. This study sought to understand the effect of using human urine derived fertilizers such as struvite, stored urine and nitrified urine concentrate (NUC) on soils, crop growth and biomass production.

A field study was carried out at Newlands Mashu research site, to investigate the response of maize (*Zea mays*) to the application of struvite, NUC and stored urine as fertilizer sources for nitrogen and phosphorus. The trial was designed as a 5x3 factorial experiment with the following factors: Fertilizers – 5 levels (positive control, negative control, NUC x struvite, NUC and stored urine) and planting time – 3 levels (planting 1, planting 2 and planting 3) but the planting treatment was applied repeatedly on the same experimental unit, laid out using a Randomized Complete Block Design. The treatments were replicated four times to give a total of 20 experimental units (3 x 1m plots). Data collected was subjected to analysis of variance using GenStatâ (Version 18, VSN International, UK) and treatment means compared at the 5% level of significance.

Significant differences ($P<0.001$) were observed between the treatments with respect to plant height at planting 1. The negative control had the highest plant height (70.2 cm) lowest plant height was observed in the stored urine (46.3cm). At planting 2 significant differences ($P<0.001$) were observed between treatments with respect to plant height, with highest plant height obtained in the positive control (85.1cm) and the lowest plant height in the stored urine treatment (61.7cm). Significant differences ($P<0.001$) were observed between the treatments with respect to plant height at planting 3. The NUC x struvite had the highest plant height (88.2cm) the lowest plant height was observed in the stored urine (46.3 cm). Dry mass obtained at the three plantings differed significantly ($P<0.001$) with the highest dry mass of 6.09t ha^{-1} attained at planting 1, followed by planting 2 with a dry mass of 4.82t ha^{-1} and the lowest dry mass of 3.32t ha^{-1}at planting 3. A significant difference between treatments in terms of dry mass was observed, with 6.02t ha^{-1}, 4.93t ha^{-1}, 4.88t ha^{-1}, 4.59t ha^{-1} and 3.3t ha^{-1} in the positive control, NUC, NUC x struvite, negative control and stored urine treatments respectively. Initially the chemical commercial fertilizers outperformed the urine based fertilizers but with time the urine based fertilizers were comparable to the chemical commercial fertilizers with respect to maize biomass production.

Human urine derived products are a viable source of nutrients for crop production, however, research is required on fate of undesired products (pharmaceuticals, antibiotics and sodium chloride) in these products.

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Emerging technologies in food production: Edible insects as food and feed

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The growing world population coupled with a fast increasing demand for food due to improving food standards is placing immense pressure on global food systems. In order to feed the world the diversification of food sources, especially protein, for human and animal consumption is paramount (FAO, 2013). In developing countries alone meat consumption is growing at a rate of 5% per year, increasing the demand for feeds resulting to high feed costs and devastating environmental consequences. In order to meet this demand, insects have been identified as a suitable candidate to supplement other animal-based proteins (van Huis, 2013). The purpose of our study was to strengthen the role of insects in local human/livestock diets while enhancing the sustainability, safety and efficiency of insect farming, processing and consumption by rearing locusts/grasshoppers as ingredient source for human food and livestock diets. We collected grasshoppers and locusts from Nakuru and Baringo counties in Kenya and reared them on small scale feeding on inexpensive feeds including grass. We identified suitable grasshopper and locust species that grow to attain high biomass, optimum growing conditions and feed requirements. Moreover, insect-based baby food and chicken feeds have been developed. Microbial analysis indicated that the meal is safe for consumption, suggesting that locusts/ and grasshoppers could be mass produced to alleviate protein malnutrition. For broader acceptance of the food/feed products developed, this paper discusses potential methods for processing of insects for human and animal consumption and the influence of processing approaches on nutritional value. Because little is known about the food safety of insects and no tentative legislation in Kenya about edible insects, this paper highlights biosafety issues on insect consumption including heavy metals, mycotoxins, pesticide residues, pathogens, natural toxins, allergens, processing contaminates and veterinary residues.

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Effect of storage on lutein levels in smooth cayenne (Ananas comosus) grown in Kenya

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Studies on the changes of carotenoids levels in fruits and vegetables as a result of storage and processing is useful in their promotion and the associated diseases[1]. Lutein is one of the most widely found carotenoid, distributed in the frequently consumed fruits and vegetables. Epidemiological studies have showed that people with *higher* lutein intake, or higher blood concentrations of lutein, have a reduced risk of coronary heart disease, stroke, and metabolic syndrome through oxidative stress and chronic inflammation. Further, lutein has long been associated with vision protection, in which it provides both by reducing oxidative stresses in the eye and by lowering chronic inflammation that can contribute to cataracts and age-related macular degeneration[2,3]. Fruits such as smooth cayenne, a common variety of *Ananas comosus* widely grown and consumed in Kenya contain substantial amounts of lutein. The fruit can be stored for several days after harvest, although being a perishability fruit. However, the effect of storage of fruit at room temperature on the levels of lutein is not known. Changes in the levels were investigated during storage of the fruit samples of sourced from Kiambu, Homabay, Kilifi, Kericho and Nyamira Counties, Kenya and analyzed within 7 days of storage under room temperature (21 to 25°C) using HPLC procedure[4]. The lutein levels ranged between 107.52±1.25 and 233.55±5.77 µg/100g in the samples analyzed, and was categorized as sufficient. The findings showed not only that the levels differed significantly among samples but also increased signicantly during storage ($p<0.05$). It was noted that longer storage of the fruit enhances the levels of lutein and therefore the consumption of the fruit after a few days of harvesting be encouraged to address chronic degenerative diseases.

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Optimized production of selected indigenous fruit trees for food and nutrition security in the Lake Victoria Basin, Eastern Africa

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Indigenous fruit trees (IFTs) provide an array of food with essential nutrients for rural communities (Mwema *et al.,* 2012). This study assessed traditional knowledge and perception of local communities on the local uses, management practices, distribution and availability of IFTs; and their contribution to food and nutritional security within the Lake Victoria Basin (LVB) districts of Uganda and Rwanda. The study was conducted in 400 households (Uganda) and 400 households (Rwanda). Data was collected through questionnaire interviews, key informant and focus group discussions with participants drawn from amongst local farmers. Propagation trials using adapting stem cutting techniques (Jeruto et al., 2008) and nutritional analysis(AOAC, 1997) were carried out on selected IFT species. The study revealed the existence of 13 and 14 IFTs in Uganda and Rwanda, respectively. The most preferred IFTs were *Canarium schweinfurthii, Garcinia buchannanii, Vangueria apiculata*, *Saba comorensis* and *Chrysophyllum albidum* in Uganda; and *Parinari curatellifolia*, *Pappea capensis*, *Myrianthus holstii*, *Garnicia buchananii* and *Ximenia caffra* in Rwanda, as major sources of food to these communities during periods of dry spells and famine, besides being used as medicine and for income generation. Age, occupation and income of the respondent significantly influenced the reported local uses of IFTs ($p \leq 0.05$*).* There was high variability in the availability of IFTs reported. Lack of proper propagation techniques, low extension services targeting IFTs, perception that IFTs take long to germinate and mature; uncertainty of IFTs seedling bearing fruit and lack of information on their management were identified as contributor of their rarity. The study also revealed communities local management practices for IFTs like planting seeds, protecting wildings, transplanting wilding to gardens, fencing wildings to keep off livestock, spearing wildings while clearing gardens, regular weeding, pruning, clearing bushes around IFTs. Scientific propagation trials on selected IFTs showed shoot development as early as two weeks of planting under 0.6% indolebutyric acid (IBA) hormone. Nutritional analysis indicated that consumption of 100g of fruit pulp of IFTs was able to meet daily Recommended Dietary Allowance of between 6-100% for dietary fibre, 10-18% (protein) , 3-24% (energy), 2-50% (fat), 33- 300% (potassium), 3-26% (magnesium), 20-160 % (iron) and 3-17.0% (zinc). The analyses of the seed oil content resulted into values that ranged from 16.00-42.67% with values of total saturated fatty acids, mono unsaturated fatty acids, poly unsaturated fatty acids and unsaturated fatty acids in the ranges of 9.28-37.72%, 11.79-58.12%, 1.38-78.92% and from 58.39-90.71%, respectively. This study confirms applicability of IFTs for food and nutritional security.

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Optimizing site specific fertilizer recommendations for maize production in transition zone of Ghana

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Experiments were conducted on Chromic Luvisol (Wenchi) and Ferric Lixisol (Mampong) to estimate the influence of site specific inorganic fertilizer rates and its integration with poultry manure on nutrient uptake, biomass and maize yield in the transition zone of Ghana. The experiment consisted of sixteen (16) fertilizer combinations ($N_0P_0K_0$, N_{30}, N_{60}, N_{90}, N_{120}, $N_0P_{10}K_{20}$, $N_{30}P_{10}K_{20}$, $N_{90}P_{10}K_{120}$, $N_{120}P_{10}K_{20}$, $N_{60}P_{10}$, $N_{60}P_{20}$, $N_{60}P_{30}$, $N_{60}P_{10}K_{20}$, $N_{60}P_{10}K_{40}$, $N_{60}P_{10}K_{60}$ and $N_{60}P_{10}K_{20}$ + PM (2.5 t/ha) with two maize genotypes: Obatampa (an open pollinated variety) and Mamaba (hybrid maize). The treatments were laid out in a randomized complete block design with three replications. Data were taken on nutrient uptake at 34 and 54 Days After Sowing (DAS), maize growth and yield. At 34 DAS, N, P and K uptake significantly increased with N, P and K fertilization showing increased availability of these nutrients in the soil. All the treatments were significantly greater than the control during the 54 DAS in respect of nutrient uptake. During the major season, Mamaba maize cultivar had the highest yield (4950 kg/ha) under $N_{60}P_{10}K_{20}$ + PM (2.5 t/ha) than other treatments. However, Obatanpa maize cultivar gave the highest yield under $N_{60}P_{10}K_{20}$ + PM (2.5 t/ha) compared to other treatments. Yield of maize for both Mamaba and Obatanpa declined significantly in the minor cropping season due to low rainfall and time of planting. In comparison, hybrid maize (Mamaba) gave the highest yield to fertilizer than open pollinated genotype (Obatampa). This indicates that hybrid maize does not require more NPK fertilizer than open pollinated in exhibiting its potential yield. Also, combined application of site specific fertilizer rate and organic fertilizer improved hybrid maize yield than using inorganic fertilizer alone.

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Occurrence, distribution and fate of copper from copper-based fungicides in soils and cocoa plants

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Cocoa is essential for the economy of Ghana and generates lots of foreign exchange for the country. However, much of Ghana's cocoa beans are lost due to pests and diseases. Fungal diseases contribute significantly to this decline, and the application of copper-based fungicides has served as the most effective way to fight fungal infections. Despite their effectiveness, there is the tendency for accumulation of copper in the cocoa environment due to its non-degradable nature. This study investigated the concentration and distribution of copper in soils and various cocoa plant parts including beans, pod, bark, and leaves from various plantations in the Wassa Amenfi West District of the Western Region of Ghana. The study also assessed the effects of soil physicochemical properties on the mobility of copper in soil. The concentrations of copper were obtained using a pinAAcle 900T Atomic Absorption Spectrometer after acid digestion. Copper content in the various cocoa plant parts ranged from 4.36 to 34.25 mg/kg, with relatively higher concentration observed in beans and pods. Also, soil physicochemical properties studied were low indicating the availability of copper for cocoa plant uptake.

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Semiochemicals released from Cowpea [Vigna unguiculata (L.) Walp.] upon Herbivory feeding and their potentials in intergrated pest management

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Food security is currently a development challenge for most Sub-Saharan Africa countries. Climatic change, poor soil fertility, low farm inputs and insect pest are major contributing factors. Pest management in Africa are mainly through the use of synthetic chemicals. However, the high cost, health and environmental effects associated with the use of these synthetically chemicals have increased the need to search for an alternative. When under herbivory attack, Plants can release blends of volatile organic compounds (VOCs) referred to as Herbivore-Induced Plant Volatiles (HIPV) which can serve as an attracting signal for natural enemies and/ or repel herbivores. The induced VOCs, can also be perceived by neighboring plants to activate their defensive mechanisms for possible attack. The role of these signaling compounds is important in the development of integrated pest management strategies which involves attraction of natural enemies to the herbivory infested plants. Cowpea is an important crop in Ghana because it serves as a cheap source of protein and can well adapt to high temperatures and poor soils. However, the yields of the crop in Ghana mainly due to biotic stress are among the lowest in the world averaging 310 kg/ha. To characterise the chemical ecological mechanism by which Ghanaian cowpea varieties (Padi tuya and Abagpaala) and their pest insects interact, the plants were challenged with five herbivores (*Maruca vitrata, Aphis craccivora, Ootheca spps, Latoia vivida* and *Myzus persicae*) and their induced signals compared to a mere mechanical damaged cowpea plants. The induced volatiles were trapped on Porapak Q and analysed using Gas Chromatography coupled Mass Spectrometer (GCMS). Herbivory induced compounds identified to be emitted by the plant included the green leaf volatiles (GLVs), 1-octen-3-ol, indole, methyl salicylate, *E*-β-farnesene, DMNT, Linalool, TMTT and Nerolidol. Inductions were specific to the herbivory and were also present in different ratios. *Aphis craccivora* a specialist did not induced any chemistry in the plant compared to a generalist *Myzus persicae* which induced the production of DMNT, sesquiphallendrene and *E*-β-farnesene. Mechanical damage plant produced only the green leaf volatiles, *E*-2-hexenal, *Z*-3-hexen-1-ol and *Z*-3-hexenyl acetate. The Herbivory induced compounds emitted by the plant in response to feeding insects could be exploited for use in developing an integrated pest management strategies for cowpea protection in Ghana.

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Identification of host plant attractants for mango stone weevil management in Ghana

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The mango stone weevil (MSW) (*Sternochetus mangiferae*) Fab. (Coleoptera: Curculionidae) is a key pest of mango (*Mangifera indica*) L. in most mango-producing countries including Ghana. The insect is important in mango production mainly because mango is the only known host plant and it is a recognized key international quarantine pest[1, 2]. Its persistence as a mango pest has been attributed to its cryptic behavior which prevents its natural enemies from providing sufficient control in both treated and untreated orchards[3]. Thus, the only control method used is insecticide application. However, this approach is hampered by lack of reliable monitoring tools to detect infestation and population dynamics of MSW as a means of informing the proper timing of insecticide application for effective control. These challenges require that stringent management practices are applied in the control of MSW, resulting in increase in cost of production. We recently demonstrated that black pyramid traps could serve as good monitoring tools for MSW in mango orchards in southern Ghana[4]. However, the performance of the traps could be enhanced by addition of a good attractant. Since mango is the only known host plant of MSW, we hypothesized that the insect could use cues from the mango tree to locate its host. Crude extracts of mango blossoms were prepared via solvent extraction. GCMS analysis of the extracts identified sesquiterpenes including β-Caryophyllene, α-Gurjunene, β-Selinene, Cis-α-Bisabolene and the aromatic compounds, Methyl salicylate and Dibutyl phthalate[5]. Preliminary olfactometer studies in the laboratory showed promising responses of both adult male and female MSW to the volatile constituents of the extracts. Also, MSW responded marginally greater to benzaldehyde, a common compound produced by ripening fruits, compared with the control (hexane)[4]. Further studies are ongoing to optimize and identify the most biologically active compound that could be deployed in the black pyramid traps for MSW monitoring in Ghana

Keywords

Sternochetus mangiferae; host plant volatiles; pyramid trap, Ghana

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Preparation of organic fertiliser from malted sorghum mash and pig manure for sustainable agriculture in northern Ghana

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Smallholder farmers produced the bulk of food consumed in Ghana. Many farmers, especially in the northern part of the country, rarely have access to government subsidised inorganic fertiliser to boost crop yield and ensure food security. There is therefore an urgent need to find a cost-effective, reliable and sustainable way to assist these farmers. Abundant malted sorghum mash (MSM), a by-product of local agro-based industry, is produced daily in northern Ghana. Organic fertiliser was prepared from MSM by co-composting it with pig manure (PM) in ratios 3:1 and 4:1 while the former alone served as the control. All stabilised samples were acidic with high organic matter (OM) content. The values of pH and OM ranged from 5.48 to 5.65 and 77 to 85%, respectively. Average total nitrogen, phosphorus and potassium contents of the matured fertilisers increased and ranged from 3.99 to 4.97%, 0.92 to 0.93% and 14 to 0.15%; respectively. The fertilisers were without obnoxious odour, had low heavy metal content and exhibited germination indices greater than 100%. Therefore, good quality, nutrient-rich and safe organic fertiliser prepared from co-composting of MSM and PM may assist to ensure sustainable agriculture in northern Ghana.

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Levels of some organochlorine pesticides in Cowpea (Vigna Unguiculata (L.) Walp) from South-South and South-West Nigeria

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Introduction

In Africa cowpea is a cheap and alternative source of protein that is affected by *Callosobruchus maculatus* and other pests, leading to huge economic losses. Farmers and merchants have resorted to the use of some banned organochlorine pesticides in its storage.

Aim and objective

The objective of this study was to detect and quantify DDT, lindane, endosulfan, aldrin and heptachlor epoxide in cowpeas collected from South-West and South-South states of Nigeria, determine the health index from its daily intake in these areas and compare the levels obtained with maximum residual limits set by WHO/EU.

Material and method

One hundred and forty-eight cowpea samples were collected from thirty-seven markets in twelve states of the South-West and South-South Nigeria, between the months of January-June, 2016. They were pulverised, extracted with dichloromethane in a Soxhlet apparatus, cleaned-up using silica gel and subjected to gas chromatography-mass spectrometry (GC-MS) analysis.

Result

Results showed that DDT, lindane, aldrin, endosulfan and heptachlor epoxide are widely used in South-West for preserving of cowpeas and ranges from trace to (11.42±0.242) µg/kg, trace to (168.00±0.114) µg/kg, trace to (406.8±12.4) µg/kg, trace to (315±0.164) µg/kg, (9.370±0.300) µg/kg to (156.52±6.23) µg/kg respectively. In South-South, it ranges from trace to (182.24±2.13) µg/kg, trace to (243.9±14.0) µg/kg, trace to (445.076±36.427) µg/kg, trace to (142.94±2.05) µg/kg and trace to (188.84±3.42) µg/kg for DDT, lindane, aldrin, endosulfan and heptachlor epoxide respectively. The limit of detection (LOD) and limit of quantification (LOQ) were in the range of 0.03-0.18 µg/L and 0.10-0.60 µg/L respectively. The RSD of the migratory time is between 3.2 % - 7.5 %, showing that the method is reproducible. Recoveries of the spiked analysts in cowpeas were in the range of 84-104 % respectively.

Conclusion

This is a wake-up call for the regulatory authority to conduct regular check on cowpeas for banned organochlorine pesticides that may have been used deliberately in preservation.

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Human exposure assessment of Ochratoxin a through the consumption of cocoa beans from four cocoa regions of Ghana and the potential public health risk

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Ochratoxin A is a potentially carcinogenic fungal toxin found in a variety of foods. This study aimed to assess the levels of Ochratoxin A in cocoa beans from Ghana and the levels of exposure by the consumers to this toxic substance. Fifty seven (57) cocoa beans samples obtained from selected districts in four regions of Ghana were analysed for Ochratoxin A using a fast analytical method based on immunoaffinity column clean-up and followed by liquid chromatography coupled to fluorescence detection The range of concentrations obtained were 0.06 to 2.193 μgkg^{1} (mean- 0.698) for Ashanti; 0.261 to 1.859 μgkg^{1} (mean- 0.933) for Brong Ahafo; 0.186 to 1.557 μgkg^{1} (mean- 0.928) for South western and 0.393 to 4.650 μgkg^{1} (mean- 1.802) for North Western regions. From the results of the study, 93% of the samples had OTA concentrations below the draft standard of 2 μgkg^{1} proposed by EU for cocoa beans and 7% had concentrations above it. Dietary exposure to the Ochratoxin A was estimated to be between 0.094 and 0.242 $ngkg^{1}$ body weight/week which were far below the Provisional Tolerable Weekly Intake (PTWI) of 100 $ngkg^{1}$ body weight equivalent to approximately 14 $ngkg^{1}$ body weight/day established by JECFA. The results suggested that consumption of cocoa beans from Ghana is unlikely to cause major toxicological effects of ochratoxin A and therefore represent a low level of public health risk.

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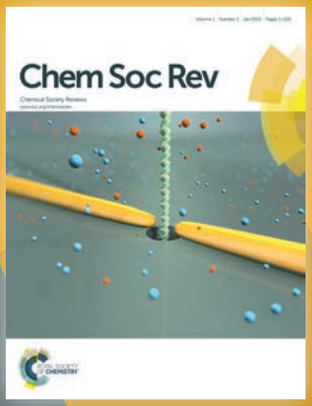

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