Fifteenth Annual Meeting of African Science Academies (AMASA-15)
13–16 November 2019 – Accra, Ghana

Science, Technology & Innovation for Food Security & Poverty Alleviation in Africa

The Role of Academies

Network of African Science Academies NASAC

iap Science Research Health
the interacademy partnership

American Academy of Arts & Sciences

Ghana Academy of Arts and Sciences Founded 1959

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ABBREVIATIONS AND ACRONYMS

AMASA	Annual Meeting of African Science Academies
ASADI	African Science Academy Development Initiative
CBNRM	Community Based Natural Resource Management
CDR	Carbon Dioxide Removal
CISP	Challenges for International Science Partnership
CSIR	Council for Scientific and Industrial Research
EASAC	European Academies Science Advisory Council
FAAP	Framework for African Agricultural Productivity
FNSA	Food and Nutrition Security and Agriculture
GAAS	Ghana Academy of Arts and Sciences
IAP	Inter Academy Partnership
IBSE	Inquiry-based Science Education
LMICs	Low- and Middle-Income Countries
NASAC	Network of African Science Academies
NASEM	National Academies of Science Engineering and Medicine (USA)
NDVI	Normalised Difference Vegetation Index
PEER	Partnerships for Enhanced Engagement in Research (USA)
PFJ	Planting Food and Jobs
S3A	Science Agenda for Agriculture in Africa
SEM	Science Engineering and Medicine
SRM	Solar Radiation Management
STI	Science Technology and Innovation
STISA	Science Technology and Innovation Strategy for Africa

Science, Technology and Innovation for Food Security and Poverty Alleviation in Africa: The Role of Academies (AMASA-15)

Edited by: Jacqueline Kado

Design and layout: Irene Ogendo

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CONTENTS

SCIENTIFIC SESSIONS

SESSION 1:
THE SCIENCE THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY AND POVERTY ALLEVIATION

SESSION 2:
THE TECHNOLOGY THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY ANDPOVERTY ALLEVIATION

EXECUTIVE SUMMARY

The Fifteenth Annual Meeting of African Science Academies (AMASA-15) was held in Accra, Ghana on 13–16 November 2019. The primary focus of the AMASA-15 was to discuss how science, technology and innovation can be utilised to address issues of food security and poverty alleviation in Africa. The theme of the meeting was, ***'Science, Technology and Innovation for Food Security and Poverty Alleviation in Africa: The Role of Academies'.***

More than a hundred (100) participants from twenty-two (22) countries[1] were present, representing several academies, universities and research institutions. The event was also graced by high profile government officials and dignitaries who mostly participated during the official opening session of the conference.

The event kicked-off with a learning collaborative session on *Science Diplomacy,* which was interactive and provided an opportunity for academies to learn from each other. Other interactive sessions held in the course of the conference tackled topics such as, *Bringing Science to the Public*, the *Science Agenda for Agriculture* and *Harnessing SEM (science, engineering and medicine) to address Africa's challenges*.

The Science Diplomacy session was hosted by the TWAS Sub-Saharan Africa Partner (TWAS-SAREP), addressed the relevance of using diplomacy in science especially in low- and middle-income countries (LMICs). LMICs were deemed as crucial in improving international relations between countries, especially in managing global commons and transboundary or shared resources, building partnerships and improving international relations.

The event also organised three main scientific sessions[2] focusing on the following:

1. Session one tackled the **science** that determines achievements in food security and poverty alleviation. This session looked into the scientific knowledge available and requirements for shifting Africa's attention towards realising the aspiration for food security and poverty alleviation.
2. Session two focused on cutting-edge **technologies** that are readily available or can be developed to meet the challenge of sustaining

[1] *Countries represented:*

[2] *18 Scientific papers that cut across the three sub themes (Science, Technology and Innovation) were presented.*

food productivity, reducing food loss and waste and recovering produce that is currently being wasted.

3. And finally, the Session three on **innovation** highlighted the success stories and innovative solutions that are available or can be developed to meet the challenge of feeding a growing, mostly disadvantaged, population by producing more food using scarce resources.

The American Academy of Arts and Sciences hosted an interactive session titled *Challenges for International Science Partnership (CISP).* The session sought to identify policy recommendations and best practices to mitigate challenges for international science collaborations between the United States of America and Africa.

The European Academies Science Advisory Council (EASAC) also hosted an interactive session to launch the NASAC/ASSAf/LEO[3] report on ***Neonicotinoid Pesticides: Use and Effects in African Agriculture.*** The session initiated both communication and dissemination of the report.

The conference was officially opened by H.E. Nana Akufo-Addo, the President of the Republic of Ghana. In his opening statement, he emphasised the key role African academies have in moving their countries onto the path of sustained progress and prosperity. He stated that all aspects of life are now ruled by science, technology and innovation.

The Ghana Academy of Arts and Sciences (GAAS) used the opportunity of AMASA-15 to also host GAAS' sixtieth anniversary dubbed ***'Beyond 60 years of Scholarly Excellence – New frontiers and Prospects'.*** Prof. Henrietta J.A.N. Mensa-Bonsu, the President of GAAS highlighted the evolution of GAAS over the 60 years, give the historical perspective, and captured the progress made in her speech. She also articulated the new prospects for the academy in the coming years as a member of NASAC.

The meeting ended with a state-sponsored luncheon to celebrate the 60-years anniversary of GAAS and to mark the end of the AMASA-15. In the end, the following key recommendations were made from AMASA-15:

Overall Recommendations:

(i) African scientists should work closely with the agricultural and industrial sectors in their respective countries to bring about social and economic transformation towards food security and wealth creation for the citizenry.

(ii) More investment is needed in research and development, capacity development, engagement of scientific community with policymakers and diplomatic corps.

(iii) The recognition by policymakers and diplomatic community on the benefits of scientific inputs into discussions is critical.

[3] NASAC/Academy of Sciences of South Africa/German National Academy of Sciences Leopoldina

Science Diplomacy:

(i) Academies should work with TWAS-SAREP to develop a strategic document that articulates and puts into context the meaning of science diplomacy in Africa.

(ii) Academies should establish an office or appoint a person responsible for science and diplomacy in their secretariats. This office would be responsible for activities that drive the academy's agenda in fulfilling its science-diplomacy mandate.

(iii) The academies must articulate relevant activities that promote science diplomacy besides the scientific issues that are global in nature.

Pesticides in the Food Security Alleviation Equation:

(i) The Neem tree and pyrethrum are natural occurring pesticides and their massive production can be encouraged among farmers.

(ii) There is a need to educate farmers and other users on the effects of the pesticides they use.

Institutions:

There was a need for all institutions present at AMASA-15 to work together, share ideas and draw lessons from experiences. In doing so, partnerships will be forged with academies to support African countries' realisation of both poverty alleviation and food security, which are sustainable development goals 1 (No Poverty) and 2 (Zero Hunger) respectively.

OPENING AND WELCOME ADDRESSES

Professor Henrietta J.A.N. Mensa-Bonsu, FGA

President, Ghana Academy of Arts and Sciences (GAAS)

The President of GAAS, Prof. Henrietta J.A.N Mensa-Bonsu, in her speech, welcomed all delegates present to the AMASA-15 International Conference and to the sixtieth anniversary celebrations of GAAS.

Prof. Henrietta J.A.N Mensa-Bonsu, FGA: President, The Ghana Academy of Sciences

She gave the historical background of GAAS, starting from its inception in November 1959 to the present. GAAS' initial goal was to promote the pursuit, advancement and dissemination of knowledge in all branches of sciences and the humanities. The academy was thereafter renamed "The Ghana Academy of Sciences" and its mission was to encourage the creation, acquisition, dissemination and utilisation of scientific knowledge for national development through the promotion of learning. The academy later morphed into two entities, Ghana Academy of Arts and Sciences, and Council for Scientific and Industrial Research (CSIR).

The academy has grown its fellowship from the initial 20 to 120 fellows representing both the science and the arts. Constitutionally, the academy is expected to disseminate and extend knowledge of the arts and sciences and this mandate is delivered through offering lectures, symposiums and conferences throughout the year.

The GAAS president citied that the relationship with NASAC started in 2001 when, as a bona fide member with other 8 academies in the continent under the auspices of African Academy of sciences (AAS), met at an inception meeting to draft the statutes forming NASAC. She stated that NASAC remains committed to enhancing the capacity of the existing science academies as well as encouraging the creation of new academies in countries where none exist in Africa. NASAC, she said, aims to specifically facilitate the provision of advice to governments and regional organisations on scientific aspects of pertinent issues to Africa's development through science academies.

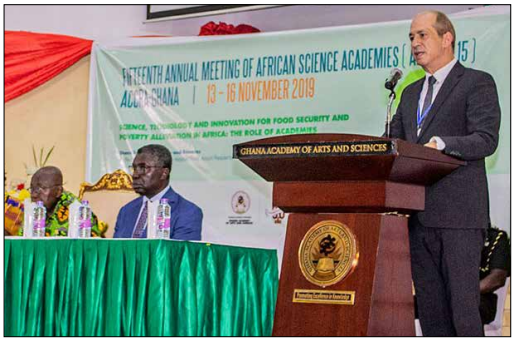
She also spoke about the long-standing relationship with AMASA, which morphed from African Science Academy Development initiative (ASADI) in

2005. GAAS hosted the fifth international conference in the series under ASADI[4] and now hosts the fifteenth AMASA on the theme "*Science, Technology and Innovation for food security and poverty alleviation in Africa: the role of academies.*" In conclusion, she wished all AMASA-15 participants productive and fruitful deliberations that would contribute to shaping a successful future for Africa.

Professor Mostapha Bousmina

President, Network of African Science Academies (NASAC)

In his remarks, Prof. Bousmina expressed his appreciation and delight in being part of the opening ceremony and sponsor of the AMASA 15. He noted and appreciated the presence of the President of the Republic of Ghana, His Excellency Nana Akufo-Addo, citing it as an indication of commitment of the government of Ghana.



Prof. Mostapha Bousmina: President, Network of African Science Academies (NASAC)

He stated that the African continent has made tremendous efforts in alleviating poverty and food security among a majority of its population. However, much more effort is still needed to enhance the situation. He further outlined key approaches that can improve the current situation[5]:

(i) Ensuring there is political stability in African countries,
(ii) Incorporating a transition towards value-addition in the various sectors. He mentioned that presently the labour market comprising of 80% informal sector, which should gradually be included in a differentiated manner into the formal sector,
(iii) For Africa to massively invest in the education sector, and
(iv) create an environment for private sector involvement that allows for more innovation, job-creation and attractive to international investors.

He further talked about the need of some African countries to put into place measures to control the fertility and demographic growth so as to achieve progress towards alleviating poverty and increasing food access to the African population.

In closing, Prof. Bousmina emphasised the need for Africa to strengthen regional and continental integration, enhance the belief in local capacities and emphasis in building manufacturing plants that will add value to its raw materials.

[4] *ASADI was a ten-year programme by the US National Academy of Science with support from Bill and Melinda Gates Foundation.*

[5] *With an average population of 20 years, Africa's population stands at 1.3 billion with 45% of this number living in urban areas. If effectively engaged, through the creation of jobs, this can be a great source of dividends to the continent.*

President of NASAC taking a photo with teh President of Ghana

Group photo of AMASA-15 Participants

President of GAAS (Ghana) receiving well wishes from the President of ANSALB (Benin)

The Executive Director of NASAC making a contribution during the proceedings

Professor Kwabena Frimpong-Boateng, FGA

Minister for Environment, Science, Technology and Innovation, Republic of Ghana

In his remarks, Prof. Frimpong-Boateng, noted that the country's manufacturing sector was insignificant before Ghana got its independence. A transition programme was introduced with the main aim of minimising imports. The programme however flopped as a result of the lack of a link between research and industry as well as a lack of leadership from technology and science.

He reported that H.E. President Nana Akufo-Addo is trying to address the new science and technology policy with emphasis on civic education and professional training. The government of Ghana, he said, promised to allocate 1% of its GDP towards the development of the science, technology and innovation sector. This would ensure a flexible installation guide backed by science and technology and the development of human capital that will sustain these industries. He wished the participants a successful meeting with beneficial outcome and welcomed the President of Ghana to the podium.

His Excellency Nana Akufo-Addo

President of the Republic of Ghana

In his speech, President Nana Akufo-Addo thanked Professor Henrietta Mensa-Bonsu, for inviting him to deliver his opening remarks at AMASA-15. He welcomed all the participants to the nation of Ghana and wished them a pleasant stay.

The President noted that the theme of AMASA-15, *Science, Technology and Innovation for Food Security and Poverty Alleviation in Africa: The Role of the Academies* is a call to action, and its attainment is vital to the future success of the respective nations. He emphasised that all aspects of our lives are now governed by science, technology and innovation.

He noted that hosting AMASA-15 in Ghana enriched the important milestone of the sixtieth anniversary since the establishment of GAAS. He affirmed the critical role that GAAS has continued to play in the growth and development of Ghana. "GAAS has stayed true to its mission of encouraging the acquisition, creation, dissemination and utilisation of knowledge in all branches of sciences, arts and the humanities", he stated.

He further stated that there was still unfinished business of providing citizens with dignified standards of living and moving many African countries onto the path of sustained progress and prosperity. This he attributed to most of the economies being substantially agrarian, dependent largely on the production and export of raw materials and being supported by the charity of so-called donors. His Excellency, President Akufo-Addo, noted that the manufacturing base that is needed to create the thousands of jobs for the youth and help raise the living standards of citizens, is weak. This, he said, could be attributed to the fact that domestic solutions to the existing problems are not well developed because the past policies were made on the basis of external support given. He urged the members of the academies of science in Africa to focus their efforts on ensuring that science, technology and innovation drive all sectors of the economies. Achieving this will not only result in progress and prosperity but also honour the generations of members of science academies in Africa.

In conclusion, he congratulated the members of GAAS on their sixtieth anniversary and wished all participants fruitful deliberations. He hoped that the recommendations from the conference would help improve the lives of the long-suffering masses of Africans. This would be critical, especially when the African Continental Free Trade Area comes into force to embrace a population of 1.2 billion people and a combined GDP of US$ 3 trillion. The forgoing would open significant opportunities for rapid economic growth of the African continent.

KEYNOTE ADDRESS

PLANTING FOR FOOD AND JOBS AS A FOOD SECURITY AND POVERTY ALLEVIATION STRATEGY — REFLECTIONS ON THE POSITIVES AND NEGATIVES

Dr. Owusu Afriyie Akoto
Minister for Food and Agriculture, Ghana

In his keynote address, Hon. Owusu Afriyie Akoto highlighted the fact that the theme of the meeting aligns with the vision of His Excellency the President Nana Akufo-Addo, which is to transform Ghana's agriculture to a level that sustainably supports the overarching goal beyond Aid. He acknowledged that in the past, decision-makers had failed to utilise the results of applied research and to fully exploit the potential of Ghana's resources, thereby leaving evidence-based research on the shelves. The government has since recognised the contribution of improved seeds and fertilisers to increase farm productivity in particular on small holding agriculture as a means of transforming and modernising Ghana's agriculture.

The agricultural contribution to Ghana's economic development has been pivotal. In the immediate post-independence era and slightly beyond, the sector accounted for about 70% of employment and 50% of the GDP with cocoa as the leading foreign exchange earner to the country. He said that President Akufo-Addo launched the *Planting for Food and Jobs programme* in April 2017 to begin the process of tackling low productivity especially in the food crop sub-sector. This, he said, explains government's massive investment in the provision of subsidised fertilisers and improved seeds for farmers, which has recorded significant improvement on the yields of the targeted crops.

The Minister further indicated that there has been successful collaboration between the Ghana Ministry for Food and Agriculture and the research institutions. This collaboration promoted higher productivity through provision of high-yield breeders and certified seeds for distribution to beneficiary farmers. A fertiliser manufacturing plant was also constructed in the western region of Ghana through collaboration with a Moroccan company. This resulted to the considerable reduction on the cost of fertilisers and thereby generating income through export of the same to the neighbouring countries.

Dr. Akoto outlined interventions that H.E. President Akufo-Addo has launched as food security and poverty alleviation strategies. The ***agricultural diversification programme,*** which aims to diversify tree-crop-agriculture and promote rural industry. The six tree-crops under this programme are cashew, coconut, oil palm, coffee, shea butter and mango. This programme is being implemented in collaboration with the District Chief Executives (DCEs) of the Ministry of Local Government and Rural Development. The ***livestock module programme*** which aims at promoting local production of meat to reduce importation as well as help create jobs. This approach would also eliminate the importation of meat products by more than US$ 400 million per year, thus saving foreign exchange. The ***greenhouse villages programme,*** which targets youth and is geared towards promoting high quality vegetable production under controlled environments. This programme targets the youth, and so far 238 graduates have been trained. ***Other programmes*** that the government had adapted include the one village one dam, one district one warehouse, and one district one factory. However, there are still challenges of agricultural financing and market surplus, which are being addressed by the value-addition under the ***one district one factory programme*** geared towards the promotion of consumption of locally produced products, market linkages and buffer stock management.

In conclusion, Dr. Akoto encouraged African scientists to work closely with the agricultural and industrial sectors of their respective countries to bring about socio-economic transformation towards food security and wealth creation for the citizenry.

GOODWILL MESSAGES

The European Academies Science Advisory Council (EASAC):

Dr. Nina Hobbhahn on behalf of the EASAC President and the Scientific Programme Director, conveyed well wishes to all the attendees and encouraged them to have an enlightening and enjoyable meeting. She urged the academies to make full use of the report: *Neonicotinoid Insecticides: Uses and effects in African Agriculture* and share it with their respective governments. EASAC does policy work and provides scientific advice to governments; it also works in partnership with NASAC.

Inter Academy Partnership (IAP):

Dr. Peter McGrath in his good will message wished all participants fruitful deliberations in the AMASA-15. He also reaffirmed IAP's commitment to support NASAC as its regional affiliate in Africa. The financial support offered by IAP to AMASA-15 was also acknowledged.

American Academies of Arts and Sciences:

Dr. John Randell brought greetings from the President of AAA&S, saying it was an honour to be partnering with NASAC to gain insights on how the United States can be a better partner to the science academies in Africa and around the world.

International Science Council Regional office for Africa (ISC ROA):

The ISC ROA Regional Director, Dr. Daniel Nyanganyura said ISC ROA was honored to be in partnership with NASAC in the AMASA-15 event. ISC ROA, he said, looks forward to collaborating with every academy in the continent, the partners and scientific communities through their partnership with NASAC.

LEARNING COLLABORATIVE

Hosted by TWAS-SAREP/ASSAf on the topic:

SCIENCE DIPLOMACY AND ITS RELEVANCE TO LOW- AND MIDDLE-INCOME COUNTRIES

Session Moderator: *Mr. Stanley Maphosa, ASSAf, South Africa*

Learning Collaborative is an opportunity for academies to learn from each other and do more in partnership. Hosted by TWAS-SAREP and ASSAf topic for the learning collaborative at AMASA 15 was *Science diplomacy and its relevance to low- and middle-income countries*. Mr. Maphosa explained that SDGs are linked to national development plans. Scientist provide science advice when they give input to national plans and development frameworks. Academies of science are expected to provide advice to their governments on national priorities. Beyond national borders, such as at sub-regional or pan-African levels, like at the African Union (AU), this kind of science advice is called science diplomacy. He went further to state that the African continent is confined in a number of transboundary, international and global challenges that require certain regulatory laws. Science academies, using the voice and platform of a collective consortium like NASAC, can influence and forge policy direction on various issues in the continent.

This session had three objectives, namely:

1. Expose academies of science in Africa to key international policy issues relating to science diplomacy.
2. Take stock of the science diplomacy tool and the various forms it takes.
3. Examine the actual importation of academies of science and fostering inter-regional dialogue in scientific cooperation.

KEYNOTE SPEAKER

Dr. Peter McGrath

Interacademy Partnership (IAP)

Science diplomacy brings together science and diplomacy and is defined by three pillars:

(i) ***Science in diplomacy,*** which is informing foreign policy objectives with scientific advice,

(ii) ***Diplomacy for science*** which is facilitating international science cooperation, and

(iii) ***Science for diplomacy*** which is using science to improve international relations between countries.

Dr. McGrath explained the difference between International Science Cooperation and Science Diplomacy; the motivation of the former being to advance science and the latter to affect relationships. The crucial need for science diplomacy is to manage the global commons (the high seas, outer space); manage transboundary or shared resources, build relationships and improve international relations.

There is a long-standing tradition of scientific collaboration between North–South and South–South, but knowledge and practice of science diplomacy is lagging behind, especially among large sections of the scientific community. In 2011, TWAS, in collaboration with the American Association for the Advancement of Science (AAAS), started a programme to raise awareness on the possibilities of science diplomacy and provided training on science diplomacy issues.

He reported that the science diplomacy activities have been embraced and are taking root; they are being rolled out in the South, with an increase in awareness and activity in recent years. In his presentation he went further to explain and give examples of the Science in Diplomacy, Diplomacy of Science, and the Science for Diplomacy.

In conclusion Dr. McGrath stated that the global South requires more and better science that is invested in research and development, capacity development, engagement of scientific community with policy-makers and diplomatic community; and the recognition by policy-makers and diplomatic community to the benefits of scientific inputs into discussions.

PANEL DISCUSSION

Prof. Himla Soodyall, *ASSAf*

In her presentation, Prof. Soodyall explained that science diplomacy is advocating for science in other social spheres. She challenged that this aspect of science was not recognised, and did not create the euphoria, emotion and synergy that arises from other sectors such as sports. She called for trustworthiness in the way the science portfolio is presented. There is a lot of success in science, which ought to be publicised by first supporting countries' national plans in realising the SDGs. This can be done in a way that collectively builds momentum that would then result in countries effectively using science to address local problems. She applauded the support shown by the government of Ghana to GAAS as it gives a sense of pride in the work being carried out by the researchers. She concluded by stating that *"Science diplomacy is the way science is integrated in the fiber of society from the political front and it represents that voice of bringing the collective that we want"*.

Dr Mobolaji Oladoyin Odubanjo, *NAS*

Dr. Odubanjo talked about the privilege scientists have to interact, collaborate and have access to each other despite their countries having diplomatic friction or

conflict. He noted that there are over twenty countries represented in the AMASA-15 conference and the next two days would be the perfect opportunity to practice science diplomacy and collaboration. He explained that every scientist should have the capacity to influence policy. These capacities need to be developed and the key to that is trust. He challenged the participants by asking the question *"How can you in three minutes explain to policymakers what you have learnt or researched on?"*

He further challenged the scientists to learn other skills, build capacity on new knowledge, and develop novel approaches for using science as a diplomatic tool. Scientists, he said, should take time to explain to policymakers and the society the meaning of scientific terminologies and the relevance of their research. In his conclusion, Dr. Odubanjo said the art of modern science begins with science advice, a capacity that is developed in-country first. This also ensures that researchers can then take diplomacy to other countries. There is need for assistance in the creation of ideal, strategic and appropriate communication that relies on sound information for science diplomacy to thrive in Africa.

Mrs. Jacqueline Kado, *NASAC*

Mrs. Kado's presentation focused on what academies can do to practice science diplomacy and how science can be made more appealing. She highlighted the following three interventions:

i. The development of a strategic document that will contextualise the meaning of science diplomacy. This will ensure that the academies focus their attention not only to science diplomacy itself but also build relationships that work. That way, the academies would transcend their own scientific disciplines and do more in society.
ii. Appointment of a responsible party to undertake science diplomacy. She explained that setting up an office or creating some position that would be responsible for science diplomacy activities or a liaison officer position, whose focus would be to drive the academy's science diplomacy agenda as it fulfills its mandate. The challenge of this, she said, is to predetermine the qualities of the office bearer, who is able to deliver on the expectations.
iii. Articulating the relevant activities that would be termed as science diplomacy. Towards this end, there is need for academies to interact with each other within their respective sub-regions and to speak to their own national governments. The academies also need to articulate science issues that are global in nature and align themselves to regional or even global aspirations. Different countries do voluntary national reviews for the SDGs, to determine progress in fulfilling the development agenda

In conclusion she said the diplomacy angle means that academies are able to articulate what science is necessary to economic development, trade cooperation and also to build relationships within the continent and globally.

PLENARY DISCUSSION

The following were the key discussion points that emerged during the plenary discussion.

1. The science diplomacy role is better suited for a government official rather than a scientist at the academy. However, there is great need to support the structure in the government to be more effective in this area. It is therefore more critical that academies take up this role to influence policy and the community.
2. It was agreed that the qualifications for a person responsible for science diplomacy should include more 'soft' skills that enhance communication rather than technical skills in science.
3. To create euphoria for science, there is need for academies to speak in one voice on cross-cutting issues and challenges. It was noted that previously science was a private affair and governments and communities were not involved. However, the situation is currently shifting towards development and is more inclusive. The use of a multi-disciplinary approach and use of simplified and sometimes indigenous language would be helpful.

SOLAR RADIATION MANAGEMENT JIGSAW EXERCISE

Dr. Peter McGrath
InterAcademy Partnership (IAP)

The goal of this exercise was to appreciate the role of science in international disputes and negotiations. The objectives were to:

(i) encourage discussion of importance of evidence, and
(ii) demonstrate one pedagogical approach for discussions.

In his introduction Dr. McGrath said that when signing the Paris Climate Agreement of 2015, nations agreed to *"holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels."* As highlighted in the IPCC 'Special Report on Global warming of 1.5°C' (released 8 October 2018 *www.ipcc.ch/report/sr15/),* global temperatures are already around 1°C above pre-industrial levels. The Royal Society's report on Geo-engineering the Climate (2009) considered the following two main methods:

(i) **Carbon dioxide removal (CDR),** which was recognised to be slow, expensive and would require new technologies, and
(ii) **Solar radiation management (SRM),** which can work quickly and would likely be affordable and could use adaptations of current technologies.

The main method proposed for SRM is stratospheric aerosol injection, whereby large erupting volcanoes blast reflective sulphate particles into the stratosphere. These particles encircle the globe, reflecting away a small amount of inbound sunlight and cooling the planet for a year or two. Using planes or balloons to inject reflective aerosol particles into the upper atmosphere would seek to replicate this effect.

While SRM has the potential to reduce some of the impacts of climate change, it could also be very risky. Overall, it is unclear whether SRM would be helpful or harmful. Developing countries would stand to gain or lose the most if SRM were ever deployed. Despite this, most research and discussion of SRM has taken place in developed countries.

Based on the above introduction, participants were engaged in a role-playing exercise – the 'jigsaw exercise' – that involved small group discussions. The groups (A–F) had 7–8 individuals and were provided with a different scenario with a position that they would be asked to *discuss*,

defend and *negotiate* in the next phase. The scenarios included (one per group) the (hypothetical) positions of:

- The Government of the USA;
- The European Union;
- ECOWAS countries;
- The World Meteorological Organisation (WMO);
- The League of Indigenous Nations (an NGO); and
- An international organisation representing the views of scientists.

In the first breakout, each group discussed and agreed its position and in the next round, one member of each group joined with a member from each of the other groups (i.e. eight groups each comprising a representative of Groups A, B, C, D, E and F) where they exchanged views and attempted to negotiate compromises or agreements between the positions. They then reconvened in their original group checking if their positions or views had changed. A representative from each group then provided feedback in plenary to all participants.

Results

Based on the plenary feedback, no specific agreements were made between the representatives, although there was alignment between the positions of the EU, ECOWAS and the League of Indigenous Nations. All constituencies agreed that more research was necessary before making any decision on deployment of SRM, which was considered risky based on current knowledge. However, there was no clear commitment to fund such research, except perhaps from the USA. This position was not clear, however, as the USA's position was not to protect its fossil fuel industries and not to believe in global warming – thus it denied the need for SRM.

Conclusion

Group discussions agreed largely with the text of the IPCC 1.5°C report, where SRM is mentioned briefly as follows:

"C1.4. Solar radiation modification (SRM) measures are not included in any of the available assessed pathways. Although some SRM measures may be theoretically effective in reducing an overshoot, they face large uncertainties and knowledge gaps as well as substantial risks, institutional and social constraints to deployment related to governance, ethics, and impacts on sustainable development. They also do not mitigate ocean acidification (medium confidence)."

So, despite SRM being considered as a 'slippery slope' to distract policymakers from the immediate and ongoing necessity to reduce greenhouse gas emissions, the earth is still warming up. The latest reports from the IPCC suggest that we have until just 2030 to shift our energy other greenhouse-gas emitting industries to climate-friendly technologies and practices.

BRINGING SCIENCE TO THE PUBLIC

Godfred Boafo
Ghana Editor, The Conversation Africa

The Conversation International is a global network dedicated to democratising knowledge in academics publications. The Conversation Africa came into being with the realisation that many people outside of the academic space without access to the research published daily in the journals and those who do, cannot understand the technical language used.

Mr. Boafo in his presentation explained that Conversation Africa works with the academics to put their research into short forms that still include the original message and then publish it with their approval. *The Conversation* is in eight regions namely: Africa, Indonesia, Australia and New Zealand, Spain, Canada, United Kingdom, France and United states. In Africa *The Conversation* are based in Nigeria, Ghana, Senegal, South Africa and Kenya. Globally, *The Conversation*, is accessed by 1.6 million readers every month using the commons model[6] with more than 500,000 unique users who directly visit their website for curated expert content.

He further reported that to date, *The Conversation* has published 4904 articles from 3199 academic authors. Only PhD holders publish on *The Conversation* because the expertise has to be respected. However, PhD candidates having attained two-years of coursework can publish within their area of research with the assistance of a supervisor. A lecturer at an institution who has taught more than five years in their area of expertise can also publish.

Mr. Boafo said that once a profile is set up on the Conversation system, one can reach other academics and form conversation networks. There is also real-time access to the analytics. "We know who is reading you, where they are reading you from, and you can reach back to those people and have a conversation with them. Anyone who tweets your articles, or comments on it or even republishes it you can see. It is a complete package, free of charge and with no need for assistance", he stated.

Academic institutions get to know how many people in the world are from their institution or affiliated to it. This is important because unless one is affiliated to a university, one would not get published. *The Conversation Africa* is funded by universities and it is a not-for-profit organisation. Since January 2019, The Conversation Africa also offers podcasts called Pasha, which means to inform in Swahili. There are already more than 1,000 downloads with over 24,000 listeners.

[6] *This is a creative model through republications - anybody can publish the articles that have been put forth so it moves quickly and reaches a wide audience base.*

SCIENCE AGENDA FOR AGRICULTURE IN AFRICA

Dr. Gordon Akon-Yamga
STEPRI-CSIR

The Science Agenda for Agriculture in Africa (S3A) is an instrument for mobilising the physical, human, institutional, and financial and policy resources required to increase the application of science, technology and innovation to achieve agricultural development goals and targets. In his presentation, Dr. Akon-Yamga stated that the S3A is crucial as Africa's population is set to double to about 2 billion by 2050 and urbanisation is projected to reach 50% by 2030. Africa maintains the highest population growth rate in the world of 2.465 per annum[7] and hence a fast-growing demand for food, feed and fibre.

The S3A was conceived as a framework for strengthening alignment of CGIAR investments in Africa with the CAADP agenda, it evolved into the framework for enhancing the application of science, technology and innovation to achieve CAADP goals, with focus on improving productivity. It is a vehicle to support the implementation of the CAADP.

He said that the Science Agenda for Agriculture in Africa is the broader guideline for the implementation of the Framework for African Agricultural Productivity (FAAP), and for achieving Priority 1 (Eradication of hunger and achieving food security) of the Science, Technology and Innovation Strategy for Africa 2024 (STISA 2024) and that its vision aligns with the AU's STISA and Agenda 2063. The vision and goals of the S3A can be realised through interventions carried out at country level through investments by governments and the private sector, and catalytic supra-national interventions. Ghana signed a commitment to adopt and localise the S3A. This has enabled the agricultural sector to increase application and impact of science and technology through increased investments. S3A in Ghana has also strengthened capacities for planning and implementation, supported enabling policies, created coordination and country ownership and provided better integrated programmes at national and regional level. In conclusion the S3A, he said, is an important instrument for harmonising investments in STI for increased agricultural productivity and its integration to other policies therefore makes it holistic and is Africa-led and Africa-owned. The S3A's attention to the *business* of agriculture shows deliberate efforts to rely on the private sector.

[7] *(UN DESA, 2013)*

IAP REPORT ON HARNESSING SCIENCE, ENGINEERING AND MEDICINE (SEM) TO ADDRESS AFRICA'S CHALLENGES

Prof. Himla Soodyall
Executive Director of ASSAf and Working Group Member of the IAP project

Published in July 2019, in the margins of the NASAC Board meeting and Academy of Science of South Africa (ASSAf) workshop in SDG-6, this IAP report was developed by a 14-member international working group drawn from senior and young academies around the world and other international science organisations such as the International Science Council (ISC). They covered a wide geographic and disciplinary range, and all had experience in international science and applying science to public policy. The working group met four times to discuss evidence and insights from a wide-range of policy practitioners. She reported that the report was the product of three-year project that made recommendations to a wide range of stakeholders including the African academies. The full report can be downloaded from *http://www.interacademies.org/56874/SEM_for_Africa.*

Prof. Soodyall said that a key part of the IAP project was to understand the policy landscape in Africa and identify where there are natural entry points or pathways for science into the UN and AU policymaking infrastructures.

The following are some key findings from the initiative:

- There are opportunities for academies and policymakers to work together at all levels. The African science community must be more proactive in seeking to support policy formulation, implementation and review, especially with respect to monitoring and evaluation, and in advocating for the vital importance of investment in national STI.
- There is an urgent need to identify and capitalise on synergies between SDGs and STISA priorities to multiply the value of specific actions, to plug data gaps and strengthen data integration, to strengthen weak indicators, and to develop a monitoring and evaluation framework for STISA-2024.
- The respective roles of the International Science Council Regional Office for Africa and the TWAS regional offices in the UN system and the African Academy of Sciences in the AU system need more support from the wider science community.

- Academies and policymakers are useful resources for each other where the academies can help to devise evidence-informed solutions and address the dearth of data on the continent.
- Policymakers can provide insights into policy questions perplexing governments and on the complexity of policymaking.
- Cooperation is most effective when academy and policymaking communities treat each other as full and equal partners, co-designing and co-framing questions, not simply as audiences for their respective messaging.
- There is an appetite amongst African early career researchers and young academicians to work together on policy issues, but there are capacity constraints.
- There is presently an unmet demand for scientists in the African diaspora to help build scientific capacity in Africa, at both institutional and individual levels and also an unmet demand from early career researchers for training in science advice-for-policy skills.

From the foregoing, the main recommendations in the report include:

- Provide more opportunities for bringing together policymaking and science communities, thereby creating a greater appreciation of, and demand for evidence by the UN, AU and their agencies.
- For IAP, NASAC and the GYA to build mutual capacity by placing open and inclusive collaboration with each other and with other stakeholders at the heart of their work. In so doing, become stronger advocates for evidence-informed policymaking and the value of independent academies on the continent.
- Build on the policy connections and opportunities presented regionally and nationally so as to develop and secure funding for science leadership and diaspora initiatives.
- Senior and young academies in Africa should:
  - Become more open, inclusive and diverse in their membership and activities.
  - Be more effective advocates for science and science funding, drawing on each other's respective strengths.
  - Align or re-orientate their activities with STISA and the SDGs.

In conclusion, Prof. Soodyall stated that the realisation of the SDGs and STISA-2024 would require cooperation at many levels, and a better understanding and appreciation of context. There are many opportunities for scientists and policymakers to work together and academies have a vital role in championing science on the continent.

SCIENTIFIC SESSIONS

The sub-themes below, derived from the main theme, separately addressed different aspects of how science, technology and innovation can contribute to the achievement of food security and poverty alleviation in Africa.

SESSION 1:

THE SCIENCE THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY AND POVERTY ALLEVIATION

The focus of this session was on determining the scientific knowledge available as well as what would be required to drive the various issues needing attention to ensure the aspiration for food security and poverty alleviation in Africa is met.

CHAIR: Prof Samuel Sefa-Dedeh

FGA[8], Vice-president, Sciences Section, GAAS

1.1 Leveraging science for food security and poverty alleviation – The role of underutilised grains

Professor Gyebi Duodu, *South Africa*

Prof. Duodu, in his presentation, delineated the work they do in regards to the role of the underutilised grains. This work speaks to the first three Sustainable Development Goals (SDGs) of No poverty, Zero Hunger and Good Health and Well-being. He noted that hunger is still on the increase in sub-Saharan Africa and the issue of climatic change is paramount, specifically on how affects agricultural activities and food security.

He said that Africa faces the triple burden of malnutrition namely the micronutrient (hunger); macronutrient (fat, protein, carbohydrates deficiency); and an uptake in the occurrence of non-communicable diseases whose drivers include urbanisation, rise in incomes and poor dietary choices. He further explained that the deaths caused by non-communicable diseases have been on the increase, which he indicated could be dietary related. For this reason he suggested that staples foods must be drought tolerant, nutritious and health promoting, especially for the African cereals and legumes like sorghum, millet, seeds and groundnuts.

Prof. Duodu cited the study of the micronutrients and macronutrients, which has taken two main strategies namely:

[8] *Prof Samuel Sefa-Dedeh is a professor in the department of Food Process Engineering, School of Engineering Sciences, University of Ghana*

(i) the multi-grain concept, which is drawing on the unique positive attributes of each grain and bringing them together, and
(ii) multi-passive fermentation which is the use of simple traditional processing techniques.

The study indicates that multi-grain concept is good for protein quality and the fermentation improves the protein quality and also has zinc and iron. Grains can also be utilised to protect against non-communicable diseases. The scientific hypothesis proposed in the study is that over nutrition makes people vulnerable to various physiological processes.

He further explained that from work done in the past, studies show that sorghum porridge can offer protection from hypertension and high blood pressure. Some of the components in the fermented grains can inhibit enzymes that are in the drugs used to treat High Blood Pressure. These components also repair DNA damage, which is believed to cause non-communicable disease[9]. Studies indicate that cowpeas have a certain measure of protection of the DNA and from inflammation.

Plenary discussions
It was observed that there is a great need to educate people on the traditional foods and make them appealing for consumption.

1.2 Achieving food and nutrition security in Africa: Knowledge gaps and needs

Professor Henrietta Ene-Obong, *Nigeria*

Prof. Ene-Obang began her presentation by giving facts on the levels of malnutrition, the challenges and the burden of food and nutrition insecurity in Africa. She stated that despite Africa's rich biodiversity, *food insecurity, hunger, malnutrition and disease* are still serious public health problems. The current burden of malnutrition is unacceptably high with 22.2% of stunted children[10], 7.5 % wasted children, and 5.6% being overweight children. She added that Africa is developing the triple burden of disease, namely under nutrition, micronutrient deficiencies, overweight/obesity as well as non-communicable disease across all age group[11]. In this regard, the causes of malnutrition are multidimensional, and results from the interaction of four major systems namely: *the agri-food system, the environment, the health system and the individual and household decision making system*[12].

To work towards achieving food and nutrition security in Africa, she recommended the need to have both a multi-sectorial approach and a food system approach. All the actors, she said, can contribute to the solution of food and nutrition security, however an improved nutrition research will also make a significant impact by

[9] *DNA in its originative form is a coil, when it gets damaged it becomes circular and vulnerable to these diseases.*
[10] *There is an upward trend from 50.6 million in 2000 to 58.7 million in 2017.*
[11] *(Development initiative 2019).*
[12] *(Hammond & Dube, 2012; Gillespie and van den Bold, 2016).*

providing the much-needed evidence for cost-effective interventions and policy decisions. She also recommended that there is need to fill research gaps in nutrition, develop and strengthen the nutrition research capabilities, provide an enabling environment for nutrition research in Africa and the governments to increase their investment in nutrition research with less dependence on donor agencies. This will ensure that the research will focus on the specific needs of the region and also focus on prevention rather than treatment.

In conclusion, as members of various science academies, she emphasised their duty to set up mechanisms that look into the issues raised and advocate for their implementation in different countries.

1.3 Cassava Diseases: Threat to food security in Africa

Dr. Patrick Chiza Chikoti, *Zambia*

In his introduction, Dr. Chikoti said that cassava is one of the key crops in the African farming enterprise. It is attractive to many farmers because it provides food security and is also a source of raw material. Unfortunately, the cassava is susceptible to many diseases, which among other factors affect its production. Dr. Chikoti covered the four cassava diseases, their symptoms and impact on the level of production. These diseases included: Cassava anthracnose disease (CAD), Cassava bacterial blight (CBB), Cassava mosaic disease (CMD) and Cassava brown streak disease (CBSD).

The implications of cassava disease are the threat to household food security as the roots cannot be consumed nor can they be used to make livestock feeds, even at low root infection. In case of early harvest, the cultivars do not yield to their maximum[13] and this creates both financial challenges as well as food instability to families that derive their livelihoods from cassava. Dr. Chikoti recommended some management solutions for the cassava diseases to include:

(i) the use of disease free planting materials, for example in Tanzania efforts to replace CBSD infected plants with clean planting materials yielded positive results (disease incidence reduction from > 60 to 39.1%)[14],
(ii) sanitation that involves the removal of diseased plants during early stages; this slows down disease development[15], and
(iii) the use of resistant cultivars. He noted that the International Institute of Tropical Agriculture has spearheaded much of the CMD resistance breeding work.

In conclusion, Dr. Chikoti noted that the diseases are indeed a security threat to food production in Africa and with the existing knowledge on the diseases; scientists have made tremendous headway in understanding causal organisms, disease spread and management. However, what still remains is translating the findings to manage the diseases for the farmers to increase their production levels.

[13] *Amposah et al., 2018.*
[14] *Legg et al., 2017.*
[15] *Fanou and Wydra, 2014.*

1.4 Identifying appropriate advisory models for science academies in Africa

Dr. Peter McGrath, *InterAcademy Partnership (IAP)*

The InterAcademy Partnership has a membership of 140 national, regional and global academies clustered into four regional networks. Dr. McGrath explained that integrating science across disciplines and boundaries helps to strengthen the capacity of systems for increasing the robustness and rigour of the evidence base. It also helps in promoting receptivity for the uptake of the outputs from science by policy makers; and increasingly involving the public in priority setting and implementation.

Dr. McGrath indicated that the *Food and Nutrition Security and Agriculture (FNSA)* Africa report highlights the opportunities for Science, Technology and Innovation (STI). The findings in the report articulated the value of scientific evidence; improved agriculture and food system efficiency; improved farming system resilience; improved food system efficiency, human health and wellbeing; improved food safety and waste reduction; and enhanced human capacity.

Dr. McGrath explained that the strength of the IAP project relied on strong core leadership, consistency in quality assurance, the involvement of younger researchers and scientist from the global south to initial contacts with policymakers as well as follow up at national, regional and global levels to stimulate debate, test recommendations and incorporate feedback into the future. He mentioned the limitations to be overcome in this global project included:

(i) academies varying in their competencies,
(ii) the need to learn from pioneering projects, and
(iii) difficulty to ascertain the longer-term impact.

1.5 Pesticides in the food security alleviation equation: The case of Neonicotinoids

Dr. Enock Dankyi, *Ghana*

This presentation summarised the findings, the perspectives and implications in the use of neonicotinoids. Dr. Dankyi outlined the history of pesticide usage in Ghana, the introduction of neonicotinoids and their use in pest control, effects of residues of neonicotinoids in the environment and an outlook and implications for their continuous use compared to other systemic insecticides. Dr. Dankyi defined neonicotinoids as the nicotinic acetylcholine receptors that kill insects by causing hyper-excitation of the nervous system. This systemic mode of action renders plant tissue toxic to insects that consume parts of the plant, however, the insecticide gets into pollen and nectar so that non-target species such as pollinators are exposed. He further explained that when neonicotinoids are applied as dressing on the plant or in soil drenching, their water solubility leads to most of the neonicotinoid leaching into the soil and aquatic systems, broadening the potential expose to natural predators and other non-target species[16].

[16] *(goulson 2013; Sanchez-Bayo 2014)*

He reported that a summary of findings from the review indicate that Neonicotinoid insecticides have widespread exposure in the environment and may be persistent in soils. The absorption of neonicotinoids to soils is generally low and presents a high possibility for leaching into surface and ground water. He also said that there is a tendency for accumulation of neonicotinoid residues in food products due to their good systemic activity and high application rates. On the perspectives and implications, Dr. Dankyi stated that there appears to be low efficiency of pesticide usage giving rise to higher financial and environmental cost implications. The agricultural intensification aimed at ensuring higher yields often neglects environmental and human health safety and has further implications on sustainability. And lastly, the inefficient use of pesticides poses significant risks to important ecosystem services including pollination, natural pest control and nutrient recycling. In conclusion Dr. Dankyi said ensuring food security and poverty alleviation will rely on sustainable agriculture underpinned by healthy biodiversity and appropriate ecosystem functions.

1.6 Neonicotinoids Pesticides: Use and Effects in African Agriculture

Dr. Nina Hobbhahn, *European Academies Science Advisory Council (EASAC)*

The study to examine the implications of neonicotinoid insecticide use for ecosystem services and sustainable agriculture in Africa was conducted between October 2018 and October 2019. It involved two workshops with scientist from 17 African Countries as well as an extensive review of relevant African research. This was a collaborative study by European Academies' Science Advisory Council (EASAC), InterAcademy Partnership (IAP) and the Network of African Science Academies (NASAC). The study looked at the extent of neonicotinoid usage in Africa, the environmental contamination, qualitative findings on honeybee population, the compliance and enforcement of regulations and the availability of extension services.

Dr. Hobbhahn reported that the key conclusions leading to the EU ban on the use of neonicotinoids was the evidence that the prophylactic use of neonicotinoids had severe negative effects on non-target organisms, which provide ecosystem services of pollination and natural pest control. She said there was clear evidence for sub lethal effects of neonicotinoids, even very low levels can have severe effects, for example, activating latent viruses. A large-scale preventive pesticide usage against occasional or secondary pests is not a sustainable approach and inconsistent with basic principles of Integrated Pest Management.

She stated that the study indicates that all countries in Africa appear to be using neonicotinoids (mostly imidacloprid, acetamiprid, thiamethoxam and thiacloprid) replacing the older pesticides, however, the market penetration is still at an early stage than in more mature markets such as Europe and North America. Overall pesticide consumption in Africa appears to be between 2.1% and 6.8% of global pesticide use with Africa flagged as the fastest growing market for insecticides in some recent market surveys with evidence of the spread of intensive techniques such as dressing seeds.

In conclusion Dr. Hobbhahn said that the sustainability of African agriculture is critical to food security and for maintaining its contribution to African economies and supporting rural communities. The biodiversity that supports the ecosystem services is critical to maintaining resilience against climate change and other environmental pressures. It is therefore essential to apply the knowledge that has already led to restrictions on the use of neonicotinoids outside Africa.

There is already evidence of negative effects of neonicotinoids that include the loss of honeybee colonies and contamination of agricultural products, soils and freshwater systems with neonicotinoid residues. Neonicotinoid usage in Africa is currently less than historical usage in intensively farmed areas of Europe, so that there is an opportunity to learn from experiences elsewhere and promote pest-control strategies that are more compatible with a sustainable and resilient agriculture for Africa's future.

Panel Discussion

PANELISTS

1. **Mr Ernest Ossei-Assibey,** *Pesticide and Fertiliser Regulation Division, Ministry of Food and Agriculture*
2. **Dr Emmanuel Agyemang-Dwomoh,** *Deputy Chief Executive of COCOBOD*
3. **Dr Enock Dankyi,** *University of Ghana*
4. **Professor Peter Kofi Kwapong,** *University of Cape Coast, UN Biodiversity and Ecosystem Services Network*
5. **Madame Victoria Adongo,** *Executive Director of the Peasant Farmers' Association of Ghana.*

The following were the key recommendations from the discussions:

GOVERNMENT:

It was reported that the government of Ghana and the Cocoa Board are aware of the harmful effects of the neonicotinoids and have hence reduced its usage since 2017. The government is in the process of looking for alternative and more suitable pesticides, and it is open to engaging with the community and tap into the available data to make informed decisions.

NATURAL PESTICIDES:

Neem tree and pyrethrum were mentioned as possible natural occurring pesticide that can be studied, and their massive production encouraged for farmers.

EDUCATION:

There is great need to educate farmers and end-users on the effects of the pesticides. Extension services were mentioned as a way to engage with the community and create awareness to help re-orient farmers from what they know and have practiced for a long time.

DATA:

It was noted that there is lack of data in Africa on the study of bees and the other pollinators.

NETWORKING:

All the institutions can benefit from each other by working together and sharing ideas and experiences.

SESSION 2:

THE TECHNOLOGY THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY AND POVERTY ALLEVIATION

This session focused on the cutting-edge technologies that are readily available or can be developed to meet the challenge of sustaining food productivity, reducing food loss and waste, and recovering produce that is currently being wasted.

CHAIR: Prof Yousuf Maudarbocus

Vice-president, Network of African Science Academies[17]

2.1 Factors influencing Camel Production Food Security and Poverty in Marsabit North District, Kenya

Prof. Timothy Maitho Nyamu, *Kenya*

Prof. Nyamu is a Professor of Pharmacology and Toxicology at the University of Nairobi. He conducted a study in Marsabit North District in Kenya in order to establish the factors that influence camel production. The objective of the study was to determine the influence of camel breeds, extension services, as well diseases and parasites on camel production in the District.

Prof. Nyamu explained that in Kenya camels are reared for meat and milk production and are used as a means of transportation, thereby making them crucial in food security in the arid and semi-arid lands (ASAL) regions of Kenya. However, despite several initiatives to improve camel stock in the country, the production has been growing slowly. He attributed this to camel diseases, reproduction diseases, lack of extension services and the presence of a hazardous plant in the region that are poisonous to the animals. He reported that there is a trend among the Gabra pastoralists in Marsabit to change to the Somali breed of camels, which are more resistant to the above-mentioned factors. Most of the pastoralists have herds of about 10 camels posing the challenge of inadequate pasture and water during the dry periods of the year. The pastoralists are also known to treat their sick camels using traditional herbal medicines, which are not effective and as a result affect their lifespan.

[17] *Prof. Maudarabocus is also the current chairman of the Radiation Safety and Nuclear Security Board and Vice- President of the Network of African Science Academies (NASAC).*

Prof. Nyamu concluded his presentation by emphasising on the need to improve disease control programmes and also to train camel farmers and Community Animal Health Workers on various aspects of camel management and control of diseases, parasites and poisoning in camels.

2.2 Improvement of the quality, the processing/Preserving Techniques and diversification of meat and meat products in Burkina Faso

Dr. Kabore Donatien, *Burkina Faso*

In his introduction, he reported that livestock is the second most important primary sector activity in Burkina Faso after agriculture. It employs about 80% of the total population and contributes more than 12% to the formation of national added value[18]. It also contributes to the food and nutritional security of the population by providing products of high nutritional value such as meat, milk and eggs; as well as fighting against poverty by increasing livestock farmers' incomes by around 3% per year[19]. He said, despite these benefits, the livestock/meat sector in Burkina Faso is insufficiently organised and animals are exported live to neighbouring countries, thus creating a loss of income for the national economy. The processing of fresh meat is also not very well developed.

Dr. Donatien and others carried out a study with the main objective to increase the value-addition of livestock meat sector through the improvement of meat products quality. The methods used included: surveys on the application of Good Hygiene Practices (GHP) in meat grillers, microbiological quality of sheep grilled offal, beef and sheep meat (fresh and grilled) and the impact of the Qualigrille oven on the quality of grilled meat. The study revealed that meat processors do not respect good hygienic practices. The beef and sheep meat (fresh and grilled) are mostly contaminated to levels that are not acceptable according to established microbiological standards whereas sheep grilled offal is mostly satisfactory. In addition, the study showed that Qualigrille has a positive impact on the nutritional, hygienic and sensory qualities of grilled meat. In view of the results obtained, the use of Qualigrille oven by meat grillers was recommended.

He mentioned the next steps as the formulation or development of new meat products, incorporating local ingredients and condiments (soumbala, moringa, spices, local green vegetables) instead of chemical additives. This would be followed by assessment of the nutritional, safety and sensory qualities of the products, then carrying out packaging and preservation tests on meat products in order to determine their shelf life. Finally, dissemination of all technologies to stakeholders through training and demonstration sessions as well as provision of support for the adoption of these technologies would be undertaken.

18 (Ministry of Animal and Fisheries Resources MRA, 2007).
19 (AAADI, 2012).

2.3 Importance of post-harvest technology on achievement of food security and poverty alleviation: Success stories and academy initiatives

Prof Ababacar Sadikhe Ndoye, *Senegal*

In his introduction Prof. Ndoye stated that Senegal decided to adopt a new strategy for a rapid development growth named *"Plan Senegal Emergent (PSE)"*, which was adopted in November 2012 by the government and its different strategic development partners. It is set within a four-year period (2014–2018) with the main objective being to achieve economic emergence by 2035. Prof. Ndoye reported on the various success stories on cereals (manual millet threshing, frozen granulated millet, dried processed cereals,) mangoes (dried and used to produce vinegar, spray drying of ginger), baobab fruit, tamarind and hibiscus.

On the Senegalese academy initiatives, he highlighted its mission of providing assistance and advice to the Government of Senegal (Public and Private Institutions) in the formulation and implementation of national science and technology policies. This helps to promote scientific research; initiate, strengthen and develop programmes in STI; promote and exploit research outputs; recognise distinguished scientists; encourage scientific vocations among young people and women; and contribute to the development of a scientific culture and an environment that is more conducive to creating linkages between science and society.

In his conclusion, Prof. Ndoye emphasised on the importance of the following:

- Promoting science and technology education, which is the real basis for sustainable development.
- Supporting to rural entrepreneurs due to their key roles on food and nutrition security using local agricultural products.
- Working with rural entrepreneurs for cost and price reduction in order to significantly enlarge their market.
- Getting facilities for rural entrepreneurs for basic production (energy, sugar, packaging).
- Training programmes on post-harvest technologies, especially for women and home economists.

These approaches view food starting from production, diversification, processing and marketing and guarantee sustainable strategies for food security and poverty alleviation.

2.4 Radiation technologies for food preservation and extension of shelf-life

Dr. Abraham Adu-Gyamfi, *Ghana*

In his introductory remarks, the Chief Research Scientist and Manager of the Radiation Technology Centre of the Biotechnology and Nuclear Agriculture Research Institute, Dr. Adu-Gyamfi stated that over half of the food produced globally is lost, wasted or discarded as a result of inefficiencies in the storage and transportation

systems. He said it is imperative that focus be directed towards radiation technology to prevent a global food crisis just as the Green Revolution used science to feed a hungry world.

He further explained that radiation technology can effectively contribute to food security through preservation, which involves the elimination of pathogens or parasites; decontamination by reducing spoilage microbes and disinfestation. Sprout inhibition and delay of ripening and senescence can also give a shelf life extension.

He talked about the various radiation technologies, extensively describing their advantages, limitations, safety and endorsement. These technologies include: E-beam irradiator, X-irradiator, Panoramic gamma irradiator, Laboratory scale irradiator and Mobile irradiator. The unique advantages of irradiation he said, are that they are "cold process" with no heat is applied (little if any increase in temperature), there is no change in physical appearance, it leaves no residues, it allows treatment of products in final packaged form, there is no significant nutritional loss and it maintains sensory quality. However, there are limitations because it cannot inactivate toxins nor destroy viruses at the doses used for decontaminating foods and it cannot guard against re-contamination.

Radiation technology has been established as an effective tool for improving the quality of food and other agricultural products. Governments should therefore create and sustain an enabling environment for effective utilisation of the technology to ensure food security. However, there is the need for increased collaboration of countries with IAEA and other international organisation for formulation and implementation of national projects. To accelerate utilisation of radiation technology for development, he said sub-regional, regional, and international collaboration among countries should be sought.

2.5 Proven technologies that have contributed to food security and poverty alleviation in Cameroon/Central African Sub Region

Dr. Kingsley Etchu, *Cameroon*

This presentation highlighted some proven (best practices) technologies that have contributed to food security and poverty alleviation in Cameroon and Central African sub-region with emphasis on innovations and technologies developed by IRAD and partners. Dr. Etchu, a researcher in Animal Nutrition and Physiology at the Institute of Agriculture Research for Development (IRAD) talked about the proven technologies that have contributed to food security and poverty alleviation. These technologies are tissue culture, proliferation in bits of fragments (PIF) and genetic improvement for the annual crops. For the perennial crops the technologies used are marcotting, grafting/budding and genetic improvement (breeding and selection). For the animal production and fisheries, the technology used is the genetic improvement through artificial insemination (AI), cross breeding, production of pelleted feed, aquaculture

development and production of floating feed for fish, feeding supplementation, among others.

He outlined the major limitations in the use of these technologies as:

(i) inaccessibility to some parts of the country,
(ii) inconsistent and insufficient financial resources,
(iii) inadequate human resource, (iv) obsolete equipment, and
(v) unavailable power supply and poor communication network.

Culture and religious taboos also challenge the uptake of some innovations, as well as lack of refresher courses to improve on skills. The technologies developed by IRAD and partners coupled with the natural diversity and human potential make Cameroon a safe haven as far as food security is concerned. Cameroon has a large rural population, which is receptive to new innovations and actively engaged in agriculture that is capable of producing enough to food for the nation and to respond in a very sensitive manner to the dynamics on the Right to Food.

There are also a number of processes in Cameroon that strengthen the integrated planning approaches between the three elements of the food-energy-water nexus. These include:

(i) the institutional structures under the Prime minister which have since developed a National Development Plan,
(ii) the Regional Growth and Development Strategies, and
(iii) the Integrated Development Plans at municipal levels.

The Cameroon Academy of Sciences (CAS) plays a major role in facilitating and engaging the government on policies that encourage food security and awareness of the State on the great potential of the agricultural sector to boost agricultural production. With all these functioning in full gear and the empowering of IRAD, he said that it is his belief that these innovations will propel the African economy.

Plenary session

The following were the key discussion points of this session:

A. Factors influencing camel production food security and poverty in Marsabit North District, Kenya

- The title of the study should be slightly modified so that it is not misleading, a follow up on this was to be made by Prof. Nyamu.
- There are attempts for value addition in camel products by producing yogurt and cheese. Camel milk is also believed to have medicinal value — rich in mineral and low in fat.

B. Improvement of the quality, the processing or preserving technique and the diversification of meat and meat products in Burkina Faso

- The use of other local products like charcoal was proposed to conserve the meat.

C. Importance of post-harvest technology on achievement of food security and poverty alleviation

- In Senegal there are many agro-food businesses working on processing agricultural produce and sold in the supermarkets, which was previously not being done.
- It was established that food security is not an increase in production but prevention and reduction of post-harvest losses.

D. Radiation technologies for food preservation and extension of shelf-life

- On the issue of the long-term effects of radiology, it was reported that a lot of study has been done to show that radiation technologies are safe. The government and key stakeholders (bureaus, research institution and private sectors) are involved in this process to ensure its safety.
- Regarding public concerns on the long-term effects of radiation, it was agreed that radiation technology is one of the most thoroughly researched technologies, with long-term studies in different countries. It was further clarified that radiation used is very low and the mechanism deals with the DNA on the insects in the food and not on the bodies of the consumers.
- It was reported that this technology has been used in Ghana since the 1970s and all the major regulatory bodies have endorsed it.
- Food fairs have been organised showcasing foods that have been radiated in a bid to educate the public on the radiation technology and how it helps in food preservation and the extension of shelf life.

E. Proven technologies that have contributed to food security and poverty alleviation in Cameroon/Central African Sub Region

- The question was raised on how sustainable this project is and if it has been tried for commercial purposes. The academies were challenged to take up the role of using the proven technologies in Africa as mentioned in the presentation.

2.6 Challenges for International Science Partnership (CISP)

Dr. Shirley Malcom, *American Academy of Arts and Sciences*

In her introduction, Dr. Malcom said that the American Academy of Arts and Sciences is supporting a multi-year project called *'Challenges for International Scientific Partnership' (CISP)* with one project working group, termed as the Emerging Science Partners (ESP). This group aims to explore issues particular to US scientific collaborations with countries seeking to boost their scientific capacity, particularly those with limited resources to do so.

This session was discussion-oriented and focused on the challenges faced by African scientific researchers and research administrators collaborating with scientists and/or funders based in the United States. The following questions formed the basis of the discussions:

- What has gone well when you have collaborated with scientists and funders in the US?
- What has been challenging in your partnerships with the US?
- What, or who, could be helpful to facilitate the establishment and oversight of future and current scientific partnerships with the US?

Below are some of the challenges the attendees drew from the group discussions.

CONCERNS	BRIEF EXPLANATIONS
Partnerships	• Good partnership needs to reflect the needs of both partners and not be one-sided. • The agenda of the partnership ought to be known by both parties.
Research areas	• These should be more targeted to address the local needs of the partners. • However, there are also interests in priority areas like in innovation, advocacy, patent, science diplomacy, etc. • The research areas should be query-based learning.
Contracts	• Contracts and budgets issued need to be reviewed and agreed upon. • An example was given of a project based in Africa, but having most of the budgetary expenditure in America.
Facilitation	• It was proposed that it would be best if the facilitation of the studies be done through NASAC other than directly through individual academies.
Collaboration & Consultation	• The collaboration is to be jointly agreed on and owned by both parties.
Brain drain	• It is well known that scientists travel where the money is, hence, many of the African scientists are moving to the United States, leading to brain drain.
Infrastructure	• The improvement of the infrastructure in the institutions and universities should also be considered, for example, upgrading of laboratories, equipment and buildings.
Other areas of collaboration & support	• Obtaining of visa. • Supply of equipment. • Patenting formation. Formation of different partnerships.

In conclusion, she acknowledged that the focus of the partnerships is on research and that each country has different needs and priorities. This by itself poses a challenge and hence the consideration of looking at the partnership regionally which would be by working together to think globally and act locally through NASAC coordination.

SESSION 3:

THE INNOVATION THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY AND POVERTY ALLEVIATION

CHAIR: Prof Isabella A. Quakyi,
FGA[20], Ghana Academy of Arts and Sciences

3.1 Establishing a Sudanese aflatoxin research and control network

Prof. Suad Sulaiman, *Sudan*

Prof. Sulaiman, in her presentation, outlined the risks of aflatoxins, challenges in managing them, conditions that favour their formation, the studies carried out so far on aflatoxins and the plans of Sudanese National Academy of Sciences on the same. Aflatoxins, she said, are a family of toxins produced by fungi, which grow on agricultural crops such as maize, peanuts, cottonseed and other vegetables. Aflatoxin thrives in humid and warm conditions and have severe toxic effects on humans such as liver cancer, birth defects, immune suppression and low productivity, increased susceptibility to disease. In animals, aflatoxins cause liver and kidney damage.

She stated that marketing agro-food products from Sudan, both locally and for export is a challenge due to concern of aflatoxins. The contamination of agricultural products with toxins causes economic loss to farmers and merchants, and ultimately national loss as a result of export reduction and rejection. To tackle the aflatoxin problem, awareness raising initiatives have been undertaken involving famers, livestock dealers, merchants, consumers and the stakeholders in the supply chain of agricultural food production. Enhanced surveillance and testing of commercially sold food products is encouraged and the intensifying of links encouraged among research institutions, the Sudanese private, small and large-scale sectors, consumers, famers and the society at large.

To this effect, the Sudanese National Academy of Sciences (SNAS) plans are to coordinate the stakeholders to form the 'Sudanese Network for Research and Control of Aflatoxin' (SAfNet). This network will advise on upgrading of agricultural production practices, transport, storage, and

[20] *Prof Quakyi is an Emerita Professor of Immunology and Parasitology, University of Ghana.*

processing, sales and safe consumption. It will also identify priorities for research and facilitate local and international links with academic institutions and funding agencies. Finally, SNAS plans to coordinate between stakeholders to develop a feasible work-plan to reduce Aflatoxin contamination.

PLENARY DISCUSSIONS

Role of the government:
It was reported that currently the testing of Aflatoxins is done for the export market only and whatever is rejected is put into the local market. However, the Sudanese Standards and Meteorology Organisation (SSMO) will be part of this network to help strengthen the existing regulations and will also provide labs to carry out the study.

Big companies: These are largely in the agricultural plantation sector and have their own network, which uses Aflasafe to 'push-out' harmful, toxin-producing strains of *A. flavus* from the field through deliberate introduction of indigenous but non-toxic, harmless strains. This process is known as competitive exclusion which is an expensive process not affordable to the small-scale producers. The companies using this process will be part of the network to secure provision of safe foods to the people.

Fertilizer: There is a company that is working with compost to produce effective micro-organisms as a fertiliser, which they claim, kills the *Aspergillus* in the soil.

Education: It was noted that the consumers do not know much about Aflatoxins and how it presents, especially during storage. It is crucial to educate the communities on Aflatoxins:

(i) the dangers of the products staying for long periods of time in storage,
(ii) the importance of sun drying, and
(iii) using plastic sheet in storage, etc.

Partners will therefore play a crucial role in disseminating this information as they have many branches that can assist in the production of education materials and short videos.

3.2 Prospects of Sorghum and Millets to Enhance Food and Nutrition Security and Poverty Alleviation in the Face of Climatic Change in Africa

Dr. Rose Kingamkono, *Tanzania*

Food insecurity in Africa is common among people living in arid and semi-arid tropical areas[21]. Due to drought, food production is limited to drought-tolerant crops such as sorghum and millets, which offer considerable opportunities in the context of improving on food insecurity, poverty, and malnutrition in Africa. Globally these crops (sorghum and millet) are widely perceived as crops in terminal decline. In the past fifty years they have been abandoned in favour of maize, wheat and

[21] *(Ahmed et al 2000; Schipmann-Schwarze 2014).*

rice[22]. Maize is a major staple food in Africa, but its local production and yield does not meet demand and the deficit is met by importation, the same with wheat. In the past ten years, Africa together with Americas (sorghum) and Asia (millets) are among the largest producer of sorghum and millet. Dr. Kingamkono reported that utilization of Sorghum and millets contributes to the food security of many of the world's poorest, and most food-insecure continents, largely in Africa and Asia[23].

On their nutritional profile[24] sorghum and millet are an excellent source of energy, iron, zinc and rich in B complex vitamins. They can be used for breakfast, lunch, dinner and even snacks and are now found in more than 350 product lines in the US alone. They are also used in the bakery industry, livestock industry, brewing industry, and renewable energy. Other uses include production of wallboards, fences, biodegradable packaging materials and solvents, dried stalks for fuel, and production of dyes[25].

In her conclusion she recommended for the effective participation of key actors involved in the production to consumption chain of sorghum and millet, so as to increase its commercialization. There is great need to research on and address these constraints facing the sorghum and millets value chains in Africa. Fostering integration of different market actors to forge business partnerships among farmers to offer bundled market services is worth consideration.

Plenary discussions

- There is need to have an inventory of the different varieties of sorghum and millet that exist and favourable areas where they grow so that the constraints can be addressed appropriately and bring value addition to the crops.
- Lack of knowledge causes farmers not to produce good variety of the sorghum and millet. This in turn affects their marketing. The formation of a consortium will look at, among other things, business development that assures both quality and quantity of sorghum and millet.

3.3 Agricultural water Innovation for enhancing Food Security in Africa

Dr. Olufunke Cofie, *International Water Management Institute*

In his introduction, Dr. Cofie said the drivers of food insecurity in Africa are population growth, urbanisation, poverty and low agricultural productivity: 240 million people in Africa were food insecure in 2016[26]. Some facts are that 80% of agricultural production is rain fed, the increased frequency of dry spell incidences are resulting in yield reduction in crops, there are 9% of global renewable water resources and there is a wide gap between water availability and water demand[27]. The domestic food production cannot satisfy the increased food demand, hence a

[22] *Seck et al. 2013, Macauley 2015, Opole 2019.*
[23] *(Krishina 2014, Mundia et al., 2019).*
[24] *(Nambiar et al., 2011).*
[25] *(House, 2005).*
[26] *(SOFI, 2017).*
[27] *(UN Water, 2016).*

massive rise in imports in the last 20 years. He explained that the Agricultural Water Management (AWM) seeks to use water in a way that provides crops and animals the amount of water they need. This is important in improving access to water management solutions and enabling smallholder farmers to increase productivity and reduce poverty, hunger and malnutrition.

The innovative AWM solutions, he said, are soil moisture retention practices, water storage options, and water lifting application methods and improving water use efficiency. He further explained that the constraints facing agriculture water management is technology, market and knowledge access, labour requirements and sustainability concerns. The five solutions pathways recommended to improve AWN in Africa are:

(i) increasing access to water,
(ii) improving value chains,
(iii) ensuring access to information and technology,
(iv) creating synergies between sectors, and
(v) adopting watershed perspectives.

Plenary discussions

- It is important to first know the water content in the soil so as to determine the soil moisture.
- There is need for people to be educated on the value of water by conserving it and making optimal use of it.
- Dams are a good way to conserve water, however, ground water is needed to avoid sedimentation and lose in volume.
- One of the biggest challenges in conservation agriculture is labour, which is not affordable to small-scale farmers. The possibility of how some of these processes can be mechanised was also discussed.

3.4 Feeding a growing population by producing more food with fewer resources

Dr. Rose Adhiambo Nyikal, *Kenya*

In her introduction Dr. Nyikal stated that the world population continues to grow geometrically which will inevitably bring about a corresponding rise in the demand for food. However, the population is growing more rapidly in areas that are now the least food secure and with violated operating platform[28]. The paradox is that by the beginning of this decade the world was already growing enough food to feed 10 billion people, which is the projected world population for 2063, and there was still hunger[29]. In this regard, Dr. Nyikal indicated that the real cause of hunger is poverty and inequality, not scarcity. Many undernourished people are resource-poor farmers cultivating small parcels of land and cannot afford to buy food. She talked of the interventions advanced by various scientists to produce more food

[28] *(Coclanis 2017).*
[29] *(Shattuck et al., 2012).*

with fewer resources for example through improvement of agricultural technologies and resource management to enhance production efficiency and increase crop yields, given particular water and nutrient input. Another intervention is the pro-environment conservation. With this intervention, individuals practice dietary change by limiting meat consumption and adopting plant-based foods. Livestock production is more damaging to the environment. The reduction of food-chain waste from field to plate (farm-to-fork) is also important.

Scientists acknowledge that there is not a single approach that can feed everyone adequately and rid the world of hunger. The diverse blueprints on agricultural transformation in Africa advance several strategies targeting increased outputs. The global reports say little about how to actually accomplish the ambitious goals and the recommendations do not extend to the policy design and implementation level[30]. Dr. Nyikal cited the proposed innovative solutions for Africa as the reduction of meat consumption and use of crop-based food, precision agriculture and farming with some success stories on hydroponic solutions, climate smart approaches, adoption of drought tolerant cereals, and use of low-cost wooden greenhouses among others. She further reported that people who have food are already doing something about producing more food, more efficiently. In this regard, nations will need innovative distribution strategies (transformation of food systems).

She concluded by saying that the ability of the proposals to meet the challenge of feeding a growing, mostly disadvantaged, population by producing more food with fewer resources, or the possibility of replicating the success stories, is the role of the academies whose role should be, among others, engaging governments in what works.

Plenary discussions

The following were the key discussion points:

- The transformation in agriculture might be about distribution and subjective judgment where each country specific problem has a specific solution.
- Farming requires resources, which are not always available, however interventions like soil testing and use of fertilizers can increase the productivity.
- Another way of increasing production with few resources is using one agricultural output as an input for another. The growing of maize can be a source of fodder for the cows and then the cow dung can be used in production of biogas.

3.5 Strengthening policy and science interface in research and development of climate smart emerging crops in Botswana

Dr. Kebadire Khola Mogotsi, *Botswana*

Dr. Mogotsi described the potential role of climate smart emerging crops in Botswana agricultural development and food security and provided recommendations on science policy interface for the research, development, domestication,

[30] *(Babu 2019).*

commercialization and conservation of climate smart emerging crops. Botswana is endowed with high value plant species traditionally used as food, medicine, fuel, fodder, fertiliser, timber, to name a few[31]. However, the plant species have experienced high levels of exploitation due to urbanisation, land degradation, deforestation, over-grazing, bush encroachment and climate change.

She said that these plant resources have a great potential for improved incomes, food security and nutrition and combating hidden-hunger caused by micronutrients (vitamins and minerals) deficiencies. The species, she said, are strongly linked to the cultural heritage of their places of origin and adapted to specific agro-ecological zones and marginal lands. Despite having traditional uses, they have been neglected by research, extension services, farmers, policy, decision makers, donors, technology providers and consumers[32]. Although some Botswana government policies support research and development on climate smart emerging crops, there has been lack of an operational policy framework and strategy on domestication and cultivation, leading to inadequate research and development on value chains to improve and promote their production, value adding and marketing as stated in the Community Based Natural Resources Management (CBNRM) policy of 1991.

She outlined the challenges experienced mainly due to lack of policy on domestication, cultivation, and conservation of plant species, which include:

(i) lack of knowledge and information on the proper use of plants components (medicinal and nutritional or even poisonous properties),
(ii) over-exploitation and unsustainable harvesting by some users,
(iii) lack of know-how by stakeholders on the technologies on value addition and marketing of the plant products, and
(iv) lack of knowledge and skills in research and development on the plants[33].

Addressing these challenges will require a paradigm shift from research and development on a few domesticated crops in Botswana, to that of a wide spectrum of indigenous plant species (climate smart emerging crops) that can meet the environmental and economic challenges of this century[34]. The Botswana government has introduced the National Agricultural Research and Development Institute, which is mandated to, among other things, conduct high quality and needs based research and development across the whole agricultural value chain for government, industry, and science[35]. This provides opportunity for enhanced science and policy interface across the agricultural value chain including *climate smart emerging crops*.

[31] *(Mogotsi et al., 2005).*
[32] *(Jaenicke and Höschle-Zeledon, 2006).*
[33] *(Mogotsi et al., (2005), Ulian et al., (2014).*
[34] *Mogotsi, et al., 2005.*
[35] *GoB, 2012.*

In order to develop interest and participation of all stakeholders in the production, value adding and marketing of climate smart emerging crops, it is important to forge strategic partnerships for a joint action or science-policy interactions – the Science-Policy Interface. Some of the science-policy interactions resulted with the following resolutions according to Mogotsi and Lekalake (2018) results, policy development, funding, capacity building, research and development, extension services, value adding, export market and value chain.

In conclusion, policymakers, scientists and end-users must talk to each other. Scientists, policymakers and Implementers should develop clear platforms of communication to enhance science-based policy- or decision-making and development for research and development. African governments should incorporate and facilitate (create conducive environment) for science policy interactions and be inclusive in policy decision-making. This is in line with national and regional policies as expressed in Botswana's NDP11 and Vision 2036 and UN's agenda 2030 Agenda for Sustainable Development, climate change mitigation strategies, and biodiversity conservation strategies, to name a few. The establishment of the National Agricultural Research and Development Institute (NARDI) is therefore an opportunity for scientists and policymakers to synergize policies that are relevant for agricultural innovations in Botswana, including strengthening research and development for climate smart emerging crops.

Plenary Discussions

The following were the key discussion points:

- Various seeds/plants that originate from our countries, but they are patented by other countries.
- Hybrid plants taste different from wild crops and this reduces consumption acceptability.
- There is lack of policy on domestication, cultivation, and conservation of plant species
- There is an MoU between Botswana Government and the Royal Botanic Gardens at Kew, UK on indigenous plants seed protection, environmental conservation and biodiversity restoration which has been reviewed by cabinet to insure that no seeds or herbarium specimen from Botswana and banked at Kew shall be shared with the third party without permission from Botswana Government.

3.6 Contribution of multi-stakeholder innovation platforms in achieving food security and improving farmers' income in Burkina Faso

Dr. Hamidou Traore, *Burkina Faso*

In his introduction, Dr. Traore gave the background on the contribution of multi-stakeholder innovation platforms. He stated that the Institute of Environment and Agricultural Researches (INERA), one of the institutes of the National Center of Scientific and Technological Research (CNRST), is implementing the Operational

Action Plan (2018–2020) of the Strategic Research Plan of CNRST (2015–2024). He informed participants that Burkina Faso implemented its West Africa Agricultural Productivity Programme (WAAPP) from 2011 to 2016. WAAPP, initiated by ECOWAS and funded by the World Bank, was coordinated regionally by CORAF and has generated and introduced numerous technologies, both in food production and processing. To disseminate these technologies, WAAPP and other development projects have adopted the multi-stakeholder innovation platforms approach.

With regard to the multi-stakeholder innovation platforms approach, Dr. Traore gave the case study of maize innovation platform (IP) in Léo, whose factors guided the choice and the IP members. The results achieved after the three years of implementation were remarkable with about 300 farmer-field days, 12 programmes broadcasted in local languages on Radio FM RED, 6 articles published in the national daily newspaper "Sidwaya" and 2 widely distributed varieties (Wari, Barka), 1 hybrid (Bondofa). From 2008 to date more than 48 Innovation Platforms (IPs) have been set up in Burkina Faso. The major achievements are knowledge acquisition, organisational capacity building, facilitation of access to finance, increase of production, improvement of producers' incomes, and construction of a mutually beneficial and equitable synergy between the key actors of the project on maize value chain in Sissili. The next step, he said, was to ensure that the entire country is implementing IPs on several value chains and that results are spread out to ensure quantitative and qualitative food security, thus reaching sustainability of socio-economic development of Burkina Faso.

Plenary discussions

The main discussion point was that one of the single factors in the success of this approach is increased productivity per hectare, farmer collaboration with research and determining a good variety of maize. There is surplus in production, which is sold for increased income and food security is achieved.

3.7 Climate smart agriculture, resilience building and food security in the Eastern Cape, South Africa

Dr. Philani Moyo, *South Africa*

In his presentation, Dr. Moyo said that climate change is currently one of the biggest threats to human development. Recent data shows that current global warming is unprecedented and is changing the world's weather and climate patterns. These climate changes are impacting rainfall, temperatures, sea levels, wind speed, ecosystems and biodiversity. There is evidence that extreme weather events in South Africa are increasing, with heat wave conditions found to be more likely, dry spell durations lengthening slightly and rainfall intensity increasing[36]. This evidence is based on several analyses of weather-station-data of the South African Weather Service (SAWS), the Agricultural Research Council (ARC), and internationally developed and maintained climate data sets such as those of the Climatic Research Unit in the United Kingdom.

[36] National Adaptation Strategy, 2017:11.

In an effort to build adaptation capacity and resilience at national, provincial and local level, the South African government has adopted the National Climate Change Response Policy (2013), National Climate Change Adaptation Strategy (2017), and Carbon Tax Act (2019). The various players at the different levels include government, (national, provincial, and local), the civil society, the private sector, and the National System of Innovation. All the players continue to build the country's resilience to climate change, albeit operating without a common reference point[37].

From the study of the adaptation and resilience at local level, understanding the strategies already being implemented by local farmers within prevailing climate realities is important. Such a local focus is more practical. Attempting to do so at national level is unrealistic due to the differences in local environments and the countrywide complexities. The emphasis on local farmers' realities encourages active participation of government entities (national, provincial and local) and scientists, and further enhances the adaptation and resilience strategies. The farmers are active adaptation agents and their resilience knowledge and practices is advanced for effectiveness through further research and development by scientists, and technical support and funding by government entities.

In conclusion he emphasised that this symbiosis, between farmers, scientists and the government, is an integrated research and development approach with real potential to build sustainable resilience. Its strength lies in integrating diverse knowledge systems by co-producing knowledge for locally relevant, enhanced adaptation and resilience.

Plenary discussions

- Putting a price on the carbon footprint is a way of responding to the climate emergency. Carbon tax is designed to bring a change in behavior. It effects to the polluter-pays-principle for large emitters and ensures that firms and consumers take the negative adverse costs (externalities) into account in their future production, consumption and investment decisions.
- Funds raised from carbon taxes will be used to benefit poor communities. The tax will be increased over time to provide a long-term price signal to decarbonise the economy. However, it is a subject to extensive debt between the private sector and the Civil Society Organisations (CSO) though the law has already been passed.
- To ensure ownership of sustainable resilience strategies, the farmers were involved in co-producing and co-owning the model. They are part of it and hence sustainability is there as long it guarantees them of their produce.

[37] *(National Adaptation Strategy, 2017:10).*

3.8 Produced in Africa, accepted worldwide; using home grown science to meet international needs

Dr. John Boright, *United States of America*

In his speech, Dr. Boright talked about the US National Academies of Science Engineering and Medicine (NASEM), which is the implementer of the USAID funded Partnerships for Enhanced Engagement in Research (PEER) programme that provides competitive grants for cooperative research. He named some teams that have been supported by these grants to include: "Scaled deployment of smart-phone agro-applications", "High-yielding Aflatoxin-resistant maize hybrids in Ghana", "Enhancing rice yields using an efficient and low-cost bio pesticide", among others. This, he said, is an illustration that innovative, and highly relevant, research is underway in Africa.

The topic of great importance in Africa is Innovation. One of the most pervasive issues for many countries in the world is that jobs are urgently needed for young citizens. Most of these jobs will be new and created by innovation; the creation process almost always involves the right technology but also other elements of innovation. The other is the role of early career in science and technology in Africa. The African academies are among the world leaders in the creation of Young Academies and these efforts involve aspects chosen to reflect specific national circumstances and priorities, but in all cases mobilising early career contributors is absolutely critical.

In the experiences of NASEM, Frontiers of Science, Engineering and Medicine is an extremely successful programme mechanism in mobilising early careers in science and technology talent. It provides critical interdisciplinary exposure and develops leadership skills. These programmes have proven to be of great value, including in seeding many follow-on collaborations. Bilateral Frontiers programmes in Africa could also play an important role in encouraging interdisciplinary creativity, and mobilising talent, innovation, and cooperation relevant to food and nutrition security in Africa. The quality and relevance of primary and secondary education is crucial and there are new efforts to build on the demonstrated effectiveness of inquiry-based science education (IBSE). IBSE also aims to integrate knowledge directly relevant to the SDGs into the learning experience of children.

NASAC continues to play the critical role of Africa meeting its needs through these needed efforts. The cooperation among the academies is an important contributor to the success of African societies meeting major global challenges. On other matters related to food and nutrition security, the NASAC's contribution to the IAP project on food and nutrition security has an excellent section identifying the primary steps necessary.

3.9 The Fourth Industrial Revolution, Artificial Intelligence and Food Security

Mr. Darlington Ahiela Akogo

In his introduction, Mr. Akogo explained that the fourth industrial revolution (4IR) is the convergence of digital, biological and physical innovation. It is a revolution that is

challenging what it means to be human. He named the other revolutions as the water and steam power to mechanise production, which was the first, while the second used electricity to create mass production and the third industrial revolution, was the Computer and Information Age (digitisation of production). He further explained the more complex exponential technologies with rapid breakthrough as artificial intelligence, drones, robotics, the Internet of Things (IoT), Virtual or Augmented reality, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing.

African agriculture faces a lot of challenges. In 2018 it was reported that 234 million people in sub-Saharan Africa were undernourished , and that the African farmers lose an estimated 49% of expected total crop yield per annum[38]. This loss and wastage cost about US$ 940 billion. There is an expectation of an increase of the food production in sub-Saharan Africa over the next 15 years by 60% so as to be able to feed its growing population. He delineated precision agriculture as an approach to farm management that uses information technology (IT) to ensure that the crops and soil receive exactly what they need for optimum health and productivity. He gave the example of KaraAgro AI, which is an all powered plant disease detection and precision application for agriculture for Africa. It is a free Android application that utilises the power of Artificial Intelligence and Data Analytics for easy and early detection of plant diseases. Currently it can detect diseases in Tomato, Maize, Bell (Sweet) Pepper, Potato, Grapes, Peach, Strawberry, Apple and Cherry. This mainly empowers small-scale farmers to ensure Quality Plant Health. The application is trained with images of healthy and unhealthy plant leaves and has had support from researchers at WACCI, University of Ghana Crop Science. The application also carries out soil and field analysis, crop monitoring and production of 3D maps at the start of the crop cycle for early soil analysis. It is useful in planning seed planting patterns and after planting the drone-driven soil analysis provides data for irrigation and nitrogen-level management. The Normalised Difference Vegetation Index (NDVI) can detect stress (pests, water shortage and diseases) in plants 10 days before it becomes visible to the human eye.

Using of drones with AI to determine the precise amount of water, fertiliser and pesticide needed at each portion of a field can lead to:

- 90% of water being saved in comparison to traditional spraying methods.
- 30% of pesticide saving is established by a high degree of precision.
- Reducing crop damage from an average of 15% to 0%.
- Could save farmers anywhere from 35 to 55 percent in labor costs.
- 40–60 times faster than manual spraying.
- Cover about 1.5 acres in just 10 minutes, 7–10 acres/hour.

He also talked about the IoT soil sensors as another technology which is used in the collection of data related to temperature, volumetric water content, rainfall, and other parameters in real-time to be analysed by AI. Farmers can utilise this information to identify trends and to predict irrigation needs. By the year 2050, IoT will empower farmers to improve crop yields by 70% and it has the potential to save

[38] Centre for Agriculture and Biosciences International).

up to 50 billion gallons of water per year. In conclusion he mentioned the upcoming research as the AI for plant breeding, for developing more effective fertilisers and pesticides, and vertical farming. There is need for a whole new perspective towards agriculture, a lot can be achieved through the phone camera as it can analyse a lot of information. The app is practical, doable and free.

Plenary Discussions

- On the cost of adapting this technology, the APP is free and can be supported by any smart phone, hence affordable to small scale farmers. The drone is targeted for the large-scale farmers and cost US$ 20, because of hosting the data.
- There is no generalisation when it looks at one leaf because the APP has the capacity to specify the exact disease. The disease detection from the leaves can alleviate the disease of the whole plant, and if the whole plant is diseased it can be removed so that it does not spread to the whole farm.
- On the water spraying aspect, the drone is connected to the source of water and so does not run out and there is efficiency in watering the plantations. The drone can also sense the amount of water required by a specific plant.
- AI is also able to identify the various livestock and indicate if they are sick or thirsty, just like face recognition for humans while using the phone.

3.10 INGSA – Africa Learning Collaborative Workshop on Government Science Advise

Moderators:
Dr. Justice Germo Nzweundji
Dr. Richard Lander Kwame Glover
Dr. Oladoyin Odubanjo
Mr. Christian Acemah

The International Network for Government Science Advice (INGSA) provides a forum for policymakers, practitioners, academies and academics to share experiences, build capacity and develop theoretical and practical approaches to the use of scientific evidence in informing policy at all levels of the government.

Dr. Odubanjo, Chair of the Steering Committee of the INGSA-Africa Chapter, defined science advice as the process, structures and institutions through which governments and politicians consider science, technology and innovation information in policy and decision-making. It is also known as science for policy and it is about linking policy and science. Policy is said to be smaller and moves faster while science is bigger and moves slower and when they come together it causes a crisis. To avoid this, the gear system in form of science advice mechanism is introduced. There is the foresight gear and the crisis gear which is engaged for example during the Ebola outbreak in West Africa. The gear system, which links policy with science, calls for trust between the politician, policymaker, media or public and scientists. The skill-sets required for science advice includes remembering the four audiences (scientists, public, policy

makers and politicians), understanding the complexities of science, getting beyond single disciplines (natural and social sciences), understanding the policy 'cycle', employing brokerage and avoiding advocacy. It requires one to have diplomatic skills, good communication skills to the four audiences, and understanding of the post-trust environment, avoiding hubris and maintaining integrity and trust of all.

To demonstrate this, the attendees of AMASA-15 were engaged in role-playing of a fictitious case study titled ***Mobilization of water and land resources for food security,*** facilitated by the moderators.

The case study discussed read as follows:
Three large investors, who are aware of the great water and arable land potential, have come to the country capital with proposals for major agricultural investment projects.

- ***Investor A*** *– whose financial resources exceed those of A and B combined is exploring the market and is open to any agricultural investment opportunities. However, he has clearly indicated to the authorities that he is not interested in philanthropy and is seeking to maximize return on investment.*

- ***Investor B*** *– would like to obtain 20,000 hectares of irrigable land along the country's largest river — a river that is shared with five other countries. He wishes to expand his grain production area, which already extends into three of the five countries along the river.*

- ***Investor C*** *– is asking for 100,000 hectares of land for biofuel production (sunflower, jatroha, oil palm) destined primarily for the European market, but some of which could be sold locally...*

SCIENCE ADVICE

After deliberations on the case study, the plenary agreed that:

Option A – they are profit-driven and would not be a favorable option for mobilising of water and land use for food security.

Option B – this is a good option, but it is best for the government to look within itself if it can do it. Empowering your own citizen without foreign arrangement is more beneficial. There would also be concern if the private investor may withdraw excessive water from the shared river (tragedy of the commons).

Option C – is mostly covering for the export market.

SESSION 4:

CHALLENGES FOR INTERNATIONAL SCIENCE PARTNERSHIPS

Scientific progress increasingly relies on international partnerships. Universities and university researchers, government and government agencies, NGOs and foundations as well as industry partners are facing a variety of new questions and challenges, including best practices for data storage, management and analysis, ethical practices and standards across cultures and regions; and lack of funding or support.

The American Academy of Arts and Sciences is supporting a multi-year project, *Challenges for International Scientific Partnerships (CISP),* which aims to articulate the benefits of international collaboration and recommend solutions to the most pressing challenges associated with the design and operations of partnerships. This initiative, funded by the Alfred P. Sloan, William and Flora Hewlett and Gordon and Betty Moore Foundations, seeks to identify policy recommendations and best practices to mitigate challenges for international science collaborations including physical facilities, distributed networks, and peer-to-peer partnerships.

The session was interactive and discussion oriented, focusing on how the American Academy and US institutions can be better partners to the emerging scientific countries working to establish and/or strengthen their scientific enterprise.

The following were the outcomes from the intensive group discussions:

MUTUALLY BENEFICIAL RESEARCH	
Proposed Recommendations	1. Journals published by US scientific societies should increase numbers of of publications from researchers in emerging science partners and put policies in place to ensure fair authorship attribution. 2. Collaborative research grants issued by the US should prioritise research that is aligned with both US and collaborators top scientific goals.
Group Discussion & Recommendations	• Editorial boards of US-based journals should be made more inclusive by adding competent board members from Africa. • There is need to eliminate bias and discrimination which often arises when papers from Africa are adjusted to be of local interest even when found to be scientifically sound and well written. • Determination of who serves as head author for a joint publication arising from collaborative research should be on the basis of scientific contribution and volume of work done not on the basis of who provided the funds for the project.

	• Collaborative research grants issued by the US should prioritise research that is aligned with both US and collaborator top scientific goals. • Peer review of African Journal. Increasing collaboration – NASAC can take on training within countries
FOCUS ON LOCAL/REGIONAL SCIENTIFIC PRIORITIES	
Proposed Recommendations	1. US scientific programmes that facilitate global science should feature research conducted by emerging science partners. 2. US universities should expand invited faculty seminar series to include more speakers from emerging science partners.
Group Recommendations	• The immediate interest can easily be defines in the SDGs; we need to create the awareness to the existence of SDGs where the priorities are summarised. • Think big – the funders can help on our ideas where we need to develop projects that would make us competitive in the future. An example was given of the space agency headquartered in Egypt. • Most countries already have national agendas of their own; and this would be the best way of engagement. The priorities should be two sided – Collaboration should be both sided – to make the conversation useful.
CAPACITY BUILDING	
Group Recommendations	• **Collaborative research plants** – most of the academies do not have a secretariat hence making the work of the academies expensive. • **Scientific Infrastructure** – a proposal to equip labs with up-to-date equipment that support the scientist and that can facilitate scientiic exchange. • Human aspect of infrastructure, which facilitates networking within the continent. Human networking support which should be sustainable, facilitate researchers and data issue. • **Avoid duplication** –Identify what really/already exists. • Government to be on "our side".
	PRIORITIES • Emphasis on priorites and teams. • Exchange programmes which are useful to the universities. • Human capacity – training and exchange programmes.
CLARIFIED PARTNERSHIP AGREEMENTS	
Proposed Recommendation 1	All parties should agree to terms before the project starts, including ethical guidelines.
New Proposed Recommendation 2	Provide training for locally-based lawyers in Scientific MoUs, intellectual partnership, and other areas.
Group Recommendations	To succeed in any partnership: • The terms of the MoU should be clear and mutually developed. • The legal and other expertise should be included in developing the MoU. • There should be capacity enhancement of the local staff, since research already exists in the African continent. Financial terms should be transparent from the onset.

The outcome paper on the exercise on the Challenges for International Scientific Partnerships (CISP), will be disseminated by mid-2020 and follow up discussions will be done through NASAC.

CLOSING REMARKS

Prof. Jonathan N. Ayertey

Chairman of the Planning Committee

Prof Ayertey expressed great honour on behalf of GAAS in hosting AMASA-15, which coincided with the celebrations of the academy's sixtieth anniversary. He thanked all the participants who honored the invitation and for actively participating in the proceedings of the international conference. He appreciated Zambia for withdrawing their interest to host AMASA-15, giving GAAS the opportunity to host AMASA alongside their anniversary celebrations. He also congratulated the Zambian academy for their continued commitment as they plan to host AMASA 16 in 2020.

Prof. Kavwanga E.S. Yambayamba

President of the Zambian Academy of Sciences

Prof. Yambayamba congratulated GAAS for hosting a successful AMASA-15 conference and sixtieth anniversary celebrations. He also warmly invited and welcomed all participants present to AMASA 16 which will be held in Zambia in 2020. The proposed revised theme after the presentations during the AMASA 15 will focus on the most critical area where Africa is going to bounce from and become productive and a volatile continent to the next generation — Child nutrition and health, the effect of climate change — A call to action. He announced that the preparations towards AMASA 16 are already underway and the Zambian academy anticipates vibrant participation and excellent paper presentations from scientists and experts on the topic.

Prof Mostapha Bousmina

President, Network of African Science Academies

Prof Bousmina in his closing remarks sincerely thanked GAAS for hosting AMASA-15. He expressed deep appreciation to the President of Ghana, His Excellency Nana Akufo-Addo for gracing the opening ceremony and Madam President Prof Henrietta Mensa-Bonsu of GAAS, for her time and commitment. He noted that the different talks and speeches were about development of the African countries and for this, he thanked the different scientists and speakers for their invaluable contribution to make AMASA-15 successful. He also emphasised the need to invest a lot in education, science and technology. The invitation of the young students to listen to the lectures given by the senior and established scientist was noted as both commendable and very inspiring. In conclusion, Prof. Bousmina thanked the outgoing Board, the organising committee of AMASA-15 and NASAC secretariat for their continued commitment and support.

ANNEXES

ANNEX 1 : List of Participants

	Name	Country of origin	Organization
1.	Mahouton Norbert	Benin	Académie Nationale des Sciences, Arts et
	Hounkonnou		Lettres du Bénin
2.	Kebadire Khola Mogotsi	Botswana	Botswana College of Agriculture
3.	Pulane Koosaletse-Mswela	Botswana	Botswana Academy of Sciences
4.	Kabore Donatien	Burkina Faso	Académie Nationale des Sciences du Burkina
5.	Hamidou Traore	Burkina Faso	Académie Nationale des Sciences du Burkina
6.	Jean Noel Poda	Burkina Faso	Académie Nationale des Sciences du Burkina
7.	Kingsley Etchu	Cameroon	Cameroon Academy of Sciences
8.	Ngalani Joseph Antoine	Cameroon	Cameroon Academy of Sciences
9.	Anglade Maan Kla	Cote d'Ivoire	Académie des sciences, des arts, des cultures
			d'Afrique et des diasporas africaines, Côté d'Ivoire
10.	Amr Farouk Abdelkhalik	Egypt	Academy of Scientific Research and Technology,
			Egypt
11.	Masresha Fetene	Ethiopia	Ethiopia Academy of Sciences
12.	Zenebework Tadesse	Ethiopia	Ethiopia Academy of Science
13.	Nina Hobbhahn	Germany	The European Academies Science Advisory
			Council (EASAC)
14.	Rolf Greve	Germany	Ministry for Science and Research
15.	Darlington Ahiale Akogo	Ghana	GUDRA Studio
16.	Beatrice Oforiwaa Dankyi	Ghana	University of Ghana
17.	Ben Ahunu	Ghana	Ghana Academy of Arts and Sciences
18.	David Dodoo-Arhin	Ghana	University of Ghana
19.	Gordon Akon-Yamga	Ghana	Science & Technology Policy Research Institute
20.	Abraham Adu-Gyamfi	Ghana	Ghana Academy of Arts and Sciences
21.	Daniel Asare-Kyei	Ghana	Ghana Academy of Arts and Sciences
22.	Eugenia Date-Bah	Ghana	Ghana Academy of Arts and Sciences
23.	Olufunke Cofie	Ghana	International Water Management Institute
24.	Owusu Afriyie Akoto	Ghana	Ministry of Food and Agriculture
25.	E. Agyemang Dwomoh	Ghana	The Ghana Cocoa Board (COCOBOD)
26.	E.K Awadzi	Ghana	The Ghana Cocoa Board (COCOBOD)
27.	Elizabeth Ardayfio-Schandorf	Ghana	Ghana Academy of Arts and Sciences
28.	Isabella A. Quakyi	Ghana	Ghana Academy of Arts and Sciences
29.	GKS Aflakpui	Ghana	Ghana Academy of Arts and Sciences

30.	Godfred Boafo	Ghana	The Conversation Africa
31.	Hilda Kwapong	Ghana	Ghana Academy of Arts and Sciences
32.	Kenneth Ampofo	Ghana	The Ghana Cocoa Board (COCOBOD)
33.	Francis Prince Ankrah	Ghana	Ghana Academy of Arts and Sciences
34.	Samuel K. Sefa-Dedeh	Ghana	Ghana Academy of Arts and Sciences
35.	P.K. Turkson	Ghana	Ghana Academy of Arts and Sciences
36.	Patrick Dacosta Awuku	Ghana	The Ghana Cocoa Board (COCOBOD)
37.	Henrietta J.A.N. Mensa-Bonsu	Ghana	Ghana Academy of Arts and Sciences
38.	Rose Emma Mamaa Entsua-	Ghana	Ghana Academy of Arts and Sciences
	Mensah		
39.	F.K Nkrumah	Ghana	Ghana Academy of Arts and Sciences
40.	H.N.A Wellington	Ghana	Ghana Academy of Arts and Sciences
41.	Justice S.K. Date Bah	Ghana	Ghana Academy of Arts and Sciences
42.	Aba Bentil Andam	Ghana	Ghana Academy of Arts and Sciences
43.	Jonathan N. Ayertey	Ghana	Ghana Academy of Arts and Sciences
44.	Kwabena Frimpong-Boateng	Ghana	Ghana Academy of Arts and Sciences
45.	Enock Dankyi	Ghana	Ghana Academy of Arts and Sciences
46.	Rex Omar	Ghana	The Ghana Cocoa Board (COCOBOD)
47.	Richard Adu-Acheampong	Ghana	The Ghana Cocoa Board (COCOBOD)
48.	Rose Omari	Ghana	CSIR- STEPRI
49.	S. Sefa-Dedeh	Ghana	Ghana Academy of Arts and Sciences
50.	Samori Abubakari Issah	Ghana	Ghana Academy of Arts and Sciences
51.	Samuel Boakye	Ghana	Ghana Academy of Arts and Sciences
52.	Takyiwaa Manuh	Ghana	Ghana Academy of Arts and Sciences
53.	Emmanuel Kyereh	Ghana	CSIR- FRI
54.	Deborah Darko	Ghana	CSIR Water research institute
55.	Gordon Akon-Yamga	Ghana	University of North Texas
56.	Kwabena Duodu	Ghana	Global Young Academy
57.	Emmanuel Owusu-Bennoah	Ghana	University of Ghana
58.	Ernest Osei Assibey	Ghana	Pesticide and Fertilizer Regulatory Division of
			the Ministry of Food and Agriculture
59.	Juana A. Boateng	Ghana	JSC International
60.	Pascal Kudiabor	Ghana	Peasant Farmers Association of Ghana
61.	Hans Adu Dapaah	Ghana	Council for Scientific and Industrial Research
62.	Victoria Adongo	Ghana	Peasant Farmers Association of Ghana
63.	Peter McGrath	Italy	InterAcademy Panel
64.	Teresa Stoepler	Italy	InterAcademy Panel
65.	Rose Adhiambo Nyikal	Kenya	University of Nairobi
66.	Jackie Kado	Kenya	Network of African Science Academies
67.	Philbert Okello	Kenya	Network of African Science Academies
68.	Raphael M Munavu	Kenya	Kenya National Academy of Sciences
69.	Timothy Maitho	Kenya	Kenya National Academy of Sciences
70.	Rahab Gitahi	Kenya	Network of African Science Academies
71.	Winnie Mandi	Kenya	Rapporteur Consulting
72.	A. Salem Sauntally	Mauritius	Mauritius Academy of Science and Technology

73.	Yousuf Maudarbocus	Mauritius	Mauritius Academy of Science and Technology
74.	Bousmina Mostapha	Morocco	Hassan II Academy of Science & Technology, Morocco
75.	Driss Ouazar	Morocco	Hassan II Academy of Science & Technology, Morocco
76.	Rajaa Cherkaoui	Morocco	Hassan II Academy of Science & Technology, Morocco
77.	Prof Henrietta Ene-Obong	Nigeria	Nigerian Academy of Sciences
78.	Oladoyin Odubanjo	Nigeria	Nigerian Academy of Science
79.	Getrude Ogieguata	Nigeria	Nigerian Academy of Science
80.	Mosto Onuoha	Nigeria	Nigerian Academy of Science
81.	Manasse Mbonye	Rwanda	Rwanda Academy of Sciences
82.	Hajja Aissatou Ndiaye	Senegal	Académie des Sciences et Techniques du Sénégal
83.	Mame Bineta Gaye	Senegal	Académie des Sciences et Techniques du Sénégal
84.	Oumar Sock	Senegal	Académie des Sciences et Techniques du Sénégal
85.	Ababacar Sadikhe Ndoye	Senegal	Académie des Sciences et Techniques du Sénégal
86.	Daniel Nyanganyura	South Africa	International Science Council Regional Office for Africa
87.	Richard Lander | Kwame Glover	South Africa	INGSA-Africa
88.	Kholani Mbhiza	South Africa	Academy of Science of South Africa
89.	Kofi Frimpong Anim	South Africa	CSIR-CSI
90.	Kwaku Gyebi Duodu	South Africa	University of Pretoria
91.	Stanley Maphosa	South Africa	Academy of Science of South Africa
92.	Barney Pityana	South Africa	Academy of Science of South Africa
93.	Himla Soodyall	South Africa	Academy of Science of South Africa
94.	Kwaku Gyebi Duodu	South Africa	University of Pretoria
95.	Philani Moyo	South Africa	Academy of Science of South Africa
96.	Robin Crewe	South Africa	Academy of Science of South Africa
97.	Suad Sulaiman	Sudan	Sudanese National Academy of Sciences
98.	Hussein A. Tijani	Sudan	Sudanese National Academy of Sciences
99.	Inna Abubaka	Sudan	Sudanese National Academy of Sciences
100.	Asifa Nanyaro	Tanzania	Tanzania Academy of Science
101.	Rose Rita Kingamkono	Tanzania	Freelance consultant
102.	Habiba Bouhamed Chaabouni	Tunisia	Tunisia Academy of Sciences, Letters and Arts
103.	Christian Acemah	Uganda	Uganda National Academy of Sciences
104.	Connie Nshemereirwe	Uganda	Global Young academy
105.	Enock Dankyi	Uganda	University of Ghana
106.	George Obeng Adjei	Uganda	Makerere University
107.	Nelson Sewankambo	Uganda	Uganda National Academy of Sciences
108.	Amanda Vernon	USA	American Academy of Arts and Sciences
109.	John Phillips Boright	USA	United States National Academies
110.	John Randell	USA	American Academy of Arts and Sciences
111.	Nkem Khumbah	USA	American Academy of Arts and Sciences
112.	Rebecca Tiernan	USA	American Academy of Arts and Sciences
113.	Shirley Malcom	USA	American Academy of Arts and Sciences
114.	Patrick Chiza Chikoti	Zambia	Zambia Agriculture Research Institute
115.	Enala Tembo-Mwase	Zambia	Zambia Academy of Sciences
116.	James Phiri	Zambia	Zambia Academy of Sciences
117.	Kavwanga Yambayamba	Zambia	Zambia Academy of Sciences

ANNEX 2: Conference Programme

SCIENTIFIC SESSIONS

PREAMBLE TO SCIENTIFIC SESSIONS

The sub-themes for the scientific sessions are derived from the main theme and separately address the different areas of the theme. Thus, each sub-theme focuses on how that area of the theme can address issues that can contribute to the achievement of food security and poverty alleviation in Africa.

THURSDAY, NOVEMBER 14, 2019	
8.15 – 8.30	Arrival of participants
8.30 – 9.00	**SESSION 1: THE SCIENCE THAT DETERMINES THE ACHIEVEMENT OF FOOD FOOD SECURITY AND POVERTY ALLEVIATION** [This section will focus on the scientific knowledge available as well as what is required to drive the various issues that require attention to ensure that our aspiration for food security & poverty alleviation in Africa is met]. **CHAIR:** Prof. S.K. Sefa-Dedeh, FGA; Vice President, Sciences Section, GAAS **Leveraging Science for Food Security and Poverty Alleviation — The Role of Underutilized Grains** | *Dr. Kwaku Doudu, South Africa*
9.00 – 9.30	**Social Protection and Food Security – the Case of Ethiopia's Productive Safety Net Programme** | *Dr. Alemayehu Seyoum, Ethiopia*
9.30 – 10.00	**Achieving Food and Nutrition Security in Africa: Knowledge Gaps and Needs** | *Prof. Henrietta Ene-Obong, Cross River State, Nigeria*
10.00 – 10.30	**Science, Technology and Innovation for Food Security and Poverty Alleviation in Africa: Identifying Appropriate Advisory Models for Science Academies in Africa** | *Leopoldina*
10.30 – 10.50	BREAK
11.00 – 12.30	• **Pesticides in the Food Security and Poverty Alleviation Equation: The Case of Neonicotinoids** | *Dr. E. Dankyi, University of Ghana* • **Launch of Neonicotinoids Report** • **Panel Discussion on Dissemination Modes for the Report**
12.40 – 13.40	LUNCH
14.00 – 16.55	**SESSION 2: THE TECHNOLOGY THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY AND POVERTY ALLEVIATION** [This section will also focus on the cutting edge technologies that are readily available or can be development to meet the challenge of sustaining food productivity, reducing food loss and waste, and recovering produce that is currently wasted].
13.50 –14.20	**Cassava Diseases: Threat to Food Security in Africa** *Dr. Patrick Chiza Chikoti, Zambia*
14.20 – 14.50	**Factors Influencing Camel Production Food Security and Poverty in Marsabit North District, Kenya** | *Prof. Timothy Maitho, Kenya*
14.50 – 15.20	**Improvement of the Quality, the Processing/Preserving Technique and the Diversification of Meat and Meat Products in Burkina Faso** *Dr. Kabore Donatien, Cameroon*
15.20 – 15.50	**Importance of Post-Harvest Technology on Achievement of Food Security and Poverty Alleviation: Success Stories and Academy Initiatives** | *Prof. Ababacar Sadikhe Ndoye, Senegal*

15.50 – 16.20	**Radiation Technologies for Food Preservation and Extension of Shelf-Life |** *Dr. Abraham Adu-Gyamfi, GAEC, Accra*
16.20 – 16.50	**Proven Technologies that have contributed to Food Security and Poverty Alleviation in Cameroon/Central African Sub-region** *Dr. Kingsley Etchu, Cameroon*
16.55	**Housekeeping Announcements/ Adjourn**
19.00	DINNER
FRIDAY, NOVEMBER 15, 2019	
	SESSION 3: THE INNOVATION THAT DETERMINES THE ACHIEVEMENT OF FOOD SECURITY AND POVERTY REDUCTION [This section will highlight success stories and innovative solutions that are readily available or can be developed to meet the challenge of feeding a growing, mostly disadvantaged, population by producing more food hopefully, with fewer resources] **CHAIR:** *Prof. Isabella A. Quakyi*
8.30 – 9.00	**Digital Tools for Agriculture and Social Protection |** *Castro Antwi Danso, Director, Sales and Marketing, Esoko Ghana*
9.00 – 9.30	**Establishing a Sudanese Aflatoxin Research and Control Network |** *Suad Sulaiman, SNAS*
9.30 – 10.00	**Prospects of Sorghum and Millets to Enhance Food and Nutrition Security and Poverty Alleviation in The Face of Climatic Change in Africa |** *Dr Rose Kingamkono, TAAS*
10.00 – 10.30	**Agricultural Water Innovations for Enhancing Food Security In Africa |** *Dr. Olufunke Cofie, International Water Management Institute, Ghana*
10.30 – 10.45	BREAK
10.45 – 11.15	**Strengthening Policy and Science Interface in Research and Development of Climate Smart Emerging Crops in Botswana** *Dr. Kebadire Khola Mogotsi, Tanzania (PANITA)*
11.15 – 12.45	**Contribution of Multi-Stakeholder Innovation Platforms in Achieving Food Security and Improving Farmers' Income in Burkina Faso** *H. Traoré, Burkina Faso*
12.45 – 13.45	LUNCH
13.45 – 14.15	**Feeding a Growing Population by Producing More Food with Fewer Resources |** *Rose Adhiambo Nyikal, Kenya*
14.15 – 14.45	**Climate Smart Agriculture, Resilience Building and Food Security In The Eastern Cape, South Africa |** *Philani Moyo, South Africa*
14.45 – 15.15	**Produced in Africa, Accepted Worldwide: Using Home grown science to meet international needs |** *Dr. Lauren Alexander Augustine, US-NASM&E*
15.15 – 15.55	**ROUNDTABLE DISCUSSION — THE 4TH INDUSTRIAL REVOLUTION, ARTIFICAL INTELLIGENCE AND FOOD SECURITY** **Moderator:** Prof. Isabella A. Quakyi, FGA **H. Traoré,** *Burkina Faso*	**Esoko,** Ghana, *Royal Society, UK* **Bright Simons,** *GhYA*
16.00 – 17.30	**INTERNATIONAL NETWORK FOR GOVERNMENT SCIENCE ADVICE (INGSA)-Africa** – Science Advice
17.35	**Closing Remarks/Handing over to the Academy hosting AMASA-16**
17.40	COCKTAIL RECEPTION
19.00	DINNER
SATURDAY, NOVEMBER 16, 2019	
8.00	**NASAC General Assembly Meeting**
13.00	**GAAS@60 Anniversary Luncheon / Send-off Reception for International Participants at AMASA-15 Venue: GAAS Auditorium**

The Network of African Science Academies (NASAC) was established on 13th December 2001 in Nairobi, Kenya, and is currently the affiliate Network for Interacademy Partnership (IAP) in Africa. NASAC is a consortium of merit-based science academies in Africa and aspires to make the "voice of science" heard by policy and decision makers within Africa and worldwide. NASAC is dedicated to enhancing the capacity of existing national science academies and champions the cause for creation of new academies where none exist.

As at November 2019, NASAC comprised of the following twenty-eight members:

Academie Nationale des Sciences et Technologies du Senegal (ANSTS)
Academy of Scientific Research and Technology of Egypt (ASRT) - *Provisional Member*
Academie Nationale des Sciences du Burkina (ANSB)
Academie Nationale des Sciences et Technologies du Congo (ANSTC)
Academie Nationale des Sciences, Arts et Lettres du Benin (ANSALB)
Academie Nationale des Sciences, Arts et Lettres du Togo (ANSALT)
Academy of Science of South Africa (ASSAf)
Academy of Sciences of Mozambique (ASM)
African Academy of Sciences (AAS)
Algerian Academy of Science and Technology (AAST)
Botswana Academy of Science (BAS)
Burundi Academy of Science and Technology (BAST)
Cameroon Academy of Sciences (CAS)
Ethiopian Academy of Sciences (EAS)
Ghana Academy of Arts and Sciences (GAAS)
Hassan II Academy of Science and Technology, Morocco
Kenya National Academy of Sciences (KNAS)
Madagascar National Academy of Arts, Letters and Sciences
Mauritius Academy of Science and Technology (MAST)
National Academy of Cote d'Ivoire
Nigerian Academy of Science (NAS)
Rwanda Academy of Sciences (RAS)
Sudanese National Academy of Science (SNAS)
Tanzania Academy of Sciences (TAS)
The Uganda National Academy of Sciences (UNAS)
Tunisia Academy of Sciences (TAS)
Zambia Academy of Sciences (ZaAS)
Zimbabwe Academy of Sciences (ZAS)

For more information, please contact us on:
The NASAC Secretariat
Miotoni Lane, Off Miotoni Road
P.O. Box 201-00502, Karen, Nairobi, Kenya | Tel: +254 712 914 285
Email: nasac@nasaconline.org | Website: www.nasaconline.org