THE NIGERIAN ACADEMY OF SCIENCE

STRENGTHENING RESEARCH CAPACITY IN NIGERIA

PROGRAMME REPORT

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About the Nigerian Academy of Science

The Nigerian Academy of Science (NAS), established in 1977 (but incorporated in 1986), is the foremost independent scientific body in Nigeria. NAS is uniquely positioned to bring scientific knowledge to bear on the policies/strategic direction of the country and is also dedicated to the development and advancement of science, technology, and innovation (STI) in Nigeria. The aim of the Academy is to promote the growth, acquisition, and dissemination of scientific knowledge, and to facilitate its use in solving problems of national interest. Over the years, the Academy has done this by:

- Providing advice on specific problems, of scientific or technological nature, presented to it by the government and its agencies, as well as private organizations
- Bringing to the attention of the government, and its agencies, problems of national interest that science and technology can help solve
- Establishing and maintaining the highest standards of scientific endeavour and achievement in Nigeria, through the publication of journals, organization of conferences, seminars, workshops, and symposia, as well as the recognition of outstanding contributions to science in Nigeria, and the development of a working relationship with other national and international scientific bodies and academies.

As with national academies in other countries, NAS is a not-for-profit organization with total membership (since inception) of 289 Fellows elected through a highly competitive process. The Fellows are scientists who have distinguished themselves in their fields both locally and internationally. Some of the Academy's members have also served as vice-chancellors of universities, directors-general of government parastatals, and ministers in federal ministries. The Academy, given its clout, can also attract other experts from around the country and internationally, when needed. NAS is Nigeria's national representative on such bodies as the International Science Council (ISC) - the umbrella body for all science associations and unions, and the InterAcademy Partnership (IAP) - the umbrella body for all national science academies globally. The Academy is also a founding member of the Network of African Science Academies (NASAC) and Nigeria's representative on the network.

Executive Summary

Research is critical to Nigeria's development, as research outputs should ideally provide a roadmap to guide the decisions of policymakers. However, the research landscape in Nigeria is faced with various challenges, which have left a capacity gap among the current crop of researchers, that needs to be filled. The *Strengthening Research Capacity in Nigeria Programme*, implemented by the Nigerian Academy of Science from March 2023 to December 2023, was designed to address the research capacity gap in Nigeria, particularly among early career researchers, as well as to facilitate an enabling environment for research and researchers to thrive.

NAS' approach was to convene a meeting of key stakeholders in Nigeria's research environment, to identify challenges to the research landscape in Nigeria, and proffer strategies to address them. Recommendations from the stakeholder engagement for strengthening Nigeria's research ecosystem are highlighted below:

- Regular needs assessments to identify skill gaps and training requirements among professionals in various sectors should be conducted. This data-driven approach ensures that training programs are relevant and tailored to specific capacity-building needs.
- Collaboration among universities, research institutions, and industries should be fostered to develop training programs that align with industry demands and provide real-world experiences for participants.
- Through prior consultation and buy-in from the private sector, research funding mechanisms such as competitive grant programs, and public-private partnerships can be identified and put in place to help fund research projects. Venture capital and innovation funds that provide funding for startups and innovative projects in areas that align with national development priorities should be established.
- Strong monitoring and evaluation mechanisms must be put in place by universities and research institutions to improve institutional efficiency and avoid grants misappropriation.
- Mechanisms for research quality evaluation and assurance should be established to ensure the quality and integrity of research, including peer review processes, and an effective monitoring system.
- Beyond the 'publish or perish syndrome' – which drives research quantity, rather than quality, government and research institutions should create incentives/reward systems that drive high-quality research production, with societal relevance.
- In collaboration with the industry/private sector, technology transfer offices should be set up within universities and research institutions to facilitate the commercialization of research, and its adoption by industry.
- Researchers should be trained on communication of research findings in a manner that can be easily understood and used by the general public and by policymakers. This would increase the demand and uptake of research by policymakers.
- Policies which support the recruitment and retention of females, under-represented groups, and persons with disability, including research grants targeting female researchers, and age-flexible PhD training support should be supported.

Also, as part of the programme, 20 competitively-selected early career researchers (ECRs) were engaged in a 5-month research mentorship programme, which had each of the ECRs paired with a

more experienced mentor. The aim was for the mentees to gain knowledge and skills in various areas including proposal writing, research methods, data analysis, report writing, research publication, and effective science communication. The goal of the mentorship programme was to strengthen the research capacity of ECRs through direct mentorship, thereby enhancing the academic and career success of the ECRs.

Mentors and mentees that participated in the research mentorship programme indicated that the programme met their expectations. The mentorship experience helped to enhance mentees' research knowledge and skills, contributed to developing personal and professional relationships, and provided platforms for research collaboration. The success stories from the mentorship program, as highlighted in this report, showed that the engagement was useful in providing support and guidance to early career researchers for a successful research career, and providing opportunities for general career development. This demonstrates a feasible approach, through mentoring, to strengthening the research ecosystem. NAS is exploring opportunities to scale-up the mentorship programme nationwide, so as to have a wider impact on enhancing the research capacity of the next generation of researchers in Nigeria.

The outputs from the programme activities have been compiled in this programme report and disseminated as a reference/ resource material for stakeholders. The report is also to stimulate discussions towards the creation of a National Research Policy for Nigeria – which would establish a framework for an improved research environment in Nigeria, and the enhancement of research quality, uptake, and impact.

Chapter 1: Introduction

1.1 Overview of Nigeria's Research Landscape

The main stakeholders in Nigeria's research landscape include the academia, research institutions, government, private sector/industry, and funding agencies. Nigeria has an extensive network of 170 universities to address the growing demand for higher education (43 federal universities, 48 state universities, and 79 private universities)[1], polytechnics, and colleges of education. Despite this large number, Nigerian universities have not fared well in global rankings. Based on performance indicators which include teaching, research impact (measured by research citations), knowledge transfer and innovation, only two Nigerian universities made the top 1000 in the world in the most recent *Times Higher Education* world universities rankings[2].

In the research framework, the government plays the roles of regulation, funding, and policymaking. The Federal Ministry of Science, Technology, and Innovation (FMSTI) centrally coordinates research and development activities in Nigeria. The Ministry is responsible for the formulation, monitoring and review of policies relating to science, technology, and innovation, diffusion of research and technology, and the promotion of indigenous research capacity to facilitate technology transfer. The FMSTI also supervises the activities of public research institutes such as the Raw Materials Research and Development Council (RMRDC), National Board for Technology Incubation (NBTI), National Office for Technology Acquisition and Promotion (NOTAP), National Biotechnology Development Agency (NABDA), Nigerian Institute for Oil Palm Research (NIFOR), Centre for Energy Research and Development, among others.

Most of the research environment in Nigeria is directly controlled by the government. However, the private sector's role in research includes translating scientific discoveries into products, services, and other developments, as well as providing research funding.

The Nigerian government's main research funding instrument, currently, is the National Research Fund (NRF) of the Tertiary Education Trust Fund (TETFund), an agency of the Federal Ministry of Education. Only public universities have access to NRF funding. International donor organizations like the Bill and Melinda Gates Foundation, MacArthur Foundation, etc, also fund research. However, their funding tends to be tied to their own research interests, and so the researchers they fund do not have complete control over the research they carry out.

Nigeria's research and development expenditure relative to its GDP has remained quite low (0.34% as at 2022)[3] despite the government's promises in the past to increase budgetary allocation to education and research. Indeed, when the challenge of funding is examined more critically, issues exist within the Nigerian socioeconomic and political system that further worsen the situation:

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[1] Number of universities in Nigeria as of 2023, by ownership. Available at https://www.statista.com/statistics/1130701/number-of-universities-in-nigeria/#:~:text=There%20are%20170%20universities%20in,and%20the%20University%20of%20Lagos Accessed 13/07/2023

[2] https://www.timeshighereducation.com

[3] Statista (2023). Value of gross domestic expenditure on research and development (GERD) in Nigeria from 2020 to 2022. https://www.statista.com/statistics/1345424/annual-gerd-value-in-nigeria

- the economy struggles with hyperinflation
- 90% of revenue is spent on debt servicing
- the education/research economy is largely import dependent, coupled with Nigeria's dwindling foreign reserves
- highly unstable currency
- Nigeria's economy is not knowledge-driven, and the prevailing culture is largely anti-intellectual
- a predominantly informal economy, with the formal sector shrinking.

Fundamental challenges within the research landscape, other than funding, that need to be addressed include an inadequate acknowledgement of the relevance of research to national development and a poor link between research and policy. Presently, most research outputs remain in theses booklets (on library shelves) and publications in journals, unknown to government and industry - two stakeholders who need the information for policy and practice.

1.2 The Capacity Gap

Various challenges plague Nigeria's research sector, including poor funding and remuneration of research staff, poor research funding, inadequate facilities, frequent labour strikes by universities and research institutes, and the increasing exodus of skilled researchers to other nations for better working conditions. Meanwhile, the more experienced and accomplished researchers are retired/retiring. This has left a capacity gap among the current crop of researchers that needs to be filled. The capacity gap among Nigerian scientists/researchers poses a challenge to the sustainability and integrity of academics, the credibility of new research findings, and the Nigerian scientific community in general.

In addition, though Nigeria has an STI (science, technology and innovation) policy in place, there is no actual research policy. Moreso, even the current STI policy does not consider gender issues particularly.

While public research institutes are commissioned to undertake research by the government, the government does not make frequent or consistent use of research findings. Moreover, research in Nigerian universities is often misaligned with national priorities. To enable the Nigerian university/research community contribute to national development through research and innovation, these challenges need to be addressed. By creating an enabling environment (institutions, policies, and programs) that supports research and researchers, and by enabling the retention and participation of women in research careers, Nigeria would be better positioned to integrate research and innovation outputs into development efforts.

1.3 Programme Aims and Objectives

The *Strengthening Research Capacity in Nigeria Programme* is aimed at enhancing scientific research capacity in Nigeria, as well as facilitating an enabling environment for research and researchers to thrive.

The NAS' approach to this was to bring together relevant stakeholders at a stakeholders' workshop, held in May 2023. Participants discussed the existing research landscape in Nigeria, identified areas of strengths, weakness, and opportunities. Particularly, challenges in conducting scientific research in Nigeria were discussed extensively. Possible means of addressing identified challenges, especially the roles of the academia, policymakers, industry, and other stakeholders were explored.

Also, as part of this programme, 20 competitively-selected early career researchers (ECRs) were engaged in a 5-month (1st June – 31st October, 2023) research mentorship programme, which had each of the ECRs paired with a more experienced mentor. The aim was for the mentees to gain knowledge and skills in various areas including proposal writing, research methods, data analysis, report writing, research publication, and effective science communication. The goal of the mentorship programme was to strengthen the research capacity of ECRs through direct mentorship, thereby enhancing the academic and career success of the ECRs. At the end of the mentorship period, a wrap-up workshop was organized to highlight the successes from this engagement, share knowledge, successes, and experiences from the mentorship period, and to discuss further strategies for strengthening research capacity in Nigeria.

The outputs from the programme activities have been compiled in this programme report and disseminated as a reference/ resource material for stakeholders. The report is also to stimulate discussions towards the creation of a National Research Policy for Nigeria – which would establish a framework for transdisciplinary research and innovation, and enhancement of research quality, uptake, and impact. Overall, the programme has contributed to improving the enabling environment for research and enhancing the research capacity of the next generation of researchers in Nigeria.

Chapter 2: Summary of Programme Activities

2.1. Stakeholders' Workshop

The *Strengthening Research Capacity in Nigeria* Stakeholders' Workshop took place on the 15th of May, 2023 at the Continental Hall, Reiz Continental Hotel, Abuja.

The purpose of the workshop was to bring together key relevant stakeholders to discuss the existing research landscape in Nigeria, identify areas of strengths, weaknesses, and opportunities. There was particular focus on challenges in conducting scientific research. Possible means of addressing identified challenges, with attention to the roles of the academia, policymakers, industry, and other stakeholders were explored. Additionally, the need for a National Research Policy, to strengthen Nigeria's commitment to improving scientific research capacity, was discussed. Participants at the workshop included researchers from universities and research institutions, officials of relevant government departments and agencies, the private sector, development agencies, and the media.

Picture 1: Participants at the stakeholders' workshop

Discussion at the workshop centered on the importance of research, and its link to national development. Research is fundamental to the generation of appropriate solutions for development. Societies that invest in research and innovation develop at a faster pace than those who do not, even if the research starts from imitating existing technology. Societies that do not develop their intellectual capital are doomed to underdevelopment and exploitation.

For research and development activities to have significant economic impact (i.e., to be marketable), they must occur within a strong innovation system, be connected to the immediate needs and demands of the society, and present a potential for entrepreneurial opportunities. Therefore, the

Nigerian government (federal & state levels) must appreciate the need for a greater commitment to strategic planning for research & innovation, related legislative reforms, and funding of research activities. The discussions are summarized below:

Science Research Capacity in Nigeria – The Status Quo

Professor Azikiwe Peter Onwualu *FAS*, the Acting President of the African University of Science and Technology, Abuja gave the keynote address. The key message, from his address, was that there is a strong nexus between research and innovation, on the one hand, and economic development on the other. He noted that Nigeria's underdevelopment can largely be attributed to the fact that the research and innovation ecosystem is weak and so does not impact positively on the productive sector of the economy. The situation, however, can be changed if the existing research and innovation ecosystem is strengthened to use research and innovation to drive the productive sector. Strategies for doing this include having strong and coordinated institutions, increased research funding, operationalization of the National Research and Innovation Council, a functional National System of Innovation (NSI), and developing a national research policy.

Brain Drain and Nigeria's Research Expertise

Professor Akinyinka Omigbodun *FAS*, a former president of the West African College of Surgeons and past Chair of the board of the Consortium for Advanced Research Training in Africa, spoke on *Brain Drain and Nigeria's Research Expertise*. Brain drain constitutes the loss of human capital - the most important resource a nation possesses. Nigeria's research institutions can only be strong if they grow and develop through the continuous production of high-quality research output. If Nigeria is unable to retain the human resources to drive growth, her institutions will ultimately decline. Nigeria's research enterprise will suffer if the trend of brain drain is not stemmed. Training and retention of researchers requires political commitment and the investment of resources. The speaker noted that the internal brain drain of researchers, to more lucrative sectors of the economy, can be just as debilitating as external brain drain resulting from migration overseas. Investment in research networks and clustering of research hubs can also help generate a critical mass that would encourage researchers to remain in the sector.

Research Funding for Nigerian Tertiary Institutions

Professor Francis Egbokhare, a former president of the Nigerian Academy of Letters, spoke on the challenge of research funding and recommendations for increasing research funding for tertiary institutions. According to him, new modes of funding and investment would require legislation that supports improved funding of research, and devotion of at least 1% of national GDP. The government can also mandate the compulsory allocation of funds to R&D activities and infrastructure in universities and research institutions by the private sector (including multinationals). There should be mandatory allocation of budgets of all public entities to R&D and mainstreaming at least 25% of all internally generated revenue in institutions to R&D. Also, the local content policy should be expanded to include consultancy and R&D in Nigerian institutions. Finally, the Nigerian government needs to stop its dependence on foreign funding for local research. The challenge with external funding is that the institutions cannot determine their own research agendas in line with the national goals. The Executive Secretary of TETFund was present at the workshop and, in his comments, stressed the importance of 'building a business-case' for research, so that potential donors see the value, and are encouraged to provide funding for research. He also promised to engage further with NAS about this and to explore how to improve funding for research.

Crisis Management in Nigerian Tertiary Institutions

Crises existing within Nigerian tertiary institutions usually emanate from stakeholders such as the Academic Staff Union of Universities (ASUU), Non-Academic Staff Union (NASU), National Association of Nigerian Students (NANS), other professional associations, etc. Government's failure to honour agreements made with these unions usually gives rise to frequent strike actions, thereby resulting in the interruption of academic activities. According to Professor Isaac Adeyemi *FAS*, a former Vice-Chancellor of the Bells University of Technology, periodic consultations with stakeholders, transparency, accountability and fairness in all dealings, periodic review of policies and agreements as well as their timely implementation, can help manage threats to the smooth running of tertiary institutions. This would consequently create a productive and beneficial research environment for the students and staff of the research institutions, and by extension, the nation.

Institutional Governance for Improved Research Capacity

This presentation, by Professor Babatunde Salako *FAS* (Director-General of the Nigerian Institute for Medical Research), focused on the governance challenges research institutions face, and recommendations for improving institutional capacity. Institutional governance provides the structure, policies, and processes that create an enabling environment for the coordination and conduct of research, and help institutions ensure that research is conducted ethically and rigorously to meet societal needs. According to him, building research capacity requires improvements at both individual and institutional levels:

- the individual level entails education and training in specific research competencies such as writing for academic journals, research methodologies, and ethical principles.
- institutional level capacity building focuses on reforming management structures; strategic protocols for recruiting and retaining researchers; incentive, reward, and recognition systems; infrastructural development such as laboratories and research equipment; and support mechanisms for scientific research.

An effective governance system entails the active collaboration between scientists, policy makers, and other research participants to improve the capacity to conduct and use research findings for the overall interest of the nation.

Strengthening Partnership and Collaboration

Perspectives from industry, policymakers, academia, and development partners with strategies to improve collaboration for increased research capacity were highlighted. There is an urgent need to improve domestic funding for public health research and stop over-dependence on foreign funding. Also important is 'building a business-case' for research so that potential donors see the value and are encouraged to provide funding. Collaboration across relevant government ministries, departments, and agencies (MDAs) increases the efficiency and effectiveness of research. It is necessary to improve coordination among research institutions, and especially trans-disciplinary coordination, to have a more robust approach to conducting research. Capacity building and knowledge-transfer is also important for implementation/translational research.

In conclusion, based on the size of Nigeria's research system, a significant opportunity exists for strengthening research capacity in Nigeria. If an enabling environment is created, and researchers are suitably incentivized to produce and disseminate high-quality research, Nigeria could become a bigger contributor to the global research landscape. Also, the need for evidence-informed policymaking cannot be over-emphasized. More effective approaches are needed to bridge the policy-research gap in Nigeria. Recommendations for bridging this gap have been highlighted in Chapter 4 of this report.

2.2 Research Mentorship Programme for Early Career Researchers

The research mentorship programme aimed to address the capacity gap among the current crop of researchers in Nigeria by strengthening the research capacity of early career researchers (ECRs) through direct mentorship, thereby enhancing the academic and career success of the ECRs. The five-month programme lasted from 1st June to 31st October, 2023.

To select participants for the programme, a call for applications by mentors and mentees (in a national newspaper, on NAS' various social media platforms, and by email) was published. 452 applications were received from interested mentees. These applications were initially screened as per the stated eligibility criteria as follows:

- PhD holders/current PhD students currently working in academic research in a STEM field;
- between the ages of 25 and 40; resident and
- working in Nigeria.

The eligible applications were further screened based on their stated research projects, career plans, and strength of reference letters submitted. 90 applicants were eventually shortlisted. These 90 applications were then independently scored by 2 assessors using the scoring matrix shown below:

Scoring Criteria	**Scoring (100 total)**
Significance of career goals: Applicant is able to articulate a well thought-out and realistic career path	40 marks
Research Impact: Proposed research is likely to have a significant societal/policy impact that is clearly outlined	40 marks
Reference: Referee makes a strong case for the applicant	20 marks

The average score from the 2 assessors was taken, and the 20 candidates with the highest scores were selected as mentees for the programme.

For the mentors, 363 completed expression of interest forms received from interested mentors were initially screened based on their teaching/research experience; scholarly status - google citation score, h-index, etc.; relevant publications; and previous mentoring experience. The selected mentees were then matched with an appropriate mentor based on location and shared research interests of mentors and mentees. Priority was given to Fellows of The Nigerian Academy of Science, given that their excellent rating is already assured. Where appropriate matches were not found among the Fellows who indicated interest, the remaining candidates were rated based on the criteria above plus their motivation/research experience and matched with the appropriate mentees.

Table 1: Distribution of Selected Mentees

S/N	Research Specialization area	Geopolitical Zone	State	Type of Institution	Gender	Age
1	Toxicology	Southwest	Oyo	Federal	Female	35
2	Biochemistry	Southwest	Ogun	Private	Female	39
3	Biochemistry	Southwest	Ogun	Private	Female	26
4	Plant breeding and genetics	Southwest	Oyo	Non-profit	Female	33
5	Food Science and Technology	Southwest	Osun	Federal	Female	32
6	Food Engineering	Southwest	Oyo	Federal	Male	35
7	Mycology and Biotechnology	Southwest	Osun	Federal	Male	32
8	Clinical Haematology	Southwest	Lagos	Federal	Male	39
9	Chemistry	Southeast	Anambra	Federal	Male	35
10	Natural product and Pharmaco-epidemiology	Southeast	Anambra	Federal	Male	33
11	Organic Chemistry	North Central	Benue	Federal	Female	38
12	Biochemical Pharmacology & Toxicology	North Central	Kwara	State	Female	25
13	Biosystems Engineering	North Central	Kwara	Federal	Male	38
14	Chemical and Aerospace Engineering	North Central	FCT	Private	Female	33
15	Fibre Science and Polymer Technology	Northwest	Kaduna	Federal	Male	33
16	Computational Chemistry	Northwest	Sokoto	Federal	Male	38
17	Physical and Computational Chemistry	Northeast	Borno	Federal	Male	35
18	Environmental Biochemistry	South-South	Rivers	Federal	Female	35
19	Environmental and Public Health	South-South	Rivers	State	Male	32
20	Cell and Molecular Biology/Phytopathology	South-South	Edo	Federal	Male	30

In view of gender equality and social inclusion (GESI) in the mentorship programming, the following were considered in the selection of mentees:

- Regional inclusion: Mentees were selected across the six geo-political zones of Nigeria.
- Gender: Of the 20 mentees selected, 9 (45%) were female, and 11 (55%) were male.
- Age: A diverse spread of early career researchers was recruited, with a mean age of 34 years. The youngest mentee was 25-years old while the oldest was 39-years old.

- Academic status: As at the time of application, five of the selected mentees were PhD holders, while the rest were at various stages of their PhD studies.

To kick off the mentorship programme, a mentor-mentee roundtable was held on the 16th and 17th of May 2023, to orientate selected participants for the programme. The mentors and mentees were briefed on the expectations for the mentorship programme, reporting schedules, and other useful information. It also presented a platform for mentees to meet, physically, with their mentors, and other mentor-mentee pairs, prior to the start of the mentorship programme.

Picture 2: Participants at the mentor-mentee roundtable

There was a goal-setting session where the mentees stated their expectations from the programme as it relates to their research and career development. An action plan to implement and achieve the set goals was devised by each mentor-mentee pair. During dedicated sessions at the mentor-mentee roundtable, each mentee had a chance to give a short presentation of their research project, to get feedback from other participants. The feedback from these sessions contributed to providing support, and improving the quality of the mentees' research. It is expected that the outputs from their various research projects (many of which are still ongoing), with relevant societal/policy implications, will ultimately contribute significantly to the existing body of knowledge in those specialties. Beyond that, the mentees have gained inspiration and critical skills (through mentorship) that would have far-reaching and long-lasting impact on research in Nigeria.

Pictures 3-5: Each mentor-mentee pair had an initial introductory meeting during the mentor-mentee roundtable

At the mentor-mentee roundtable, participants were introduced to the *Strengthening Research Capacity in Nigeria Programme,* including the motivation for the programme, and how the research mentorship programme would contribute to achieving the overall programme objectives - improved research capacity in Nigeria, strengthened networks, collaboration, and knowledge sharing among researchers, as well as production of research outputs with policy-relevant implications. Discussions at the roundtable are briefly outlined below:

The Role of Mentorship in Securing the Future of Science: Dr. Enang Moma, National Professional Officer (Science) at the United Nations Educational, Scientific, and Cultural Organization (UNESCO) delivered the keynote address, titled *The Role of Mentorship in Securing the Future of Science*. She emphasized that science lays the foundation for practices, innovations, and technologies needed to address global challenges today and in the future. She noted that there is a need to mobilize science and scientists at multiple levels and across disciplines to achieve the global sustainable development goals. Mentorship is necessary to encourage more young people to enroll in STEM courses and build a critical mass of scientists.

Academic Writing and Plagiarism: This session, facilitated by Dr. Loretta Ntoimo (a member of the Women's Health and Action Research Centre) was held to brief participants on academic writing, including plagiarism and its implications. Academic writing is important for knowledge production. It is critical for policymaking and other planning purposes, and it contributes to sustainable advancement and development when evidence/lessons from research are used. Plagiarism has a negative impact on research/researchers; it gradually erodes public confidence in the power of research. It also misleads the academic community, policy makers, and the society who depend on empirical research evidence. Mentorship and collaboration with established scientists can help early-career researchers to position themselves to publish in top journals and improve their visibility.

Avoiding Predatory Journals and Conferences: Professor Friday Okonofua *FAS*, the Editor in Chief of the African Journal of Reproductive Health gave a presentation on this topic. He noted that early career researchers, due to their inexperience, and in a bid to climb up the academic ladder, inadvertently, fall prey to exploitative academic journals and conferences. Ultimately, such publications will adversely impact on the reputation and career of the scientist. Nigerian scientists are some of the most affected globally by these predatory journals and conferences. These fraudulent journals and conferences do not provide adequate scientific content or editorial control over the publications and presentations. Papers selected by these journals and conferences do not go through a rigorous peer-review process as is expected for quality academic products. Tips for identifying predatory journals and conferences were outlined by the speaker, as well as online databases/resources for genuine journals. Mentees were also encouraged to speak to their supervisors and other colleagues for advice, prior to submitting articles for publication, in order not to fall victim to predatory journals.

***Best Practices in Research Methodology*:** To achieve the objective of producing high quality research, the mentees and mentors had a refresher session on research methodology. Professor Olanike Adeyemo *FAS*, a professor of Veterinary Public Health and Preventive Medicine at the University of Ibadan, facilitated the session. This presentation covered important points including choosing the right research methodology (quantitative or qualitative) depending on the aims and objectives of the proposed research; data collection methods and sampling strategies; and data analysis techniques. Also, the need for multidisciplinary and interdisciplinary research and collaboration as an approach for knowledge transfer, and for solving research problems was emphasized.

Developing an Effective Career Plan: Dr. Abidemi Akindele, a member of the Global Young Academy and former president of the Nigerian Young Academy, spoke on career progression and fulfillment. An effective career plan is an important first-step to career fulfillment as it provides guidance for a successful professional life; aids identification of career options and the development of a strategic plan for achieving set goals. It keeps one focused, even in the face of challenging situations. Mentees were advised to take time out for self-assessment in order to identify their individual skills, interests, values, preferred work environment, etc – all of which are important in identifying a career path and developing a career plan.

Maximizing the Mentorship Experience: A breakout session was designed for the mentees, where they were given important tips for making the most of the research mentorship programme. The panel for this session was made up of members of the Nigerian Young Academy, who had also passed through mentorship in the past. Among others, there were tips for maintaining a good work-life balance, mentees were encouraged to cultivate the habit of listening, sharing experiences, and giving feedback. Mentees should be available and responsive to advice from mentors, show humility, and respect confidentiality. Mentors were encouraged to track the progress and successes of their mentees and be open to changes.

Selected mentees at the event had a chance to pitch their proposed project proposals and got inputs from other participants. There was also ample opportunity for networking among the mentors and mentees. Some mentees were immediately given links to possible equipment and collaborators for their research.

Mentees and mentors in the mentorship programme were required to abide by agreements stated in a code of conduct agreement. These expectations included committing to regular meetings over the course of the programme (in person at least once, and through other channels at other times), maintaining confidentiality, and providing program feedback to the NAS team. To ensure the success of the programme, it was important for mentors to commit to meeting regularly with the mentees to review progress, give feedback, provide recommendations for improvements, and guide research/ career development (such as reviewing grant proposals, journal submissions, and proposed conference presentations).

Mid-way into the programme, the NAS team held virtual check-in meetings with the mentees, to review their experiences in the research mentorship programme. The purpose of the meeting was for the NAS team to interact one-on-one with the mentees, and learn more about their progress, successes, and challenges with the mentorship programme. The mentees' feedback from the check-in meeting was mostly positive. The main challenge reported by a few mentees was the initial difficulty in scheduling meetings with their mentors due to conflicting schedules, and this had been largely resolved at the time. Some other mentees reported funding challenges in ongoing research, and difficulties in accessing laboratory facilities to run analysis for their research. In some cases, the mentors were able to provide support in exploring possible scholarship and other funding opportunities, as well as access to needed facilities for their mentees. All the mentees stated that they hoped to continue the relationship with their assigned mentors beyond this programme.

At the end of the mentorship period, the programme beneficiaries were convened at a wrap-up workshop to highlight the successes from the engagement, share knowledge, successes, and experiences from the mentorship period. Additionally, there were breakout sessions with discussion topics tailored to the specific needs of mentor and mentee groups. The mentees' session was

focused on leadership, and on paying forward the mentorship experience. The mentors' session was on exploring ways to institutionalize mentorship programmes in Nigerian universities. There were also discussions on partnership and collaboration in research, and on how to leverage social media networks for personal branding and visibility. Each mentor-mentee pair had an opportunity to meet for a final review session.

Insights and ideas for sustainability and scaling of the mentorship programme were also gathered from mentors, mentees, and other stakeholders at the wrap-up workshop.

Success stories shared by mentees:

- "The relationship has encouraged me to think outside the box of plant breeding, that is, see opportunities that I can fit in outside plant breeding. An example is attending the Complexity Global School for Emerging Political Economies in South Africa next month December, which will mainly involve applied research in plant breeding for policymaking."

- "I was selected for the 2023 Taiwan Government (Fully funded) PhD Scholarship. My mentor provided useful advice in the course of my application."

- "My mentor evaluated my career progression since I became a Faculty at the First Technical University and assessed my preparation for the next level of promotion. Consequently, I have fulfilled the necessary conditions for my next promotion and I will move to the next level seamlessly."

- "I was selected as a Fellow of the Nigeria Science Leadership Programme (NSLP) following a rigorous selection of 25 early career researchers amidst 1700 applications. My mentor helped review my application to the programme. This is one of the low-hanging fruits that was gleaned during the mentorship programme. The Programme held at the International Institute of Tropical Agriculture in Ibadan, Oyo State, Nigeria, between 19 and 24th October, 2023. My perspective of leadership was changed during the programme and I have been more equipped with skills that will aid my leadership of a team of researchers that would address different challenges posed by plant pathogens and climate change to food production and productivity in sub-Saharan Africa."

- "Four scientific papers, including two original articles, one review article and a book (in collaboration with my mentor) were written during the mentorship journey."

- "I had the privilege of participating in a webinar on *Design of Experiments* hosted by the Royal Society of Chemistry. This opportunity, facilitated through the guidance of my mentor, allowed me to gain insights into the intricacies of experimental design, which is crucial in scientific research."

- "I am working on a research project with my mentor on phytoremediation assisted with animal manure and have learnt a lot from this project. The project has exposed me to collaborations with colleagues in other disciplines."

- "I have learned effective time management techniques from my mentor, such as prioritizing tasks and setting specific goals."

- "I have attended so many conferences and workshops within and outside Nigeria, my presentation skills have greatly improved, and I am on the path of completing my Ph.D."

- "In collaboration with my mentor, we have successfully initiated research collaborations with scholars in South Africa, enhancing the global reach and impact of our work."

Chapter 3: Summary of Programme Outputs

3.1 Achievements

Useful recommendations for strengthening Nigeria's research capacity emerged from the stakeholders' workshop (see more on this in Chapter 4). The workshop agenda was tailored to address specific stakeholder groups in reference to strengthening Nigeria's research capacity i.e. strengthening national commitment (for policymakers); strengthening institutional capacity (for universities/research institutions); improving personal capacity (for individual researchers); and strengthening partnership and collaboration (for industry/civil society). Additionally, the need for a National Research Policy was discussed.

"At the start of the mentoring program, I was confused and tired of walking in circles regarding my unpublished research findings, my current research study, and finding a way to matter and belong in the scientific community. These worries and fears were shared with my mentor, and during the period of the formal mentorship, I was able to find a breakthrough concerning all the issues I had. At the end of the mentorship program, I had learnt how to write a proper manuscript for submission to appropriate journals. I have more confidence in myself. I have submitted a review article to the *South African Journal of Botany*, and it is in the second stage of review. Furthermore, I have been able to complete 95% of my research through constant input and motivation from my mentor."

Through the mentorship programme, the Nigerian Academy of Science achieved such outcomes as improved research knowledge and skills, enhanced theses quality, as well as an increase in the quantity and quality of research papers written by the mentees. Several mentees reported that they are better skilled in conceptualizing and designing research frameworks. A mentee reports:

'the mentorship has had tremendous impact on my research including improved research design through guided intensive review writing on my research topic. Two review manuscripts have been drafted for publication – "Microbiome and drug resistance in breast cancer" and "The role of chemo-preventives in reducing tumoral heterogeneity and metastasis in breast cancer". Three research papers written from my research have been sent to high impact scopus-indexed journals for publication. I also have increased interaction with the science community through conferences and abstract presentations.'

The one-on-one pairing, with well-established researchers/mentors, provided mentees with a personal relationship, inspiration, and offered opportunities for focused guidance by their mentors. Furthermore, pairing with mentors with the same, or similar, research interests afforded the opportunity for the mentee to receive relevant research-specific advice based on the mentor's experience. Additionally, having a mentor outside of the mentee's institution was beneficial as it created a safe space for mentees to be open about various concerns, and for their mentors to give objective advice. Some mentees have also had professional development opportunities provided to them by their mentors, e.g. by way of introduction to professional associations.

One of the mentors introduced his mentee to contacts at the Nigerian Stored Products Research Institute (NSPRI) for the purpose of exploring research collaboration and potential research funding for his mentee. Another mentee was nominated for the Young Physician Leadership Programme in June 2023, by his mentor, for the InterAcademy Partnership's Young Physician Leaders (YPL) programme. The NAS mentorship enabled his nomination as only IAP partner organizations (which NAS is) can nominate candidates for the programme. His mentor knew of the opportunity as he is a Fellow of NAS. Mentors also provided support and assistance in reviewing mentees' applications to various opportunities. A mentee who applied for the African Women in Agricultural Research and Development (AWARD) Leadership Programme for Emerging African Women in Science reported that her mentor provided ample guidance during the application process.

Mentees were required to provide regular reports, including number and format of meetings with their mentors, grants and applications reviewed, conference attendance, publications, and perceived helpfulness of mentee-mentor interactions in specific areas e.g. in research writing. Apart from monitoring the project, this also helped the mentees develop important skills necessary for accountability.

The mentorship programme also provided a platform for networking and collaboration. A mentee reported that "*based on the advice of my mentor, I applied and gained memberships of the Royal Society of Chemistry (RSC) and the American Chemical Society. These societies were part of my short-term career goals. Joining them was strategic to my career development as they offer support to early career scientists. As a result of the new membership, I obtained a researcher development grant from RSC which enabled me present a part of my research findings at the annual conference of the Chemical Society of Nigeria flawlessly*".

The mentees set up an informal network via social media (WhatsApp) to share information about research, and career opportunities amongst themselves. They also explored identifying projects that they could work together on. The mentees are writing a review article, to be submitted to a journal for publication. The article is titled *"Innovative Approaches to Mentorship for Science Advancement in West Africa: A Review of Best Practices and Success Stories"*. The article is currently being reviewed, and they plan to send it to a suitable journal soon.

3.2 Status and Next Steps for Establishing a Framework for the Creation of a National Research Policy for Nigeria

So far, there has been no successful attempt to develop a national research policy, due to poor inter-sectoral collaboration, such that individual sectors find it easier to create research policies for themselves. For example, the National Agricultural Research Policy and the National Health Research Policy are specific to the agriculture and health sectors respectively. The situation begs the question of which ministry/agency would be in charge of formulating a national research policy, and the ability of that ministry to successfully coordinate all other sectors and come up with policy strategies or provisions that would be acceptable to all. Another challenge is that policies and strategies are often not continued by new administrations, such that new policies are created that cannot be delivered within the duration of the administration only to be discontinued afterwards. This creates duplication of policies, and undermines their effectiveness, as they are usually not fully implemented.

At the stakeholders' workshop held in May, Professor Williams Siyanbola (the former Director-General of the National Centre for Technology Management) spoke on the need for a national research policy. In his exposition of the subject, he emphasized that the current situation in Nigeria requires a careful balance between existing policies and any new one, including a possible national

research policy (in the face of existing research policies for specific sectors e.g. National Health Research Policy, National Agricultural Research Policy, etc). Already, there is a significant coordination gap in Nigeria's policy space. There is also a real risk of duplication of activities because several similar institutional policies and frameworks exist such as the National Science, Technology, and Innovation (STI) Policy, the National Science, Technology, and Innovation Roadmap (NSTIR), and the National Intellectual Property Policy, which have overlapping areas.

A national research policy is needed as a national and central policy that will help coordinate, give an overview of research needs, direction, and funding in the country, and will be complemented with sectoral research policies. If carefully formulated and implemented, a national research policy will make the setting of a national research agenda easier. It would facilitate coordination within a fragmented research system like in Nigeria's, where too many institutional actors work in isolation. With a national research policy, every actor has a clear roadmap to link to. It would also outline mechanisms for responding to changes in the global research landscape. With a well-managed national research policy, it becomes easier to determine the nation's capacity gaps and forge plans to plug the gaps, thereby contributing to research ecosystem strengthening. Most importantly, a national research policy provides an opportunity for the integration of monitoring and evaluation mechanisms into the national research landscape. Such mechanisms will hold universities and research institutions accountable, as well as provide metrics by which they may subsequently receive funding.

Another aspect which a national research policy would address is increased collaboration between local, regional, and national institutions. Government funding initiatives could encourage inter-institutional collaboration by making such collaborations an eligibility requirement for funding. Actors in the Nigerian research landscape such as the Tertiary Education Trust Fund (TETFUND) could begin to implement such initiatives.

Beyond that, the key output of the *Strengthening Research Capacity in Nigeria* programme is to produce recommendations, informed by the engagement of early career researchers (ECRs) and/or other stakeholders, that would strengthen the research capacity in-country while also providing an impetus for establishing a national research policy. In learning from and addressing prior challenges in establishing a national research policy, any effort to create one would have to be preceded by intensive advocacy to the Presidency and to key individual ministries for support and collaboration.

In developing a possible national research policy, a first step would be to designate a coordinating body (possibly within an already existing agency) with technical expertise to set a roadmap for developing the national research policy. Extensive consultation must be done, involving the input of all key stakeholders from different sectors who would have a role in the policy. The consultations are vital to ensure that the policy would be reflective of the research needs of the various sectors of the economy, Nigeria's development priorities, as well as global trends.

Nigeria's development priority, according to the *National Development Plan 2021-2025,* is to create an enabling environment, for the qualitative participation in vital sectors of the economy, that will open opportunities for the private sector to be a major engine of growth[4]. In line with this, a wide range of stakeholders, including government agencies, academia, industry/private sector, civil society, and international organizations, should be engaged to ensure diverse perspectives and inputs. Collaboration

[4] National Development Plan (NDP) 2021-2025 Volume I (2021) Federal Ministry of Finance, Budget and National Planning

among the manufacturing, power/energy, urban development, digital economy, financial, and other sectors is especially necessary in infrastructural development for investment in research infrastructure (including state-of-the-art laboratories, research centers, and technology parks). One of the targets mentioned in the NDP 2021-2025 is to set up six technology and innovation centres across Nigeria's six geo-political zones by 2025. To lay the foundation for this, Nigeria must pursue a technology transfer and acquisition agenda in areas that limit Nigeria's economic productivity (including manufacturing machinery, digital innovation, artificial intelligence, etc.) and strengthen systems for registering patents, as well as promote and protect indigenous intellectual properties arising from such innovations. This technology acquisition agenda would also be pursued in harmony with the education sector to build a globally competitive workforce with skills that can support Nigeria's development priorities, as well as align with global trends. In line with the NDP's projected outcome to lift 35 million people out of poverty and create 21 million full-time jobs, the policy must also promote inclusivity, ensuring that it addresses the specific needs and concerns of marginalized communities and minority groups.

Furthermore, the various existing sectoral policies would need to be analyzed and evaluated to decide what areas can be incorporated into the national research policy in such a way that the needs of all parties are adequately catered for. Consideration of already existing science/research policies is important, particularly implementation gaps, and future priorities. The policy should have a long-term vision, spanning at least a decade, to provide stability and continuity for research initiatives; it should also be flexible enough to adapt to global trends. Also, lapses in the effective implementation of existing policies need to be identified, and strategies put in place in the new policy to address implementation gaps. Facilitating government–academia collaboration is a necessary step in ensuring that practical ways for using research findings to influence policymaking in Nigeria is contained in the policy that is eventually developed.

In addition, a robust system needs to be in place for monitoring the progress of research initiatives, evaluating the impact on development, and adjusting policy strategies accordingly. A dedicated body responsible for implementing, monitoring, and periodically reviewing the national research policy to ensure its effectiveness should ideally be established.

3.3 Initial Results of Mentorship Programme

At the orientation roundtable to kick off the programme, each mentor-mentee pair had a goal-setting session where the participants stated their goals and expectations from the programme. 90% of mentees had goals relating to increased research publications, conference attendance/ presentations, and assistance in reviewing ongoing research manuscripts. 80% of mentees indicated that their goal was to secure scholarships/grants for their research projects. Some other mentees simply wanted advice on how to climb up the career ladder, acquire presentation skills, expand their network with established researchers, or build a visible online presence.

To investigate the progress/impact of the mentorship programme in achieving these goals, the mentees were required to fill out monthly reports to elicit information on the following areas:

- Research experience gained, including research tasks completed (or ongoing) during the programme
- Research output (including any abstracts submitted or presentations made), research articles derived from thesis or initial research results during the program, work published, etc
- Mentees' rating of the mentor-mentee relationship, professionalism, and guidance received from mentor

- Interactions with other mentees and mentors in the programme
- Benefits gained and challenges faced during the programme
- General professional/career guidance provided by mentor

Research experience gained

Several mentees reported gaining a variety of research experiences and getting a better understanding of the research process during the programme. Through their mentors' guidance, they were able to build skills in idea conceptualization, literature review, research design, proposal writing, as well as analyzing and interpreting statistical results. Thus, the mentorship programme was successful in helping mentees develop research skills.

Research output (abstracts, presentations, and publications)

Some of the mentees presented at conferences, and published articles in journals. With guidance from their mentors, several mentees prepared and submitted abstracts to academic conferences.

- *A mentee attended the 46th International Conference of the Chemical Society of Nigeria held in Anambra State, from 17th- 23rd September 2023 where she presented a paper on "Phenolic profile and antimicrobial analysis of bee propolis from Enugu and Owerri apiaries".*
- *A paper titled, 'Variation in the morphology and effector profiles of Exserohilum turcicum isolates associated with the Northern Corn Leaf Blight of maize in Nigeria', was published in BMC Plant Biology, DOI 10.1186/s12870-023-04385-7.*
- *A research manuscript titled, 'Rapid screening methods for identification of resistant maize inbreeds to fungal foliar pathogens', is being prepared, and would be submitted to a journal to be considered for publication.*
- *One of the mentees' research manuscripts, "Critical Factors and Mechanisms Regulating Organic Micropollutant Adsorption from Water and Wastewater", is currently being updated and would be submitted to the Journal of Water Process Engineering to be considered for publication. Another of his research manuscripts titled, "Optimization of activated carbon production from Pentaclethra macrophylla pods for adsorption of azo dye wastewater", has been submitted to the Nigerian Journal of Technological Development (domiciled at the University of Ilorin, Kwara State). The article is currently being reviewed by the journal, and he is awaiting feedback.*
- *Another mentee did a poster presentation of her research abstract at the 8th UNIBADAN Biomedical Conference, at the University of Ibadan on the 11th – 15th of September, 2023.*

Additionally, in some instances, the mentor provided resources and suggestions for time management, as well as support and guidance to help avoid common mistakes and pitfalls. These helped the mentees stay organized and complete their research more efficiently. For example, one of the mentees reported that *"during this mentorship programme, I have successfully completed my research studies, which aligns with the research timeline but would have been impossible without the drive and mentorship from my mentor".*

Mentee ratings of mentorship received

Each month, the mentees were asked to rate their satisfaction with the mentorship experience. Their responses over the five-month programme are aggregated as shown in the figure below. In a questionnaire filled by the mentees, 85% of them stated that career counseling, professional network opportunities, scholarship or research funding opportunities, and research/publishing ethics are areas in which they had developed their capacity through the programme.

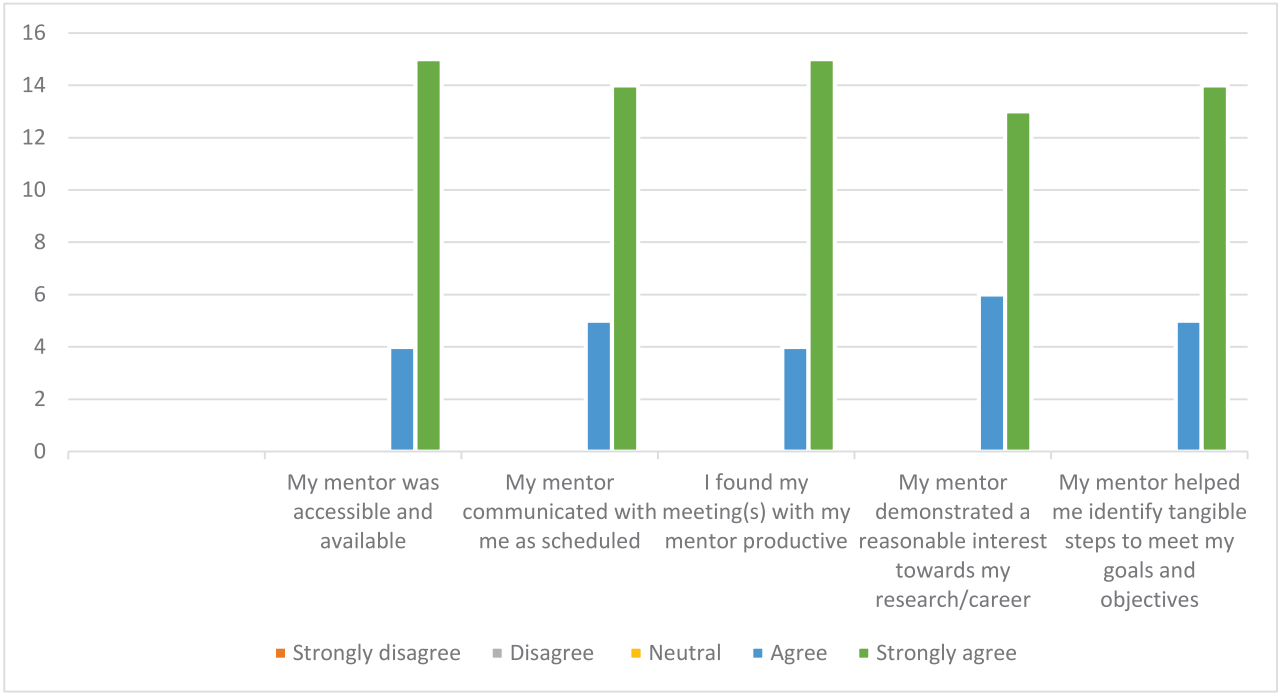

Figure 1: Mentees' satisfaction with their mentors

Interactions with other mentees and mentors in the programme

The mentors and mentees set up a network, via WhatsApp, to foster the sharing of ideas, and discussions on professional development opportunities. Aside of their assigned mentors, several mentees received research linkages and other support from other mentors in the programme.

Benefits gained and challenges faced during the programme

Several mentees indicated that they had challenges in accessing laboratory facilities/ equipment, as well as funding for their research projects. The project helped identify some options (people and institutions) through which they could access needed facilities for their research. Many of the mentees received support from their mentors on scholarship applications, and on other funding opportunities.

General professional/career guidance provided by mentor

Three mentees reported that they were selected to participate in the Nigeria Science Leadership Programme (NSLP). This opportunity was shared with them by their respective mentors. The programme was held at the International Institute of Tropical Agriculture in Ibadan, Nigeria, from the 20th to the 24th of October 2023. The NSLP serves early-to-mid-career researchers in basic and applied science, engineering, and social sciences. The goal of the program is to foster the development of academics in Nigeria, equipping them with skills in thought leadership, team development, engagement, and research collaboration. Other mentees received support from their mentors in reviewing scholarship and post-graduate fellowship applications. Mentors also provided advice in navigating issues around work-life balance, career growth, relationship with colleagues, etc.

Feedback from Mentees

- *I see the NAS Mentor-Mentee programme as an opportunity of a lifetime. I am grateful for the opportunity to attain self-improvement for perpetual growth through it.*
- *The programme is a beautiful initiative with lots of insightful lessons and welcome experiences and networks.*
- *My mentor provided significant inputs that led to the completion of a research grant project I was working on before I got admitted into the mentorship program. I also got professional development in form of enhanced research skills, effective communication, networking and collaboration.*
- *I have met with my peers working on climate change and environmental protection, and very senior and highly experienced scientists. We have established working relationships, and I look forward to a sustained working relationship.*
- *I have two successful publications now as a result of this mentoring program, and more manuscripts are currently being prepared for submission to suitable journals.*
- *I especially benefited from information on predatory journals, and developing an effective career plan.*
- *The encouragement I received from my mentor built up my self-belief and confidence, and I believe this attitude enhanced every other aspect of the mentorship and made it more successful.*
- *I was in the dark regarding what I needed to learn to grow, publish, reach the peak of my career, and achieve my goals and aspirations. All these lessons were made possible through the mentorship programme.*
- *The mentorship program significantly improved my perspective on research and learning through my highly experienced mentor. It was a great opportunity for me to expand my network with very senior researchers and my peers. I feel so much joy to be a part of the journey to building a brighter future of research and development in Nigeria.*

Feedback from Mentors

- *This is a good venture. It will actually improve the academic career of younger researchers.*
- *I am happy and encouraged to see my mentee make significant progress in her research and career through this mentorship programme. I also have new networking opportunities with experienced researchers through this programme*
- *Prior to the commencement of this programme, my mentee's work had known a drag due to some pending challenges. The first thing I did was to discuss the project's timeline. Thereafter, the work has gained significant progress and our collective target (her supervisor's inclusive) is to see to its completion this year and that we are taking adequate steps to achieve. Issues related to access to equipment have been addressed by making the required contacts.*
- *My mentee is close to securing a foreign scholarship for his PhD program. I issued a recommendation letter on his behalf*
- *I linked my mentee with the Vice President of the Organization for Women in Science for the Developing World (OWSD), and she is now a member. She will help start a branch in her university. I also facilitated her participation in a bioinformatics training programme.*
- *I have also learned some skills on building trust and providing guidance to early career researchers.*
- *The programme is set to secure the future of research in Nigeria*
- *My mentee listens and puts to practice all instructions given in prior meetings. She requests for clarifications on issues she was not clear with, and this has made me understand her mode of learning and how to explain future concepts to her for easy understanding and adoption. She has also exposed me to some literature on membrane technology. Rubbing minds with her has helped us beat a faster pace than we would if our meetings were simply the one-way approach.*
- *I have new and better perspectives on mentoring. I better appreciate some serious challenges that junior researchers grapple with, but which are pretty easy to surmount with proper guidance. Mentoring brings out the best in both the mentor and the mentee.*
- *My mentee's skills in scientific writing and grant proposal writing have been sharpened through the mini-projects he was engaged in during the period of mentorship.*
- *My assessment has shown considerable progression of the mentee on the overall*
- *I have learned from my mentee's dynamism, promptness in report submission and his ability to multitask.*

In conclusion, all the mentors and mentees that participated in the research mentorship programme indicated that the programme met their expectations. The mentorship experience helped to enhance mentees' research knowledge and skills, contributed to developing personal and professional relationships, and provided platforms for research collaboration. The mentors also benefited in terms of knowledge of newer research areas gained, and even learning from their mentees' work ethics.

3.4 Lessons Learned and Opportunities

NAS aims to ensure the continued success and growth of the mentorship programme, and encourage the institutionalization of the practice in Nigerian universities. For increased impact on the research landscape, future mentorship programmes, preferably, should have more beneficiaries, and have a longer duration. From the feedback solicited from the participants, 95% of mentees felt that five months was not a suitable period to achieve much, and suggested time periods ranging from one year to 18months. NAS proposes to engage with stakeholders in the academia to ignite an appetite, and perhaps a strategy, for the integration of mentorship programmes in universities across the country. Increasing the number of mentees (possibly 50-100 for a next cohort), will also mean that the possibility of additional mentorship tracks (inclusive of training for mentors). NAS would exploit her connections with the Nigerian Young Academy (NYA) to source for other early-to-mid career researchers who can be peer mentors and offer further assistance to selected mentees. Limited access to research funding was a major challenge for most of the mentees in the mentorship programme. As such, NAS aims to explore collaborations that would contribute to providing research grants to the mentees to help fund their research projects.

One of the desired outcomes from the mentorship programme was for sustainability. Also, to further cement their mentorship experience, project beneficiaries were encouraged to mentor others too. Feedback from mentees indicated that this intended outcome was already being produced. For example, one of the mentees reported that, as part of her vision to give back to the society, she started her first physical mentorship meeting with the Biochemistry department's graduating class at her institution. She gave a career talk on 'A journey of self-discovery'. Another mentee reported that she has a mentoring group at her department in Kwara State University, Malete. She also serves as an advisor for Yattiyr Scholarship Initiative, a scholarship initiative aimed at providing scholarships for students whose parents cannot afford their basic education.

The participants identified areas for programme improvement, and these include:

- Access to Resources: It would be useful, in the future, to collate resources on such topics as grant writing, work-life balance, research funding opportunities, and other useful areas. These resources should be domiciled on a virtual platform and made available to all mentees.

- Programme Monitoring: Improved tracking of meeting schedules, and report documentation would ensure better engagement with beneficiaries, and ensure that expectations are met. It is also important to develop an effective means of holding mentors accountable to deliver on such programmes, especially as their involvement is largely voluntary.

- Reporting: Various communication channels, including social media, newsletters, and other channels should be used for programme publicity, and ensure that the results from the programme are well documented and reported.

In addition to this, NAS would continue engaging with the current beneficiaries to encourage them to become advocates and supporters of the programme in future. NAS would also leverage partnerships with other organizations and institutions that share similar goals to access additional resources and funding. A communication plan would be developed to keep stakeholders, donors, and the public informed about the programme's progress and success.

Chapter 4: The Way Forward

4.1 Recommendations for Strengthening Nigeria's Research Ecosystem

Based on feedback from the stakeholders' workshop, and the mentorship programme, these recommendations have been proposed to address challenges in Nigeria's research landscape:

Training and capacity building approaches that enhance/complement current practices

There's a need for training and retention of researchers in Nigeria if the country is to develop. Research capacity in Nigeria can be strengthened through doctoral research training and fellowships, training of university and research institutes staff, developing research infrastructure such as laboratories and research hubs. To enhance current training and capacity building practices in Nigeria, especially in the context of research and development, the following recommendations should be considered:

- Needs assessment: Regular needs assessments to identify skill gaps and training requirements among professionals in various sectors should be conducted. This data-driven approach ensures that training programs are relevant and tailored to specific needs.
- Diverse training methods: Learning institutions should implement a variety of training methods, including online courses, workshops, seminars, and mentorship programs, to accommodate different learning preferences. This would help improve inclusivity, as well as help institutions adapt to shocks such as that brought about by the COVID-19 global pandemic.
- Collaboration: Collaboration among universities, research institutions, and industries should be fostered to develop training programs that align with industry demands and provide real-world experiences for participants. Opportunities for internships and apprenticeships should be made available to allow participants gain practical experience in research and development settings, thereby providing valuable on-the-job training. Collaboration with international institutions and organizations should be explored to offer exchange programs, scholarships, and access to global expertise, fostering a global perspective in training.
- Gender and inclusivity focus: It is important to ensure that training programs are accessible and tailored to the needs of all genders, while particularly encouraging more women to participate in research and development fields considered.

Funding strategies and mechanisms

Scarce research funding, and the exclusion of private research institutes and private universities from receiving public funding (such as from the TETFUND) place significant constraints on research production. A significant portion of the national budget is to be allocated to research and development, ensuring stable and consistent funding over the long term. Through prior consultation and buy-in from the private sector, research funding mechanisms such as competitive grant programs, and public-private partnerships can be identified and put in place to help fund research projects. Venture capital and innovation funds that provide funding for startups and innovative projects in areas that align with national development priorities should be established. Individuals, corporations, and foundations can be encouraged to establish endowments and philanthropic initiatives dedicated to funding research and development in Nigeria. Tax incentives or credits for companies that invest in research and development activities can be used to encourage private sector engagement in research funding. Strong monitoring and evaluation mechanisms must be put in place by universities and research institutions to improve institutional efficiency and avoid the misappropriation of grants.

Research quality control and monitoring

Much of Nigeria's research appears to be of low quality, as inferred by the low number of citations recorded by Nigerian research publications compared to other Sub-Saharan African countries. Mechanisms for research quality evaluation and assurance should be established to ensure the quality and integrity of research, including peer review processes, and an effective monitoring system. Ethical guidelines should be incorporated to ensure that research and development activities are conducted with integrity and respect for human rights and the environment. Potential risks and ethical dilemmas that may arise from certain research, such as those in the fields of biotechnology and artificial intelligence, should be identified, and risk management plans considered. There is a need for transparency and accountability on the part of researchers in the collection and communication of research data. This would improve the integrity of academics, the credibility of new research findings, and of the Nigerian research community in general. Finally, trainings can be conducted for researchers on research design, data analysis, issues related to predatory academic journals, and other relevant areas, to enhance research quality and effectiveness.

Creating incentives/reward systems that drive high-quality research production

Beyond the publish or perish syndrome – which drives research quantity, rather than quality, government and research institutions should create incentives/reward systems that drive high-quality research production, with societal relevance.

To promote innovation, an environment conducive to innovation should be fostered by providing incentives for research commercialization, such as tax incentives for the private sector, grants, and intellectual property protection. Prestigious national and institutional awards for researchers who produce high-impact, socially relevant research should be established. These awards can include cash prizes, medals, and public recognition.

Also, a performance-based funding model that allocates more resources to institutions and researchers who consistently produce high-quality, relevant research can be implemented. This encourages a culture of accountability and research excellence. Promotion criteria in universities and research institutions should be revised to place a significant emphasis on research with societal relevance and impact. Researchers would be evaluated based on the tangible contributions of their work to the community and the nation. Mechanisms can also be created for researchers to receive feedback from end-users and stakeholders to improve the societal relevance of their research.

Promoting collaboration between different players in the research ecosystem

A practical mechanism for interdisciplinary collaboration between different research institutions, industries, and sectors should be explored. Joint research initiatives that bring together researchers, institutions, and industry partners to work on pressing societal challenges and opportunities should be fostered. Also, research clusters and networks focused on specific fields/areas of interest, where multiple players can pool their expertise and resources can be created.

In collaboration with the industry/private sector, technology transfer offices should be set up within universities and research institutions to facilitate the commercialization of research, and its adoption by industry. Researchers should be trained on communication of research findings in a manner that can be easily understood and used by the public and by policymakers. This would increase the demand and uptake of research by policymakers. Thus, it would be useful to include programs to enhance science communication to the public and policymakers thereby increasing awareness of the

value of research. The public should be effectively engaged in discussions about research priorities and their potential impacts, fostering a sense of ownership and accountability. Surveillance that is systematic, simple, and consistent is required for data collection, analysis, and monitoring of research trends for policymaking.

Addressing Barriers to GESI in the Nigerian Research Ecosystem

Traditionally, under-representation and exclusion of women, due to cultural and religious biases, cut across geographical locations and sectors. Although women have striven to distinguish themselves academically, men still occupy most top leadership positions in research/academia. There is, therefore, a need to support women to take up such leadership positions by addressing the gender gap at all levels of education, mentoring young girls and women through tertiary education, and providing opportunities for collaborations to enable them progress up the academic ladder. At the institutional level (government, private sector, academia), formal mentoring for female researchers should be institutionalized. If not in existence, gender and sexual harassment policies should be developed. Also, policies which support the recruitment and retention of females, under-represented groups, and persons with disability, including research grants targeting female researchers, and age-flexible PhD training support should be promoted.

4.2 Conclusions

NAS has continuous engagements through its other programmes with stakeholders in the research landscape. The learnings and recommendations from the *Strengthening Research Capacity in Nigeria Programme* will be carried forward through these other engagements. Most especially, NAS would engage the stakeholders towards the creation of a national research policy for Nigeria. The Tertiary Education Trust Fund (TETFund) is currently making efforts to establish a comprehensive research and development strategy for Nigeria, in line with the country's development priorities. A five-member committee, with four NAS Fellows, has been set up to drive the implementation of this initiative.

The mentorship program under this project has shown success in providing support and guidance to early career researchers for a successful research career and providing opportunities for general career development. NAS is exploring opportunities to sustain and scale-up the mentorship programme, so as to have a wider and longer-lasting impact on enhancing the research capacity of the next generation of researchers in Nigeria.

Annex 1: List of Selected Mentors and Mentees

S/N	Mentee	Gender	Mentee's Institution	Mentee's Field of Specialization	Matched Mentor	Mentor's Gender	Mentor's Institution	Mentors' Field of Specialization
1.	Cynthia Aghogho	Female	International Institute of Tropical Agriculture (IITA)	Plant Breeding and Genetics	David Ojo	Male	National Horticultural Research Institute (NIHORT)/ University of Ibadan	Plant breeding
2.	Cynthia Ikeji	Female	University of Ibadan	Toxicology	Chinedum Babalola FAS	Female	Chrisland University	Pharmacology & Toxicology
3.	Emmanuel Ohaekenyem	Male	Nnamdi Azikiwe University	Chemistry	Sunday Atawodi FAS	Male	Federal University, Lokoja	Chemistry
4.	Ernest Agwamba	Male	Covenant University, Ota	Computational Chemistry	Abubakar Sambo FAS	Male	Usmanu Danfodiyo University, Sokoto	Energy Planning, Renewable energy, Thermofluids
5.	Faith Bankole	Male	Obafemi Awolowo University	Mycology and Biotechnology	Abiodun Claudius-Cole	Female	University of Ibadan	Mycology/Plant Pathology/Soil Microbiology
6.	Gabriel Ogbeh	Male	University of Ilorin	Biosystems Engineering	Christopher Akinbile	Male	Federal University of Technology, Akure	Agricultural & Environmental Engineering
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18.	Uchechi Onyedikachi	Female	University of Port Harcourt	Environmental Biochemistry	Bamidele Olu-Owolabi FAS	Female	University of Ibadan	Ecotoxicology/ Hydrobiology
19.	Uebari Korfii	Male	Rivers State University	Environmental Chemistry	Ikenna Onyido FAS	Male	Nnamdi Azikiwe University	Parasitology and Public Health/ Histoscience
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