



**TEN-YEAR TENURE AS DEPUTY VICE CHANCELLOR, RESEARCH PRODUCTION AND
EXTENSION (RPE) DIVISION, JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY**

Prof. Esther Murugi Kahangi

April, 2017

MESSAGE TO STAKEHOLDERS



Jomo Kenyatta University of Agriculture and Technology (JKUAT) recognizes as her two principal responsibilities the creation of new, and communication of existing knowledge to her students and to society. Success in meeting these responsibilities places the university among the leading research institutions in Kenya. JKUAT research, innovation and extension portfolio has been growing over the years supported by a continued and substantial commitment of University resources and external sponsors. This growth must be sustained and guided by more than just the quest for new knowledge. There must be a solid administrative structure operating under established policies and procedures, which encourages all stakeholders to sustainably continue seeking necessary resources, and promote accountable management and use of the resources in accordance with the regulations spelt out by the University and external donors. The operational focus of Research, Production and Extension Division (RPE), is headed by the Deputy Vice Chancellor (RPE), who reports to the Vice Chancellor and to the JKUAT Council

This report collates the progress made in research, innovation and technology transfer during my tenure as the Deputy Vice Chancellor (DVC) in charge of the division. It captures the progress made under different categories in terms of funding, research and technology transfer outputs and JKUAT linkages and collaborations. It also provides recommendations and way forward for the future. It is important for all stakeholders to appreciate the positive growth made so far with a view of allowing the RPE division to provide a conducive operating environment for them.

The report is an important step towards documenting information required by future RPE managers and other stakeholders.

A handwritten signature in black ink, appearing to read 'Esther Kahangi'.

Esther Murugi Kahangi, Ph.D. MBS
DEPUTY VICE CHANCELLOR, RESEARCH, PRODUCTION AND EXTENSION

ACKNOWLEDGEMENTS

First and foremost, I wish to thank the Almighty God for giving me the strength and spirit to handle the arduous task of heading the RPE Division for 10 years, while dealing with a multiplicity of stakeholders all through the period. I acknowledge with thanks the University Council, for showing confidence in my performance in the said office and thereby granting me two serving terms of tenure. Also importantly, I wish to express my sincere gratitude to the Vice Chancellor, Prof. Mabel Imbuga, for enabling a cordial working relationship and unwavering administrative support during the two terms of service. My appreciation also goes to the staff of RPE Division for their support and commitment to duty during our decade of working partnership. Let me also acknowledge the entire University community for providing a friendly working environment full of healthy social experiences.

It goes without saying that this report is the result of hard work from researchers and innovators, who delivered outputs that form the bulk of the document. Also deserving recognition is the entire students' body, especially those who organized and participated in the Tech Expo, for their creativity that has resulted in generation of innovations, some of which have since been turned into viable businesses. My special thanks to Mr. Vitalis Opondo, for editorial input in this report; Mr. Stanley Maloi and Mr. William Ndung'u, for compilation and analysis of financial data, and Mr. Kelly Muhindi, for typesetting and design work. Also in the same regard, I sincerely thank the researchers who participated in critiquing and proof-reading the various sections, and all other players who contributed in one way or another towards the publication of the report.

I thank the University for setting aside significant financial resources for supporting research activities, innovations, extension and technology transfer, and annual Tech Expo. Equally critical is the National Commission for Science and Technology (NACOSTI), for continually providing financial support for JKUAT research and innovation activities for both staff and graduate students. My great appreciation also to our international donors who have generously supported JKUAT scholars in the various research activities reported in this publication. It is my prayer that this support will continue for years to come.

Also with regard to research, I salute the University Chancellor, Prof. Godfrey Maloi, who is a renowned scholar, for the keen interest he has shown in our research activities and innovations.

TABLE OF CONTENTS

Message to Stakeholders.....	i
Acknowledgements	ii
1.0 Overview of Research Production and Extension	1
1.2 Research, Production and Extension Division (JKUAT).....	2
1.2.2 Directorate of Research Services	3
1.2.3 Directorate of Production	4
1.2.4 Directorate of Extension and Technology Transfer	4
1.2.5 Linkages Office	5
1.2.6 Research Institutes and Centers	5
1.3 Performance of Research and Innovation in JKUAT in the Last Ten Years	5
1.4 Research Grants.....	6
1.4.1 JKUAT	6
1.4.2 NACOSTI.....	7
1.4.3 International Donors	8
2.0 THEMATIC RESEARCH AND INNOVATION AREAS	9
2.1 Food Security	9
2.1.1 Research Focus	9
2.1.2 Land Management and Soil Nutrition.....	10
2.1.3 Crop Production and Improvement.....	10
2.1.4 African Leafy Indigenous Vegetables.....	11
2.1.5 Post-harvest Handling and Value Addition.....	12
2.1.6 Value Addition of Emerging and Underutilised Crops	12
2.1.7 Below-Ground Crop Pests.....	13
2.1.8 Insects for Food and Feed.....	13
2.1.9 Key Outputs.....	13
2.1.10 Funding Analysis	14
2.2 Nanotechnology	15
2.2.1 Research Focus	15
2.2.2 Current Nanotechnology Research	16
2.2.3 Key Outputs.....	16
2.2.4 Funding Analysis	17
2.3 Natural Products	18
2.3.1 Research Focus	18
2.3.2 Human Diseases.....	18
2.3.3 Animal Diseases	19
2.3.4 Food Preservation and Probiotics Using Natural Products.....	19
2.3.5 Therapeutic, Beauty and Industrial Products.....	19
2.3.6 Toxicology.....	20
2.3.7 Key Outputs.....	21
2.3.8 Funding Analysis	21
2.4 Human and Animal Health Sciences.....	22
2.4.1 Research Focus	22
2.4.2 Human Health.....	23

2.4.4 ICT and Health	26
2.4.5 Key Outputs.....	26
2.4.6 Funding Analysis	26
2.5 Water Resource Management Research	27
2.5.1 Research Focus	27
2.5.2 Water for Agriculture.....	28
2.5.3 Catchment Management, Soil Erosion and Sedimentation control.....	28
2.5.3.1 Bathymetric and Sedimentation Survey Project	29
2.5.4 Linking Water Science and Engineering to Business and ICT.....	29
2.5.5 Climate Change and Water Resources	30
2.5.6 Groundwater Management	30
2.5.7 Water for Future Cities.....	31
2.5.8 Improve Access to Clean Water, Sanitation and Hygiene.....	31
2.5.9 Key Outputs.....	32
2.5.10 Funding Analysis	32
2.6 Information Communication Technology (ICT)	33
2.6.1 Research Focus	33
2.6.2 Data Science, Big Data and Cloud Computing.....	33
2.6.3 Human-Computer Interaction and Cognitive Computing	34
2.6.4 Internet-of-Things, Ubiquitous Computing and Robotics.....	35
2.6.5 E-Learning.....	35
2.6.6 Key Outputs.....	36
2.6.7 Funding Analysis	36
2.7 Engineering Technologies and Industrial Development.....	37
2.7.1 Research Focus	37
2.7.3 Research under Agricultural Machineries and Processes.....	38
2.7.4 Researches under Industrial Machineries and Processes.....	38
2.7.5 Infrastructure and Environmental Challenges Thematic Area.....	41
2.7.6 Researches under Infrastructure.....	41
2.7.7 Environmental Challenges.....	42
2.7.8 Sustainable Transport Vehicles and Systems	44
2.7.9 Development of Materials for Watercrafts.....	44
2.7.10 Communication and Security Systems.....	44
2.7.11 Key Outputs.....	45
2.7.12 Funding Analysis	45
2.8 Built Environment and Infrastructure Technologies	46
2.8.1 Research Focus	46
2.8.2 Energy Efficiency in Buildings.....	47
2.8.3 Urban Planning and Design.....	47
2.8.4 Human Settlements	48
2.8.5 Architectural Pedagogy	48
2.8.6 Transport and Infrastructure	48
2.8.7 Heritage and Conservation	49
2.8.8 Key Outputs.....	49
2.8.9 Funding Analysis	50

2.9 Social Economic Theme	51
2.9.1 Research Focus.....	51
2.9.2 Borrowing from Formal and Informal Financial Sector.....	51
3.0 RESEARCH INSTITUTES/ CENTRES	52
3.1 Institute of Biotechnology Research	52
3.1.1 Research Focus.....	52
3.1.2 Plant Biotechnology.....	52
3.1.3 Animal Biotechnology.....	52
3.1.4 Microbial Biotechnology.....	53
3.1.5 Genetic Studies on Wildlife.....	53
3.1.6 Key Outputs.....	53
3.1.7 Funding Analysis.....	53
3.2 Institute of Energy and Environmental Technology (IEET)	54
3.2.1 Research Focus.....	54
3.2.2 Small Hydro Power.....	55
3.2.3 Wind Energy.....	55
3.2.4 Thermochemical and Biochemical Conversion of Biomass into Biofuel.....	56
3.2.5 Solar Photovoltaic (PV) and Solar Thermal Energy.....	56
3.2.6 Integration of Solar and Wind Energy.....	56
3.2.7 Research, Training and Consultancies.....	57
3.2.8 Occupational Safety and Health (OSH).....	57
3.2.9 Key Outputs.....	58
3.2.10 Funding Analysis.....	59
3.3 Sustainable Materials Research and Technology Centre (SMARTEC)	59
3.3.1 Research Focus.....	59
3.3.2 Research on Eco-housing.....	60
3.3.3 Stabilization of Black Soil Using Rice Husk Ash and Lime.....	60
3.3.4 Animal Dung and Municipal Solid Waste Ash as Alternative.....	60
3.3.5 Reclaimed Asphalt Concrete as a Cold Mix Surfacing Materials.....	61
3.3.6 Stone Dust in Production of High Performance Concrete.....	61
3.3.7 Sisal Fibre Reinforced Cement Mortar with Termite Clay Soil for Roofing Tiles.....	61
3.3.8 Model for Optimizing Earth Moving Operations in Kenya.....	61
3.3.9 Shredded Waste Plastic Bags and Waste Sugar Cane Ash Mix.....	61
3.3.10 Consultancies.....	62
3.3.11 Short Courses.....	62
3.3.12 Key Outputs.....	62
3.3.13 Funding Analysis.....	63
3.4 Sino-Africa Joint Research Centre (SAJOREC)	64
3.4.1 Research Focus.....	64
3.4.2 SAJOREC Activities.....	64
3.4.3 Sino-Africa Joint Research Centre and the JKUAT Botanical Garden.....	64
3.4.4 Facilitation of Staff Training.....	65
3.4.5 Facilitation of Student/Staff Scholarships.....	66
3.4.6 On-Going Research Activities.....	66
3.4.7 Key Outputs.....	67

3.5 Water Research and Resource Center (WARREC)	68
3.5.1 Research Focus	68
3.5.2 WARREC Becomes a Kenya Vision 2030 Flagship Programme.....	69
3.5.3 Research and Promotion of the System of Rice Intensification (SRI)	69
3.5.4 Fog Harvesting Research Pioneered in the Ngong Hills	70
3.5.5 Groundwater Risk Management for Growth and Development	70
3.5.6 Bathymetric Reservoir Survey of Ruiru Dam.....	71
3.5.7 Scoping Study of Water User Associations of Tana Catchment	71
3.5.8 Identifying Key Issues to Manage Water Resource Users Associations.....	71
3.5.9 MoUs Signed with Partner Institutions	72
3.5.10 WARREC Hosts a Water Knowledge Portal.....	73
4.0 EXTENSION AND TECHNOLOGY TRANSFER	74
4.1 Activities of the Department	74
4.1.1 Shows Exhibitions and Trade Fairs	74
4.1.2 JKUAT/ JICA in-Country Training Programme	75
4.1.3 Farmer Voice Radio Project Intervention.....	76
4.1.4 Strategic Value chain Study for the Small holder Dairy Industry.....	76
4.1.5 Development of a Training Manual for Fruits and Vegetables	77
4.1.6 Capacity Building on Cow Milk Value Chain in Nairobi County	77
4.1.7 Training of People Living with Disabilities, Youth and Women on AGPO	78
4.1.8 Upgrading Small Scale Miners in Taita Taveta - Innovation Project	78
4.1.9 Farm Forum	78
4.1.10 Funding Analysis	79
4.2 University Community Collaboration Department (UCCD)	80
4.2.1 Introduction	80
4.2.4 Master Plan and Maintenance of High Standard Built Environment.....	80
4.2.5 Secure and Safe Environment Which Prevents and Fights Crime.....	80
4.2.6 Industrialization and Creation of Wealth	81
4.2.8 Public Health and Personal Hygiene Education	81
5.0 THE JKUAT TECH EXPO	82
5.1 Introduction	82
5.1.0 Health.....	82
5.1.1 Social Interaction/Communication	82
5.1.2 Waste Management.....	83
5.1.3 Food Security/Agriculture.....	83
5.1.4 Renewable Energy	83
5.1.5 Security	83
5.1.6 Education.....	84
5.1.7 Transport	84
5.1.8 The Future of the Tech Expo.....	84
5.1.9 Funding Analysis	85
6.0 JKUAT PARTNERSHIPS	86
6.1 Collaboration with Universities.....	86
6.2 Collaboration with Research and Development Institutions/ Donor Bodies.....	87
6.3 Collaboration with National Institutions and Government Line Ministry	87
6.0 Conclusion and Recommendations.....	88

5.0 References.....	91
6.0 Appendices.....	93

LIST OF ACRONYMS

AGPO	Access to Government Procurement Opportunities
AICAD	African Institute for Capacity Development
AIR	American Institute for Research
APHRC	African Population and Health Research Center
ASDSP	Agriculture Sector Development Support Programme
AUSAID	Australian Agency for International Development
AVRDC	The World Vegetable Centre
BECANET	Biosciences Ecosystem and Central Africa Network
BIO-EARN	East African Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development
BMBF	Federal Ministry of Education and Research, Germany
BMGF	Bill and Melinda Gates Foundation
BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CHE	Commission for University Education
CKNAS	Central Kenya National Agricultural Society
CPC	Chemistry Products Centre
CSR	Corporate Social Responsibility
DAAD	German Academic Exchange Service
DANIDA	Danish International Development Agency
DEVCO	International Cooperation and Development
EDULINK	ACP-EU Co-operation Programme in Higher Education
EPSRC	Engineering and Physical Sciences Research Council
ESPA	Ecosystems Services for Poverty Alleviation
EU	European Union
FOTEC	Food Technology Centre
GIS	Geographic Information Systems
GLOWS	Global Water for Sustainability
HORTINLEA	Horticultural Innovation Learning for Improved Nutrition and Livelihood in East Africa
ICGEB	International Centre for Genetic Engineering and Biotechnology
ICRAF	World Agroforestry Centre
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFS	International Foundation for Science

IGU	Income Generating Units
ILRI	International Livestock Research Institute
JICA	Japan International Cooperation Agency
JCDC	Juja Community Development Committee
JKUAT	Jomo Kenyatta University of Agriculture and Technology
JUHOLIWA	Juja Hope of Life Welfare Association
KAPAP	Kenya Agricultural Productivity Programme
KARI	Kenya Agricultural Research Institute
KENET	Kenya Education Network
KMA	Kenya Maritime Authority
MEWR	Ministry of Environment and Water Resources
NACOSTI	National Commission for Science, Technology and Innovation
NCIIA	National Collegiate Inventors and Innovators Alliance
NCWSC	Nairobi City Water and Sewerage Company
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SIRCA	Securities Industry Research Centre of Asia-Pacific
SIDA	Swedish International Development Cooperation Agency
SMEs	Small Medium Enterprises
SRISTI	Society for Research and Initiatives for Sustainable Technologies and Institutions
TWAS	The World Academy of Sciences
UCCD	University Community Collaboration Directorate
URIs	University Radio Interns
USAID	United States Agency for International Development
VicRes	Lake Victoria Research Initiative
VLIR	The Flemish Interuniversity Council
WWFEN	World Wide Fund

1.0 Overview of Research Production and Extension

The purpose of documenting research, innovation and technology transfer activities at JKUAT is to create a baseline upon which future RPE managers will build and direct these activities and create an environment for broadening the knowledge base, which will lead to new discoveries and inform new policies that ensure discoveries are incorporated into society in a productive and beneficial manner. Although the RPE Division was established way back in 1994, no documentation has to date been compiled for the wider readership of JKUAT community and Kenya as a whole. Furthermore, we are living in era in which harnessing and documentation of knowledge generated in an institution is very critical for current and future decision-making. It is important to point out that this publication contains only records of activities managed and administered by the RPE Division. It is appreciated for instance, that there are several research and innovation activities that are carried out by postgraduate students, which are handled by the Directorate of Post Graduate Studies. It is hoped that in future, RPE Division will penetrate all research and innovation activities within the University for purposes of identifying useful products that can be up-scaled and put into use.

1.1 Role of a Research Unit in a University

In knowledge-based economies, universities have emerged as key elements of innovation systems, both as human capital providers and seedbeds of new businesses. The emergence of the entrepreneurial university is a response to the increasing importance of knowledge in national and regional innovation systems and the recognition that the university is a cost-effective and creative inventor as well as a transfer agent of both knowledge and technology. Governments in developed countries are focusing on the potential of the university as a tool for enhancing innovation environments and creating a regime of science-based economic development. As knowledge becomes an increasingly important part of innovation, the university as a knowledge producing and dissemination institution plays a larger role in industrial innovation.

A typical entrepreneurial venture converts raw materials into finished products for profit. The university can be likened to an entrepreneurial venture. Well-researched knowledge is a raw material to be converted to products, processes, and service (Slaughter & Rhoades, 2004). Therefore, one way for universities to become entrepreneurial is by commercializing research findings and innovations. Good examples of this trend include the U.S. Kauffman report (2005) shows that in the mid to late nineties, there was an increase in funds-generated from university-industry technology transfer through licensing. This was caused by the enactment of the Bayh-Dole Act (Patent and Trademark Amendments of 1980) that invigorated the technology transfer process from universities and federal laboratories to business and industry

When universities profit from the conversion of research results into licensing then academic entrepreneurship and/or academic capitalism can be said to be active. An excellent attempt to establish a framework to better understand and explain academic entrepreneurship, the domain of entrepreneurship that includes venture development from universities, was developed by O'Shea *et al.*, (2005). They categorize the determinants of academic entrepreneurship into four focused areas: individual attributes; organizational; institutional; and external determinants of spin-off activity.

The individual attribute line of research holds that since academic entrepreneurship is a reflection of individual initiative, it is related to the individual personalities, traits, and ability to conduct entrepreneurial activity (Roberts, 1991). The individual researcher at the university is therefore an important stakeholder in the process of innovation commercialization.

Organizational determinants relate to university resource availability. These resources include expenditure on research and development (Lockett & Wright, 2004), the existence of leading researchers (Zucker *et al.*, 1998), technology transfer offices (Chugh, 2004), and university incubators (Tornatzky, 1996).

The institutional determinants relate to the university culture, social norms, attitudes and behaviors of faculty members (Shane, 2004; Roberts, 1991), reward systems regarding research and commercialization (Birley, 2003; Thursby & Kemp, 2002), and technology transfer policies and procedures (DiGregorio & Shane, 2003; Goldfarb & Henrekson, 2003).

The external determinants attempt to explain the success of academic entrepreneurship activity through factors that are peripheral to the university including access to venture capital resources (Florida & Kenney, 1988).

Recent research suggests that many northern research universities have adopted formal mission statements regarding the role and importance of technology transfer (Markman *et al.*, 2005). The statements include core values in relation to the stakeholders of the technology transfer process.

1.2 Research, Production and Extension Division (JKUAT)

The RPE Division is in charge of management and administration of all research, innovation, technology transfer and collaboration activities in JKUAT. The division was established through the Jomo Kenyatta University of Agriculture and Technology Act, 1994. The main objectives of the division are:

- (i) To play an effective role in the development of agriculture and technology in conjunction with industry;
- (ii) To provide extension services to contribute to the social and economic development of Kenya.

It is commendable that the drafters of this Act clearly appreciated the emerging importance of research units in modern institutions of higher learning as described above.

1.2.1 RPE Division in the Last Ten Years

I took up the position of Deputy Vice Chancellor, RPE in the year 2007. My first priority was to reorganize the division and give it a new administrative outlook that would enable it to effectively pursue its mandate in line with the University mission and vision. The new structure was in addition to enable the divisions operate in tune with the evolving role of modern universities and contribute to fundamental science, applied science and the overall national development agenda in line with Vision 2030.

The reorganization saw RPE being split into three directorates and one office as below:

- (i) Directorate of Research Services;
- (ii) Directorate of Production;
- (iii) Directorate of Extension and Technology Transfer;
- (iv) Linkages Department.

Research Institutes and centers also form an integral of the RPE division.

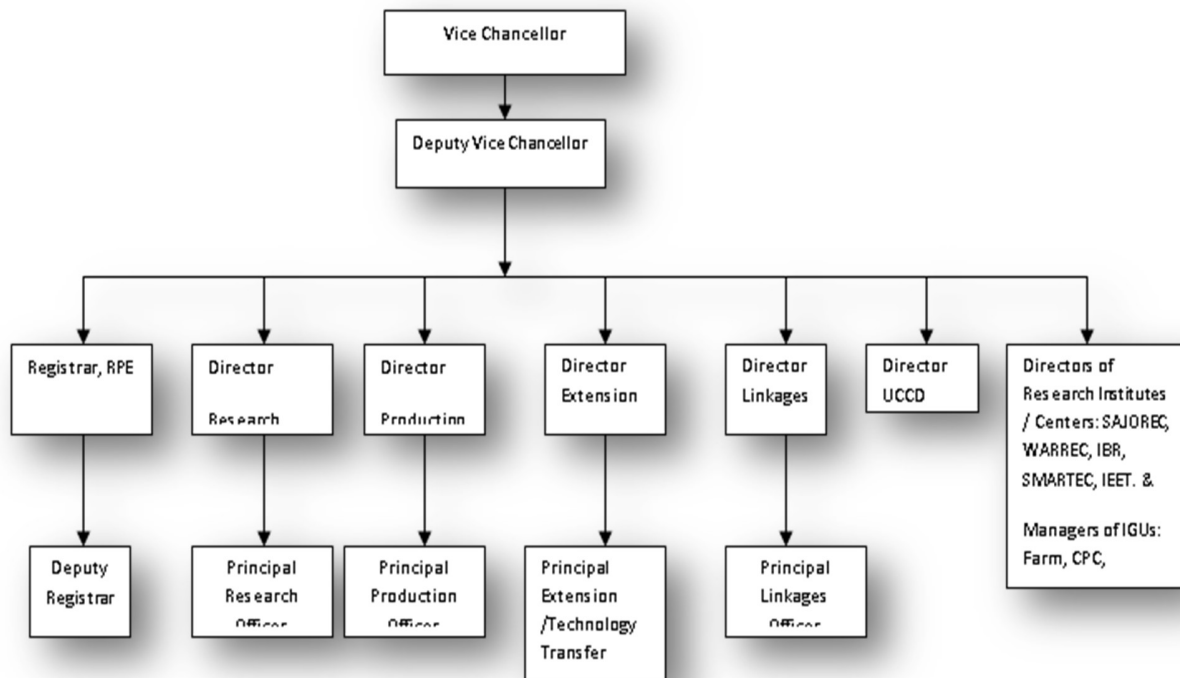


Fig. 1: RPE organizational structure

1.2.2 Directorate of Research Services

The underlying principle for establishing the Directorate of Research Services was to support research activities of Departments, Schools, Faculties and Institutes by providing strategic direction and ensuring that the University continuously improves the environment for research.

The objectives of the Directorate of Research Services are:

- (i) To enhance the University's national reputation as a leading research institution and to establish a higher international profile for its research activities;
- (ii) To embed and sustain an active research culture that generates well-researched knowledge that could be converted to products, processes, and services to impact on economic development;
- (iii) To create a conducive environment for staff and students to explore their maximum potential in research and innovation.

The specific roles and functions of the directorate are:

- (i) To formulate, administer and rollout relevant research policy guideline;
- (ii) To fund raise for research activities;
- (iii) To provide research link between RPE and Academic Affairs Division, BPS, Faculties, Schools, Institutes and Departments;
- (iv) To evaluate in conjunction with the Directorate of Production research discoveries that qualify for up-scaling and commercialization;
- (v) To determine the most effective way of utilizing the university research grant;

- (vi) To prepare relevant research policies and research contract agreements;
- (vii) To identify and establish direction and priorities for cross-disciplinary research needs;
- (viii) To coordinate internally funded research proposals evaluation and processing;
- (ix) To identify research funding opportunities and alert researchers in the university;
- (x) To undertake monitoring and evaluation of the internally funded research projects;
- (xi) To monitor externally funded research projects by documenting contracts signed, financial expenditures, progress reports submitted to funders and key performance indicators;
- (xii) To ensure that researchers are provided with expert guidance through organizing training in research proposal development, Intellectual Property Rights, Project Management, etc.
- (xiii) To maintain a database of university research findings including those from students' projects;
- (xiv) To maintain database of experts in various academic disciplinary areas from within and outside the university ;
- (xv) To maintain database of university research publications;
- (xvi) To mobilize researchers from various academic disciplines to write proposals in response to calls for proposals made by various granting organizations;
- (xvii) To coordinate the publication of JAGST (in consultation with the editorial board) and other relevant publications;
- (xviii) To facilitate seminars/conferences for presentation of research findings and related matters;
- (xix) To identify, support and reward excellence and achievement in research, activities;
- (xx) To provides secretariat services to senate subcommittee (Research, Publication, and Printing Committee (RPPC)).

1.2.3 Directorate of Production

The Production Directorate of RPE has as its main responsibility the up-scaling/piloting research, innovation products, and coordinating Income-Generating Units (IGUs) in the university.

The specific roles and functions of the directorate of production are:

- (i) To develop innovation and commercialization policies;
- (ii) To receive, assess and approve as appropriate the funding requests for piloting and up-scaling of R&D products from research Directorate and other sources;
- (iii) To fund raise for piloting and incubation activities;
- (iv) To up-scale university innovations to bring them closer to the market;
- (v) To source for potential partners, investors, venture capitals, Angel Investors, to support startups of new businesses from piloted innovations;
- (vi) To formulate and provide policy guidelines on operations and management of IGUs;
- (vii) To receive, process and approve proposals on new income-generating activities;
- (viii) To monitor and evaluate the performance of innovation projects, IGUs, and production of reports thereof for decision-making.

1.2.4 Directorate of Extension and Technology Transfer

The principle of establishing an Extension and Technology Transfer Directorate is to attain excellence in dissemination/transfer of knowledge/innovations generated within the university or adapted from other sources to enable the institution to play a leading role in economic development.

The specific roles of extension directorate include are:

- (i) To coordinate activities related to Technology Transfer and Extension Services in the University;
- (ii) To formulate, administer and roll out policies that relate to technology transfer;
- (iii) To ensure the public benefits from university research;
- (iv) To conduct socio economic impacts of technologies that JKUAT has transferred to industry/society;
- (v) To conduct environmental impact assessment of the universities technologies;
- (vi) To train end users on adoption and utilization of new technologies;
- (vii) To disseminate knowledge of the universities technologies through training, mass media, ICT, etc.;
- (viii) To carry out market survey, market surveillance and market intelligence, value chain studies and give feedback to the university (researchers/innovators).
- (ix) To equip women and youths and people living with disabilities with relevant knowledge and skills.

1.2.5 Linkages Office

The role and functions of the linkages office are:

- (i) Searching potential partners for links (active pursuit) and availing JKUAT for links (putting JKUAT at disposal);
- (ii) Coordinating the establishment of linkages and collaboration initiated by academic departments and other partners;
- (iii) Analyzing, monitoring, and evaluating university linkages and collaborations;
- (iv) Identifying joint management committees that oversee the implementation of the collaboration activities; Encouraging and strengthening existing linkages and collaborations;
- (v) Terminating linkages and collaborations;
- (vi) Enabling a clear understanding of contract agreements;
- (vii) Enabling a clear understanding on benefit sharing.

1.2.6 Research Institutes and Centers

The University establishes research institutes and centers of excellence in fields that she deems important and would therefore make considerable contribution through concentrated research. Research institutes draw members from different disciplines at faculty or school level to concentrate expertise in areas of interest. The current research institutes are Institute of Biotechnology Research (IBR) and Institute of Energy and Environmental Technology (IEET)

A research center draws on expertise within a given department to concentrate on a core area of departmental interest. The research centers currently in existence are Sustainable Material Research and Technology Centre (SMARTEC), Sino-Africa Joint Research Centre (SAJOREC), and Water Research and Resource Centre (WARREC).

1.3 Performance of Research and Innovation in JKUAT in the Last Ten Years

The RPE Division is in charge of management and administration of all the research and innovation being carried out in the University including Research Institutes and Centers. The specific roles involving these management and administration duties are described above. As the RPE Division carries out its mandate, it is governed by various policies and senate committees. The policies include:

- (i) The Research Policy;

- (ii) The intellectual Property Policy;
- (iii) The Human Ethics Policy;
- (iv) The Animal Ethics Policy;
- (v) The Bioethics Policy

The Senate committees are Research, Publication and Printing (RPPC) and the Innovation committees. In connection with publication of University Journal of Agriculture Science and Technology, books and any other publication materials, the division has Editorial Board with an Editor in chief.

In the last ten years, research and innovation projects carried out in the University have grown exponentially in terms of funding levels. There are three main sources of research funds in the university namely; JKUAT, Government of Kenya (through NACOSTI) and more recently the National Research Fund (NRF), and other local and external international donors. The innovation projects are mainly funded by JKUAT.

1.4 Research Grants

1.4.1 JKUAT

University research grant initiative is a novel idea, which was initiated in the year 2005, and runs to date. Through team of experts under my leadership, a structured system for award of internal grants has been put in place to ensure flawless utilization. In the last ten years, demands for these grants have exponentially increased. This is largely due to research sensitization carried out by the Division through the calls for proposals and several training workshops over the years. Fig. 2 and Fig. 3 show the trends of the cumulative internal research and innovation funds, respectively.

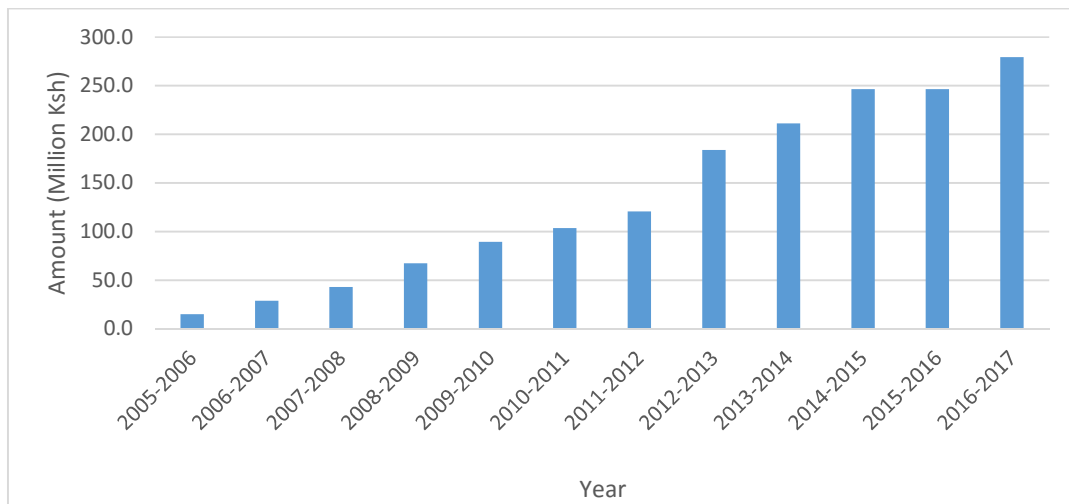


Fig 2: JKUAT cumulative research funding (2005 - 2016)

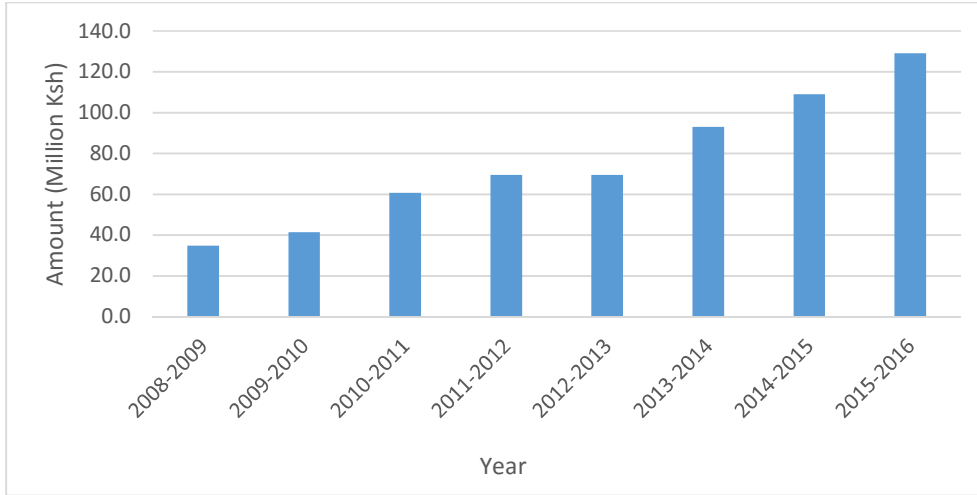


Fig 3: JKUAT cumulative innovation funding (2008 - 2016)

1.4.2 NACOSTI

When I took office in 2007, there were only two projects funded by the then Commission for Higher Education (CHE) which was then handling government research grants. This was not encouraging as it gave the impression that our faculty members were not capable of attracting these funds. During my first three years in office, I personally scrutinized each proposal before submission to NACOSTI, giving guidance on improvements to make them competitive. I also ensured that each proposal and the required supporting documents was forwarded to the donor on time. Consequently, many researchers began winning funding from NACOSTI, which spurred much encouragement. Currently, JKUAT is among the leading public universities in attracting NACOSTI grants, with a total of about Ksh 251 million attracted within the 10 years (Fig. 4).

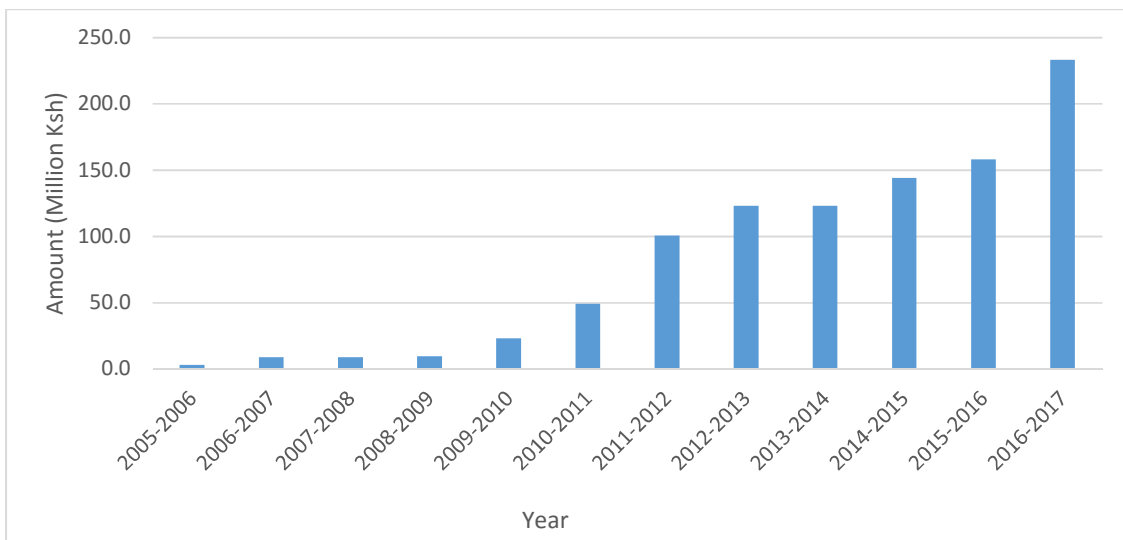


Fig 4: NACOSTI, Cumulative research funding (2005 - 2016).

1.4.3 International Donors

Along with the increasing quality of proposals submitted annually to NACOSTI, as evidenced by increased funding, the quality of proposals submitted to international donors has improved greatly, resulting in increased funding, Fig. 5. International donor fund is the highest among the three research funders. In the last 10 years, JKUAT has received cumulatively over 2 billion Ksh from various international donors, as in appendices 1 – 14.

The RPE Division gives a high premium to Monitoring and Evaluation of all the research projects under its watch. Researchers are required to declare the key performance indicators that will enable the division to determine whether or not the objectives of the research are met, and if the outputs are of any use to the intended end-user and the larger society. Alongside this, a research notebook is assigned to every researcher to record all ongoing activities. This is important for purposes of intellectual property ownership, and remains the property of the University.

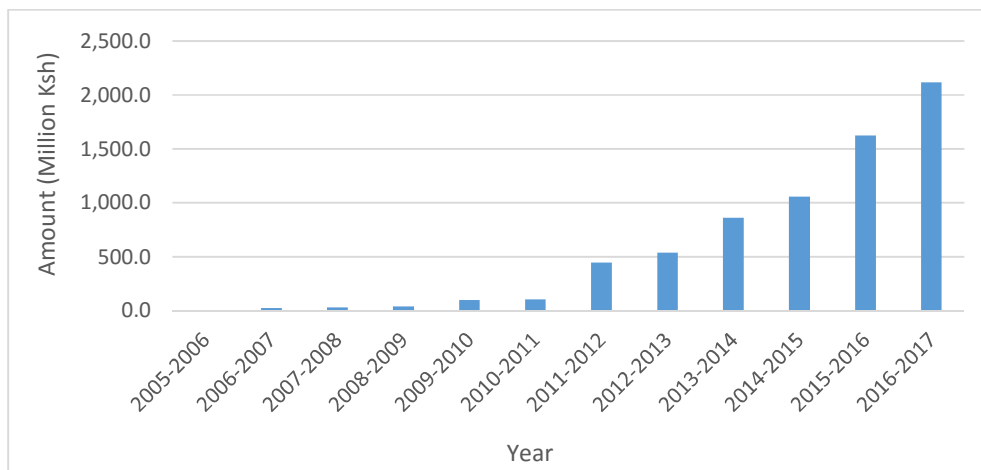


Fig. 5: International donors cumulative research funding (2005 - 2016)

International donor funds contribute the highest proportion (79%); while JKUAT contributes 11% and NACOSTI 10% respectively, see Fig. 6.

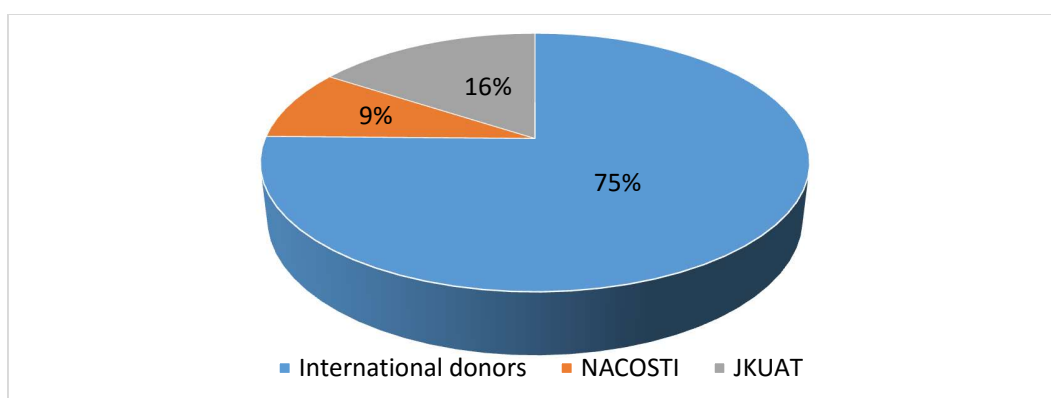


Fig. 6: Distribution of research funding in JKUAT

2.0 THEMATIC RESEARCH AND INNOVATION AREAS

JKUAT researches and innovations are categorized into nine (9) thematic areas, namely; Food Security, Nanotechnology; Natural Products; Animal and Human Health; Water Resource Management; Information Communication Technology; Engineering Technology and Industrial Development; Built Environment and Infrastructure Technologies, and lastly Social Sciences. In addition, the university has established areas of excellence hosted in institutes and centers, namely, Institute of Biotechnology Research (IBR) and Institute of Energy and Environmental Technology (IEET); Center of Sustainable Material Research and Technology (SMARTEC), Sino-Africa Joint Research Center (SAJOREC) and Water Research and Resource Center (WARREC). Figure 7 shows funding distribution in percentage among research themes, institute and centers.

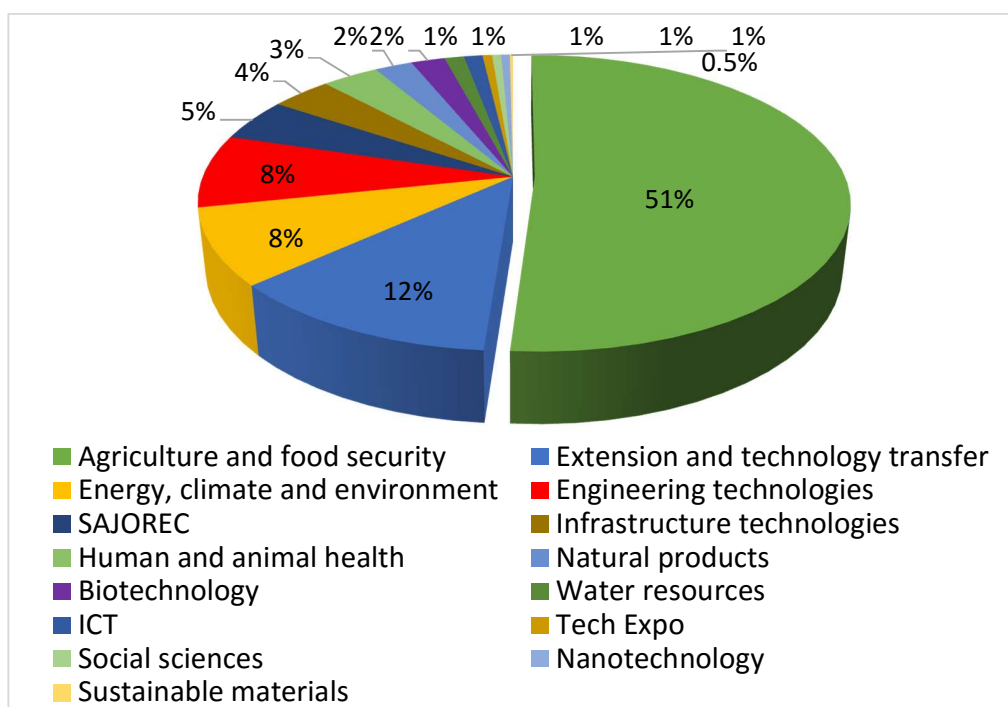


Fig. 7: Distribution of funding per theme (2005 - 2016)

2.1 Food Security

2.1.1 Research Focus

The United Nations Food and Agriculture Organization estimated that 795 million people of the 7.3 billion people in the world were suffering from chronic undernourishment in 2014-2016. Almost all the hungry people, 780 million, live in developing countries representing 12.9% of the population in developing countries (FAO, 2015). In order to mitigate food insecurity, numerous stakeholders proposed solutions and action plans to address future food security needs. One of the proposed interventions was to significantly increase investment in agricultural research and development especially in the developing world. Universities and multinational research institutions took the mandate to spearhead researches activities in the area of food security. JKUAT is one of the stakeholders involved in addressing national food insecurity in Kenya. In line with this intervention, food security as a research theme in JKUAT has attracted the largest

amount of funding from internal and external sources, taking up 54% of total funding for all the research themes between 2005 and 2016 (Fig. 6).

In order to meet the millennium development goals (MDGs) and, more recently, the sustainable development goals (SDGs) relating to food insecurity, researchers at JKUAT have continuously undertaken relevant research across different segments of the food value chain. This has largely been a team effort traversing various departments (mainly from the Faculty of Agriculture) and targeting development of local solutions from farm to table. To describe the key research areas over the last 10 years, an agricultural value chain approach was adopted.

2.1.2 Land Management and Soil Nutrition

Sustainable land management strategies including use of environmentally friendly approaches for land preparation have increasingly drawn the attention of researchers. The key issues tackled address machinery for land preparation and harvesting, soil fertility, soil nutrition, soil pollution, land degradation and the impact to crop production through soil water retention capacity and consequently, plant water use efficiency. Soil fertility studies focus on increasing productivity of high value cash crops such as tea and coffee, field crops such as rice and sorghum, and fruits and vegetables. The main aim is to determine fertility level components in the soils and develop techniques and equipment to facilitate farmers in assessment of their soils using cheap and affordable techniques. A lime kit was developed for testing lime requirements for acid soils in Kenya for improved crop production. A variety of tractor-drawn implements were developed to manage soil hard pans.



Shujaa mini-tractor developed by JKUAT, SRISTI and NMC

2.1.3 Crop Production and Improvement

Globally, crop breeding and agronomic improvements have achieved linear world food production at an average of 32 million metric tonnes per year (Tester and Langridge, 2010). Scientists at JKUAT have endeavoured to increase food production through numerous crop improvement techniques. Traits of importance for food security that have been targeted by researchers include yield, disease and pest resistance, water use efficiency, nutritional traits and agro-ecological suitability among others. The main crops studied include indigenous vegetables, rice, bananas, mango, papaya, cassava and maize. In addition, use of bio-fertilizers and bio-control systems for sustainable crop production has increased as exemplified by the rice bio-fertilizer and banana endophytes research. Innovations around nanotechnology and their use in agricultural production were also explored. The effects of climate change and variability were considered during the development of new seed varieties.



Improved virus-resistant papaya



Short stem, high yield, blast-resistant rice breeders lines

Some key products from the researches include high yielding and virus-resistant papaya varieties, aromatic and rice blast-resistant breeders lines, somaclonal variants and mutants of sorghum with high salinity tolerance and a diagnostic kit for virus detection in cassava and sweet potato. In addition, researchers collected and selected indigenous dwarf and salinity tolerant mango rootstocks which have the potential to increase yields. Improvement of crop varieties has been coupled with technologies for improving water use efficiency such as the case of capillary wick irrigation for high value crops. Soil-less farming has also been explored for people in cities or slums through development of vertical gardening and aquaponic systems. Improved crop management practices were developed through integrated weed and pest management practices. Some examples of these include management of striga through biocontrol microbes, management of thrips using entomopathogenic nematodes for french beans, among others.



Tissue culture banana inoculated with endophytes to resist soil nematodes

2.1.4 African Leafy Indigenous Vegetables

Numerous researches have been conducted in JKUAT to enhance and promote the use of African leafy vegetables in Kenya and in East Africa. Despite the demand for the African leafy vegetables, lack of quality seeds has hampered their production. In July 2016, the Kenya Plant Health Inspectorate Service (KEPHIS) licensed JKUAT researchers to commercialize the vegetable varieties which included; African nightshade (managu-Kikuyu), vine spinach (nderema-Luhya), jute mallow (mrenda-Luhya), and spider plant (saga-Kisii). Numerous farmers have adopted the seeds and are commercially producing the vegetables for the local markets. A number of African leafy vegetables have gained entry into supermarkets and open markets in Kenya. In addition, researchers found one species of African nightshades, *Solanum sarrachoides*, which is resistant to the invasive tomato red spider mite *Tetranychus evansi*, when grown in the field.



A healthy spider plant grown for seed production

Due to the high nutritive value of African leafy vegetables, research on them has attracted other stakeholders such as The Horticultural Innovation and Learning for Improved Nutrition and Livelihood in East Africa (HortinLea) which is a multi-institutional partnership between African and German researchers. Some of the research aspects in HortinLea include; increasing water use efficiency, production systems, development of integrated pest management strategies, integrating Kenyan smallholder farmers in the local value chains of indigenous vegetables and imbedding the relevant local knowledge in agricultural innovation process among others.



A charcoal cooler for extending shelf life for mangoes

2.1.5 Post-harvest Handling and Value Addition

Significant strides in post-harvest handling and value addition of crops have been made by JKUAT scientists. Post-harvest losses due to ripening and high respiration rates have been reduced through design and development of technologies for cold storage of fresh produce. For instance, the solar charcoal cooler for mango, use of infrared blocking films in paprika and use of 1-Methyl Cyclo Propene and activebags® packaging for extending the storage life of mangoes, passion fruits and tissue culture bananas. Other technologies include control and prevention of aflatoxin contamination in maize using absorbent polymers in storage structures. Postharvest storage life has been complemented by food processing and preservation technologies that extend the shelf-life of the produce, ensure consumer safety, eliminate seasonality issues and expand the number of the products in the market. Some of the notable outputs include development of mango-based products such as leather, wine, chips and powder.

Farmer groups in Tharaka Nithi, Meru, Machakos and Makueni Counties who suffer large post-harvest losses in mangoes were trained by a JKUAT team on mechanisms of reducing the losses through value addition technologies that extend the shelf life of the product. This ensures that seasonality issues are avoided and that the farmers can generate income from the mangoes throughout the year. This attracted the Government of Makueni County, who after visiting the trained farmers' groups, decided to develop a business plan for the construction of a multipurpose fruit processing plant with a special focus on mangoes. A multidisciplinary team from JKUAT developed the business plan. One of the JKUAT staff members was appointed by the Government of Makueni County to be a member of the task force responsible for the planning and implementation of the business plan for the proposed Kalamba Fruit Processing Plant. In addition, JKUAT also benefited from a research fund (Kshs. 13 million) from the Rockefeller Foundation to work with the United Nations -Women in accelerating access to postharvest technologies for women farmers in Kenya. This ongoing project involves development of Customer Journey Maps within the mango value chain and identifying the key bottlenecks that can be solved technologically. A multidisciplinary team was formed to fabricate post-harvest handling and processing equipment that will help women farmers to get better livelihoods through increased income generation.



A JKUAT researcher training farmers in Makueni County on mango processing

2.1.6 Value Addition of Emerging and Underutilised Crops

Ongoing research on emerging fruits such as cactus and baobab is focusing on how rural communities can earn extra income through processing the duo into a variety of products including juices, jams, jellies, food additives and concentrates. Underutilised crops such as amaranth have been given a new look by demonstrating their nutritional importance. It is in this respect that JKUAT conducted several trainings to promote increased inclusion of amaranth in composite flours. Non-traditional but important crops like bamboo have been demonstrated to promote good health when consumed. Products generated from this research will diversify the variety of foods consumed in Kenya.



Cactus juice processed in JKUAT

The common staples of sub-Saharan Africa have been given more prominence in an attempt to decrease severe malnutrition through collaborative efforts. For instance, the beans project, is focusing on production, postharvest

handling and storage, value addition and product diversification, including consumer studies to promote increased consumption. Sorghum has been promoted as a climate smart crop and its significant role as a food or industrial crop. JKUAT scientists are researching on sorghum as food and feed. JKUAT recently acquired a new baking unit. A total of 43 students and 29 incubatees were supported to develop their businesses on sorghum products.



A sorghum crop at the JKUAT tuition farm

2.1.7 Below-Ground Crop Pests

Tomato (*Solanum lycopersicum*) is one of the important vegetables grown in Kenya. Production of tomatoes in Kenya has been mainly under open field conditions until recently where modified high tunnels ('greenhouse') were introduced. Greenhouse tomato production in Kenya is hampered mainly by below-ground pests' mainly bacterial wilt (*Ralstonia solanacearum*) and root knot nematodes (RKNs). Ongoing research at JKUAT is utilizing farmer knowledge and practices to generate scientific evidence of the mechanisms of infection in order to develop simple and affordable tools for smallholder farmers for their management



Tomato plant wilted due to *Ralstonia solanacearum*, and root knot nematodes damage on tomato roots

2.1.8 Insects for Food and Feed

Studies have been conducted to highlight the role of insects as animal feed and human food. One such study has explored the potential of termites and mayflies in the production of animal feed in the Lake Victoria Basin. More recently, the role of insects in green economy have attracted much interest, particularly in the case of edible insects like *Ruspolia differens*, grasshoppers and the cricket. Nutritional profile as well as toxicity studies have been done for a diverse range of animal feed formulations containing insects. This is exciting and is increasingly gaining global attention.



Large-scale cricket farm at JKUAT

2.1.9 Key Outputs

Table 1: Key performance indicators under food security theme

Capacity building	Quantity
Post-doctoral researchers	4
PhD	40
MSc	100
BSc	14
Technicians	4
Internships	2
Other Key Performance Indicators	Quantity
Publications in peer reviewed journals and conference proceedings	113
Number of products developed* Publications in	16
Projects ready for patenting / plant breeders rights **	2
Infrastructure developed***	7

***Products Developed:**

1. High yielding virus resistant pawpaw varieties;
2. Bio-fertilizers for rice production;
3. Bio-pesticides for rice blast and aflatoxin;
4. Salinity tolerant sorghum;
5. A lime testing kit in acid soils;
6. Indigenous dwarf and salinity tolerant mango rootstocks;
7. Capillary wick irrigation system;
8. Vertical farming method for cities and slam dwellers;
9. Aquaponics systems;
10. Biocontrol microbes for striga;
11. Endophytes for the control of nematodes in bananas;
12. Entomopathogenic nematodes for management of thrips in French Beans;
13. Basic seeds for indigenous vegetable;
14. Solar charcoal cooler for reducing post harvest losses in the farms;
15. Several processed food products (juices, jams, wines, flour, food additives, concentrate, gellies, confectionaries, etc from various crops such as fruits and vegetables, amaranth, rice etc.and new crops such as cactus and boabab;
16. Animal feed from sorghum and insects.

****Products ready for patenting or plant breeder's rights:**

1. Endophytes for the control of nematodes in bananas (Registration to PCPB applied);
2. High yielding and virus resistant pawpaw varieties (application for Plant Breeders rights made).

*****Infrastructure Development**

The following infrastructure were established through research funds:

1. Virology laboratory;
2. Modern fruit tree and vegetable nursery;
3. An artificial paddy field for rice research;
4. A complete furnished project office with a boardroom for the Legume project;
5. A double cabin Toyota pick-up for cassava virology research;
6. Several modern greenhouses for research projects;
7. Rearing facilities for cricket and grasshopper multiplication for research in insect for food and feed.

2.1.10 Funding Analysis

Fig. 8a and 8b below shows the cumulative funding for food security research projects in JKUAT between 2005 and 2016 and funding proportions, respectively.

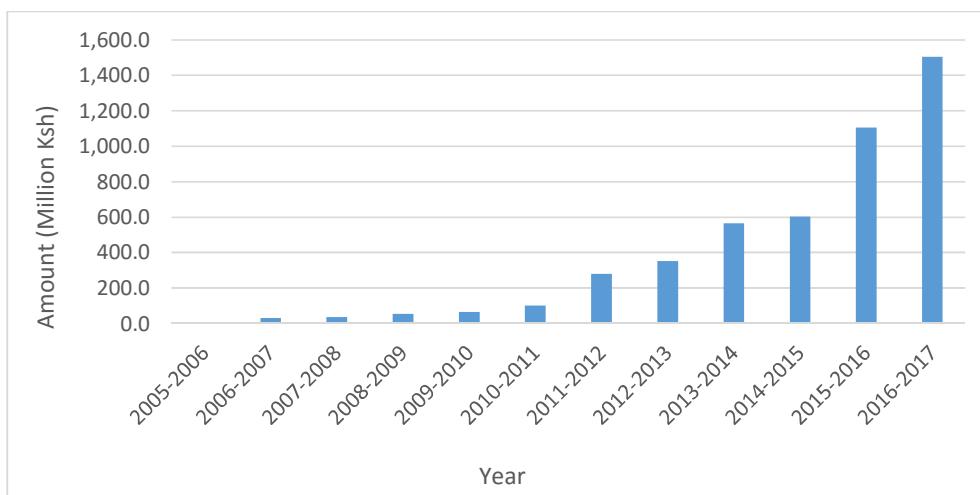


Fig. 8a: Cumulative funding for food security research theme (2005 - 2016)

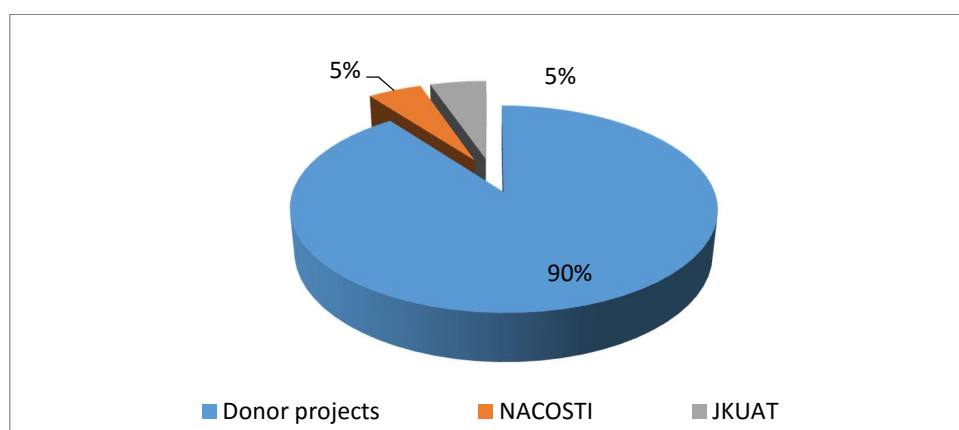


Fig 8b: Food security research funding distribution

2.2 Nanotechnology

2.2.1 Research Focus

Nanotechnology is the manipulation of materials at nano-scale (in the order of 10^{-9} m). It refers to the synthesis and/ or use of materials of nano-scale dimensions or having certain nano-scale features. It may also refer to the fabrication of novel devices with nanomaterial. At nano-scale, some materials exhibit novel properties that are different from their micro properties such as optical, thermal, therapeutic, etc. Due to this unique behavior of nanostructured materials, nanotechnology has shown great prospect in addressing many agricultural, environmental and health challenges. The fusion of nanotechnology with other technologies such as biotechnology has accelerated the development of smart products some of which are commercially available in the market. The range of nanotech products includes smart drug delivery systems for therapy of important diseases, nano-sensors for monitoring of environmental pollutants, controlled and smart release systems for agrochemicals and electronic nano devices.

2.2.2 Current Nanotechnology Research

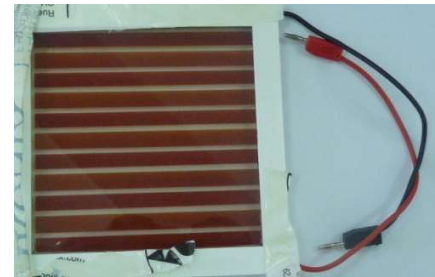
Nanotechnology work in JKUAT is funded under innovation, as it targets development of specific products. Various individuals and teams are involved in nanotechnology research either as part of their postgraduate studies or through the research/innovation activities funded by the university and other donors.

One key research area is in nano-agriculture. Agrochemicals are wasted using conventional application methods through evaporation and leaching. Scholars are addressing this problem by researching on nano materials that facilitate slow agrochemical release, which in return minimize the losses and thereby make agriculture more profitable. Researchers are also using nanotechnology in combating plant diseases by establishing suitable nano-carriers for biological control organisms. They have succeeded in developing chitosan and silica nanoparticles as carriers for Biological Control Agents against *Rastonia solanacearum*, the causative agent of bacterial wilt in tomatoes. A patent for this technology was applied. Additionally, a nano-based method for reducing the high levels of chemical residues in crops such as tomato is under investigation.



Tomatoes treated with bio-antagonists adsorbed on chitosan immobilized silica nanocomposites growing on soil infested with *Ralstonia solanacearum* in JKUAT

Another key nanotechnology research area is development of a highly efficient, low-cost nanostructured solar photovoltaic (PV) module. The main aim is to develop and market low-cost solar PV modules made from nanostructured solar cells with locally available manufacturing process. This will replace high cost silicon PV modules currently in use. Of great potential, is the high efficiency projected from these cells, which is far greater than that from silicon cells.



A low-cost nano-structured solar photovoltaic module under development in JKUAT

2.2.3 Key Outputs

Table 2: Key performance indicators under Nano technology theme

Capacity building	Quantity
PhD.	3
MSc.	5
BSc.	1
Technicians	1
Internships	1
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	4
Number of products developed*	3
Products ready for patenting **	1

***Products Developed**

1. Chitosan and silica nanobiopesticide
2. Mesoporous Silica-urea
3. Mesoporous Silica-metalaxyl Slow release agrochemical composites

****Products ready for patenting**

1. Patent filed for Chitosan and silica nanopesticide

2.2.4 Funding Analysis

The fig 9a shows the cumulative funding for nanotechnology research since 2009 when JKUAT began venturing in this area while (Fig. 9b) shows percentage distribution of funding per donor.

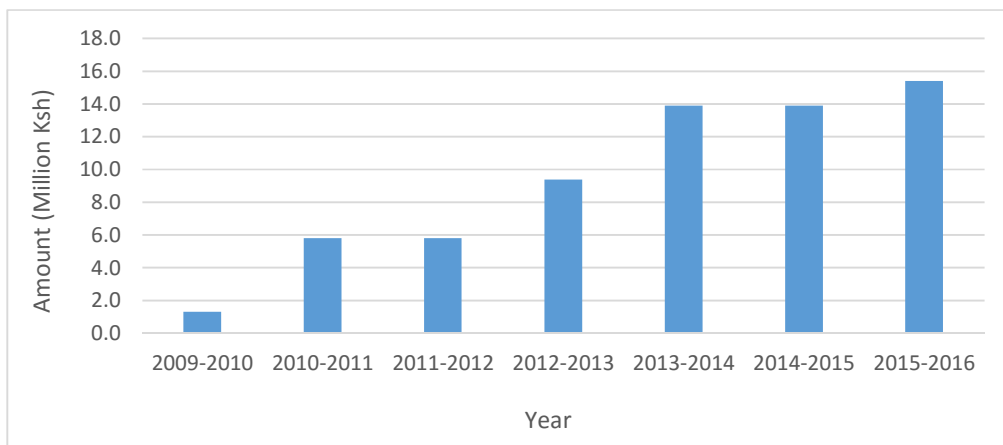


Fig 9a: Cumulative funding for nanotechnology research theme (2009 - 2016)

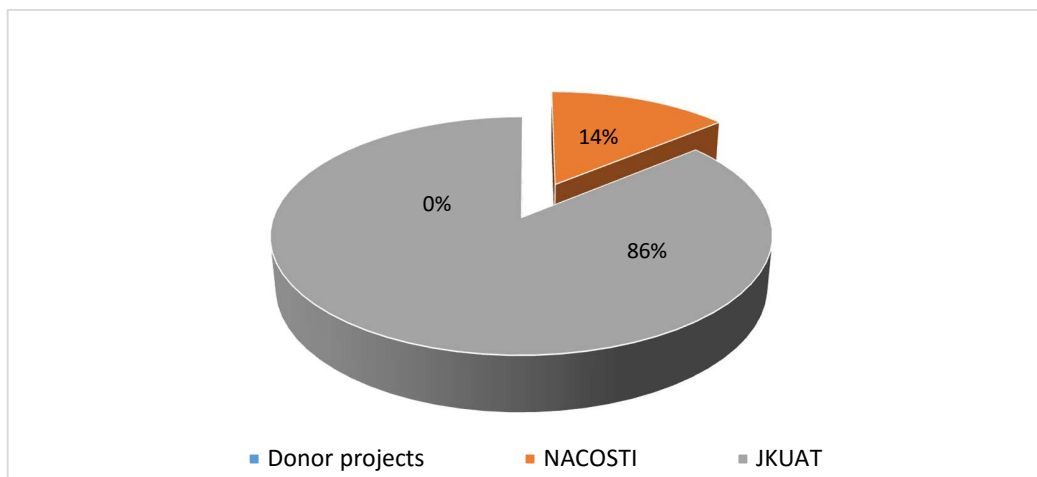


Fig 9b: Nanotechnology research funding distribution

2.3 Natural Products

2.3.1 Research Focus

A natural product is a chemical compound or substance produced by a living organism found in nature. Some of the key sources of natural products include plants, animals, fungi and bacteria. Natural products are of key interest to man, as they are exploited for health and industrial benefits. Some scholars at JKUAT are engaged in the natural products research to generate products for human and animal health, food preservation and probiotics, industrial and beauty.

2.3.2 Human Diseases

Malaria is the leading cause of morbidity and mortality in Kenya. Over 20 million Kenyans are at risk of contracting malaria (Ministry of Health, 2014). Drug resistance has been identified as one of the factors that leads to severe malaria and high mortality as observed in malaria-endemic areas. Researchers under the natural products research theme have addressed management of malaria through development of phytomedicines from locally available medicinal plants (*Zanthoxylum usambarense* and *Warburgia ugandensis*) that have active compounds against the *Plasmodium* parasite. Scientists were able to produce a capsule against malaria parasites, which is still under trial.



A plant used as herbal medicine

Schistosomiasis/bilharzia at the Mwea Irrigation Scheme is a big challenge to the farmers. Researchers tested the use of crude extracts from the roots of *Solanum incanum* to control the disease. They came up with a crude extract, which has active ingredients against Schistosomiasis. Further research is ongoing in order to encapsulate the active compounds from *Solanum incanum*.



Schistosoma mansoni, the parasite that causes schistosomiasis

HIV-1 infections lead to opportunistic fungal and bacterial infections that normally attack immune-compromised persons. Management of these infections is usually expensive and not affordable to most patients. Scientists at JKUAT explored on the utilization of natural products from tropical plants biodiversity such as *Moringa oleifera* in the control of HIV-1 asymptomatic infections. Laboratory tests indicated that plant extracts have inhibitory activity against the opportunistic bacterial and fungal infections. The researchers aim is to come up with novel method of enhancing or boosting the immune system and protecting the patients from opportunistic diseases.

Scholars in JKUAT in collaboration with other Universities are undertaking a study to evaluate, as a prerequisite to human clinical trials, the anticancer properties of candidate medicinal plants.

2.3.3 Animal Diseases

Domestic animals are sources of income to a large proportion of the Kenyan populations. Animal diseases directly cause poor health and loss of production of the host animals, and can be fatal if left untreated. Treatments using conventional medicines are usually expensive and beyond the reach of most poor livestock owners. In order to bridge the gap between production and input costs associated with treatments, researchers at JKUAT investigated on the use of herbal medicine obtained from medicinal plants for the management of diverse animal diseases.



Sheep infected with helminthes

One disease our researchers have investigated is the gastro-intestinal helminths such as *Haemonchus contortus* in sheep and goats. Investigators from JKUAT engaged in novel research activity using *Prosopis juliflora* (commonly known as *Mathenge*) to come up with an anthelmintic capsule which has proven to be effective against helminthes, which are great threat to livestock industry in Kenya. Further studies have also shown that the natural medicinal capsule has double advantage because being a natural product it has reduced the resistance to synthetic anthelmintic, which has been a hindrance to the treatment of this condition.



Infected sheep on antihelmintic treatment

Related investigations were done on use of natural and locally available products such as urea molasses blocks supplemented with pineapple by-products for the management of gastro-intestinal helminths in goats and sheep. The study revealed that supplements developed from pineapple can control gastro-intestinal helminths in dairy goats, thus leading to increased milk and meat production.

2.3.4 Food Preservation and Probiotics Using Natural Products

In order to avoid synthetic preservatives, there is pressure to adopt natural alternatives for maintenance or extension of product shelf life. Traditionally, communities in Kenya (such as Pokot and Maasai) have used herbs for the preservation of meat and milk. To study their efficacy, JKUAT scholars collected some of the commonly used herbs (including *Ziziphus abyssinica*, *Tamarindus indica* L. (commonly known as *Mkwaju*). They conducted taxonomic, chemical analysis and efficacy tests on these herbs. The herbs were found to have meat preservation as well as anti-oxidant properties. Scientists also isolated probiotics from fermented Maasai milk. The probiotics were characterized and tested for their effectiveness and placed on the list of probiotics to be used for health benefits.



Gourds for fermenting Maasai milk

2.3.5 Therapeutic, Beauty and Industrial Products

Investigations have explored the use of natural products for development of therapeutic and beauty products. Therapeutic products such as anti-bacterial, anti-fungal and anti-aging compounds were extracted from camel and goat milk and from plants such as amaranth, cucumber and peanuts. The research led to

development of lotion products rich in retinol and tocopherol, which are antioxidants. The product from the camel milk has since been patented.

Yellow Oleander (*Thevetia peruviana*) is a poisonous plant and contains numerous toxic compounds. The scholars focused on extraction of compounds that may be useful for development of rodenticides. Tests proved that the compounds were indeed toxic to rodents. This is still under product development.

The move towards the establishment of bio-fuels industry in Kenya began in 2006. In order to provide the technological support for this sector, JKUAT is involved in research activities on biodiesel extraction from plants. Researchers have extracted biodiesel from Yellow oleander and croton tree (*Croton megalocarpus*). The biodiesel from these sources has been tested on commercial electricity generators and is ready for up scaling. Other research has explored the extraction of oil from cashewnut shell.



Yellow oleander (Thevetia peruviana)

Other researches under the industrial products from natural sources include extraction of enzymes and metabolites from termite guts and algae from the Kenyan coast. The enzymes have the potential for bleaching application in the textile industry.

2.3.6 Toxicology

The safety of herbal medicine for human is paramount in human health. After establishing that some herbal formulations were indeed toxic, JKUAT researchers developed a protocol for testing the safety of herbal medicines in use in Kenya.



Bio-diesel extracted from yellow oleander by JKUAT scientists

2.3.7 Propagation, Molecular Characterization and Ethnobotanical Survey of Endangered Plant Species

Research under natural products is also directed towards over exploited and endangered plant species. One such study is addressing *Strychnos henningsii* (Muteta in Kikuyu), an indigenous tree species which is over exploited due to its medicinal value. The tree species has therefore become rare and users increasingly find it difficult to find populations or individual trees for their use. The research team set out to study the tree species for sustainable utilization and conservation.

#The study addressed the following areas of *Strychnos henningsii*: Phytochemical screening and antimicrobial assays of leaves and stem bark; Micropropagation & Macropropagation studies; Ethnobotany; Genetic diversity (including molecular characterization) and Species Niche modeling and Toxicity studies. A workshop for users of the tree and a proceeding from this workshop), A booklet entitled '*Strychnos henningsii*: A practical guide' was also published.

2.3.7 Key Outputs

Table 3: Key performance indicators under Natural Products theme

Capacity building	Quantity
PhD.	7
MSc.	11
BSc.	17
Technicians	4
Internships	2
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	39
Number of products developed*	7
Product ready for patenting**	2

*Products Developed

1. Probiotics from milk fermented using Maasai traditional techniques;
2. Anti-malaria capsules undergoing final product development;
3. Natural anti-helminthes encapsulated powder extract from *Mathenge* for control of gastro-intestinal helminths in small ruminants;
4. Bilharzia management technique using natural product;
5. Anti-aging lotion from Camel milk;
6. Bio diesel from yellow oleander tree;
7. Enzymes for application in the textile industry.

In addition, natural herbs from which meat preservation products can be developed were identified.

**Products Ready for Patent

1. Anti-aging lotion from Camel milk (patented)
2. Encapsulated herbal anthelmintic powder extract from *Prosopis juliflora* (*Mathenge*), for ruminant animals. (Applied for patent)

2.3.8 Funding Analysis

Fig. 10a and 10b below shows the cumulative funding for natural products research projects in JKUAT between 2005 and 2016 and funding proportions, respectively.

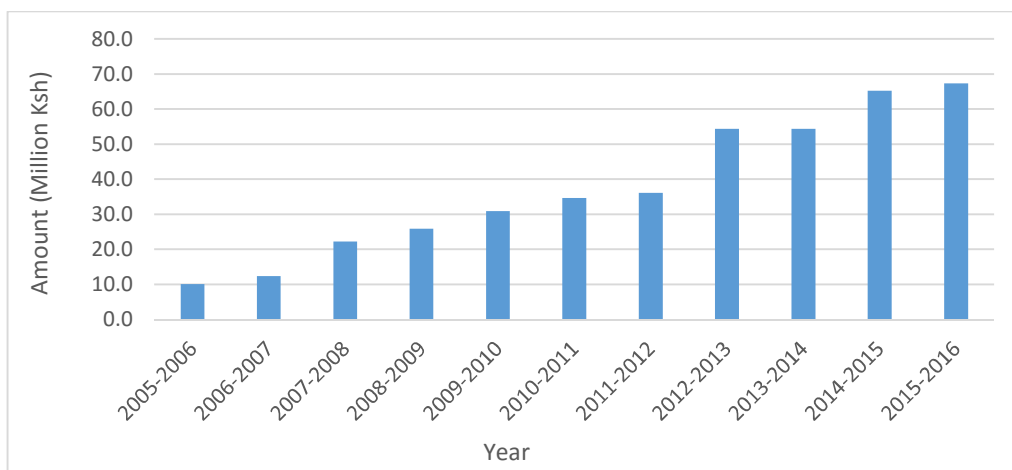


Fig. 10a: Cumulative funding for natural products research theme (2005 - 2016)

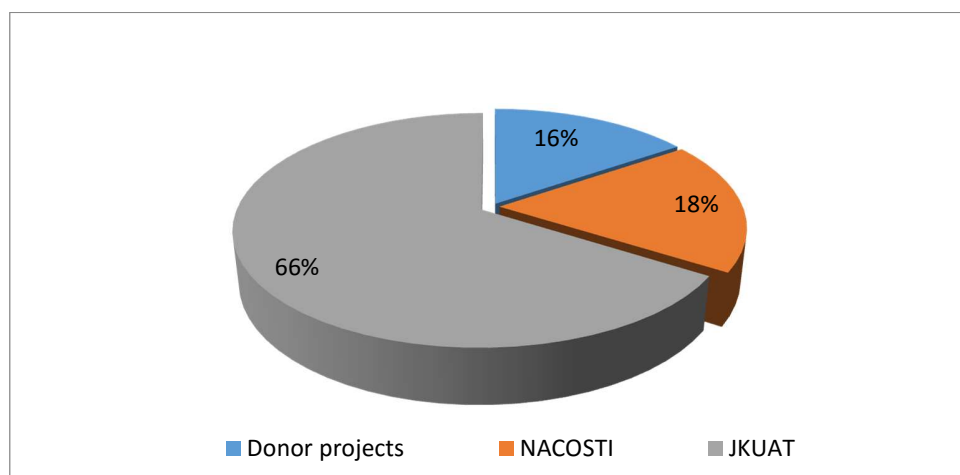


Fig. 10b: Natural products research funding distribution

2.4 Human and Animal Health Sciences

2.4.1 Research Focus

Good health is central to human happiness and well-being in addition to being an important requirement for economic progress. Researchers in JKUAT have used various approaches to improve health. They have focused on HIV/AIDS, cancer, sleeping sickness, malaria, toxoplasmosis and helminthiasis. The studies were conducted with both international and national collaborators. In some of the studies, seed funding was provided by JKUAT and their key findings enabled access funding from international organisation. The details of research are discussed below.

2.4.2 Human Health

2.4.2.1 HIV

The HIV/AIDS epidemic remains a global health challenge of unprecedented dimensions and a monumental threat to development. There are nearly 37 million people living with HIV/AIDS around the world and seventy percent of newly infected persons live in sub-Saharan Africa (UNAIDS, 2016). The need to reduce HIV/STI transmission is of high priority in Kenya. Scholars in Public Health Department in JKUAT have focused on epidemiology of the HIV, including its socio-economic effect on households, its impacts on various categories of patients, factors that influence uptake of family planning among HIV infected women, association between substance abuse and sexual risky behaviors among students in public universities in Kenya, predictors of HIV/AIDS treatment failure and the prevalence and patterns of HIV-1 drug resistance among children. In addition to the JKUAT funding, scientists have also attracted international funding. Among those include a study funded by National Institute of Health (NIH). In that study, an innovative method - the use of mobile phone call reminders to improve retention to care for HIV-infected adolescents is being investigated. In another study, the Bills & Melinda Gates Foundation has also funded a study to determine the feasibility of HIV-1 self-testing among individuals using pre-exposure prophylaxis.



Samples collected from herbalists for the studies on safety and toxicity

Diagnosis of HIV is important in management of disease. In this area, the feasibility of using depeptidy peptidase IV CD26 as a surrogate marker in monitoring anti-retroviral drug therapy is being investigated. In another study, the susceptibility of opportunity infections (yeast) in HIV patients have been determined.

2.4.2.2 Microorganisms

Studies in infections caused by microorganisms in man have focused on factors influencing tuberculosis control, association of *Helicobacter pylori* sub-type with clinical outcome in patients and evaluation of measles immunity among children aged 9-59 months. Research on viral diseases have been at genetic level and include controlling Rift Valley Fever Virus using RNA silencing and genetic characterization of arboviruses and other emerging pathogens

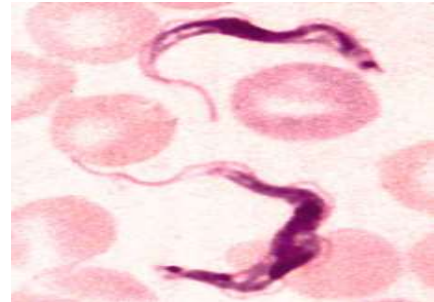
2.4.2.3 Cancer

Cancer research in JKUAT has focused on breast and cervical cancer. The factors that influence breast cancer screening in persons attending hospitals have been established. Research has focused on determining the feasibility of p16INK4a/Ki-67 biomarker for detection of Cervical Dysplasia among women. In another study, the association between HPV and HIV co-infection amongst women in Kenya were established. With support from NACOSTI, a colposcope was installed at Thika Level 5 Hospital for use by hospital staff and JKUAT researchers for screening of cervical cancer and other gynaecological problems. Another study is underway on diagnosis of biomarkers for the semi-invasive endometriosis.

2.4.2.4 Malaria

Malaria is widespread in the tropics. In the recent past, there were 214 million cases of malaria worldwide resulting in an estimated 438,000 deaths, 90% of which occurred in Africa. Malaria is commonly associated with poverty and has a major negative effect on economic development.

In an effort to improve drugs for malaria scientists in JKUAT are using the rational approach in drug design. In collaboration with scientist from KEMRI, chemical synthesis of hybrid drugs has been undertaken. The efficacy and safety of these hybrids (aniline-artesunate conjugate and quinoline-methyl amino acid hybrid) have been tested using *in vitro* and *in vivo* system. The efficacy and safety of two promising hybrids have been evaluated and the research team recommends their development especially against the drug resistant parasites. In collaboration with scientists in Institute of Primate Research (IPR), JKUAT scientists have also focused on the baboon model of malaria. The studies have established the role of Ligand receptor process in pregnant olive baboons infected with *Plasmodium knowlesi*.



Blood sample showing the human African trypanosome, which causes sleeping sickness

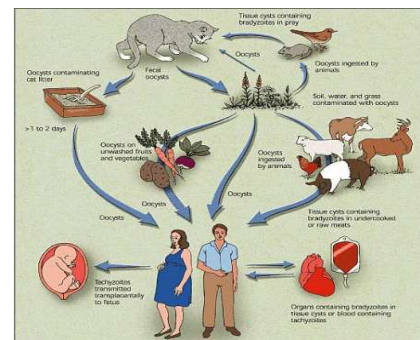
2.4.2.5 Sleeping Sickness

Sleeping sickness is a zoonotic disease affecting many countries in Africa. Scientists in JKUAT are studying various aspects of the disease. To reduce the transmission of the disease scientists in the Department of Biochemistry have identified *Glossina morsitans morsitans* odorant binding protein genes in *Glossina fuscipes fuscipes*: Also together with collaborators from ICIPE and Egerton University, the team is investigating the role of tricorn protease in development *Trypanosoma brucei brucei*.

In collaboration with scientists from the Institute of Primate Research, scientists in JKUAT are also focusing on diseases diagnosis. Their studies have established that biomarkers IL-6 can be used in staging the disease. The team also established that LAMP test can use non-invasive samples such as urine and saliva. Further, the team developed a safer Non-human primate model of the disease.

2.4.2.6 Toxoplasmosis

Toxoplasmosis, a little-known public health threat is, also being studied by a multi-disciplinary approach by JKUAT scientists. *Toxoplasma gondii* is zoonotic and in human leads to severe disease in congenitally infected infants and immunocompromised people. The studies have established the epidemiology of the disease in animals and humans in Thika. The team in collaboration with the University of Guelph, Canada was able to attract further funding from Canadian African Research exchange Grant (CAREG), International Development Research Centre (IDRC). Using that fund, the parasite has been isolated from chickens and cats, characterized and a cyro-bank of parasites (tachyzoites and bradyzoites) has been established in the Department of Biochemistry. The JKUAT scientists are also developing rodent and non-human primate models to enhance pathogenesis studies. Because of the risk of contamination, the team has trained laboratory staff in both IPR and JKUAT on biosafety issues. In future, the team aims at developing public health messages regarding prevention of the disease in human and improving the diagnosis of toxoplasmosis in man and his domestic animals.



Life cycle of *Toxoplasma gondii*, a zoonotic parasite

2.4.2.7 Leptospirosis

This is an eco-epidemiological project whose goal is to empower urban slum people through mitigated public health and socioeconomic burdens arising from Leptospirosis. The project is solely interested in determining the seasonal burdens arising from Leptospirosis in slum dwellers and animals in Kibera slums in Kenya. Subsequently, the study will develop and analyze a mathematical model that will track *Leptospira* bacteria in urban slum dwellers, slum domestic animals and pets and the slum physical environment.

The project will apply the model by:

- (i) Assessing the contribution that biotic (animal/human) and abiotic (soil/water) habitats play in the observed bacterial dynamics;
- (ii) Identifying vulnerable habitats (biotic/abiotic) to focus interventions effectively reduce the bacterial loads;
- (iii) Assessing effectiveness of relative impacts of preventative and control strategies targeting these habitats;
- (iv) Applying the model as a prediction tool for improved surveillance of Leptospirosis in urban slums in Kenya.

2.4.2.8 Helminthes

The prevalence and intensity of soil-transmitted helminthes and schistosomiasis in infants and pre-school children in Mwea has been assessed and found to be a major threat to the health and well-being of the children in this area. A program on their control is being finalised to be recommended to the relevant ministry for incorporation in the control regime of these conditions. From the results of this study, the Ministry of Health is expected to upscale the helminth control.

2.4.2.9 Occupational Health

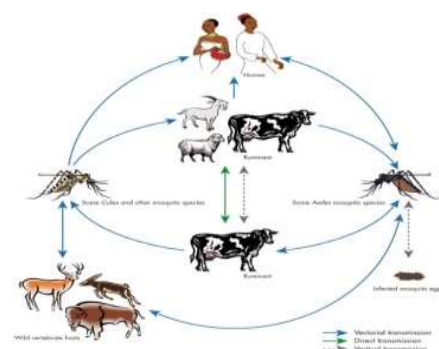
Occupational health problems related to quarry workers, tea pickers, and construction workers exposed to organic solvents were investigated.

2.4.3 Animal Health

On improvement of animal health, various studies are underway. An epidemiological survey of gastrointestinal nematode (GIN) of cattle in Kirinyaga County has been undertaken. In addition, scientists are screening *Bacillus* species from *Rastrineobola argentea* (commonly known as omena) for bacteriocins against bovine mastitis pathogens.

2.4.3.1 East Coast Fever

East Coast Fever is prevalent across the eastern, central, and southern parts of Africa, including Kenya. About 28 million cattle in the region are at risk and the disease kills at least 1 million cattle per year (AU-AIBAR, 2011). Economic losses are concentrated on small-scale resource-poor households. In Kenya, the disease poses a significant threat to the livestock sector. In JKUAT, research on *Theileria parva*, the causative parasite has focused on immune responses during the infection.



Infection cycle of Rift Valley Fever

2.4.4 ICT and Health

In health, the use of up-coming technologies such as fibre optic nano chemical sensor for selected carcinogenic compounds' vapours, and the use of ICT a simulated model for computer aided home based health system has been evaluated.

2.4.5 Key Outputs

Table 4: Key performance indicators under Human and Animal theme

Capacity building	Quantity
PhD.	5
MSc.	20
BSc.	2
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	14
Number of products developed*	6
Products ready for patent**	6

*Products developed:

1. Biomarker for late staging sleeping sickness.
2. That LAMP test for diagnosis of sleeping sickness.
3. A cyrobank for parasites (tacyzoites and bradyzoites).
4. Accurate method for establishing the safety of herbal preparations
5. Three drug compounds for Malaria.
6. Three products for Leishmaniasis.

**Products ready for patent

1. Three drug compounds for Malaria.
2. Three products for Leishmaniasis.

Extension to Community

A colposcope donated to Thika Level 5 Hospital.

2.4.6 Funding Analysis

Fig. 11a shows the funding trends in 2005-2016. Funding sources are also shown on (Fig.11b)

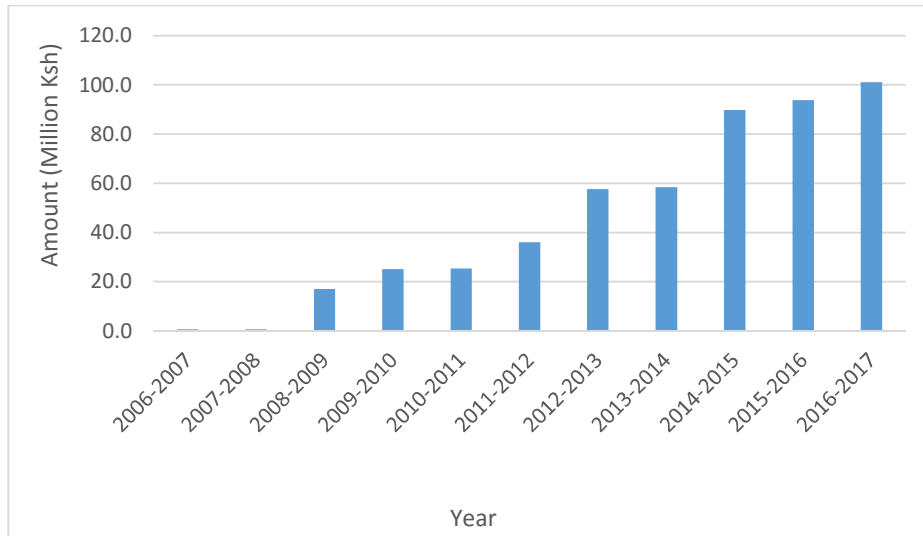


Fig. 11a: Cumulative funding for human and animal health research theme (2006 - 2016)

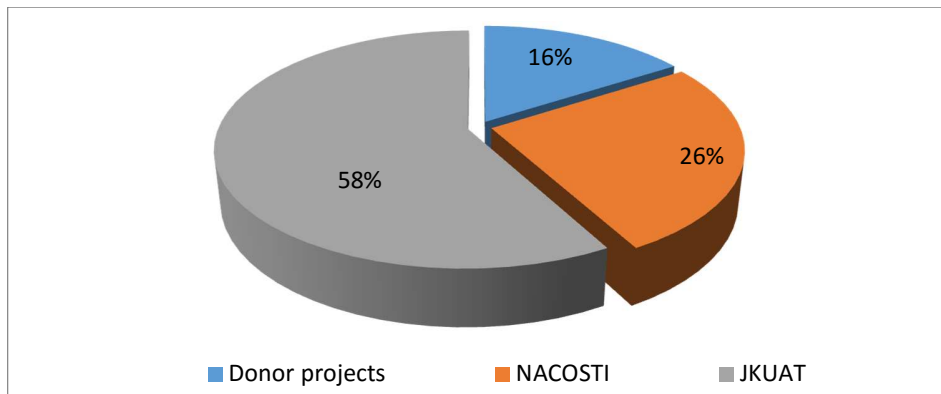


Fig 11b: Human and animal health research funding distribution

2.5 Water Resource Management Research

2.5.1 Research Focus

Water affects almost all aspects of economic development, human wellbeing and environmental sustainability. The importance of water is stressed in the Sustainable Development Goals (SDGs) number 6. The SDG goal number 6 is dedicated to solving problems of improved water, sanitation and hygiene that affect the world. Additionally, water plays a crucial role in other SDG such as SDGs focusing on ending poverty and hunger, ensuring human health and wellbeing, gender equality, sustainable energy, reducing inequality, building sustainable cities, combating climate change, conserving oceans, seas and marine ecosystems, ensuring peace and security and building partnerships. These important aspects of water affect Kenya, a water scarce country. It has an estimated 681 m³ of available water resource per capita which is close to 500 m³ a threshold for absolute scarcity (Falkenmark, 1989). There are vast temporal and spatial variations in water resource availability in the country. Given this critical role of water, it is important therefore to spur research in the various water aspects.

In this regard, JKUAT researchers from various disciplines have endeavored to understand the dynamics of water in terms of quality and quantity, and to relate this to dimensions of socioeconomic development and environment. Researchers have employed various tools and aspects of research to develop and test solutions to the variability of water availability. Some of the approaches and tools they have employed include hydrological models, such as Water Evaluation and Planning System (WEAP) and Soil and Water Assessment Tool (SWAT) to predict and test alternative opportunities of water management, carrying water surveys, sedimentation assessment using state of the art multi-frequency Acoustic Profiling System (APS), use of Geographical Information System (GIS) and Remote sensing technology, deployment of mobile water quality laboratories for improved assessment of water quality status and development of decision support tools (DST). All these tools were combined to inform the development of the water sector.

The multidisciplinary sub-research themes in water can be broadly classified into the following categories:

1. Water for agriculture: water harvesting and irrigation;
2. Catchment management, soil erosion and sedimentation control;
3. Water management and business linkages;
4. Climate change and water resources;
5. Groundwater management;
6. Water for cities;
7. Water for sanitation, hygiene and health.

2.5.2 Water for Agriculture

Agriculture uses 70% of all water abstracted from our water bodies. Irrigated agriculture contributes significantly to food security and this role is expected to grow in the future as irrigation schemes are expanded. Water harvesting also harnesses water for agricultural production. JKUAT researchers have shown that about half of the pumped irrigation systems used by smallholder farmers are inefficient due to poor design, operation, and management.

In a research on integrated water resources management for Makueni District, the investigators applied a field-based water balance models (WaSiM) to simulate soil moisture under different soil and water conservation practices in Kaiti watershed. The findings of this research were presented to Makueni County government for implementation and inclusion in their programmes. Future research activities under this theme will focus on enhanced technical and economic efficiency of agricultural water use, automation of irrigation and water harvesting, reuse and recycling of water and estimating water footprints.



Mr. S. Kibe, centre, the JKUAT lead researcher on ground-water mapping in Makueni, with the Makueni Governor Prof. Kivutha Kibwana, right, and a county official

2.5.3 Catchment Management, Soil Erosion and Sedimentation control

The catchment is a basic unit for water management. In Kenya, catchment management takes place from the micro- to macro-catchment level involving a variety of stakeholders from communities to national level water managers. At JKUAT, scholars have contributed immensely towards understanding catchment hydrology, impacts of climate change, land use change, soil and water conservation, water infrastructure development (e.g. dams) on water and land resources and the use of remote-sensing data for water management. Soil erosion has been a major focus including studies on its causes, control and impacts. The on-site impacts of soil erosion include land degradation and reduced agricultural productivity and off-site

impacts such as reservoir sedimentation, damage to water, transport and irrigation infrastructure and vital ecosystems and reduction of water quality. A recent study by JKUAT researchers established that Ruiru dam, which supplies water to Nairobi City, has lost about 12% of its initial volume. The study in Ruiru was carried out using multi-frequency Acoustic Profiling System (APS). This study generated new information that could lead to improved management of the upstream landscape and reservoir. In this sub-theme, future research direction is to quantitatively estimate loss of soil and deposition using dating techniques in lieu of missing long-term data.



A student carrying out sedimentation survey in Ruiru Dam

2.5.3.1 Bathymetric and Sedimentation Survey Project

Effective management of reservoirs continuously requires data on their current volume. In reservoirs, volume loss occurs due to sedimentation, which in Kenya, is a recurrent problem caused by anthropogenic accelerated soil erosion. Post-impoundment sedimentation can be determined using multi-frequency Acoustic Profiling System (APS) coupled with vibracoring technology. This state of the art technology is now available in JKUAT through a collaborative initiative.



Prof. Kahangi (DVC RPE), launches the Bathymetric Survey Project at Ruiru Dam in July 2015.

The collaborative initiative was joint effort of JKUAT, USDA-ARS and Baylor University in Waco TX. Staff from these three organizations wrote a proposal, which lead to the funding of the project by the USAID. Other organizations have since partnered with JKUAT in the project. These include the Nairobi City Water and Sewerage Company (NCWSC), World Agroforestry Centre (ICRAF) and Dresden University of Technology (TU Dresden). The project was officially launched in July 2015 in a ceremony officiated by JKUAT's DVC-RPE, Prof. Esther Kahangi, and NCWSC Managing Director Engineer Philip Gichuki.

Beyond the project launch, in 2015, the research have been able to further survey and carried out training and capacity building activities. Survey has been done in Thika reservoir, (aka Ndakaini) and Lake Naivasha. As per the time of preparation of this book, data analysis was ongoing for Thika reservoir and Lake Naivasha. The project has so far attracted a PhD candidate, two MSc students and multiple BSc students. Furthermore, two NCWSC staff were involved in hands-on training during the surveys.

2.5.4 Linking Water Science and Engineering to Business and ICT

Leveraging the growth in private sector and ICT could spur developments in the water sector. JKUAT researchers have been engaged in studies to test how financial incentives to land owners could enhance adoption of sustainable agriculture and land management practices. At JKUAT, researchers were involved in the scoping study for Payment for Ecosystem Services (PES) in Sasumua catchment. In these studies, the researchers evaluated the impact of soil and water conservation practices on soil erosion and sedimentation. These studies have culminated in a pilot PES project in Sasumua which is funded by the World Bank under the KAPSLM project. JKUAT has also carried hydrological studies that contributed to the WWF's PES project in Lake Naivasha Basin. In Sasumua watershed JKUAT Staff worked in

collaboration ICRAF, KALRO, Ministry of Environment and Natural Resources among others. They used hydrological models, including SWAT, to design the PES scheme for the watershed where they showed the plausible impact of structural and non-structural interventions. They also identified areas where interventions could be prioritized.



A JKUAT field demonstration in Sasumua watershed

JKUAT researchers have developed the first watershed stewardship standard for the flower industry in Lake Naivasha and this standard has been integrated in the revised Kenya Forest Service (KFS) Silver Standard. This is another market based instrument that aims to catalyze watershed management. Future research activities in this sub-theme will aim at linking disciplines of science, engineering, ICT and businesses to generate innovations in the water sector. The focus will be; water and environmental economics, public-private partnerships in water sector, water supply/water saving innovations; sustainable financing of water supply, and centralized wastewater treatment systems, innovation on low-cost on-site sanitation. Other areas of focus will be payment for ecosystems services, water stewardship standards, and home-grown ICT solutions for the water sector, (e.g. smart metering, billing and payment, reducing unaccounted-for water, massive water data collection, M&E tools to track progress towards SDG).

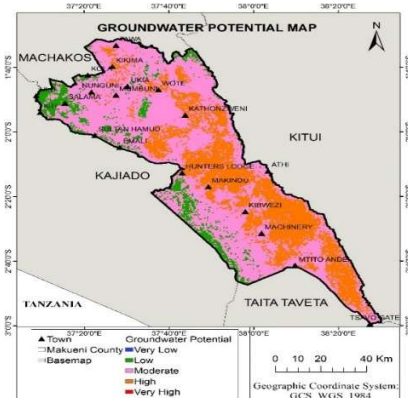
2.5.5 Climate Change and Water Resources

Climate change and its impact on water resources will continue to make the attainment of the SDGs more difficult. The current methods of assessing climate induced risks to water resources are not sufficient to inform decisions for the water sector. Research on the impacts of climate change on water resources needs to be sustained as new information and tools become available. JKUAT researchers have carried out various studies on climate change. In Western Kenya, JKUAT scholars used SWAT to simulate the impact of different climate change scenarios on the water resources of Mt. Elgon watershed. Similar studies were done in Mara, Nyando and Yala watersheds of Western Kenya. Further research activities of this sub-theme will focus on climate, water and ecological systems by developing solutions to protect life and infrastructure from extreme weather events (floods, drought). Other areas of focus will be on improving weather and climate information services to agriculture and water sectors.

2.5.6 Groundwater Management

Groundwater is a hidden but a valuable water resource. It is estimated that sustainable groundwater comprises 20% of our renewable water resources. Groundwater could meet a significant proportion of our national water demand if low cost technologies to exploit it are developed. The major threats to groundwater are over-abstraction and pollution. Compared to surface water, groundwater resources are not well understood and thus there is considerably less information available for decision-making.

To contribute to increased understanding of groundwater JKUAT researchers have mapped the potential of groundwater in some parts of Arid and Semi – Arid lands (ASALs) of Kenya. Investigators in JKUAT have carried out research in Makueni County to map



Groundwater management map of Makueni County

groundwater related to quantity and quality. The aim was to reduce the incidences of drilled boreholes being abandoned on account of low yield or poor quality.

The researchers have evaluated ways of improving ground water quality using locally available and appropriate technologies. The use of groundwater models such as MODFLOW and its derivatives to predict groundwater potential and groundwater quality were used. JKUAT researchers in conjunction with Penn State University (USA) developed and tested low cost drilling rig. This drilling rig was handed to an enterprise for mass production. Future research activities in this sub them will aim at groundwater modelling, groundwater surveying, assessment of groundwater potential, simulating pollutant transport in groundwater, developing technologies to monitor groundwater, development of low cost technologies for exploitation of groundwater.

2.5.7 Water for Future Cities

There is continuous growth in urbanization globally which is projected to increase by 2.5 billion by 2050¹. This increase in urbanization growth is mainly concentrated in Asia and Africa. By 2030, a third of Kenya's population will be residing in urban centers. The fast growth of urban centers and unmatched development of water infrastructure will continue to be a challenge to our urban centers in the future. Challenges such as sustainable water supply to the cities, management of demand and loss of supplied water, policy and governance issues and conflict management over resources need to be addressed. In preparation for increased urbanization, JKUAT researchers have carried out studies on Urban and peri-urban food production such as in the informal dwellings in Kibera in Nairobi county. These studies explored how to use wastewater to grow food in the urban using furrow irrigation systems. Future research activities will focus on reducing non-revenue water, exploring alternative sources of water and improving urban food production.

2.5.8 Improve Access to Clean Water, Sanitation and Hygiene

Access to clean drinking water is important for both humans and livestock. Additionally, water is a vital requirement for hygiene and sanitation purposes. Water sources are under pressure due to increasing population and intensive farming. As a result, human and household wastes often pollute sources of water available.

JKUAT researchers have carried out studies in both urban and rural Kenya to understand the needs for Water Access, Sanitation and Health (WASH) and identify current and future gaps in meeting WASH needs of the local community. A research carried out at the Upper Mara region demonstrated plausible impact of underdeveloped water, sanitation and hygiene (WASH) in Upper Mara region. The research also showed that, considering the current hydrological, climatic and water demand scenario, there would be a 2.37% unmet water supply need by the year 2030 in Upper Mara and the situation could be worse in the light of increased demand or low river flows due to changes in hydrological and climatic conditions. Future research activities will aim at improving access to clean water, sanitation and hygiene.

2.5.9 Key Outputs

Table 5: Key performance indicators under water resource theme

Capacity building	Quantity
Post-doctoral researchers	7
PhD.	16
MSc.	76
BSc.	45
Technicians	12
Internships	11
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	98
Number of products developed*	7

*Products Developed

1. Groundwater maps covering potential in Makueni.
2. Groundwater Quality Index (WQI) for Makueni County
3. A non-motorized aeration and filtration unit for removing Iron and Manganese designed and fabricated and tested for field deployment.
4. Low cost drilling rig
5. Watershed model for water resources management in Ruiru Reservoir.
6. Policy Brief on Payment for Ecosystem Services in Kenya
7. Design of the Pilot PES Project in Sasumua Watershed Kenya

2.5.10 Funding Analysis

Fig. 12a shows the funding trends in 2005-2016. Funding sources are also shown on (Fig. 12b).

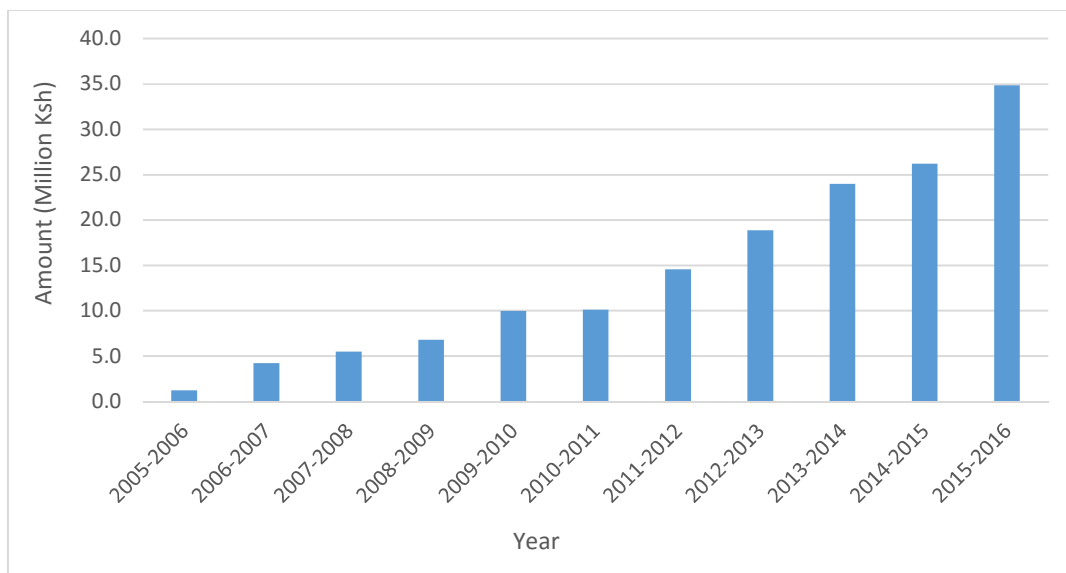


Fig. 12 a: Cumulative funding for water resource research (2005 - 2016)

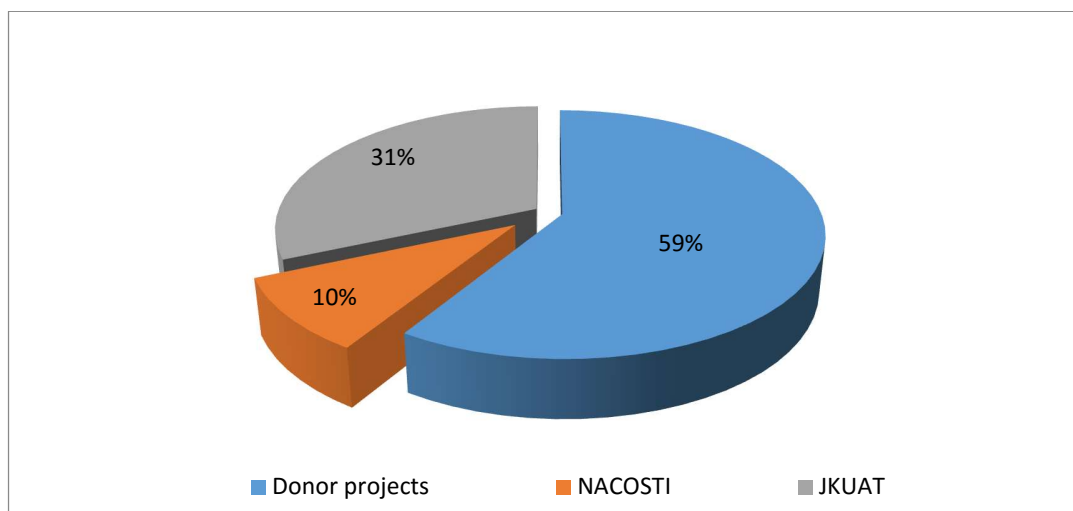


Fig. 12 b: Water resource research funding distribution

2.6 Information Communication Technology (ICT)

2.6.1 Research Focus

ICT is the study of the technology used to handle information and aid communication. In addition to the study areas of Information Technology, ICT also encompasses telephony, broadcast media and all types of audio and video processing and transmission.

Current ICT research in JKUAT revolves around the design and use of technology to address challenges in learning, agriculture, health, business, security, data and information management. The ICT research projects in JKUAT are described in the sequel under specific ICT research areas.

2.6.2 Data Science, Big Data and Cloud Computing

Data science is a field that revolves around processes and systems to model, transform, process, analyze and visualize data, thereby communicating what may be considered as knowledge or insights. Data science is closely related to and intersects with big data and cloud computing.



Poultry project team members working on a mobile application

Data science research in JKUAT focuses mainly on data analytics and information visualization. There are several projects on data analytics and information visualization in agro-informatics. For instance, the Belgium-funded project on ICT support for legume and data science research, involves collaboration between the School of Computing and Information Technology (SCIT) and the Faculty of Agriculture. There is also a project on data modeling and analytics of poultry genome, which involves collaboration between the School of Computing and Information Technology and the Institute for Biotechnology Research (IBR). A mobile application for recording poultry data has been developed.

Moreover, there is a Kenyan-German Centre for Data Analytics project in which there is research being conducted on data analytics, business intelligence (BI), information visualization, and architectures for data centre and cloud computing. The project involves collaboration between JKUAT and Flensburg University of Applied Sciences (Germany). The Kenyan-German centre is being set up in the Department of Information Technology.

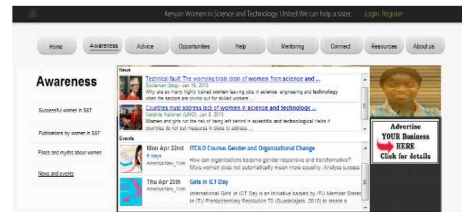


The VC, JKUAT, receives the signage for the Kenyan-German Data Analytics Centre from Flensburg University of Applied Sciences

Besides supporting information sharing and dissemination, the Maize Information Repository (MFIR) project has implemented a rule-based logic programming solution for maize farmers. The MFIR project involves the School of Computing and Information and the Faculty of Agriculture. JKUAT is also collaborating with Sapienza University of Rome (Italy) in a research project on the visualization of data streams in industrial environments. The project has resulted in staff visits, and research publications.

2.6.3 Human-Computer Interaction and Cognitive Computing

Human-Computer Interaction (HCI) is the design, evaluation and implementation of interactive computing systems and the study of the major phenomena surrounding them. Cognitive computing seeks to simulate the human thinking, problem-solving and reasoning processes through computing.



User interface for StoreRooms

There are several projects in JKUAT whose primary focus is developing user interfaces and interactive applications for users in developing countries. For instance, projects such as PANCAKE (Portal for Free and Appropriate Computer Science Research Resources for Kenyans), StoreRooms (Science and Technology Opportunities and Resources Portal for Kenyan Female University Students) and MFIR.

PANCAKE intends to develop an interactive online portal for sharing and disseminating information relevant to Kenyan ICT researchers. PANCAKE is also seeking to learn and predict user thought patterns, interests and preferences during the interaction behavior through user modeling, adaptation and providing recommendations by primarily referring to the user profile, interaction logs, user task and context. The system consequently adapts, tailors and personalizes itself to dynamically suit the end user.



The home page of the MFIR portal

StoreRooms provides an interactive portal for sharing and disseminating information relevant to Kenyan female science and technology students. MFIR utilizes web and phone technologies in order to support the sharing and dissemination of maize information relevant to Kenyan farmers. There is also a project seeking to support users from developing countries in agri-business through the use of ICT. The foregoing projects on developing user interfaces and interactive

applications for users in developing countries have developed computing systems, built human capacity, acquired research infrastructure, and realised publications.

There are other projects in JKUAT that are focusing on designing gesture-based interactions for learning and for healthy living. For instance, gesture-based gaming for teaching music to children project in collaboration with Sapienza University of Rome (Italy). The project with Sapienza University of Rome has resulted in staff visits and a research publication.

2.6.4 Internet-of-Things, Ubiquitous Computing and Robotics

Internet of Things (IoT) is a network of physical objects or 'things' connected to computing systems that presents huge potential to exchange useful data and services, and in the process spurring innovation and socio-economic transformation. IoT entails a radical evolution of the current Internet into a network of interconnected objects that not only senses/harvests information from the environment and interacts with the physical world, but also relies on the Internet to provide services for information transfer, analytics, applications and communications. Ubiquitous computing is characterized by: natural user interfaces that support/permit the humans to interact with computing machines by the use of more natural interaction paradigms (e.g. speech, gesture), context-awareness which enables applications to operate taking into account the context, and automatic capture/recording and management of live experiences. Ubiquitous computing is considered to cover other fields such as pervasive computing, ambient computing, mobile computing, and wearable computing.



A visiting research collaborator from University of Paris 8

There are several JKUAT ICT research projects in IoT and robotics. One of the projects focuses on the design, application and deployment of drones for smart farming in collaboration with University of Paris 8. There is also a project that focuses on the automation of shopping experience in supermarkets. In addition, there is a proposed project on the design, application and deployment of drones for disease monitoring and control. Some of the JKUAT ICT projects in ubiquitous computing mainly focus on context-awareness. For instance, projects involving the development of location-aware applications through the use of GIS and other location technologies, m-health applications which sense the environmental conditions (such as weather) and advise the patient or user accordingly in collaboration with Nokia.

There are also JKUAT ICT research projects in ubiquitous computing that are using more natural interaction paradigms and biometrics to enhance authentication of users especially in banking (such as ATMs) and other fields with restricted document access. The foregoing projects have enabled the School of Computing and Information Technology to publish research papers, to build human capacity and also to support the upgrading of infrastructural capacity to support research in IoT, ubiquitous computing and robotics.

2.6.5 E-Learning

The broad objective of the current e-learning projects in JKUAT is to enhance access, relevance, and quality of education and learning. One of the e-learning projects is an EDULINK project that seeks to exploit e-learning in improving quality and relevance of African university graduates to labour markets. Another

ongoing project supports mobile and flexible learning through m-learning. The e-learning projects have so far resulted in the development of e-learning tools and the publication of research papers.

2.6.6 Key Outputs

Table 6: Key performance indicators under Nano technology theme

Capacity building	Quantity
Post-doctoral researchers	1
PhD.	9
MSc.	4
Technicians	1
Internships	2
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	20
Number of products developed*	4

* Products developed:

1. Maize information repository system
2. Mobile application for recording poultry data
3. Science and technology opportunities and resources portal for Kenyan female university students
4. Computer science opportunities and resources portal for Kenyan university students

2.6.7 Funding Analysis

Fig. 13a show the funding trends in 2005-2016. Funding sources are also shown on (Fig. 13b).

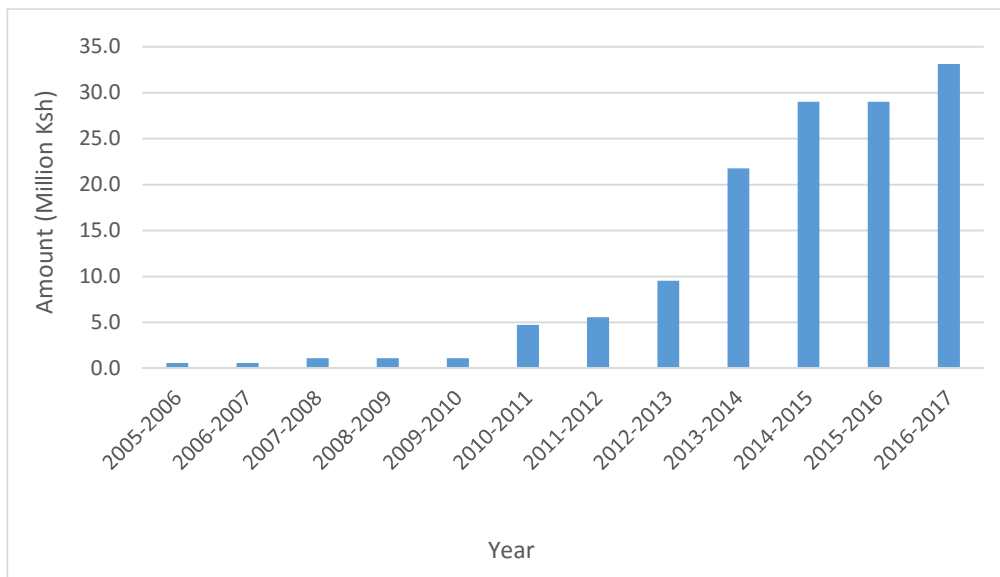


Fig. 13 a: Cumulative funding for ICT research theme (2005 - 2016)

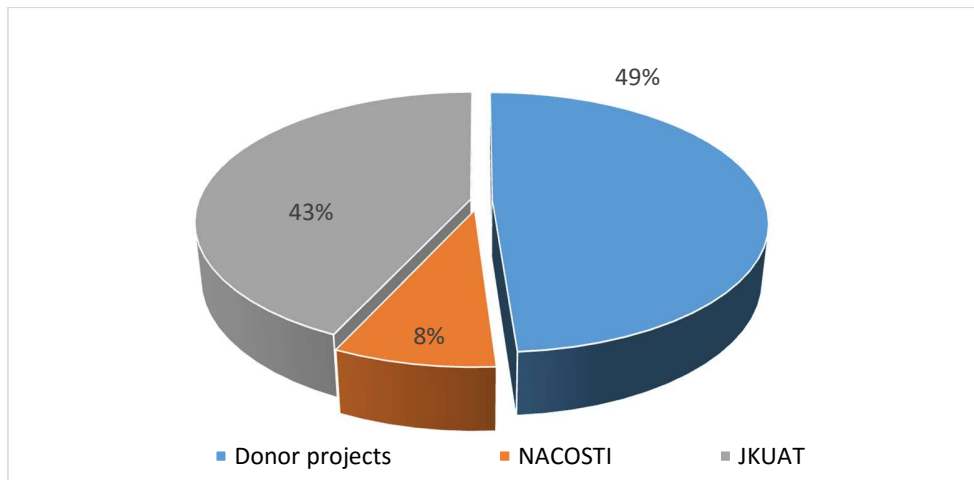


Fig. 13 b: ICT research funding distribution

2.7 Engineering Technologies and Industrial Development

2.7.1 Research Focus

In line with its mission, JKUAT identified key thematic research areas under the Engineering Technology. These are:

- (i) Industrial and Agricultural Machineries, and processing
- (ii) Infrastructure and Environmental challenges and,
- (iii) Sustainable transport systems.

Described here are details of the research activities under the various thematic areas.

2.7.2 Industrial and Agricultural Machineries and Processes Thematic Area

Under the Industrial and Agricultural Machineries, and processing thematic area, the subthemes include Machine Tools, Agro-machinery, Manufacturing Processes and Agro-processing. The focus of this thematic area is developing efficient and affordable technologies and processes for both manufacturing and agricultural purposes.

The current research under these themes include, postharvest machines and food processing; ploughing, planting and hauling systems, precision machine tools, machining processes, manufacturing productivity and quality management. Other emerging areas are crosscutting and are related to both machineries and processes.



Rice combine harvester developed at JKUAT

2.7.3 Research under Agricultural Machineries and Processes

The research under this sub-theme aims at the mechanization of small-scale farms for improved productivity and food security as well as processing of crops for development of new products. It also targets systems for handling and storage of agricultural crops for reduction of postharvest wastage.

2.7.3.1 Development of a Rice-Combined Harvester

A rice-combined harvester that can be used by smallholder farmers in Kenya was developed through co-funding by National Commission for Science, Technology and Innovation (NACOSTI) and JKUAT, with the parts produced in collaboration with Numerical Machining Complex (NMC). This equipment is currently undergoing performance testing under different farm conditions.

2.7.3.2 Development of a Sustainable Drier

There is need for efficient and sustainable drying systems for crops to enhance postharvest shelf life. Drying crops with oil fuels or electricity is expensive, and unsustainable. As an intervention, a solar crop drier was developed and enhanced to incorporate convective draft and with a provision for utilizing biomass fuel. The hybrid drier utilizes solar energy when available, or biomass when solar energy is inadequate. It is expected that hybrid driers will provide continuous and efficient drying.



Tunnel solar drier developed at JKUAT

2.7.3.3 Research on Development of Tissue Papers from Herbs

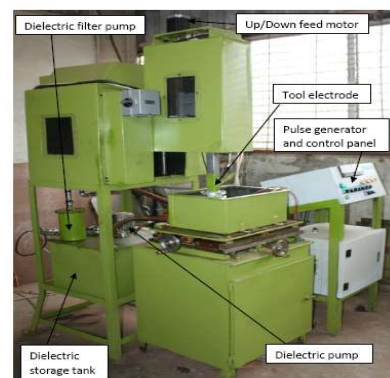
There is an ongoing research on development of tissue papers made from leaves of some specific plants that were traditionally used in raw form. The study is in two phases, the first being a survey of the plants and analysis of the biochemistry, including assessment of the cellulose content and any curative properties. The second phase will be to develop a system for making tissue papers out of selected plants. It is expected that affordable and hygienic tissue paper will be developed from this project.

2.7.4 Researches under Industrial Machineries and Processes

The research under the industrial machineries and processes aims at addressing the challenges on productivity and quality for local manufacturing industries. The investigations focus on the relevant improvement of manufacturing capabilities and efficiencies by small and medium manufacturing enterprises (SMEs). Development of machine tools is an important avenue for providing the local industry with practical solutions for manufacturing of quality products. Under this subtheme, low cost machine tools are developed. Further, there is ongoing research on various industrial processes and practices, with a view to optimize process performance.

2.7.4.1 Optimization of machining parameters in Electrical Discharge Machining (EDM)

Electrical Discharge Machining (EDM) is a material removal process for machining of hard materials or for producing components with complex shapes, especially for die and mould industries. The research on EDM started as an innovation in which an Electrical Discharge Machine was developed under JKUAT

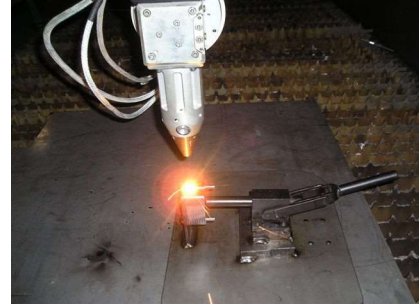


Electrical discharge machine developed at JKUAT

funding. The objective was to develop local capacity for manufacture of capital equipment, and to demonstrate capacity and capability for machine tool design and production within JKUAT. The machine is being used for research on material removal processes for better control of the machining process. The research results were published in various international Journals.

2.7.4.2 Research on Laser Beam Machining

Laser has gained popularity as a viable alternative for material removal in machining and for joining of materials. The conventional systems traditionally used for these processes have limitations in some applications, which are easily overcome by using laser systems. The research on laser beam machining focuses on the laser beam/material interaction and optimization of the parameters for quality and efficient machining. A computer numerically controlled laser beam delivery system was developed. Experiments were carried out using a 60W Continuous Wave CO₂ laser, Polymethyl methacrylate (PMMA) and soda-lime glass materials. The studies were also extended to numerical analysis of the process using Neodymium-doped Yttrium Aluminium Garnet (Nd:YAG) laser on silicon. The appropriate laser beam machining conditions with respect to quality parameters such as the heat affected zone, kerf-width and surface roughness were established.



Laser welding process

2.7.4.3 Research on Laser welding Process

On the welding front, joining of miniaturized components, especially for electronics, which utilizes dissimilar materials, is quite difficult using mechanical means. A laser system is a viable alternative for joining the dissimilar materials. There is however a challenge due to the difference in material behaviour when irradiated with a laser beam. The research on laser welding therefore focused on establishing the optimum parameters for efficient welding of metals to plastics, for high joint strength. It is expected that the process will lead to improved productivity in welding of metal to plastic.

2.7.4.4 Optimization of Resistant Spot Welding Process

One major challenge faced in RSW is inconsistency in weld quality. Cold weld and expulsion are welding flaws, which lead to weak joints and low welding efficiency. In this research, an on-line quality assessment and control model based on Learning Vector Quantization Neural Network (LVQ-NN) system and Adaptive Neuro-Fuzzy Inference System (ANFIS) was developed. The ANFIS model identifies the RSW dynamical system based on given input output data, and can be used to approximate nonlinear systems with minimum training data, high learning speed and precision. The control algorithm demonstrated robust performance reducing the number of expulsion welds by 30% compared to the conventional controller, while increasing the number of normal welds by 31%.



A mechatronics engineering student carrying out machining tests

2.7.4.5 Research on Chatter Vibrations in Machining

Vibrations occur during high speed milling of hard materials at some cutting conditions. These vibrations have an adverse effect in that they cause rapid tool wear, poor surface finish and lead to low productivity. This research sought to address the problem of regenerative chatter vibration in milling of pockets. Various machining strategies for avoidance of chatter vibration were explored. A Mathematical model was developed, that generates a chatter index based on the cutting conditions and determines if these conditions will lead to vibrations or stable machining. Based on the output of the model, the machining conditions are adjusted iteratively until conditions for stable machining are obtained. The model, which was tested experimentally, effectively predicts conditions for chatter-free machining at optimized material removal rates.



CNC machining of aluminium

2.7.4.6 Industrial Maintenance Optimization

Equipment maintenance is central to productivity, quality and efficiency for any industrial process. The maintenance function is however usually expensive. In many cases, the top management view maintenance as an unnecessary since its benefit is not readily seen. The common practice in industry is therefore to carry out breakdown maintenance, which is triggered only by failure of equipment. This strategy results in downtimes, which lowers quality and productivity. This research seeks to assess the maintenance practices in Kenyan industries, and to develop a decision making tool that can be used in determining the best maintenance approach for a given industrial environment. The output of the study will be an optimized model for use by manufacturing, energy, transport and service industries. So far, an assessment has been done on thermal power generation plants.



Coconut value chain research

2.7.4.7 Research Chair on Manufacturing

JKUAT has recently won a bid for NACOSTI/IDRC funded Research Chair (RC) on Innovations in Manufacturing. This inter-disciplinary RC will focus on development and transfer of technologies in coconut

value chain. The RC will carry out research and innovation activities in partnership with coconut industry and other institutions. The main areas of focus include coconut-based fabrics and textiles, food and beverages, beauty products, biomass energy, and associated tooling and machineries for the coconut subsector. The RC will also carry out research on policy intervention necessary to reap maximum benefits for coconut farmers and processors. The expected outcomes of the research are:

- Enhanced capacity for research in the coconut value chain;
- Competitive and marketable value-added coconut products for domestic and export markets;
- Increased knowledge and skills in coconut value-addition;
- Increased employment and business opportunities within the coconut subsector;
- Growth in the nuts and oil crops subsector;

- Increased foreign exchange earnings;
- Increased wealth creation in the manufacturing sector
- Growth in the SMEs and cottage industries
- Increased patents and faster technology transfer.

2.7.5 Infrastructure and Environmental Challenges Thematic Area

The ongoing research under the thematic area of infrastructure and environment include energy resource, sustainable building materials, eco-materials, construction materials and pollution control schemes.



Pelton wheel turbine for micro-hydro power generation

2.7.6 Researches under Infrastructure

2.7.6.1 Frequency Stabilization in Micro-Hydropower Plants

There are many mini and micro-hydro power plants being set up along Kenyan rivers. Electrical power is generated at a specific frequency and most utilities are designed to operate with input at this frequency. In Kenya, this standard frequency is 50Hz, and this should be maintained within an acceptable limit for stable distribution. Fluctuations of load on the demand side may cause the generation frequency to vary, which poses a challenge. The research seeks to develop an electronic controller for the mini- and micro-hydropower plants to regulate and maintain the required frequency.

2.7.6.2 Use of Distributed Generation in Congestion Management

Electrical power generators, transmission as well as distribution lines and transformers are designed to operate between certain specified limits of power generation, voltage magnitude at the various buses, and the power flow limits of lines and transformers. Congestion is the operational situation when any of the system components reaches, or exceeds the specified limits. Congestion mainly occurs during the peak hours of demand. In this research, the level of congestion in the Kenyan power system is investigated. A power system without congestion or transmission network losses will have a uniform price at all buses. As soon as congestion and system losses arise, prices in some buses will increase, while in other buses it decrease. The approach undertaken to alleviate congestion is to incorporate distributed generation (DG). Nodal pricing will be used to indicate prospective DGs. It is expected that this approach will reduce congestion.

2.7.6.3 Research on Maximum Wind Power Tracking and Wind Data Logging System

Wind energy is being harnessed as a sustainable and renewable source for application in electrical and mechanical power generation. The direction of wind changes randomly, and this poses a challenge when one attempts to reap maximum power possible from the wind. In addition, daily wind data is important especially in the aerospace industry, as well as for site location for wind energy harvesting. Research was done on data logging measurements for wind characteristics. A micro-controller based system for data logging which efficiently measures wind speed was developed. Further, the research seeks to develop a system that will be used to effectively track the wind direction and orient the system for maximum power output accordingly.

2.7.6.4 Low Power Energy Harvesting Through Vibration Attenuation

Research is ongoing on harvesting of low electrical energy using vibrations and piezo-electric effects of some materials. In many machine operations, vibrations are undesirable and often it is necessary to find out means of attenuating or completely eliminating the vibration. This research explores the use of piezoelectric transducers in suppressing the vibrations while at the same time harvesting energy emanating from the process. It is expected that an optimized system developed will harvest maximum energy through suppression of vibrations in machineries.

2.7.7 Environmental Challenges

There are a number of ongoing researches under environment subtheme, in the areas of materials, emissions, pollution and energy.

2.7.7.1 Development of Eco-Friendly Construction Materials

The research aims to enhance the strength of the naturally occurring materials through mixing with small additives of some other materials to make a composite. The effect of recycled clay products and ceramics on normal concrete was investigated. The mechanical properties, namely compressive strength, tensile strength, torsion and expansion characteristics, are being investigated. It is expected that optimal mixing ratios for materials superior to normal concrete will be established. The material developed will be useful especially for low-cost housing.



Interlocking stabilized block

2.7.7.2 Emission Characteristics of Diesel Engines

Emissions from internal combustion engines are of global concern due to the negative impact they have on the environment. The research addresses the combustion characteristics and performance of a four-stroke diesel engine. A diesel engine was modified with a view to improving its performance while at the same time reducing the environmental unfriendly emissions, which include SO_x, NO_x and CO₂. The output of this research will help in minimizing the environmental impact arising from diesel-powered vehicles and thermal power plants.



Industrial emissions

2.7.7.3 Development of a Bioreactor for Algae Production

The research aims at developing a bioreactor for production of algae, which in turn will be used for sustainable production of bio-fuels. It is expected that the bioreactor will produce algae perpetually for sustained production of bio-fuel.

2.7.7.4 Development of an Organic Power Cycle Plant for Geothermal Power Plant

Power generation from geothermal wells utilizes heat from the wells to produce steam for running turbines. After expansion through the turbines, the fluid still has high thermal energy that can be utilized in a binary

cycle. This research aims at making a model for extraction of maximum energy for power generation in the geothermal power plant. An organic power cycle for Olkaria Geothermal Power Plant was designed and simulated. The low-temperature heat in fluid after the first stage turbines is converted into useful work that can in turn be converted into electricity. The output of the research will provide means for development of a system that will help improve the conversion efficiency of geothermal power plants, leading to lower costs of electrical power, and sustainable power generation.



Geothermal plant at Olkaria

2.7.7.5 Gravity and ground magnetic studies around Lake Magadi

This research was done with a view to locating any body at depth with sufficient magnetic susceptibility and density contrast that may represent magmatic intrusions. Magadi area is located in the southern part of the Kenyan rift, an active continental rift that is part of the East African Rift system. Thermal manifestations in the form of hot springs in the northern and southern shores of Lake Magadi and high heat flows suggest geothermal potential in the area. Magma detected at shallow depths may be used as a heat source for a geothermal resource while seismic activity due to its presence may be considered



Lake Magadi

a geo-hazard to nearby cities. From the magnetic field data, an attempt was made to estimate depth to the curie isotherm using spectral analysis. The slowly cooling magmatic intrusions heats underground water producing hot springs that issue from faults. The result of this study indicates presence of shallow heat sources that could harness geothermal energy exploration. The intrusives detected may be causing stress on the rocks which may lead to high chances of an earthquake around the area.

2.7.7.6 Human-Elephant Conflict

Kenya is faced with a constant conflict between humans and animals. Farmers often lose their crops to animals when the animals invade farms in search of food. Elephants are especially a problem as they damage large areas and are also dangerous to humans. This study seeks to develop a solution for reducing

the conflict between elephants and agriculturalists in Voi region in Kenya. The research is looking into the feasibility of using bees as a deterrent for the animals. Beehives will be placed at regular intervals along the border between farms and forest. These will serve as a source of honey in addition to keeping elephants at bay.



2.7.7.7 Climate Change mitigation for shipping industry- Maritime Technology Cooperation Centre

JKUAT in collaboration with the Kenya Maritime Authority (KMA) and Kenya Port Authority (KPA) has won an international competitive bid to host the regional Maritime Technology Cooperation Centre (MTCC) for the Africa region with effect from March 2017. The MTCC will be funded by the European Union through the International Maritime Organization (IMO). The centre will carry out research to mitigate harmful effects of climate change.



Resolving elephant-human conflict using bees

It will focus on efforts towards effective implementation and enforcement of the global energy-efficiency regulations related to international shipping. The research will focus on emission reduction strategies for ships docked at ports in Kenyan coast. Data on emissions and energy utilization by ships around the Kenyan ports will be collected. Mechanisms for “cold ironing” will be worked out, whereby all auxiliary engines will be switched off once the ships dock and instead the services be run on shore power from the national grid.

2.7.8 Sustainable Transport Vehicles and Systems

Transportation challenges are wide and varied in nature, and can be addressed by developing technologies/solutions that are sustainable within a given environment. Under the thematic area of sustainable transport vehicles and systems, the research subthemes include, materials for transport vehicles and navigation and communication systems.



A docked ship in Mombasa. The MTCC will carry out research on emissions from such vessels

2.7.9 Development of Materials for Watercrafts

Many materials used to build bodies of watercrafts are prone to degradation through erosion, corrosion and fatigue. This research seeks to develop alternative materials suitable for watercraft manufacture, that will ensure watercraft safety, reliability and affordability. The suitability of various materials available locally is being assessed. The main parameters to be investigated in the research include: corrosion resistance under different water conditions, fatigue characteristics and specific strength on the watercraft material, water permeability and ease of manufacture. An analysis of the cost of the alternative materials and manufacturing is also being carried out. At the end of this research a comprehensive report will be prepared on the alternative materials to be used for manufacturing of small watercrafts.

2.7.10 Communication and Security Systems

2.7.10.1 Development of Controller for Antenna Tracking

In communications, antennae for satellite dishes require to track communication signals accurately. The positioning of the antennae is usually done manually or automatically which is either cumbersome or

inaccurate process and often lead to poor signal tracking. This research aims at addressing the problem by developing a neural fuzzy-based controller for the signal tracking system. This controller utilizes artificial intelligence in positioning the antenna which is driven by servo motor as the actuator.

2.7.10.2 Development of Digital Holograms

This research seeks to develop a system for producing embossed holograms mainly for ascertaining products authenticity, anti-counterfeit and identification. The holograms are embedded on products that require protection, such as copyrights. The work utilizes low power He-Ne laser. The holograms have successfully been produced as demonstrated with reconstruction of embossed numbers.

2.7.11 Key Outputs

Table 7: Key performance indicators under Engineering Technologies and Industrial Develop theme

Capacity building	Quantity
PhD.	5
MSc.	20
Technicians	3
Internships	8
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	103
Number of products developed*	5
Infrastructure developed / maintained**	5

* Products Developed:

1. Prototype of a rice combine harvester
2. An Electrical Discharge Machine
3. Pelton wheel turbine for micro-hydro power
4. A hybrid crop drier
5. Formulation for stabilized building blocks

**Infrastructure Development

1. A surface roughness tester acquired
2. Maintenance tools acquired
3. Power generation test rig developed

2.7.12 Funding Analysis

Fig. 14a shows the funding trends in 2005-2016. Funding sources are also shown on (Fig. 14b)

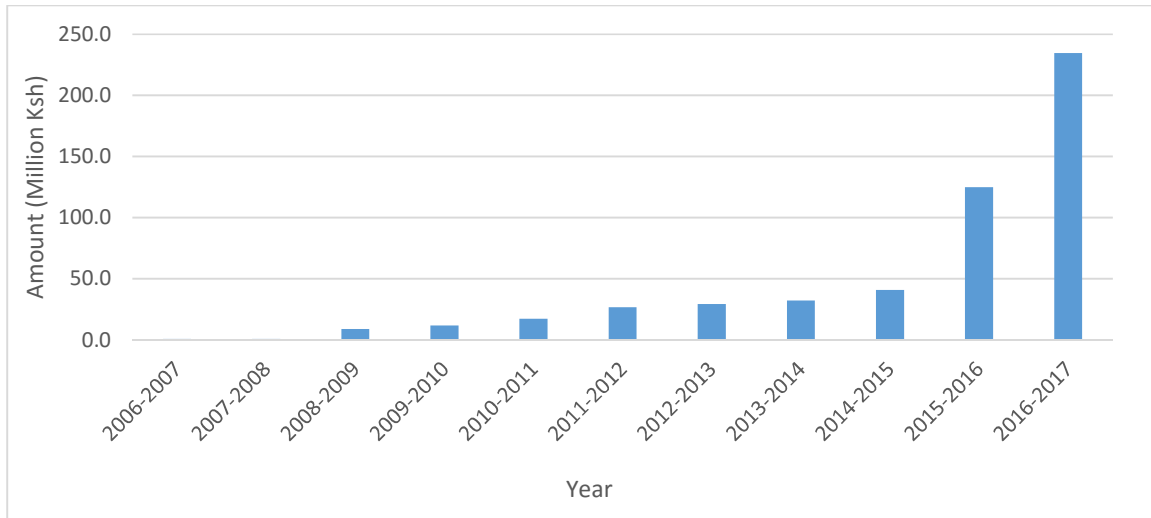


Fig. 14 a: Cumulative funding for engineering research theme (2006 - 2016)

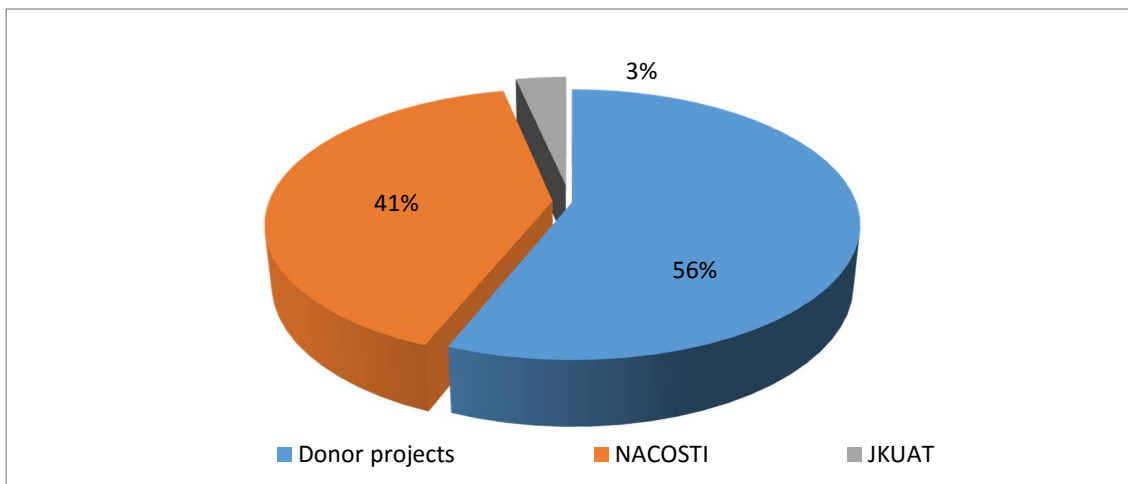


Fig. 14 b: Engineering research funding distribution

2.8 Built Environment and Infrastructure Technologies

2.8.1 Research Focus

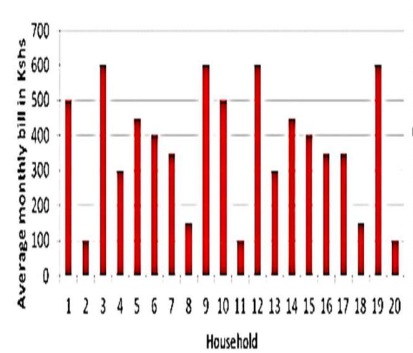
The School of Architecture and Building Sciences (SABS) brings together various disciplines related to the built environment. These include Architecture, Landscape Architecture, Quantity Surveying, Construction Management, Real Estate Management, Urban Design and Urban Development. The School, together with its Center for Urban Studies (CUST), undertakes research and consultancies in varied areas of the built environment. Research undertaken by both staff and students falls within the following sub-themes; Energy Efficiency in Buildings, Urban Planning and Design, Human Settlements and Housing, Architectural Pedagogy, Transport and Infrastructure, Heritage Conservation.

2.8.2 Energy Efficiency in Buildings

The School undertook energy audits in Nairobi, Machakos and Meru under the UN-Habitat programme of Promoting Energy Efficiency in Buildings in East Africa in 2012/2013 over a period of eighteen months. The main task was to establish energy consumption data base using performance-based evaluation system for Kenya and included:

- (i) Elaboration of the methodologies for data collection on buildings in Kenya.
- (ii) Induction training of students on the data collection method.
- (iii) Energy audit of sampled housing units in different climatic zones covering the following details; building information, energy consumption per component namely lighting, heating, cooling/ventilation, cooking etc.
- (iv) Contribution to the development of the national performance-based evaluation system.

The study audited a total of 301, 176 and 76 housing units of varied typologies in Nairobi city, Machakos and Meru towns, respectively.



Sample of energy use data for Mathare



Training student auditors on data collection

2.8.3 Urban Planning and Design

In collaboration with Augsburg University of Applied Science and Technology (Germany), University of Rwanda and Stellenbosch University (South Africa), the School conducted a two years joint research titled Laboratory for an Integrated African Network for the Built Environment (LIANE) between 2013 and 2015. The aim of the study was to set up a scientific and technical database for future interventions of planning focusing on:

1. Documentation and evaluation of existing processes of settlement growth and development.
2. Planning of suburban, peripheral and rural settlements, including strategies for land utilization (water and energy supply, infrastructure for transport and service delivery, local added value strategies etc.).
3. Low-cost housing typologies and building technologies for growing and moving populations.
4. Health and security challenges in new settlements with inadequate infrastructure.

Of the four growth corridors radiating from Nairobi, the Nairobi-Athi River Corridor was selected because of its distinct and fast growth pattern. This section is characterised by industrial, commercial and residential buildings. The outcome of the research was a comprehensive documentation of data relevant for urban planning, design and development, and study visit of two graduate students to Rwanda and Germany.



Aerial view of Mlolongo Town



The proposed planning intervention for Mlolongo Town

2.8.4 Human Settlements

Housing for low-income groups and the urban poor presents the greatest challenge in the area of human settlements. The School undertook research in this area titled “Post occupancy evaluation of slum upgrading projects: a comparative study between self-help initiatives and Government sponsored initiatives”. The research evaluated two slum upgrading projects in Nairobi, namely, Kambi Moto in Huruma (where there is an informal delivery system) and Kibera Decanting Project (where residents were moved to facilitate the upgrading of their slum dwellings). The research examined the delivery processes and the perception of the users of both the delivery process and the final upgraded houses. The output of this research is a book to be launched by 2018.



Kambi Moto self-help housing

2.8.5 Architectural Pedagogy

In collaboration with Augsburg University of Applied Sciences (Germany), Uganda Martyr University, University of Rwanda, Stellenbosch University (South Africa), American University in Cairo and UN-Habitat, the School undertook research titled “Joint Development of Courses for Energy Efficient and Sustainable Housing in Africa” running from 2013 to 2016.



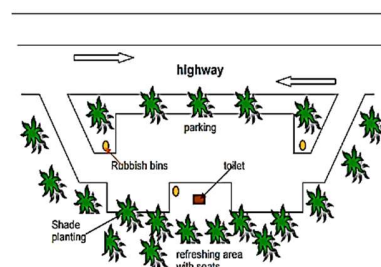
Prototype structure designed and built by students of the School of Architecture

The objective of the research was to foster academic capacity building at the participating universities in the development of sustainable and energy-efficient housing, development of relevant curriculum and regional integration in the field of higher education. The outcome included the implementation of design/build approach to the teaching of architecture. Students designed and constructed a prototype building as part of the teaching research outputs. Students’ participation entailed design and use of building materials and construction technologies.

2.8.6 Transport and Infrastructure

A research titled “Enhancing Travelers’ Safety and comfort: planning of rest stops on Kenyan highways” was conducted by the School in 2010. The aims of the project were to:

- (i) Determine the frequency and severity of fatigue- related crashes and accidents on highways;
- (ii) Reduce traffic crashes by preventing drivers from being exposed to the potential risk of fatigue;
- (iii) Understand the effect of fatigue on the behavior of drivers on highways in Kenya;
- (iv) Examine the frameworks of institution, planning and policy implemented in Kenya with reference to fatigue related accidents;
- (v) Identify the need for rest areas, considering the safety, location and environmental aspects associated with highway travel;



sample layout of highway rest stop

- (vi) Increase the safety and comfort of drivers in a bid to reduce, or in the very least, delay the onset of fatigue;
- (vii) Identify the best practices for rest areas on Kenyan highways;
- (viii) Provide some control practices and planning options in a bid to reduce the risk of drivers being exposed to fatigue;
- (ix) Provide a solution for illegal shoulder parking on highways.
- (x) The outcome of this study was a workshop to policy makers and several publications.

2.8.7 Heritage and Conservation

Heritage conservation is threatened as the world globalizes and African economies open up to new realms of growth in the international markets while increased building construction, infrastructural expansion as well as terrorism destroy existing heritage assets. Kenya in particular prides itself as a prodigious habitat for abundant and various natural and cultural heritage assets including archaeological sites, wildlife, landscapes and folklores.

Research in the area of architectural heritage was conducted in the School to document and analyze historic buildings in Nairobi. The project commenced in September 2012. The main objective of the study was to document all the listed historic buildings in Nairobi. The research beneficiaries included local conservation advocates, land-use planners, economic development coordinators, tourism promoters and the public. Phase I of the research was completed in October 2015 with a publication of a “Nairobi: An Architectural Jubilee 1963-2013, Volume 1.

Kenyan scholars have for a long time relied on foreign knowledge in seeking to understand and explain the issues affecting cultural heritage in the country and the continent at large. The foreign principles, concepts and theories when applied in solving local problems are limited and in many cases incoherent to the cultural values, economic status and politics of Kenya. It is therefore pleasing to see a new book that has been developed through intense research by local academics and professionals that will be very useful to graduate students as well as conservation practitioners in Kenya and abroad.

The book “Conservation of Natural and Cultural Heritage in Kenya *A cross- disciplinary approach*” was published in 2016. This book provides an overview of conservation practices in Kenya from 2000 to 2015 and highlights the role of natural and cultural heritage as a key factor of social-economic development, and as a potential instrument for conflict resolution.

Further research undertaken under the theme was the study titled “Preservation and Presentation of Historic Towns” and was published as a book. Another study under the same theme was entitled “Thimlich Ohinga: Traditional conservation practices” was published in as an article.

2.8.8 Key Outputs

Table 8: Key performance indicators under built environment and infrastructure technologies theme

Capacity building	Quantity
PhD.	3
MSc.	18
Internships	4
Other Key Performance Indicators	Quantity
Publications in peer reviewed journals and conference proceedings	63
Consultancies	6
Number of products developed*	8

*** Products developed:**

1. Energy use in buildings database.
2. Urban planning, design and development data
3. Design-build curriculum (Training of trainers)
4. Students design/build prototype construction
5. Good school, good neighbourhood handbook
6. Guidelines for achieving “good school, good neighborhood” model
7. “Conservation of Natural and Cultural Heritage in Kenya *A cross- disciplinary approach*”
8. Nairobi: An Architectural Jubilee 1963-2013, Volume 1.

2.8.9 Funding Analysis

Fig. 15a show the funding trends in 2005-2016. Funding sources are also shown on (Fig.15b)

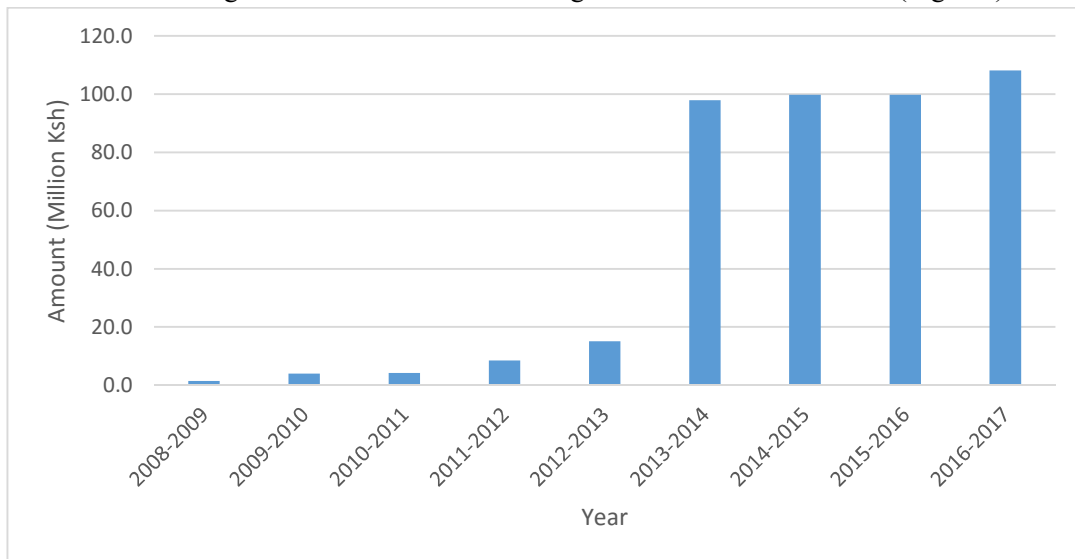


Fig. 15 a: Cumulative funding for infrastructure technology research theme (2008 - 2016)

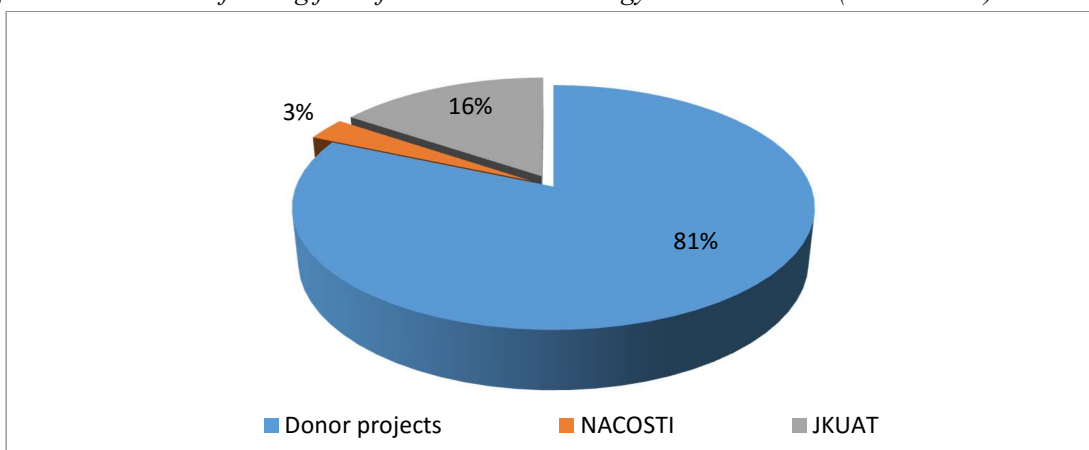


Fig. 15 b: Infrastructure technology research funding distribution

2.9 Social Economic Theme

2.9.1 Research Focus

A Policy on Clustering as a County Industrialization Strategy to Accelerate the Sustainable Achievement of Vision 2030

Kenya has a national long-term development policy called Vision 2030 that aims to transform the country into a newly industrializing, middle-income country providing a high quality of life to all its citizens by the year 2030. The Vision comprises of three key pillars: Economic; Social; and Political. While the Economic Pillar aims to achieve an average economic growth rate of 10 per cent per annum and sustaining the same until 2030, the Social Pillar seeks to engender just, cohesive and equitable social development in a clean and secure environment. The pillars are anchored on the foundations of macroeconomic stability; infrastructural development; Science, Technology and Innovation (STI); Land Reforms; Human Resources Development; Security and Public Sector Reforms. Research being conducted in JKUAT is addressing the social pillar that support the achievement of the Vision 2030. The project is on a policy on clustering as a county industrialization strategy to accelerate the sustainable achievement of Vision 2030: “A Case Study of Bungoma County.”

This research conceptualization focuses on the oil crop and particularly sunflower as the focal point for the cluster. Rural farmers are contracted to plant sunflower which is bought from them by the project for pressing of vegetable oil using a local appropriate technology – the Kick Start (formerly ApproTec) oil press. The cake that remains after the pressing of oil is used to make animal (including poultry and fish) feed. This then creates need for poultry, dairy and fish farming. Roof and runoff water is harvested to fill the fish ponds. Cow dung, poultry droppings and fish gut are fed into a digester to produce biogas. The slurry that remains in the digester is used as organic manure for the farmer.

This cluster therefore comprises of the core activities of oil crop farming, poultry keeping, aquaculture, dairy farming, vegetable oil production, animal feed production. Subsidiary activities include transportation and distribution. In Kenya such clustering has concentrated in the urban and pre-urban areas with examples including the cut flower cluster in Naivasha, metal works cluster in Kamukunji, Kariobangi light industries, fish cluster in Kisumu. Much of this clustering is more by default rather than by design.

This research focuses on providing answers to two key questions - What form of clustering suits Kenya’s rural settings? What policy interventions are necessary to achieve rural clustering?

2.9.2 Borrowing from Formal and Informal Financial Sector

In the social sciences, research has focused on why people prefer to borrow from the informal financial sector rather than the formal financial sector. This is because researchers have observed that majority of small and medium enterprise owners rely on the informal financial sector to meet their credit needs despite it being more unreliable and in some instances more expensive than the formal financial sector. Preliminary findings indicate that they are likely to borrow from the informal financial sector if it is cheaper, more easily accessible, is near to them, does not have complicated procedures and does not have stringent collateral requirements. If banks would like to attract such kinds of borrowers, then they should ensure that these qualities are entrenched.

3.0 RESEARCH INSTITUTES/ CENTRES

3.1 Institute of Biotechnology Research

3.1.1 Research Focus

Biotechnology is a broad discipline in which biological processes, organisms, cells or cellular components are exploited to develop new technologies. New tools and products developed by biotechnologists are useful in research, agriculture, industry and other diverse fields. Under the Institute of Biotechnology, researchers apply biotechnological approaches to address challenges in areas of food security, health and poaching of wildlife.

3.1.2 Plant Biotechnology

Under food security, research is directed towards applying biotechnology tools to solve the challenging problems of food crop diseases that affect productivity and income of farmers. Specifically, researchers have sought to identify viruses that cause maize lethal necrosis (MLN), a devastating maize disease in Rift Valley. Researchers have also tackled *Striga* (witchweed) that can cause up to 70% yield loss in maize and other cereals. In this regard, they developed genetically modified maize that is *Striga*-resistant. Drought is a big challenge for farmers who rely on rain-fed agriculture and as such, scholars have investigated ways to improve drought-tolerance in sweet potatoes and maize in Kenya.



Maize lethal necrosis (MLN)

Research is also being conducted on edible African *Solanaceae* plants to improve their nutrient content and productivity to benefit consumers and farmers.

One of the old technologies developed in the institute in mid-nineties is the tissue culture banana technology, which has revolutionized the banana production industry in Kenya by improving yields and incomes. The institute has continued to multiply the tissue culture bananas for the farmers under Jomo Kenyatta University Enterprise.



Tissue culture banana seedlings growing in a greenhouse in JKUAT

3.1.3 Animal Biotechnology

In animal biotechnology, researchers have developed tools to improve livestock. They have characterized local poultry and their wild relatives from different agro-ecological zones to understand their genetic make-up and use this knowledge to improve productivity. In particular, they have studied genes responsible for adaptive and production traits in indigenous chicken.



JKUAT researcher examining indigenous chicken reared for genetic traits

Rabbit farming is an emerging business that needs to be backed with research to improve productivity. To facilitate this improvement researchers are conducting genetic characterization of indigenous and exotic rabbits in Kenya. Particularly

researchers are analyzing meat production traits in local and exotic rabbits to improve protein nutrition as rabbits provide cheap healthy meat.

3.1.4 Microbial Biotechnology

Scholars have also used biotechnological approaches to exploit the Kenyan microbial resources. They have characterized microbes from hot springs of soda lakes and screened them for bioactive metabolites (enzymes and antibiotics) in order to identify enzymes that can be applied in commercial enterprises.



Students collecting data on a rabbit

3.1.5 Genetic Studies on Wildlife

In order to deter poaching menace in Kenya, researchers developed microsatellite DNA markers for application in wildlife forensics in Kenya. Research has also developed Rhinoceros DNA index register database to protect and manage Kenyan Rhinoceros. This work has since been published in the *Nature* journal.



The lead researcher on rhino DNA markers at work

3.1.6 Key Outputs

Table 9: Key performance indicators under Institute of Biotechnology Research

Capacity building	Quantity
PhD.	4
MSc.	2
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	9
Number of products developed*	2

***Products Developed:**

1. Striga-resistant genetically modified maize variety
2. DNA database for management of rhinoceros populations.

3.1.7 Funding Analysis

Fig. 16a shows the funding trends in 2005-2016. Funding sources are also shown on (Fig. 16b).

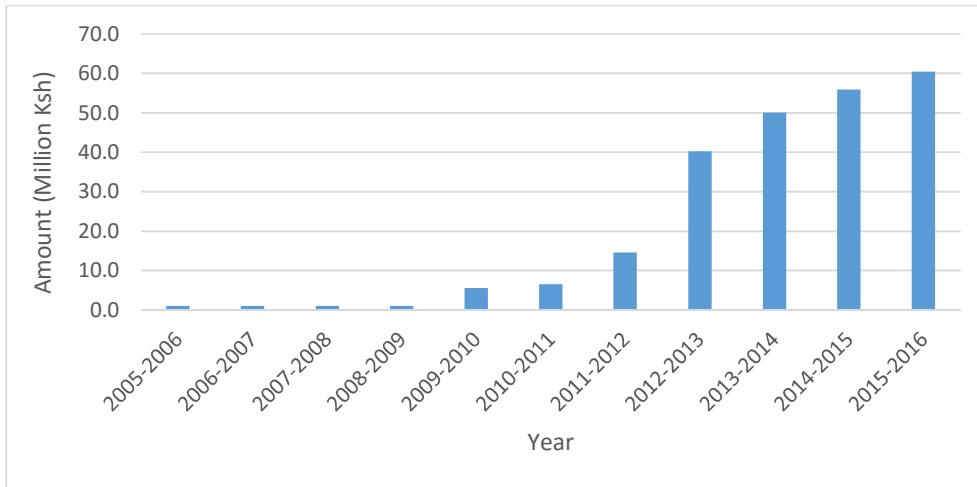


Fig. 16 a: Cumulative funding for the Institute for Biotechnology Research (2005 - 2016)

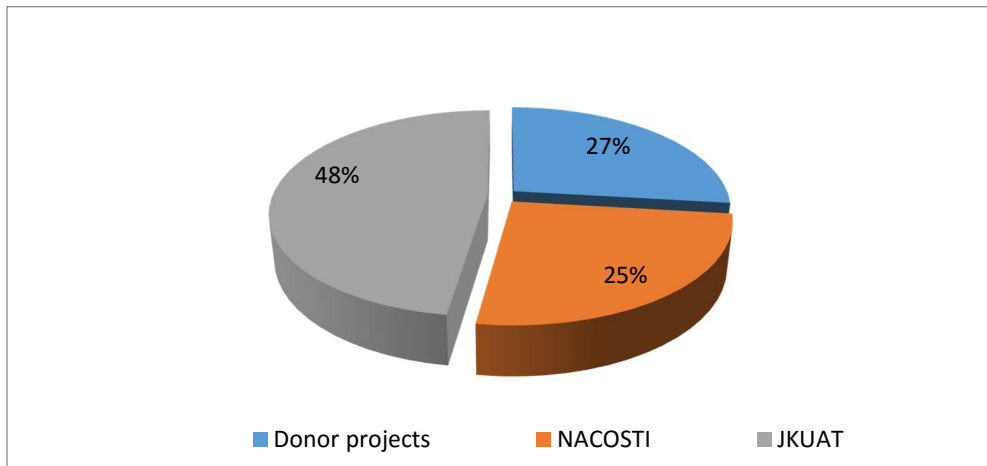


Fig. 16 b: Institute for Biotechnology Research funding distribution

3.2 Institute of Energy and Environmental Technology (IEET)

3.2.1 Research Focus

The Institute of Energy and Environmental Technology engages in research, training, innovations and consultancies in the areas of renewable energy, environmental conservation and climate change, as well as occupational safety and health.

In the area of renewable energy, the institute conducts research, training and consultancies in wind energy, biomass conversion, small and pico-hydro power generation, solar photovoltaics (PV), solar thermal energy and solar - wind hybrid systems. The institute has



H.E. President Uhuru Kenyatta following explanations on the working of a wind turbine

collaborated with both Ashikaga Institute of Technology (AIT) and Osaka City University of Japan through the Japanese International Cooperation Agency (JICA) to support and build local capacity in renewable energy for rural electrification under the Bright project. Through the support, several IEET research teams have Japanese counterparts who guide and advise on technology development and dissemination. Other international research collaborators include the Karlsruhe University of Applied Sciences of Germany, who are collaborating with IEET in the development of membrane bioreactor (MBR) and renewable energy solutions for Recirculation Aquaculture Systems (RAS). The institute also offers postgraduate training in Energy Technology at Masters and Doctorate level as well as short courses in Solar Photovoltaics, solar water heating, biogas and wind technologies, Environmental impacts assessments and environmental audits..



Hon. Cheboi (Govenor Baringo County) following explanations on the working of the gasifier.

3.2.2 Small Hydro Power

The small hydro power group is engaged in the testing and experimenting on various materials to improve the performance and durability of Pelton buckets and Hydrum using locally available materials. To this end the team has set up a hydro turbine test bench and has developed a Hydrum and a Pelton bucket using locally available materials. Piloting is ongoing in Central Kenya, an area endowed with many small rivers. The main aim of the research is to develop durable products that will resist environmental stress.



A water hydrum being installed in central Kenya

3.2.3 Wind Energy

The wind research group engages in wind resource monitoring, small wind turbine design and fabrication. The group has installed a meteorological station within the University and at St Francis Xavier High School in Naivasha to study wind flow patterns. A 25W and a 200W wind turbine for domestic use have been designed and fabricated. These are undergoing field tests at JKUAT. The team has also developed a curriculum for training practitioners in the wind energy sector. Participants in these trainings are drawn from the University, Technical Training institutes (TTT's) and industry. The aim is to accelerate the uptake of wind energy in Kenya as a potential resource for domestic and grid connection.



A small-scale wind turbine fabricated by JKUAT scientists

3.2.4 Thermochemical and Biochemical Conversion of Biomass into Biofuel

The biomass group conducts research in thermochemical and biochemical conversion of biomass into fuel gases and liquid biofuels for electricity generation. Design and fabrication of a medium size gasifier for the gasification of rice husks from Mwea, Kenya to Syngas were completed. Gas upgrading systems using locally available materials was developed. Additionally, experiments on biogas generation using water hyacinth at the Lake Victoria basin were also successfully completed. The biomass team has a pilot and demonstration plant at Kisumu's Dunga public beach in conjunction with Ecofinder, a local non-governmental organization. A biogas purification and compression system were developed and cylinders for domestic use are being developed. The team has also developed a Biogas training manual.



JKUAT researchers at the Nyeri ASK show exhibiting a rice husk gasifier

3.2.5 Solar Photovoltaic (PV) and Solar Thermal Energy

Research in solar photovoltaic (PV) and solar thermal energy at IEET involves the development of solar components using locally available materials as well as building capacity in solar technology in Kenya. A charge controller that protects batteries from overcharging was developed. The team is now testing a battery for use with the controller in an advanced solar home system. In conjunction with the Kenya renewable energy association and other stakeholders, the team participated in the development of a curriculum for solar PV training and solar water heating training. The PV training is a two-tier training, involving trainees and training of trainers. The trainings are aimed at increasing the capacity of tertiary institutions and vocational training institutions to offer these training courses in their institutions. After successful training the trainees are eligible for licensing by the Energy Regulatory Commission as solar system installers in Kenya. The team has trained more than 300 solar practitioners in Kenya.



Solar training practical session

3.2.6 Integration of Solar and Wind Energy

Research on the integration of solar and wind energy for development of solar-wind hybrid systems is ongoing. The project is aimed at developing hybrid systems by integrating the two abundant energy resources. Kenya is a country with widespread wind and solar energy resources and the integration of the two resources will complement one another ensuring a 24-hour and all season electricity source. A pilot project was set up at the Saint Xavier Girls' Secondary School in Naivasha, Kenya.



Installation of a 200W wind-turbine electricity generator at Saint Xavier Girls' Secondary School

3.2.7 Research, Training and Consultancies

Research, training and consultancies in the area of environmental management and climate change mitigation is a key area under IEET mandate. The institute is a lead trainer and consultant for the National Environment Management Authority (NEMA) in Environmental Impact Assessment and Environmental Audit (EIA & EA). The institute has trained staff from National and County governments, Ministry of Lands and Housing, World vision, World health organization (WHO) among others in EIA & EA. Research on development of environmental technologies for wastewater and solid waste management as well as climate change mitigation and adaptation is carried out by research fellows and postgraduate students at the Institute. The institute also offers postgraduate training in Environmental Legislation and Management at Master and Doctorate level. A master of science course in Climate Change has been developed and is undergoing review by stakeholders. The institute is currently assessing air quality in Nairobi City and Environs in a project that is funded by the National Commission of Science, Technology and Innovation (NACOSTI). NACOSTI has also funded another research aimed at conversion of agricultural residues in Mwea, Kenya into chemical products for Small and Micro Enterprises development as a strategy for crop value addition.



Factory visit by IEET Solar Water heating trainees at Steelstone Ltd.(Nairobi)

3.2.8 Occupational Safety and Health (OSH)

Occupational Safety and Health (OSH) research, training and consultancies have been ongoing on since the inception of the institute. Research in this area is geared toward the improvement of the workplace and the safety and health of the worker. The institute also offers postgraduate training in OSH at Postgraduate Diploma (PGD OSH), Masters (MSC OSH) and PhD levels (PHD OSH) in collaboration with the Directorate of Occupational Safety and Health Services (DOSHS). Research is centered on the areas of workplace information, workplace management, risk assessments, ergonomics, safety technology, occupational hygiene, employee safety and health among others.



IEET staff at an OSH workshop

Research on worker safety, hygiene and health has been conducted and used to improve the workplace conditions in the following sectors; woodwork industry, metal processing, recreation, secondary schools, airports, chemical processing industry, pesticide handling and agrochemicals among others. Flower farms, dumpsites, petrol stations, universities and research institutions were also extensively studied. Information dissemination has been done through information and knowledge sharing as well as through consultations and training.



A training session conducted by the IEET

3.2.9 Key Outputs

4. Table 10: Key performance indicators under Institute of Energy and Environmental Technologies

Capacity building	Quantity
PhD.	13
MSc.	70
Technicians (Short course training)	1380
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	112
Number of products developed*	10
Patent Applied**	2
Infrastructure developed***	6

*Products Developed

1. Hydraulic ram (hydram) – surface modified with non-corrosive and durable material. The developed hydram is cheaper than imported varieties and has reduced noise
2. Small scale wind turbine- operates at low wind speed – made using reinforced glass fibre
3. Biomass gasifier- made using local materials, cheap with innovative gas cleaning devices.
4. Modified internal combustion engine to run on biogas.
5. A process of conversion of water hyacinth to biomethane - with innovative gas cleaning devices, storage cylinders and compressors.
6. Charge controller for solar PV application,
7. Pelton type mini hydro turbine – with innovative surface preparation.
8. System and process for conversion of plastic waste to energy resources
9. Process and machine for biodiesel production from animal fats and used vegetable oils.
10. Biogas packaging and storage system

**Patent Applied

1. System and process for conversion of plastic waste to energy resources
2. Biogas packaging and storage system

***Infrastructure Developed/Acquired

1. A Hydro-turbine test bench
2. Wind laboratory with a variable speed wind generator, generator coil winding machine, anemometers, wind vanes, torque meter, data loggers
3. 3 biogas digesters, and gas engine generators
4. Solar PV lab – panels, inverters, controllers, batteries, irradiance meters, clamp meters, infrared thermometers, data loggers, fittings and fixtures
5. Fabrication workshops – welding and metal work
6. Two gasifier - All Power Labs (APL) 10kW, and a locally fabricated 10kW gasifier

To support the research activities, the Institute has over 300 postgraduate students at various stages of their studies.

3.2.10 Funding Analysis

Fig. 17a show the funding trends in 2005-2016. Funding sources are also shown on (Fig. 17b).

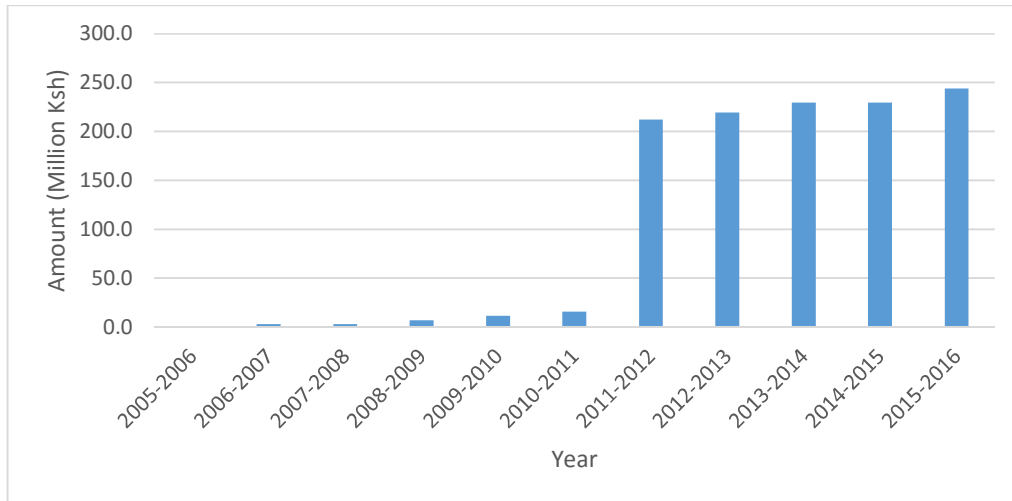


Fig. 17a: Cumulative funding for Institute of Energy and Environmental Technologies (2005 - 2016)

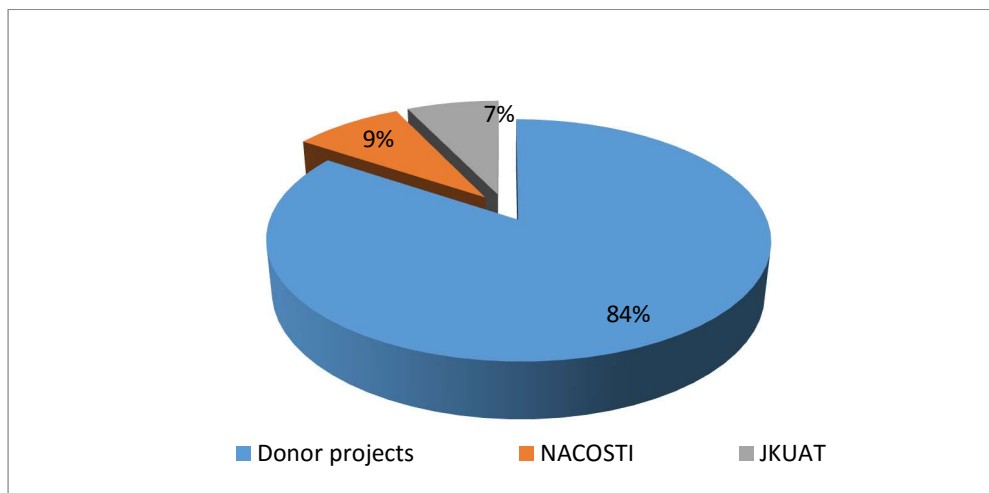


Fig 17 b: Institute of Energy and Environmental Technologies funding distribution

3.3 Sustainable Materials Research and Technology Centre (SMARTEC)

3.3.1 Research Focus

The Sustainable Materials Research & Technology Centre was established as a multi-disciplinary center that engages in research, training and consultancies in 2008. The research focuses in the areas of sustainable construction, converting waste into riches and contributing to UN 2030 Agenda on Sustainable Development Goals. The main activities of the center fall under:

3.3.2 Research on Eco-housing

Traditional use of quarry-based stones is expensive, has high-energy consumption and negative environmental consequences since the pits have to be filled. JKUAT researchers have contributed immensely towards development of sustainable materials and technologies for eco-housing and infrastructure. Pioneering work in eco-housing includes use of interlocking stabilized soil blocks and rammed earth for buildings. Full-scale buildings have been constructed for demonstration and are in use. These include an Eco Building (SMARTEC office in JKUAT), JKUAT stand, Nyeri showground, staff houses at Kiria-ini High School (Murang'a County) and Infill walls in Technology House and COHES Building, JKUAT.

The strength for the interlocking stabilised soil block is attained by compaction using a block making machine and curing under moist hessian. No cement is required between the joints. This has led to savings of up to 60% on the cost of walling. The popularity of using the interlocking stabilized soil block led to improvement of the old block-making machine to a newer more efficient one. The old machine required at least two people to compress the blocks while the new one requires only one person. Use of the eco-materials helps in reduction in energy consumption and cost of construction and results in affordable and sustainable construction within reach of the ordinary person.

3.3.3 Stabilization of Black Soil Using Rice Husk Ash and Lime

Constructions on areas with black cotton soil necessitate that the soil be excavated, disposed off, and suitable material brought in to replace it. This is very expensive and has negative environmental impacts in the dumping areas and the borrow areas. Research has devised a way of using rice husk ash and lime to stabilize the black cotton soil. Rice husk is normally burned or used as compost manure. Stabilizing black cotton with rice husk ash makes use of two wastes to give a desired product a suitable material for road construction with no negative environmental impact.

3.3.4 Animal Dung and Municipal Solid Waste Ash as Alternative Stabilizer for Clay Blocks

Burning of clay blocks causes degradation of environment by release of greenhouse gases and destruction of trees. A research arrived at providing a solution by using animal dung and municipal solid waste ash as an alternative stabilizer for clay blocks. This will help in reducing emission of greenhouse gas, reduce demand for waste dumpsites, reduce cutting down of trees and contribute to sustainable development goals



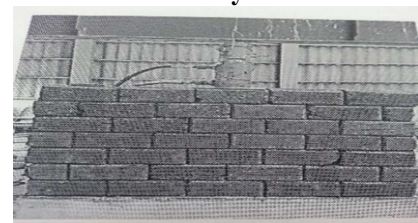
SMARTEC office in JKUAT constructed using eco-blocks



Original design of the block-making machine



Improved block making machine that requires one operator



Wall panel for tests

3.3.5 Reclaimed Asphalt Concrete as a Cold Mix Surfacing Materials for low Volumes Roads

Disposal of old asphaltic concrete from rehabilitation of existing roads in open spaces has led to environmental degradation while lack of sufficient funds has led to low volume roads being left in a deplorable state. Reuse of reclaimed asphalt concrete as a cold mix surfacing materials for low volumes roads has proved to be beneficial. The benefits include environmental protection and rehabilitation of more low volume roads due to use of relatively inexpensive reclaimed asphaltic concrete.

3.3.6 Stone Dust in Production of High Performance Concrete

Stone dust is a waste in production of masonry stones, and has to be disposed of, leading to negative environmental impact. Traditional use of river sand in production of concrete has led to degradation of riverbeds, with negative environmental impacts. The currently used concrete results in buildings with many columns and large beam sizes resulting in reduced lettable and useable space. The key issues addressed in the research is the assessment of stone dust in production of high performance concrete. Use of high performance concrete contributes to the following.

- (i) Reduced negative environmental impact in disposal of waste stone dust, and reduced degradation of riverbeds.
- (ii) Reduction in number of columns and reduced member sizes in a building resulting in economical and sustainable construction.

3.3.7 Sisal Fibre Reinforced Cement Mortar with Termite Clay Soil for Roofing Tiles

Shortage of housing in Kenya, has led to slums due to high cost of construction. Assessment of the Feasibility of Using Sisal fibre Reinforced Cement Mortar with Termite Clay Soil (with very little agricultural value) for Roofing Tiles has proved to reduce the cost of construction of roofs, thus leading to affordable dwellings contributing to reduction of slums.

3.3.8 Model for Optimizing Earth Moving Operations in Kenya

Earthmoving is one of the most expensive operations in construction of roads. Inefficient earth moving operations results in high construction costs leading to construction of fewer roads. This has initiated development of a model for optimizing earth moving operations in Kenya. Optimizing earth-moving operations contributes to efficient earth moving operations, reduced construction costs hence more roads constructed.

3.3.9 Shredded Waste Plastic Bags and Waste Sugar Cane Ash in Bitumen and Bituminous Mix for Improved Road Performance

Normal bitumen cracks at high temperatures in the topics, resulting in cracked roads which has led to potholes and high maintenance costs. In order to improved road performance, researchers in the centre have proposed the use of shredded waste plastic bags and waste sugar cane ash in bitumen and bituminous mix. Use of this modified bitumen that can withstand high temperatures and heavy loads will lead to sustainable and economic construction of roads in Kenya, with a relatively longer service life. Waste plastic bags and waste sugar cane degrade the environment and their use goes a long way in contributing to:-

- (i) Sustainable roads.
- (ii) Reduction in cost of maintenance of roads.
- (iii) Construction of more roads since money for maintenance is available for new roads.
- (iv) Reduces negative environmental consequences of disposal of waste plastic bags and waste sugar cane.

Other researches undertaken include investigations in different areas like devising necessary interventions on collapsing building structures in Kenya, causes of delay in large civil engineering projects in Kenya and sustainability of steel construction technologies in mobile telecommunication industry in Kenya, amongst others. The study on causes of collapsing building structures in Nairobi County and its environs was done to help in devising necessary interventions and thus alleviate the problem. This will contribute to Sustainable structures, safe construction and reduction of loss of life and property. Masts for the telecommunication industry are mainly in steel construction. An investigation of the sustainability of steel construction technologies in mobile telecommunication industry in Kenya is ongoing and will guide the use of steel leads in terms of efficiency, economy and sustainability.



Construction consultancy work by SMARTEC at DKuT

3.3.10 Consultancies

A number of consultancies have been carried out the major ones being Dedan Kimathi University of Technology (DeKUT) Sundry Road Works, Rugby pitch and construction of the Academic Block.

Remunerations from Consultancies for Dedan Kimathi University of Technology

Project	Amount Paid in Kshs
Link Road	615,593.75
Games Pitches	351,098.85
New Academic Block	3,617,000.00
Sundry Road Works Phase 1	1,142,718.50
Sundry Road Works Phase 2	1,401,106.00
TOTAL	7,127,517.10

3.3.11 Short Courses

SMARTEC and National Construction Authority (NCA) plan to jointly conduct the first specialized short course on Concrete Technology.

3.3.12 Key Outputs

Table 11: Key performance indicators under Sustainable Materials Research & Technology Centre

Capacity building	Quantity
PhD	7
MSc	12
Other Key Performance Indicators	Quantity
Publications in peer reviewed journal and conference proceedings	26
Number of products developed*	2
Products ready for patent**	1
Infrastructure developed***	4

*** Products Developed**

1. A protocol for stabilizing black cotton soil using rice-husks and lime.
2. Eco-blocks

****Products ready for Patent**

1. A protocol for stabilizing black cotton soil using rice-husks and lime.

*****Infrastructure Developed**

1. An eco-block SMARTEC office
2. An eco-block house in the Nyeri ASK JKUAT stand
3. Staff houses at Kiria-ini High School in Murang'a County
4. Infill walls in Technology House and COHES Building in JKUAT

3.3.13 Funding Analysis

Fig. 18a shows the funding trends in 2005-2016. Funding sources are also shown on (Fig. 18b)

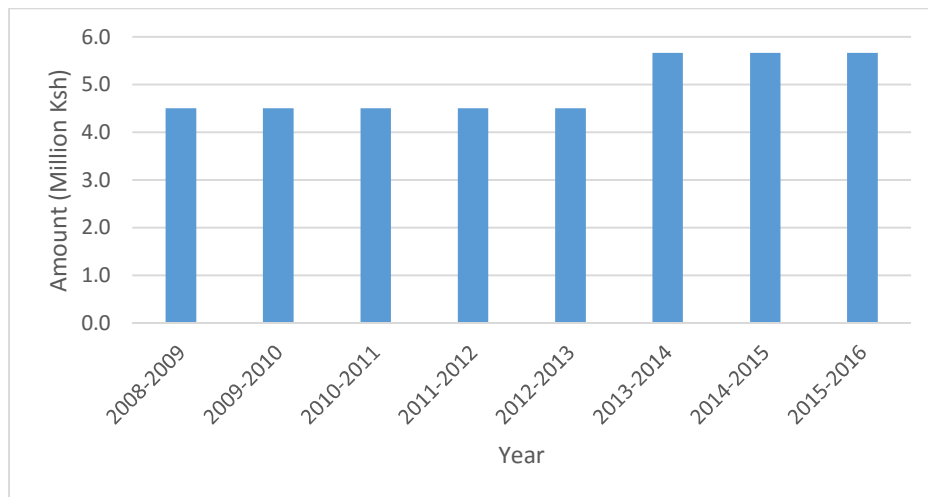


Figure 18a: Cumulative funding for Sustainable Materials Research and Technology Centre (2008 - 2016)

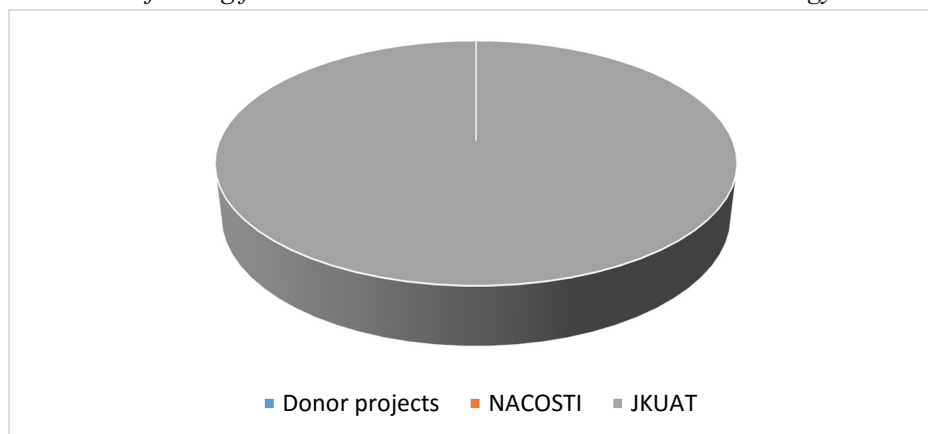


Fig 18b: Sustainable Materials Research and Technology Centre funding distribution

3.4 Sino-Africa Joint Research Centre (SAJOREC)

3.4.1 Research Focus

The Directorate of Sino-Africa Joint Research Centre (SAJOREC) was established in JKUAT in September 2011. The directorate seeks to ensure conservation of biodiversity through learning, training and research and to enhance cooperation with Chinese agencies and institutions in research and training. Biodiversity or "biological diversity," generally refers to the variability of life on Earth. One of the most widely used definitions defines it in terms of the variability within species, between species and between ecosystems. It can refer to genetic variation, ecosystem variation, or species variation within an area, biome, or planet. Conservation of biodiversity involves research and education on the trends and process of biodiversity loss, species extinctions, and the negative effect these are having on our capabilities to sustain the well-being of human society. Biodiversity is of great importance in order to maintain stable ecosystems and indeed for the sustenance of humankind.



JKUAT, National Museums of Kenya and Chinese Academy of Sciences researchers on a joint field exercise.

3.4.2 SAJOREC Activities

On-going activities in SAJOREC directorate include overseeing establishment of the Sino-Africa Joint Research Centre and the JKUAT Botanical Garden (SAJOREC headquarters) in JKUAT main campus, Juja. Additionally enhancing capacity building in biodiversity conservation by holding sensitizations/training/workshops for staff in both Kenya and China. We also facilitate scholarships for students pursuing post-graduate studies in science related fields to the University of Chinese Academy of Sciences. Other activities include conducting field and laboratory based biodiversity research and documenting research outputs and innovations by publishing monographs as well as academic papers in Science Citation Index (SCI) listed peer refereed journals.



The Sino-Africa Joint Research Centre

3.4.3 Sino-Africa Joint Research Centre and the JKUAT Botanical Garden

This is a Chinese-aided government to government project between the Government of Kenya and the Government of the People's' Republic of China. The project has established the Sino-Africa Joint Research Center and a 40-acre Botanical Garden in JKUAT main Campus in Juja. The research center which occupies 3 acres of the botanical garden comprises administration offices, conference and accommodation facilities, and six specialist research laboratories fully equipped to engage in cutting-edge research, namely;

- (i) Agriculture science and technology laboratory.
- (ii) Biodiversity conservation laboratory.
- (iii) Water resources management laboratory.
- (iv) Microbiology laboratory.
- (v) Geographic and remote sensing laboratory.



A natural products laboratory in SAJOREC

- (vi) Natural products development laboratory

The facility also has conference facilities and accommodation for visiting scientists. The accommodation facilities in SAJOREC include deluxe guest rooms, kitchen and dining facilities and are designed to accommodate 43 guests at a time. The conference hall has a sitting capacity of 200 persons.

The JKUAT Botanical Garden is based on nine thematic gardens, namely;

- (i) African indigenous plants garden comprising germplasm native to the African continent categorized into the different ecological zones.
- (ii) Medicinal plants garden.
- (iii) Rare and unique plants garden
- (iv) Orchard of cultivated and wild edible fruit trees.
- (v) Bamboo garden.
- (vi) Rose garden
- (vii) Tea garden
- (viii) Aquatic plants garden with water lilies, lotus ponds and submerged plant observation areas.
- (ix) Asian and exotic plants garden comprising flora from other continents

The Botanical Garden serves four main purposes:

- (i) Providing new plants of economic importance to society including medicinal, ornamentals, trees for reforestation and plants for industry, fruits and cash crops.
- (ii) Keeping plants for study of growth, adaptability, economic and genetic characteristics.
- (iii) Disseminating cultural and scientific information about plants to the general public.
- (iv) Preserving endangered and rare plants and also investigating methods of conservation in natural habitats.

The garden also provides recreation for guests and is expected to contribute to agricultural productivity through conservation and distribution of the many promising but underutilized and neglected food, medicinal and industrial crops, as well as wild relatives of crops which are used in plant breeding to impart resistance to drought, pests and diseases and to adapt crops to other adverse environmental conditions.

Construction of the SAJOREC project begun on 29th May, 2015. The handing over ceremony was presided by the Chinese Ambassador to Kenya His Excellency Dr. Liu Xianfa at the SAJOREC center in JKUAT main Campus Juja, on 26th September, 2016. Regional SAJOREC offices have been established in Mwanza, Tanzania, Addis Ababa, Ethiopia and Antananarivo, Madagascar.

3.4.4 Facilitation of Staff Training

SAJOREC organizes annual forums of African and Chinese scientists dubbed the ‘Sino-African Researchers’ conference. The inaugural Sino-Kenyan Researchers’ conference was held on the 7th and 8th of August, 2013 at the Utalii Hotel in Nairobi. The main objective of the forums is to bring together African and Chinese scientists and lay the ground for future research activities in SAJOREC. The forums have brought together African scientists and their counterparts from leading Universities and Chinese Academy of Sciences research institutes in China. So far several collaborative research activities have arisen from the forums.

SAJOREC also organizes workshops and training sessions for African and Chinese researchers with an aim of enhancing skills transfer. The workshops have brought together scientists and officials from Kenya and other African Countries, and Chinese officials and scientists. Four International training workshops have been held since the year 2011.

A workshop on molecular systematics held in Wuhan Botanical Garden, Chinese Academy of Sciences (WBG CAS) in April 2011 for JKUAT staff and researchers from other parts of Africa. Over 22 leading scientists from across the African continent were in attendance. Another workshop on molecular biology was held in April, 2012 in WBG CAS where participants from 16 leading research institutions from the African continent participated. A workshop was held in WBG CAS on dryland management in October 2013. The workshop brought together researchers and officials from Kenya and other African Countries and Chinese officials and scientists.



The Director, SAJOREC delivering a speech during a workshop in China, in 2013

There have also been short course training programs where staff from different institutes in Kenya have travelled to China to be trained in various laboratory techniques in their respective fields of work.

3.4.5 Facilitation of Student/Staff Scholarships

Since 2013 the SAJOREC initiative has awarded full graduate (Masters and PhD scholarships) to 88 students from Africa to the prestigious University of Chinese Academy of Sciences for post-graduate studies in various disciplines. Sixty (60) of the students are from Kenya with 51 being JKUAT students. The students were admitted to the University of Chinese Academy of Sciences (UCAS) in China and trained in various Chinese Academy of Sciences (CAS) under different specialties including Plant biosystematics, Plant phylogenetics, Viticulture techniques, Virology, Environmental science, Ecology, Plant phylogenetics, Botanical garden establishment and maintenance among other programs.

3.4.6 On-Going Research Activities

Research activities in SAJOREC are mainly collaborations between JKUAT researchers and those from various research institutes of the Chinese Academy of Sciences (CAS). The main focus of the research collaborations is biodiversity conservation and improvement in agricultural techniques. Listed below are some of the areas of research:

- (i) Floristic investigation of selected regions in Kenya and documentation of plant germplasm in different biodiversity hotspots for *in-situ* conservation in the JKUAT Botanical Garden.
- (ii) Biodiversity studies on selected endangered plants in the East African Flora
- (iii) Formulation of appropriate conservation strategies for selected endangered plants species in the Kenyan flora.
- (iv) Comparison of grape cultivars and building of a demonstration vineyard in Kenya.



JKUAT students receiving scholarships for study in CAS University

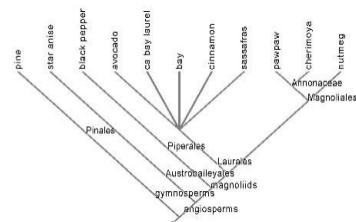
- (v) Evaluation and improvement of Chinese cultivars of grapes for local conditions for conservation and documentation.
- (vi) Development of microsatellite markers and population genetic structure of *Hagenia abyssinica* (Rosaceae), an endangered tree endemic to the tropical African mountains and formulation of conservation strategies for the species.
- (vii) Comparative phylogeography of two genera (*pordocarpus* and *dodoneae*) endemic to Northeast and East Africa to gain a better understanding of the phylogeography of the species and formulation of conservation strategies.
- (viii) Complete chloroplast genome of *Dendrosenecio brassiciformis* and phylogenetic position within *Asteraceae*. Gaining a better understanding of the genetics of the species and formulation of conservation strategies for the species.
- (ix) Distribution and phylogeography of genus *Lobelia* in the flora of tropical East Africa to gain a better understanding of the distribution and phylogeography of the species and formulation of appropriate conservation strategies for the species
- (x) Effects of elevation and climatic variables on the diversity, richness and evenness of invasive plant species in Kenya and Uganda. Better understanding of the biology of invasive species and formulation of better control strategies for the invasive species.
- (xi) Construction of the Tree Life for Angiosperms in Kenya to gain a better understanding of the evolutionary biology of the species and for formulation of appropriate conservation strategies for threatened and endangered species.
- (xii) Research on Plant Diversity Patterns and Their Formation & Maintenance Mechanism in East Africa to enable better understanding of the diversity of the species and formulation of appropriate conservation strategies for threatened and endangered species



Sedum keniensis pordocarpus spp, a new plant species described by SAJOREC researchers



Dendrosenecio spp, A high altitude species on the Aberdares



Phylogenetic tree

3.4.7 Key Outputs

Table 12: Human capacity development under SAJOREC

Capacity building	Quantity
Post-doctoral students	1
PhD	10
MSc	88
Technicians	14
Key Performance Indicators	Quantity
Publications in peer reviewed journal	61
Number of products developed*	2
Infrastructure developed**	9

***Products Developed**

1. Common Plants of Kenya- (Practical field guide by SAJOREC researchers invaluable to practitioners in the tourist industry for field activities)
2. *Sedum keniensis* –A new plant species described by SAJOREC researchers in Kenya in 2016. The plant has shown great potential for culinary use (salads).

****Infrastructure Development**

Modern research center with:

- (i) 24 furnished offices and a conference facility (sitting capacity of 200)
- (ii) Accommodation facilities (Capacity of 43 persons)
- (iii) Prefabricated accommodation facilities (capacity of 80 persons)
- (iv) Agriculture science and technology laboratory.
- (v) Biodiversity conservation laboratory.
- (vi) Water resources management laboratory.
- (vii) Microbiology laboratory.
- (viii) Geographic and remote sensing laboratory.
- (ix) Natural products development laboratory.

The facility also has four hectares of modern agriculture demonstration zone and a thirty-seven-acre botanical garden.

3.5 Water Research and Resource Center (WARREC)

3.5.1 Research Focus

The Water Research and Resource Centre (WARREC) was established in 2011 with support of the then Ministry of Water and Irrigation. The aim was to set up a centre of excellence for providing services in Research, Science and Technology in the broad context of the water sector in Kenya. The *mission* of WARREC is to facilitate research in the broad fields of water resources planning, development and management and to facilitate innovations and knowledge to serve diverse stakeholder groups. These include communities at the grassroots, researchers, water resource managers, policy makers and water users.

The objectives and mandates of WARREC include, to:

- (i) Enhance and facilitate research, innovation, science and technology in the broad water sector issues and activities,
- (ii) Strengthen human and institutional capacities of water sector stakeholders in Kenya,
- (iii) Facilitate networking and cooperation between institutions and individuals in the water sector,
- (iv) Provide advisory services, advice policy and facilitate science communication,
- (v) Carry out any other lawful activities for the furtherance of water sector services and development.

Within a short time since establishment, the center has made great strides in ensuring that research, science and technology is ingrained in the water sector planning, particularly in the Government ministries, parastatals, NGOs and stakeholder organizations. This has been achieved through advocacy, developing MoUs with strategic institutions, implementing joint research projects, capacity building for target actors in the water sector and participation in workshops, conferences, exhibitions, events and other forums. Some of the milestones on research achieved by WARREC are summarized here.

3.5.2 WARREC Becomes a Kenya Vision 2030 Flagship Programme

One of the earliest efforts was to institutionalize WARREC within the Government of Kenya's development plans. Towards this end, WARREC was listed in 2013, as a Flagship Programme of the Kenya Vision 2030 as contained in the country's, "Second Medium Term Plan (MTP2), 2013–2017, To actualize the MTP2 roles, WARREC spearheaded the signing of MoU with the then Ministry of Environment, Water and Natural Resources (MEWNR), JKUAT, University of Nairobi (UoN) and the Kenya Rainwater Association (KRA) in 2015. WARREC has been working with the Ministry of Water and Irrigation (MWI) providing technical capacity in various initiatives

3.5.3 Research and Promotion of the System of Rice Intensification (SRI): An Innovation in Kenya

The System of Rice intensification (SRI) was introduced in Kenya at the Mwea Irrigation Scheme in July 2009, through collaborative efforts of National Irrigation Board (NIB), JKUAT, African Institute for Capacity Development (AICAD), World Bank, farmers and other stakeholders. In 2010, JKUAT, through the RPE Division, provided funding to upscale the technology through research, extension and outreach. The project has since been involved in capacity building of over 5,000 farmers while producing 1 PhD and 6 MSc students.



A student measures water into an SRI plot

Generally, there is now proven evidence that SRI increases rice yields and saves water. SRI rice gave yields ranging from 6.0 to 8.5 t/ha compared to less than 4t/ha normally recorded for conventional method. Farmers have noted that a bag of SRI paddy weighs 100-110 kg compared to 80-90 kg for conventional rice. Furthermore, there is 30% water savings under SRI. Thus, farmers have become encouraged, and many continue to adopt SRI.

The project also conducted the first ever research on the impact of SRI on mosquito larvae. The results obtained showed that mosquito larvae were completely eliminated under SRI. This is because SRI dries the paddy for 7 days, while mosquito larvae die within 2 days if exposed outside of water, meaning all larvae died in SRI paddies.

The SRI project, which is still ongoing has implemented scientific research, farmer trials, capacity-building and outreach activities for farmers and other stakeholders. The success of the intervention has been phenomenal. WARREC has continued facilitating research and technical backstopping to SRI initiatives. As a result, by June 2016, over 8,000 farmers had adopted SRI, majority of them in Mwea, with others being in Ahero, West Kano, South West Kano and Bunyala Irrigation Schemes.



A mosquito trap used to assess larvae survival rates in Mwea

SRI has been rated an innovation and featured various media houses, including; The Daily Nation, Star newspaper, E-Rails, Business Daily and JKUAT magazine. A video documentary on SRI in Kenya won 1st prize by FARA (Forum for Agricultural Research in Africa), awarded at the 6th Africa Agriculture Week, on 20th July 2013 in Accra, Ghana. The documentary is available at: <https://www.dropbox.com/s/rhuzup3mz9zwr8h/ARD%20ON%20SRI%20-%20KENYA.flv>

3.5.4 Fog Harvesting Research Pioneered in the Ngong Hills

Fog harvesting is an innovative technology for collecting the tiny water droplets present in fog, by using equipment known as *fog collectors*. A fog collector consists of a single or double layer mesh net supported by two posts rising from the ground, each having a gutter and drain pipes which channel the water to a storage tank. Fog collectors also harvest rainfall, drizzle and mists. The typical water production rates from a fog collectors range from 20 to 1,000 litres per day, depending on net size, mesh/fibre design, fog density and wind.



Fog harvesting equipment installed at Ilmasin Primary School in Ngong Hills,

The pioneer fog collectors were installed in the Ngong Hills by a team of JKUAT researchers in 2013. They first conducted research using 1 sq.m size experimental collectors. Research findings obtained showed that the equipment worked well, collecting 3 litres/m²/day of fog water and over 50 litres/m²/day of rainwater. Based on these results, the team installed a large conventional fog collector measuring 40 sq.m. Finding this too expensive (KSh.250,000), they designed their own fog collectors measuring 20 sq.m utilizing local materials, thereby lowering the cost to KSh.50,000. They also trained local communities and school children on fog harvesting. In August 2014, the fog collector equipment was handed over to communities at Ilmasin Primary school, in a ceremony presided over by JKUAT Vice Chancellor Prof. Mabel Imbuga and DVC-RPE Prof. Esther Kahangi.



The vice-chancellor hands over fog harvesting equipment to Ilmasin Primary School, Kajiado

The fog harvesting project has been rated an innovation and was featured by local and international media, including; The Daily Nation, German TV, Reuters, Voice of America, QFM-TV, KTN, CitizenTV Digital, The Star and JKUAT magazine. The feature is available at:

<https://www.dropbox.com/s/dj6d8972scilkwb/Fog%20Harvesting%20Ngong%20Hills-Kenya%20interview.mp4>

3.5.5 Groundwater Risk Management for Growth and Development (Gro for Good) in Kwale (UK-AID)

WARREC is a partner in the research project entitled “Groundwater Risk Management for Growth and Development (GRo for GooD). The project, led by Oxford University of UK, is implemented in Kwale County and funded by UK NERC’s ESRC/DFID for the period 2015-19. The project aims at improving the understanding of groundwater risks and institutional responses against competing growth and development goals to accelerating and sustaining Africa’s development. The project has developed cutting-edge digital technology to assess pumped groundwater in Kwale County. It assesses both water quantity and quality as affected by various uses and users (domestic, mining industry and irrigated agriculture).

3.5.6 Bathymetric Reservoir Survey of Ruiru Dam

Reservoir sedimentation is a recurrent problem in Kenya, caused by escalating soil erosion, particularly from the highland areas, which have the combination of steep slopes, erodible soils and high rainfall. Until now, there was no way of determining reservoirs sedimentation, or the types and sources of these sediments in Kenya. This was until the introduction of the first *state-of-the-Art multi-frequency reservoir survey equipment (bathymetric boat)* in Kenya, through a project pioneered by JKUAT in collaboration with the Nairobi City Water and Sewerage Company (NCWSC).



The DVC-RPE launches the Bathymetric survey equipment at Ruiru dam.

An initiative to bring a bathymetric boat to Kenya was pioneered by JKUAT lecturer, Dr. Joseph Sang, who in 2012, organized for the donation of the bathymetric boat, by United States Agency for International Development (USAID), through the United State Department of Agriculture–Agricultural Research Services (USDA-ARS) and Baylor University (Waco TX) to JKUAT. The Nairobi City Water and Sewerage Company (NCWSC) was the first to use the equipment with the sediment assessment conducted at Ruiru Dam, launched in a ceremony officiated by JKUAT’s DVC-RPE, Prof. Esther Kahangi, on 13th July 2015.



Demonstration of the working of the Bathymetric survey equipment

Since then, the bathymetric equipment has been used to assess the sediment yields in Ndakaini Reservoir and Lake Naivasha with results being used in watershed modelling studies. The equipment has been used to support PhD, MSc and BSc students’ research projects. The bathymetric equipment can be hired for use by other institutions or researchers.

3.5.7 Scoping Study of Water User Associations of Tana Catchment

WARREC, working in collaboration with the Water Resource Management Authority (WRMA) carried out scoping studies on Water Resources Users Associations (WRUAs) in the upper catchments of the Tana Basin, focusing on the Thika sub-catchment. This project was funded by University of the Sunshine Coast (USC) of Australia and implemented in 2013. The study was part of preparatory data collection designed to identify entry points for developing Water Allocation Plans (WAPs). The findings showed that WRUAs in the Thika sub-catchment have developed good institutional capacities and record keeping.



WRUA member watering seedlings in Tana RiverBasin

3.5.8 Identifying Key Issues to Manage Water Resource Users Associations (WRUAs) in Tsavo Catchment

The Tsavo River catchment is transboundary between Kenya and Tanzania, lying in the south-western corner of Kenya at the foothills of Mt. Kilimanjaro. The area is generally semi-arid and dependent on erratic rainfall patterns that are experienced mostly in the upper catchments. But the Tsavo catchment

Human encroachment in Kimana wetland Tsavo catchment

is also degraded. This is due to expansion of agriculture and human settlements on the upper catchments, while reduced grazing space has resulted in overgrazing and denudation of vegetation in the lower areas. Poaching, including game meat hunting, has decimated the wildlife, while water resources have reduced, and wildlife faces competition from over-grazing and human encroachment.



Based on these observations, JKUAT's WARREC in collaboration with the Water Resources Management Authority's (WRMA), Tsavo Sub-Regional Office, Ministry of Agriculture and the Kenya Wildlife Service (KWS) together implemented training of WRUAs in the Tsavo River catchment, accompanied by a rapid rural appraisal. The initiative was co-financed by the World Wide Fund - Education for Nature ((WWF-EFN) of USA and JKUAT. The training was held in April 2014 in Loitokitok, Kajiado County. This helped build the capacity of WRUAs and their stakeholders in Tsavo catchment on integrated water resource management (IWRM).



Participants of a workshop on field assessment of Kimana wetland in Tsavo river catchment

A follow up mission implemented in October 2014 found that the project had succeeded in stimulating action by the WRUA leaders. It achieved community sensitization, conflict resolution on water resource management, stimulating;

- (i) Enforcement of by-laws to prevent pollution of rivers,
- (ii) Processing the gazettement of wetlands (by WRMA),
- (iii) Reviewing WRUA sub-catchment management plans (SCMPs),
- (iv) Processing of applications by WRUAs to Water Services Trust Fund (WSTF) for funding,
- (v) Water source protection activities, and
- (vi) Campaigns to reduce charcoal burning.

3.5.9 MoUs Signed with Partner Institutions

WARREC has developed and facilitated the signing of Memorandums of Understanding (MoUs) between JKUAT and relevant institutions for collaboration on water and related issues. The institutions are:

- (i) World Vision-Kenya (WVK)
- (ii) University of the Sunshine Coast (USC) of Australia
- (iii) Tana and Athi River Development Authority (TARDA)
- (iv) The Ministry of Environment, Water, Environment and Natural Resources, jointly with University of Nairobi and Kenya Rainwater Association.
- (v) Nairobi Water and Sewerage Company (NCWSC)
- (vi) Kenya Water Institute (KEWI) jointly with Living Water Africa Region (LWAR)
- (vii) Athi Water Services Board (AWSB)
- (viii) Water and Sanitation for the Urban Poor (WSUP)
- (ix) National Water Conservation and Pipeline Corporation
- (x) Centre for Science and Environment (CSE) of India.

3.5.10 WARREC Hosts a Water Knowledge Portal

WARREC has developed its website for the dissemination of research and innovations to target users. The website is frequently updated with information and activities. For more information on WARREC, contact: <http://www.jkuat.ac.ke/departments/warrec/>.

4.0 EXTENSION AND TECHNOLOGY TRANSFER

JKUAT has a rich technological, skills and information base that promises to transform subsistence agriculture and cottage industries into competitive sectors, both locally and globally. Vision 2030, Kenya's development blueprint, recognizes technology dissemination and facilitating its adoption, as a critical input required for the transformation of SMEs to competitive industrial and service based enterprises with increased value addition and market access. The main challenge with regard to technology access is that most resource-poor farmers and SMEs lack appropriate technologies, skills and information for productive functioning of enterprises. Linkages to facilitate flow of innovations between SMEs and training/research institutions are weak so that SMEs are forced to innovate crudely in their activities leading to low efficiency.

The Directorate of Extension and Technology Transfer of RPE Division is mandated to address the above challenge while facilitating attainment of a - core function of JKUAT, i.e. 'To play an effective role in the development of agriculture and technology and to provide extension services so as to contribute to social and economic development of Kenya'.

The overall objective of the extension directorate is to disseminate research findings, knowledge and technologies to the public and promote adoption for rapid industrial and agricultural development

4.1 Activities of the Department

Towards the attainment of the above objective, the department currently carries out the following activities:

- (i) Packaging and transferring technology to end users through various channels i.e. radio, TV, trainings, etc.;
- (ii) Conducting studies along agricultural value chains to identify challenges/opportunities and develop appropriate intervention packages;
- (iii) Studying markets to generate market information/trends and advice clients appropriately;
- (iv) Coordinating the participation of the university in shows, exhibitions, field days, trade fairs and open days;
- (v) Conducting training programs for women groups, youth groups, persons with disabilities, schools, institutions, industry, farmer' and community based organizations;
- (vi) Receiving learning parties such as farmers groups, SMEs, students, and industrialists on knowledge acquisition mission;
- (vii) Developing information communication and education materials;
- (viii) Enhancing partnerships with industry, providing consultancy activities and fundraising.

4.1.1 Shows Exhibitions and Trade Fairs

In the last ten years the Directorate has consistently taken part in major shows and exhibitions such as Central Kenya National ASK show at Nyeri, Nairobi international trade fair, the annual Commission for University Education (CUE) exhibition, JKUAT annual open day, JKUAT annual Tech Expo and exhibitions organized by other institutions

The goal of participating in these exhibitions is to showcase the university technologies, knowledge, skills and services to the general public, customers, industry and stakeholders. The University has reached

thousands of members of the public through the two shows in the last 8 years. This has helped to disseminate various technologies in the areas of food value addition, equipment and machinery, ICT solutions, general agribusiness improvements, beauty products and detergents, cost effective building materials, environment improvement and water harvesting among others. The university has excelled in these exhibitions winning an average of an average of 10 top awards in various categories in Nyeri and Nairobi ASK shows, in the last 10 years.



H.E. President Kenyatta presents a trophy to the Vice Chancellor at the Nairobi International Trade Fair

4.1.2 JKUAT/ JICA in-Country Training Programme for Optimizing the Capacity of Grassroot Women

JKUAT with support from the Japanese International Co-operation Agency (JICA), has implemented an annual training course for rural women to scale up their knowledge and skills so as to improve household food security and income, as well as building their capacity to address socio-economic, environmental and cultural challenges in Kenya.

From inception of the program in 1994 up to 2008, only about 750 women from around the country, this within the JKUAT main campus. From 2009, the Division prevailed upon the sponsor to increase funding and devolve the training to the counties with a view to enhancing outreach and providing better opportunities for women in the far-flung regions in the country. This initiative has resulted in a total of 2726 between 2009 and 2017.

The focus of the training has been to inculcate practical skills to rural women for enhanced livelihood improvement with emphasis on the following:

- (i) Imparting basic life improvement skills to women farmers in the areas of agriculture, community development, health, nutrition, entrepreneurship and environmental management;
- (ii) Changing the attitudes of women towards various socio-cultural issues such HIV/AIDS, female genital mutilation, gender issues etc.;
- (iii) Developing problem identification and solving skills of rural women farmers;
- (iv) Training on development of new products and value addition;
- (v) Raising the self-esteem and social status of women;
- (vi) Training on leadership, organizational and management skills of grassroots women leaders;
- (vii) Imparting entrepreneurship skills among women, networking and sourcing funds;
- (viii) Incubating of business enterprises



A women's training session on fruit and vegetable processing

The benefits of the program to the trainees have been immense, and ex-participants acquired knowledge and skills that have enabled them to improve their farming activities, increase food.

4.1.3 Farmer Voice Radio Project Intervention

Between 2009 and 2013, the Extension and Technology Transfer directorate with other partners in the country implemented a radio extension programme, Farmer voice radio (FVR), funded by the Bill and Melinda Gates Foundation through the American Institute for Research (AIR). The purpose of the project was to enhance the use of radio as an interactive tool for impact-driven extension services to small-holder farmers, at sustainable scale, to improve their productivity. This is because radio is still accessible, affordable, and flexible and in rural areas, it is often the only mass medium available.

The FVR programme provided Kenyan farmers with accurate, timely, focused, and frequent messages with feedback and follow up. During the implementation period, over 5000 agriculture short messages and 4000 radio programs were aired and disseminated to farmers. During the period Radio listenership increased to over 30% and adoption of technologies averaged 25% of the listeners and up to 360% improvement in productivity recorded for cereal crops

A total of 153 University Radio interns (URIs) were also attached to the programme to support farmers with information. This enhanced the flow of knowledge and skills to farmers, improved undergraduate students capacity to work in the field, and enhance the dissemination of best farming practices. The project also set up 4 demonstration greenhouses which helped in training 150 youths on greenhouse management skills.



University radio interns during a recording session, and a URI interviewing a star farmer

4.1.4 Strategic Value chain Study for the Small holder Dairy Industry in Central Kenya

With support from Kilimo Trust, JKUAT extension staff together with county livestock extension officers carried out an exhaustive value chain analysis of the smallholder dairy sector in central Kenya region between 2008 and 2011. The purpose of the study was to obtain an in-depth understanding of the smallholder dairy sector, identify and document the challenges faced by key players especially farmers and propose investment measures and modalities that can promote growth and competitiveness of the sector.



Dairy cows in a small farm in central Kenya

The study developed a systematic value chain map of the smallholder dairy sub sector in central Kenya, comprising 5 million farmers producing 2.2 billion liters of milk annually, a collection/bulking/freezing/processing segment with over 150 co-operatives, 500 self-help groups, and 32 milk processors, and a distribution/retailing segment with 5000 distributors, 45 hotels, 2000 milkbars/hawkers, 7 small retailers and 10 large retailers.

Challenges and opportunities in the dairy industry at production, bulking, freezing, processing and marketing were also documented and the study is widely quoted in the dairy subsector locally and globally. This study led to:

- i. Consolidation of JKUAT as a leader in dairy matters, which led to huge demand for information on dairy support (over 3000 actors were reached);
- ii. Recognition of two staff members in extension directorate (Mr Mbugua Nyori and Dr. Francis Njunge) as international Value links Methodology trainers for value chain development;
- iii. The report on dairy enabled one staff member (Mr. Mbugua Nyori) to be invited to participate in a Workshop on “Technology Survey of Gaps in the Dairy Value Chain” by Global Good Fund of Bill Gates Foundation in Washington DC. The aim of the workshop was to address technology limitations of small holder dairy farmers in Eastern Africa;
- iv. One Dairy self-help group from Tetu Nyeri that participated in the project moved from 3000lts to about 50,000lts in less than one year winning a prize from a Netherlands organization for being the best in smallholder organization in the dairy sector.

4.1.5 Development of a Training Manual for Fruits and Vegetables

With support of 5million Ksh. from KAPAP, JKUAT developed and tested a training manual for actors and service providers in the fruit and vegetable value chain in Kenya. The manual provides a valuable reference for those engaged in the fruits and vegetable value addition or service providers who support these actors to enhance their capacity to engage in profitable value addition agribusiness activities. During the project over 40 trainers of trainers were also empowered.



Cover page for the technical manual developed by JKUAT extension officers

4.1.6 Capacity Building on Cow Milk Value Chain in Nairobi County

In 2015/16, the extension directorate competitively won funding to build capacity of cow-milk value chain actors in the nine sub-counties of Nairobi County for equitable commercialization by mobilization and formalization of the milk value chain. The initiative achieved the following:

- (i) Actors in the value chain were mobilized to form one county and 9 sub county milk value chain platforms;
- (ii) 25 mobilisers were trained and cow milk value chain profiled leading to information and data availability;
- (iii) Two hundred cow milk value chain actors were sensitized and mobilized into marketing groups and linked to each other and 35 groups reached and strengthened. Some have already been



An actor in cow milk value chain project in Ruai, Nairobi

registered and went on to receive milk coolers, pasteurizers and dispensers from the county government;

- (iv) Sixty-seven youths and disabled actors from over 10 groups exposed to 8 flagship opportunities in the milk value chain and 57 members trained on waste management opportunities.

Due to the success of this initiative, the directorate won another competitive grant (2016/17) to facilitate commercialization of broiler value chain. The facilitation will involve product development, value addition and development of standard safety and quality guidelines in the sub-counties.



An ongoing project on broiler value chain

4.1.7 Training of People Living with Disabilities, Youth and Women on AGPO

Following a presidential directive in 2013, the government is implementing the Access to Government Procurement Opportunities (AGPO) initiative to facilitate the youth, women and persons with disability-owned enterprises to participate in government procurement activities. In line with this, the directorate trained 223 youth and women and 21 persons living with disabilities.



AGPO trainees displaying their certificates

4.1.8 Upgrading Small Scale Miners in Taita Taveta - Innovation Project

Between 2009 and 2011, the directorate in partnership with the Department of Mining, JKUAT, carried out training and backstopping activities to upscale the mining skills of small scale gemstone miners in Taita Taveta. The miners were previously exploited by middlemen and realized very little value for the gemstones. Besides being trained on how to identify and classify the gemstones they were provided with basic equipment to determine the grades and types of minerals, hence realizing maximum value. After the training, the miners acquired better understanding of the stones and got better prices for the gemstones.



A JKUAT extension officer in a gemstone mining demonstration session

4.1.9 Farm Forum

The Farm Forum, formerly known as Mkulima TV, was started in 2011 under the initiative of three institutions, namely, Kenya Agricultural Research Institute (KARI), now KARLO, Kenya Broadcasting Corporation (KBC) and Jomo Kenyatta University of Agriculture and Technology (JKUAT)

The programme brings a new concept of agricultural extension to serve the farmers of Kenya. The extension services to the farmers in the past were done by Extension staff in the Ministry of Agriculture, but currently due to financial constraints the Government has not been able to employ and sustain enough of these staff resulting into dissemination of technologies and knowledge being frustrated. Having noted the above, KARI and JKUAT realized that they needed a different tool to disseminate their research findings and technologies to the farming communities. These would be done by:

- (i) Repackaging knowledge and information into a TV documentary to be broadcasted in English and Kiswahili so as a complement other efforts of reaching farmers in the rural settings;
- (ii) Making CD/DVD copies of the TV documentaries to be used as educational materials for farmers and as part of take home materials for those attending agricultural shows / field days;
- (iii) Developing an online database of the documentaries and availing them through the internet.



A farmer being interviewed during a Farm Forum TV recording

Through KBC TV documentaries on Sundays at 4:00 pm and 9:30 pm, the initiative has aired 40 television episodes, as at December 2016.

4.1.10 Funding Analysis

Fig. 19a show the funding trends in 2005-2016. Funding sources are also shown on (Fig. 19b)

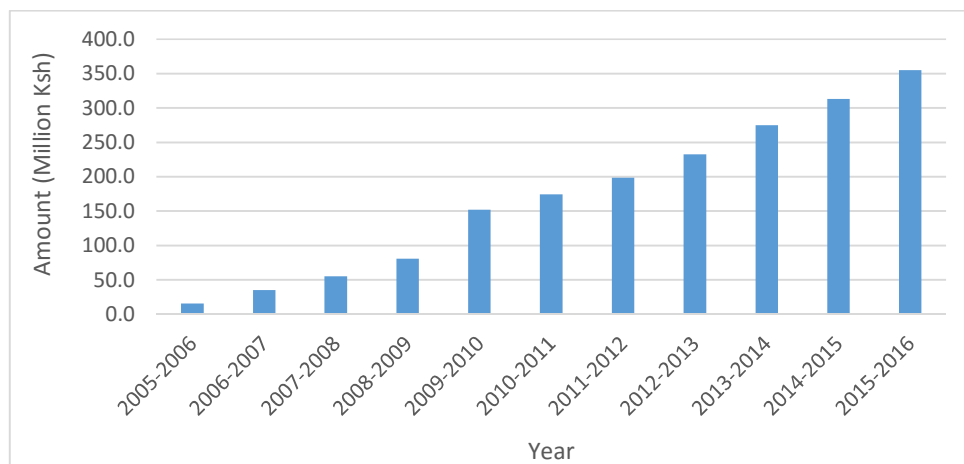


Fig. 19 a: Cumulative funding in extension and technology transfer field (2005 - 2016)

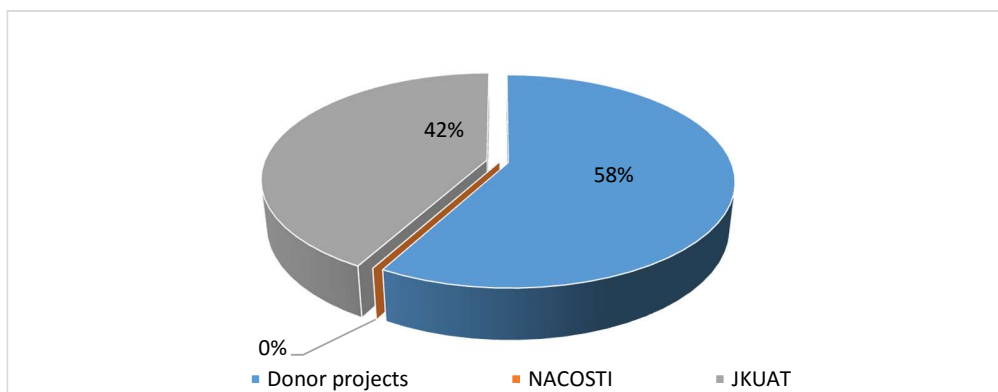


Fig 19 b: Extension and technology transfer funding distribution.

4.2 University Community Collaboration Department (UCCD)

4.2.1 Introduction

The University Community Collaboration Directorate (UCCD) was established in 2005 under the Research Production & Extension Division of JKUAT. To achieve its mandate, UCCD collaborates with the Juja Community Development Committee (JCDC) which comprises of all local leaders.

The main objective of UCCD is to carry out corporate social responsibility activities for the University within Juja area. The other goals are to:

- (i) Advance environmental stewardship and sustainability;
- (ii) Conduct training for economic empowerment and industrialization;
- (iii) Hold workshops and stakeholder forums for the residents to educate them on opportunities for sustainable development.

4.2.2 Current Activities

- (i) UCCD in collaboration with the Kiambu County Ministry of Environment is currently involved in holding sessions for Juja Environmental Management. A ten-member committee and under the chairmanship of Director, UCCD, is in the process of coming up with eight concept papers, all on means of curbing environmental degradation issues in Juja Sub-County;
- (ii) The Department has trained the Kiaora Group of People with Disabilities on Beads Arts, and is assisting the group to access sponsors for raw materials and market;
- (iii) Training on preparation of probiotic yoghurt, which is beneficial to people living with HIV-AIDS, was conducted in November 2013 in collaboration with the Department of Food Science and Technology, and COHRED. The trainees from the five wards (5) in Juja Sub-County are TOTs who formed working groups in Juja Community;
- (iv) UCCD organized training on bakery products for the Juja Hope of Life Welfare Association (JUHOLIWA), a registered self-help group that assists people from disadvantaged backgrounds. The department is hoping to support the members once they are ready to establish a cottage industry.

4.2.3 Achievements

4.2.3.1 Distribution of Nissin Food Products

A collaboration between Nissin food holdings of Japan and JKUAT was initiated in 2007 by RPE to distribute noodles to schools. The role of UCCD in this arrangement was to distribute the product to primary school children around Juja.



A school-feeding programme initiated by UCCD in 2007

4.2.4 Master Plan and Maintenance of High Standard Built Environment

In 2007, UCCD and Juja Community Development Committee (JCDC) with the help of the then Thika County Council planner, came up with the land use zoning map for Juja. UCCD in collaboration with JCDC also conducted a public rally for bodaboda operators in Juja, educating them on the importance of conducting their business in an organized manner.

4.2.5 Secure and Safe Environment Which Prevents and Fights Crime

UCCD in 2007 trained Juja community members on Community Policing and facilitated the formation of 13 policing wards. Additionally, in 2010 UCCD carried out a survey of security hot spots in Juja, relayed the information to community members during a seminar, and posted the report to relevant government

offices for them to take necessary action. The directorate linked up with the then Nairobi Metropolitan to facilitate the installation of additional security lights in Juja.

4.2.6 Industrialization and Creation of Wealth

The directorate has so far facilitated trainings as follows:

- (i) Five registered groups from Juja community were trained on bar soap making. The groups were also supported with a bar soap processing machine and start-up capital to assist in production of market samples of the bar soap.
- (ii) Twenty members of Juja Hope of Life Welfare Association (JUHOLIWA) were trained on yoghurt making. The group is in the process of establishing a cottage industry in yoghurt making.
- (iii) Kiaora Disability group were trained on the beads art. The group is now sourcing for funds for mass production of beads art items.



Pendo Womens' Group being trained in soap and detergent making, above, and Soap making material donated by UCCD to the group

4.2.7 Infrastructure Development and Environment Maintenance

UCCD continues supporting the community youths in environmental clean-up within Juja town and neighboring areas. The directorate has assisted in grading roads, in addition to digging of trenches, donation of culverts and tree seedlings.

4.2.8 Public Health and Personal Hygiene Education

In 2007, UCCD in collaboration with the JKUAT Hospital public Health Department carried out a survey on the quality of borehole water in Juja and high contamination findings were established. The directorate initiated the Juja water sewerage project, which prompted the Athi Water Services Board to roll out a sewerage project for Ruiru, Juja and Thika.

UCCD also organized for the medical examination of the group of People with Disabilities in Juja by the University Hospital doctors.

4.2.9 Human Capacity Development to give life-long skills

- (i) UCCD in 2006 facilitated the reopening of the Juja Farm Youth Polytechnic that had closed for almost ten (10) years. Some of the materials donated to assist in the establishment of departments at the Polytechnic were salvage vehicles sourced from insurance companies, sewing machines, tailoring materials, computers, library books and a greenhouse package from the University.
- (ii) UCCD has organized for attachment of Polytechnic instructors in various departments of the University.
- (iii) The directorate has also organized eye-opener tours for the Polytechnic students and also offered free transport services using the University bus during various functions of the Polytechnic.

5.0 THE JKUAT TECH EXPO

5.1 Introduction

A notable achievement during my tenure is the promotion of innovations among the JKUAT student fraternity. This is through the annual JKUAT Students' Tech Expo exhibition, which was first held in 2010. The forum provides a platform for students from various departments in the University to showcase their technological innovations on a competitive platform. It also provides an opportunity for students to interact with various researchers, industry players and policy makers, while at the same time creating opportunity for self-employment. The Tech Expo is organized by students with support from RPE Division. In addition, various industry players provide financial and logistical support.

The exhibition currently focuses on eight categories, namely, Health, Security, Education, Renewable Energy, Food Security/Agriculture, Waste Management, Transport, and Social/Communication.

5.1.0 Health

The Health category has seen students present a number of viable innovations. Among the most notable is the *iDaktari*, a medical services digitization platform that featured in the 2012 Expo. The project was later exhibited at the PIVOT East Competition in Uganda, where it impressed one of the judges, Henrick Albertsen, who facilitated the demonstration and subsequent rebranding of the innovation in Denmark for international market.



Former Permanent Secretary, Dr Bitange Ndemo, in discussion DVC-RPE during the 2016 Expo

Other projects that have made a mark in the Expo include the *Smart Health Monitor*, *Diabetes Manager*, *Automated Pill Dispenser*, *Life Buddy*, *NxtGen Doctor*, *Fine Living* and *Cancer Smart*.

5.1.1 Social Interaction/Communication

This category has seen student innovators form companies such as *Momentum Core Limited*, which develops and sells entertainment software, primarily mobile gaming solutions. One innovation, '*Simiyu the Chicken*', entertainment software, won the top prize in the 2013 Expo. The innovation was then presented at the 2014 Mobile World Congress in Barcelona. Another innovation that stood out is the *Core Center* that entails remote management of customer / client services via a call center. The project has since been adopted at the JKUAT industrial center to manage the government laptop dissemination project.



CEO Chandaria Foundation, Mr. Darshan Chandaria and other guests admiring a student's voter registration innovation

In the 2016 Tech Expo, a leading presentation was the *JKUSA Online*, a platform meant to harmonize online communication of students through a central medium. Other innovations included the *Television Signal Transmission through Power Lines*, *Internet of Things*, and *Cloud 9*.

5.1.2 Waste Management

The winning project in this category during the 2014 Tech Expo was *'Plastobricks'*. The project was premised on a simple concept of developing composite construction materials from plastic waste and sand. The innovators of the project have since established a company, *EcoJenga Limited*, which is currently operational.

Other projects in the category include the use of Hyacinth to make ceiling boards (*Hyaboard*), *Energy Care System*, and *Plastic Infused soil*, *Green Paver*, *Mining Oil from Plastic Waste*, *Taka Smart*, *Smart Waste Collection system*, and *Garbage Bin overflow detection system*, among others.



An innovation on development of herbal drinks from waste tea fluffs during the 2014 Tech Expo

5.1.3 Food Security/Agriculture

Due to growing student interest and participation, the 2015 Tech Expo witnessed very fierce competition, with several cutting edge innovations on show. The overall winning project, *'Miraa Beverages'*, which uses the Miraa plant to make beverage, both soft and alcoholic, has attracted global attention. Another innovation in same category, the *Tamarilo project*, which uses the tree tomato fruit, has been commercialized by the innovator who markets flavours to Fresha Dairy Ltd. The innovator uses the tree tomato plant to produce different edible products such as juices, wines, food flavors, etc. The company, based at the Nairobi–Mombasa highway, has more than 9 residential employees and an export market in Ethiopia.



Eco-wilt project on display during a Tech Expo

Other notable innovations in the category include the *Nelion Farm*, *Shamba Smart*, *Sisal Decorticator*, and *Adaptive Agriculture for Climate change*.

5.1.4 Renewable Energy

Innovations that have featured dominantly in the Renewable Energy category include the *Digital Power Distribution*, *Power-Tele SED*, *Bio-thermal electric production*, *Wind Facades*, *Smart Power Systems*, *Hybrid Power*, the *Piezoelectric Board*, *Robocut*, and the *Automated Water Desalination*.



Bio-thermal electric power production project on display

Due to growing interest, more innovations are set to be presented in this category in future.

5.1.5 Security

In view of security concerns in the country and the region, students have come up with several projects to address the challenge. A project tagged *'Tulinde Taifa Letu'* was among the winning exhibits in the 2014 Tech Expo. Through this technology, every citizen is to have a multipurpose smart card to ensure accountability and safety within buildings.

Other notable innovations include the *Nyumba Kumi*, *Biometric Car Security*, *Landmine Detector*, *Transformer Monitoring and Geolocation*, *Smartika Home*, *Lapsec* and *Digital Store Keeper* among others.

5.1.6 Education

The Education category has attracted several innovations from students, and understandably so due to the fact that they are poised to comprehend the intricate challenges that face the sector, as well as possible remedies. Some of the projects that have featured in this category include a project tagged '*Tichaa*'. This is an app that creatively employs learning segments such as language, colors, shapes, alphabets and numbers to give children a friendly platform for learning.



A display for an intelligent robot for detecting explosives

Other innovations in the category include the *Online Tutoring system*, *Amigos*, *Ultipedia*, *TeachSpace*, *GIS Management Portal*, *eBursary System* and *KSLMoby*.

5.1.7 Transport

Transport and Infrastructure is another category that continues seeing new innovations every year. A notable display is the "*JKUAT Race Car*", witnessed in the 2016 Expo. Other brilliant innovations in the same year include "*the Smart-Park*", a parking system that seeks to remedy the parking nightmare witnessed in major urban centres in Kenya, the *Smart Speed Governor*, *Matatu Yetu*, *Sectionalized Street Lighting*, and *Wireless Power Transmission*.

5.1.8 The Future of the Tech Expo

Many other unique projects continue showing up at the JKUAT Tech Expo, with a display of creativity, critical thinking, passion and deep insight. There is therefore potential for a much brighter future for the Expo in the coming years. This however will only remain a reality if the University continues providing the much required material and financial support to the showpiece.

The JKUAT Tech Expo should aim at continuously encouraging students to view themselves as creative thinkers and innovators with ability to address pressing societal problems, especially through creation of new businesses and employment.

The ultimate goal is to ensure that students acquire the necessary knowledge and skills that will help them develop relevant and high value innovations that will end up being commercial products not only locally, but also globally.

It is encouraging to note that within the seven years that the Tech Expo exhibitions have been held, over five new companies (*iDaktari*, *mobile gaming solutions*, *Core Center*, *Plastobricks*, and *Tamarilo products*) have been created from the showcased innovations. This shows that the students' innovations will be a major source for creation of new businesses and the much-needed employment in the near future.

5.1.9 Funding Analysis

Fig. 20a show the funding trends in 2011-2017. Funding sources are also shown on (Fig. 20b)

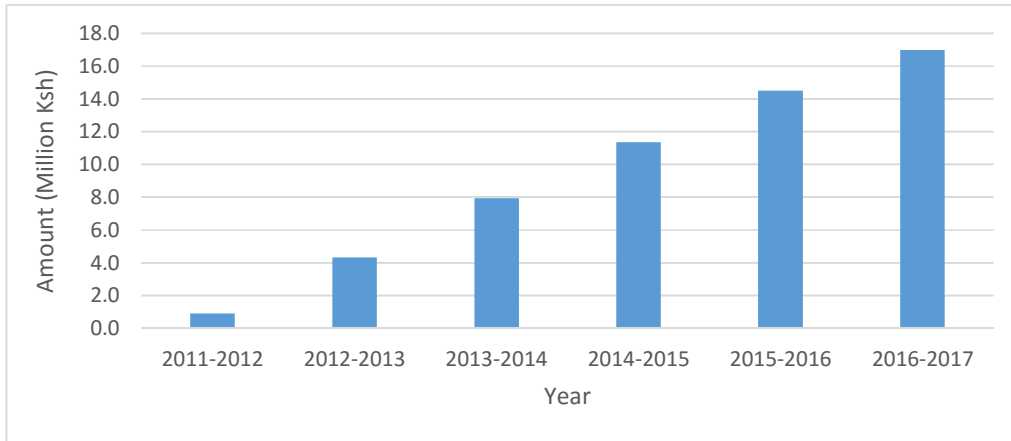


Fig.20a: Cumulative funding for JKUAT Tech Expo (2011 - 2016)

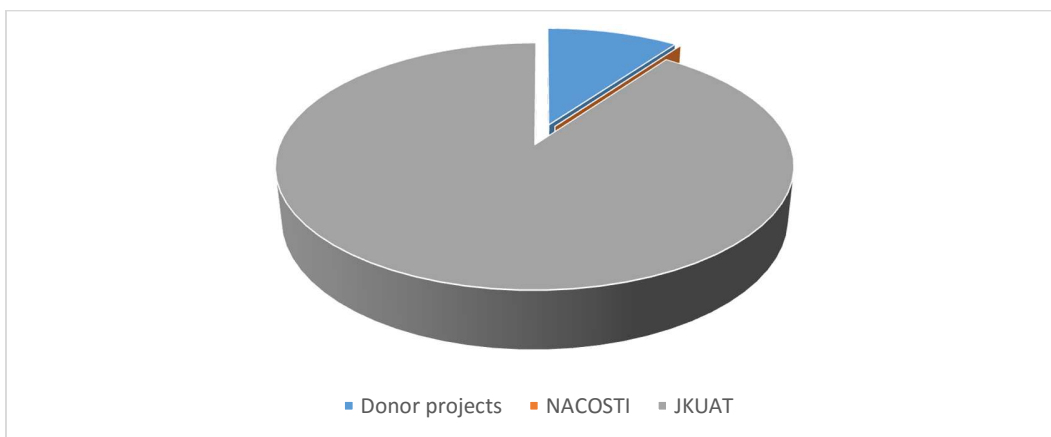


Fig. 20 b: JKUAT Tech Expo funding distribution

6.0 JKUAT PARTNERSHIPS

JKUAT currently has a partnership portfolio of 215 institutions. In managing these partnerships, the Linkages Directorate is involved in:

- (i) Coordinating the establishment of linkages and collaboration initiated by academic departments and other partners;
- (ii) Identifying Joint Management Committees that oversee the implementation of the collaborations;
- (iii) Enabling a clear understanding of partnership agreements including sharing of benefits.

Fig. 21 below shows collaborations over the years. The collaborations are in four (4) categories namely; Universities, Research and Development Institutions, National Institutions and Government line Ministries, Industries and Private sectors.

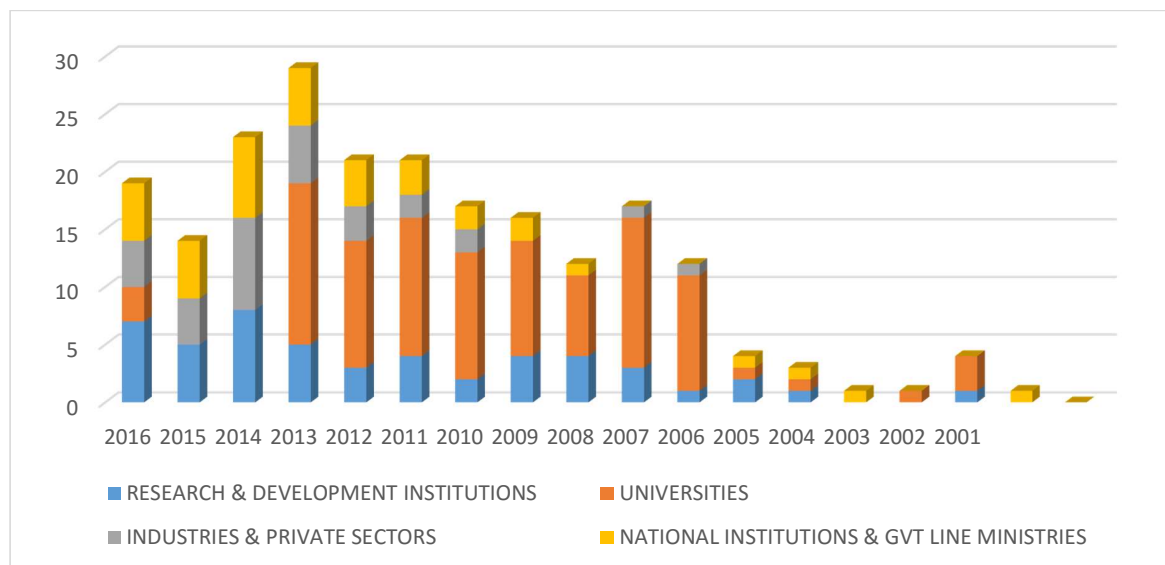


Fig. 21: JKUAT collaborations (2001 – 2016)

6.1 Collaboration with Universities

At the moment, there are 97 collaborations with universities, involving the following joint activities:

- (i) Student exchange;
- (ii) Consultancy programmes;
- (iii) Publications;
- (iv) Staff exchange & training;
- (v) Sharing of laboratory and research facilities.

Some universities involved in this collaborations are: Flensburg University of Applied Sciences in Germany; Pennsylvania State University in the USA; Bournemouth University in the UK; Swedish University of Agricultural Sciences in Sweden; Okayama University Japan; Yeungnam University in Korea; Curtin University of Technology in Australia; Warsaw University in Poland; University of Pretoria in South Africa; University of Mines and Technology in Ghana and Masinde Muliro University of Science & Technology.

6.2 Collaboration with Research and Development Institutions/ Donor Bodies

In this category, there are a total of 50 collaborations. The ongoing activities for the active ones include;

- (i) Internship and attachment programmes for students;
- (ii) Exchange and dissemination of information;
- (iii) Technology transfer;
- (iv) Research;
- (v) Innovation;
- (vi) Technology development;
- (vii) Sharing of physical facilities.

Some collaborations in this category are; Centre for Science and Environment (CSE); Water and Sanitation for the Urban Poor (WSUP) and African Agribusiness Incubators Network (AAIN).

6.3 Collaboration with National Institutions and Government Line Ministry

In this category, there are 38 collaborations involved in the following activities:

- (i) Capacity building in various disciplines;
- (ii) Joint research projects;
- (iii) Creation and sharing of knowledge;
- (iv) Innovation;
- (v) Technology adaptation and transfer.

Some national institutions involved in this collaborations are: National commission for Higher Education, Eritrea; Kenya Agricultural and Livestock Research Organisation (KALRO); Murang'a county government hospital and Kenya Ports Authority (KPA). The government line ministries include: Ministry of Education; Ministry of Industrialisation and Ministry of health.

6.4 Collaboration with Industries and the Private Sector

There are 30 collaborations with the following ongoing activities; joint consultancy programmes, student attachment and sharing of physical facilities.

Examples include: Safaricom Limited, that donated a telecommunication lab to the University; Cybercomb Africa Limited, working with JKUAT to commercialize students' ICT innovations; First Avenue International (FAI) and Postal Corporation of Kenya (PCK), that are working with the University to develop a technology to convert their manual letter delivery boxes into digital.

6.0 CONCLUSION AND RECOMMENDATIONS

The introduction by the University of a research fund managed by the Research, Production and Extension (RPE) Division in the year 2006 has generated an increase in research activities within the institution, with many staff members and even students showing great enthusiasm to participate in studies of various concepts. Motivation for research has also been triggered by the following measures undertaken by the Division:

- (i) Equipping young and upcoming scientists in the institution with skills for proposal writing through seminars and workshops, where the said skills are deliberated on in detail. Another approach widely employed is critiquing draft research proposals and offering technical advice before the documents are submitted to such donors as NACOSTI;
- (ii) Maintaining a keen and consistent follow up on ongoing researches, and being readily available to the researchers for personalized consultations as necessary. The Division, led by the DVC, RPE, strives to make individual contact with all the researchers, providing guidance where there may be challenges, and acknowledgement where positive strides have been made;
- (iii) Timely endorsement of funding requests done by researchers through the Division, and provision of other necessary support;
- (iv) Emphasis on each research team outlining the key performance indicators through a prescribed form. This has enabled the capturing of research outputs under each thematic area.

As evidenced by the greater part of this report, a lot of progress has been realized over the years in various research thematic areas, and many study concepts can still be explored for greater insights. There is still, however, need to focus on attainment of research-based competence, which is critical in development of innovations and new technologies, which will in the long run impact positively on social economic aspect of the nation while upholding the position of the University. As we all may appreciate, innovation is not a one-off flash of inspiration, but a long process of experimentation and resilient learning – hence the need for detailed nurturing and monitoring.

The University needs to inculcate a research and innovation environment in which the institution continually interact with stakeholders at various levels, so that products generated can be turned to new businesses that will impact on livelihoods across the country. Such scenarios exist worldwide, with the Stanford University in the USA, for instance, generating US \$ 2.1 Trillion towards the national economy, and creating 3 million jobs annually from new businesses through innovations and inventions.

Research management, although a relatively new field, has become critically important to institutions of higher learning across the globe, given the budgets allocated to research and the growing emphasis on innovation and commercialization. In this regard, it is imperative that JKUAT, like other universities worldwide, pays increased attention to the training of RPE staff to enable them steer the research and innovation process to commercialization. In the same regard, avenues need to be sought to upscale research in the social sciences disciplines, as this has been largely insignificant over the years while the Agriculture and Technology disciplines continue making great strides.

In view of all the above observations, I hereby table the following recommendations to pave the way for a robust research, innovations and subsequent commercialization culture within Jomo Kenyatta University of Agriculture and Technology:

- (i) As a precondition for appointment, all directors under the RPE Division, being the top research managers, should be fundraisers with proven track record. They should be able to solicit funds to part-run their directorates/institutes/centers, so as to raise the University research portfolio to the highest level. It must be appreciated that the University alone cannot achieve this through its internal resources. In addition, appointment for directorship should be based on a two-year renewable contract, based on performance;
- (ii) The RPE research and innovation managers should be keen on helping the researchers to identify research products and guide them towards the next line of action. One way of achieving this is by maintaining a very efficient M&E schedule for all ongoing research. Majority of research results take several years to translate into innovations and commercial products, and close monitoring is therefore important.

For externally funded projects, the researcher should be compelled to fill the RPE Key Performance Indicators form, before any funds are accessed, to enable the tracking of the research outputs. In addition, the researchers should continually provide RPE with copies of progress and final reports submitted to donors.

- (iii) While RPE maintains a critical position in the University through management and disbursement of research funds, the Division is currently not directly held accountable by the University Council as is the case with HR, Finance and Academic Affairs. There needs to be a committee of the University Council in that specifically oversees RPE matters and monitors all the expected outputs and performance.
- (iv) At all costs, researchers should be smoothly enabled to conduct their studies without undue delays from the facilitators (mainly RPE and Finance Department). Interruptions in the release of research funds may discourage researchers from soliciting external funding while also compromising timely delivery of quality outputs. Even more serious, such delays may place the University at the risk of being blacklisted by donors, implying that it will be difficult for JKUAT researchers to raise funds internationally. In this regard the institution of an autonomous research account and the creation of a Grants Office, as stipulated in the UMB and Senate-approved Revised Research Policy, is a matter of urgency.
- (v) The Directorate of Production should begin piloting and incubating products that have been generated from research over the last ten years. This will require fundraising and identification of strategic partners, and putting up incubation facilities.
- (vi) JKUAT grants for graduate student research should be placed under the management of RPE. This will give the Division the opportunity to demand for key research outputs that the students will generate. Of importance here is that a research product currently in the process of commercialization by JKUATES (Baby food for malnourished children), was developed by a PhD student.

- (vii) There is need to actualize a University award scheme approved by UMB and Senate for researchers who have excelled in various fields of study/thematic areas, in 2013. The approved categories were :
- Most notable contribution to the field/area of study;
 - Most leveraged funds;
 - Most visible impact on community livelihood and wealth creation;
 - Most tangible influence on public policy change;
 - Most demonstrable potential for commercialization.
- (viii) Institutes and centers of research should be reviewed for productivity and viability every five years. Such reviews will be vital for ensuring that there is continued need for their existence, and that the Directors are continually raising funds for quality research and facilities.
- (ix) The University Council should concentrate on technology transfer of marketable products from research and innovation. Much focus should be placed on putting up infrastructure facilities for incubating SMEs and industry.
- (x) Despite the critical services they provide, a number of directorates in the division have very few staff and in some instances none. The linkages directorate has no staff member since the acting director was transferred to the Academic Division. Both the Extension and Production directorates have an average of 2 technical officers, this making effective delivery of services extremely difficult. It is therefore necessary for the University management to consider hiring or transferring staff members with the relevant qualification to the affected directorates.

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6.0 APPENDICES

1. Agriculture and Food Security

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Dr. Daniel Sila	Strengthening the Kenya National Food Fortification Programme to improve the health and nutritional status of poor and vulnerable groups.	2016	European Commission (DEVCO)	352,000,000
2	Prof. Willis Owino	Enhancing Local Food Security and Nutrition through Promoting the use of Baobab (<i>Adansonia digitata L.</i>) in Rural Communities in Eastern Africa.	2016	German Federal Ministry of Food agriculture	33,000,000
3	Prof. Mabel Imbuga	Evaluation of suitability of human solid waste from green toilet system as fertilizers for agricultural use.	2016	JKUAT	4,500,000
4	Prof. Mary Gikungu	An innovative approach on the use of managed bees as biocontrol agents vectors for increased coffee production	2016	JKUAT	4,500,000
5	Dr. Shadrack Muya	Conservation and utilization of Oryx as an emerging livestock in arid and semi-arid areas in Kenya	2016	JKUAT	4,299,420
6	Dr. Daniel Sila	Legume Centre of Excellence in Food and Nutrition Security (LCEFoNS)	2015	VLIR-UOS Flemish institution	462,000,000
7	Dr. John Kinyuru	Using the edible insect <i>Ruspolia differens</i> to enhance food security in East Africa	2015	Flemish institution / KU Leuven	40,000,000
8	Prof. Willis Owino	Development and Evaluation of Sweet Sorghum (<i>Sorghum Bicolor L. Moench.</i>) Grain as an Alternative Energy Source In Chicken Feed Formulae	2015	RUFORUM	6,000,000
9	Prof. Anselimo Makhoha	E-Learning net-work on food and nutritional security project	2015	EDULINK	2,000,000
10	Dr. Fridah Wanzala	Enhancing local food security and nutrition through promoting the use of Baobab (<i>Adansonia digitata L.</i>) in rural communities in Eastern Africa	2014	German Federal Ministry of Food agriculture	11,236,800
11	Dr. Judith Okoth	Up-scaling the production of nutrient dense Amaranth-Sorghum grain products to improve the nutritional status of under 5 year olds in Kenya	2014	JKUAT*	4,500,000
12	Dr. Willis Owino	Sweet sorghum production and processing in Kenya	2014	JKUAT*	4,500,000
13	Dr. John Kinyuru	Up-scaling of cricket farming and utilization as a source of protein in animal feed	2014	JKUAT*	4,430,080
*JKUAT funded Innovation projects.					

14	Dr. Patrick Ajwang	The effect of infra-red blocking films on the growth , yield & quality of paprika (<i>Capsicum annum L.</i>)	2014	JKUAT	3,931,200
15	Prof. Willis Owino	Postharvest research project on indigenous vegetables	2014	USAID through AVRDC	3,060,000
16	Prof. John Wesonga	Testing Liquidseal for roses post-harvest	2014	LiquidSeal	1,240,153
17	Abel Muthangu Kagunda	Determine the distribution and diversity of cassava brown streak virus and cassava genotypic reaction to the disease in Kenya	2014	NACOSTI	1,000,000
18	Prof. John Wesonga	Demonstrate projects climate management in East African greenhouses	2014	DVL plant	974,493
19	Prof. Willis Owino	Fruiting Africa "Baobab - Yoghurt project"	2014	IFAD	956,100
20	Simon Ngángá Njuguna	Evaluation of the effects of dry methods on quality of macadamia nuts using colour image analysis, (Post graduate student)	2014	NACOSTI	169,480
21	Dr. John Kinyuru	Insects for green economy (Multi-institutional)	2013	DANIDA	100,000,000
22	Prof. John Wesonga	SP6: Variety Development and Seed Systems	2013	BMBF and BMZ	22,752,523
23	Prof. Christopher Kanali	Transfer of indian farm and food processing machinery to promote food security in Africa (Kenya)	2013	SRISTI	19,227,317
24	Prof. Willis Owino	Harnessing Genomics of Edible African Solanaceae Plants for Improved Nutrition and food security	2013	USAID via NAS	18,555,075
25	Prof. Christopher Kanali	Renewable energy and food processing to improve rural livelihoods	2013	EPSRC	12,716,900
26	Prof. John Wesonga	SP1: Increasing Water Use Efficiency in African Leafy Vegetable Production Systems	2013	BMBF and BMZ	12,120,000
27	Prof. John Wesonga	SP2: Development of integrated pest management strategies for the production of important vegetables crops in Kenya	2013	BMBF and BMZ	6,328,800
28	Prof. John Wesonga	SP4: Quality assurance and preservation of African vegetables during postharvest for reducing food losses and improve nutritional value, storability and food safety	2013	BMBF and BMZ	5,559,960
29	Prof. Losenge Turrop	“SP13: Transferring research results into policies and practice” within the framework of “Diversifying Food Systems: Horticultural Innovations and Learning for Improved Nutrition and Livelihood in East Africa” (HORTINLEA)	2013	BMBF and BMZ	5,430,960
30	Dr. Daniel Sila	Domestication and value addition of edible wild nopal cactus towards increased food security and incomes in ASALs	2013	JKUAT*	4,518,800
*JKUAT funded Innovation projects.					

31	Prof. Stephen Githiri	Mutation breeding of maize for glyphosphate herbicide tolerance and other useful agronomic traits	2013	JKUAT*	2,990,000
32	Prof. John Wesonga	SP5: Impact of fresh and processed African leafy vegetable and food safety	2013	BMBF and BMZ	2,335,800
33	Dr. John Wesonga	Strengthening agriculture training capacity of higher education institutions in East Africa (Collaboration with KU)	2012	EDULINK & EU	50,000,000
34	Dr. Joseph Wakibia	Nutritional evaluation of selected Kenyan seaweeds as potential feed ingredients for farmed Nile tilapia (<i>Oreochromis niloticus L.</i>) in semi-intensive pond systems.	2012	JKUAT	4,499,000
35	Dr. Urbanus Mutwiwa	Protected cultivation: using light filtration to control pests and diseases for sustainable greenhouse vegetable production in Kenya	2012	JKUAT	4,493,300
36	Prof. Glaston Kenji	The identification and selection of edible bamboo species that will grow well in different parts of Kenya and South Africa	2012	NACOSTI	3,000,000
37	Prof. Wesonga / Prof. Imbuga	Promotion of greenhouse farming for food security	2012	NACOSTI	2,200,000
38	Dr. Fred Mwirigi	Developing sustainable solutions to the challenge of value addition in the seafood supply chain along the Kenyan coast	2012	JKUAT	1,580,250
39	Lilian Anyango Ochieng	Genetic analysis of resistance of sweet potato (<i>Ipomea batatas</i>) to the sweet potato weevil (<i>Cylas ssp</i>) in Kenya (Post graduate student)	2012	NACOSTI	1,196,100
40	Josphat Runkua	Genetic Diversity, Pomological Characterization and Postharvest Physiology of <i>Vitex payos</i> (Lour) Merr Fruit Growing in Kenya (Post graduate student)	2012	NACOSTI	1,171,900
41	Johnson Omukhulu Neondo	Management of <i>Striga hermonthica</i> through bio prospection of bio control microbes in maize fields from western region (Post graduate student)	2012	NACOSTI	1,170,000
42	Mwajita Rashid	Use of bio-fertilizers for sustainable rice production in Kenya (Post graduate student)	2012	NACOSTI	1,100,000
43	Dr. Lucy Kananu	Investigation of allelochemicals in high-value leafy vegetables that confer their susceptibility to root-knot nematodes (Post graduate student)	2012	NACOSTI	847,675
44	Dr. Lucy Kananu	Pesticidal effects of aerial plant extracts of African nightshades on the tomato spider mite (Acari: Tetranychidae)	2012	IFS	510,000
45	Simon Amukoche	Development of maize cow pea precooked product (Post graduate student)	2012	NACOSTI	500,000
46	Peter Karuri	Assessment of the levels of ochratoxin in coffee beans from the coffee growing region of Kiambu County, Kenya (Post graduate student)	2012	NACOSTI	193,000
*JKUAT funded Innovation projects.					

47	Meshack Kipruto Korir	Design, development and testing of an improved charcoal cooler for storage of mangoes (Post graduate student)	2012	NACOSTI	190,806
48	Thaddeus M. Mangenya	Assessment of catechins and polyphenols as parameters of tea quality in Kisii, Muranga and Meru ecological zones (Post graduate student)	2012	NACOSTI	170,000
49	Lynda Samato Mesopfir	Assessment of levels of macro and micro nutrients in the soil and wheat in Narok North District (Post graduate student)	2012	NACOSTI	126,500
50	Dr. Daniel Sila	Amaranth / Beans project	2011	ILRI / AUSAID	51,590,750
51	Prof. Esther Kahangi	Bio enhanced seeds and seedlings for Africa	2011	Bio-Innovate Africa	51,000,000
52	Dr. Hunja Murage	Rice breeding	2011	NACOSTI	27,000,000
53	Prof. Willis Owino	Mango and passion fruit project	2011	KAPAP - Mango	8,000,000
54	Dr. John Wesonga	Learning and Innovation in Horticultural Value Chains to Improve the Livelihood Situation of Rural and Urban Poor in Kenya, Ethiopia and Tanzania (HORTINLEA)	2011	Hortinlea	9,000,000
55	Prof. Elijah Ateka	Strengthening capacity for maintenance and movement of clean sweet potato germplasm in Eastern Africa	2011	BECANET	6,845,475
56	Dr. Fridah Wanzala	Production of disease free papaya (<i>Carica papaya L.</i>) planting materials of known sex for commercial fruit production	2011	RUFORUM	5,100,000
57	Prof. Elijah Ateka	Enhancing capacity of national cassava research programs to diagnose, characterize, monitor and sustainability manage viruses affecting cassava production	2011	BMGF	4,558,524
58	Prof. Arnold Onyango	Modification of the fatty acid profiles of farmed tilapia and catfish for improved health and livelihood in Kenya	2011	JKUAT	4,000,000
59	Dr. Daniel Sila	Improvement in mango production and value addition: Towards increased marketing, food sustainability and security	2011	JKUAT	4,000,000
60	Dr. Hunja Murage	Interdisciplinary study on the blast outbreak in the Mwea irrigation scheme in Kenya	2011	NACOSTI	2,000,000
61	Dr. Hunja Murage	Use of Bioagents to control aflatoxins in maize	2011	NACOSTI	1,500,000
62	Dr. Martha Makobe	Heavy metal contamination of African Indigenous vegetables in urban and peri-urban Nairobi and their potential as phytoextractors	2011	NACOSTI	1,500,000
*JKUAT funded Innovation projects.					

63	Dr. Dancun Mbuge	Postharvest Control of aflatoxin contamination in stored maize using super absorbent polymers (SAPS) in improved and affordable designs of storage structures (Post graduate student)	2011	NACOSTI	993,000
64	Albert Gamoe Locham	The influence of fishing pressure on life history traits of coral reef fishes in coastal Kenya (Post graduate student)	2011	NACOSTI	900,000
65	Prof. Elijah Ateka	Improving food production, health and adaptation to climate change in Makueni and Siaya districts Kenya (Post graduate student)	2011	IDRC	678,143
66	Dr. John Wesonga	Development of Novel Products from <i>Hibiscus sabdariffa L.</i> (Roselle) & Evaluation	2011	JKUAT*	500,000
67	Prof. Bancy Mati	Identifying solutions to key challenges facing adoption of the system of rice intensification(SRI) in Kenya	2011	AICAD	340,000
68	Prof. Mary Abukusu	Improving the quality of African indigenous vegetable seed systems for enhanced food security and climate change resilience	2010	NACOSTI	12,000,000
69	Prof. Elijah Ateka	Rice blast (<i>Magnaporthe grisea</i>) Herbert infectivity dynamics in the Kenyan rice germplasm	2010	JKUAT	4,500,000
70	Prof. Bancy Mati	Determining the scientific basis for up-scaling the system of rice implementation (SRI) for increased rice production in Kenya	2010	JKUAT*	4,500,000
71	Edward Mamati	Delivery of cowpea seed for adapted lines with high productivity	2010	JKUAT*	3,600,000
72	Dr. Johnson Kinyua	Soil fertility assessment in tea growing areas of Kenya: Working towards tea fertilizers	2010	JKUAT	3,590,000
73	Dr. Arnold Watako	Studies on growth and flower quality of Mobydick (<i>Gomphocarpus fruticosae</i>)	2010	JKUAT	1,625,550
74	Peter Masinde	Participatory evaluation and selection of high yielding spider-plant lines for increased per-urban vegetable production (Post graduate student)	2010	NACOSTI	1,300,000
75	John Mwangi	Diversity of rice and blast pathogen population, interactions of rice and blast pathogen and strategies for resistance management in Kenya (Post graduate student)	2010	NACOSTI	1,200,000
76	Milka Nyaberi	Development of a preservative from <i>Tamrindus indicas</i> and <i>Ziziphus abyssinica A.</i> Rich herb and determination of the phytochemical and nutritive constituents for preservation and value addition of fish (Post graduate student)	2010	NACOSTI	1,200,000
77	Titus Kathurima	Molecular resolution of genetic variability of CBSV and development of diagnostic kit for cassava and sweet potato viruses (Post graduate student)	2010	NACOSTI	1,200,000
*JKUAT funded Innovation projects.					

78	Dr. Everlyn Okoth	Molecular resolution of genetic variability of CBSV and development of diagnostic kit for cassava and sweet potato viruses (Post graduate student)	2010	NACOSTI	1,200,000
79	Adija Baraza	Determination of the effect of location and production system on the post-harvest physical-chemical properties and shelf life of purple passion fruit (Post graduate student)	2010	NACOSTI	200,000
80	Saggafu Salim Masito	Molecular resolution of genetic variability of CBSV and development of diagnostic kit for cassava and sweet potato viruses (Post graduate student)	2010	NACOSTI	200,000
81	Prof. Mary Abukusu	Assessment of Water use Efficiency of Slender leaf (<i>Crotalaria ochroleuca</i>) for food, nutrition and health security in Kenya	2009	JKUAT	4,500,000
82	Dr. Muturi Mwangi	Environmentally cleaner utilization of cashew nut shell liquid as an industrial raw material	2009	JKUAT*	3,182,307
83	Dr. Charles Kimani	Increasing profitability of horticultural production through water saving irrigation, improved crop husbandry and value addition technologies	2009	NACOSTI	1,747,950
84	Prof. Esther Magiri	Improving basmati rice quality and production through physico-chemical and molecular characterization	2009	JKUAT	1,198,875
85	Dr. Martha Makobe	Field evaluation of seeds of somaclonal variants in search of salinity tolerant sorghum (<i>Sorghum biolar</i> (L) Moench) for growth in arid and semi-arid regions (ASAL) (Post graduate student)	2009	JKUAT	800,000
86	Dr. Johnson Kinyua	Soil fertility assessment in tea growing area of Ngere tea factory, Thika District (Post graduate student)	2009	JKUAT	200,000
87	Dr. Hunja Murage	Selection of rice lines after hybridization	2008	JKUAT*	4,500,000
88	Prof. Willis Owino	Technology adoption for industrial exploitation of sweet sorghum	2008	JKUAT*	4,468,000
89	Dr. Fridah Wanzala	Commercial and industrial development of papaya (<i>Carica papaya L.</i>): varietal improvement, production and processing technologies for wealth creation in rural areas	2008	JKUAT	3,800,000
90	Prof. Mabel Imbuga	Characterization of three plasmodium falciparum proteins, P. falciparum glycogen synthetase – 3 (PfGSK – 3), P. falciparum casein kinase 1 (PfCK- 1) and P. falciparum 14-3-3 (Pf 14-3-3) and the response of Pf GSK -3, PfCK1, PfMRK and PfPK6 to various flavanoids	2008	JKUAT	3,027,980
91	Prof. John Wesonga	Evaluation of capillary wicks for use in irrigation for intensive horticultural crop production in Kenya.	2008	JKUAT	1,788,888

*JKUAT funded Innovation projects.

92	Dr. Njue Mugai	Calibration of lime requirement tests for acid soils of Kenya through maize yield and development of a quick liming test kit-intermediate and appropriate technological innovations for enhanced food security.	2007	JKUAT	2,919,120
93	Prof. Christine Onyango	Community-based improved utilization of pearl millet and sorghum varieties grown in arid and semi-arid parts of Eastern province of Kenya	2007	AICAD	850,000
94	Prof. Esther Kahangi	Enhanced tissue culture plants for East Africa	2006	Bio-Earn	11,893,200
95	Eng. Njuguna Ndirangu	Design , performance testing and commercialization of greenhouse solar dryer with forced convection air system	2006	NACOSTI	6,000,000
96	Prof. Francis Mathooko	Evaluation of 1-methyl cyclo-propene as a tool for extending the post-harvest storage life and quality of mangoes and tissue culture bananas	2006	JKUAT	4,500,000
97	Prof. Linus Gitonga	Effect of nitrogen fertilizer on thrips population dynamics and their management using Entomopathogenic Nematodes and Anthocirc predators on French beans in Kenya.	2006	JKUAT	1,254,600
98	Prof. Glaston Kenji	Value adding on termites and mayflies for production of livestock feed for formulate and entomophily in Lake Victoria basin	2006	Vicres	1,039,805
99	Dr. Martha Makobe	Field evaluation of seeds of somaclonal variants in search of salinity tolerant sorghum (<i>Sorghum biolar</i> (L) Moench) for growth in arid and semi-arid regions (ASAL)	2006	JKUAT	835,800
100	Dr. Arnold Watako	Optimization of cultural practices of field grown small holder summer flowers in Kenya: studies of mobydick	2006	JKUAT	800,585
101	Prof. Joseph Keriko	Determination of the lipid contents, fatty acids composition, the levels of EPA and DHA in some common fish species found in Kenyan waters.	2005	JKUAT	4,020,115
102	Prof. James Makanga	Development of solar charcoal cooler for storage of farm produce in marginal areas of Kenya	2005	JKUAT	1,014,468
103	Mr. Titus Kadere	Study and improvement of alcoholic beverage (Mnazi).	2005	JKUAT	631,000
		Total			1,504,576,527
*JKUAT funded Innovation projects.					

2. Nanotechnology

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Dr. Waweru Mugo	Development of graphene based high efficiency solar cells as a green energy source	2015	JKUAT*	1,500,000
2	Dr. Wanyika Njuma	Mesoporous silica nanoparticles aided biological control agents in the control of bacterial wilt in tomato (<i>Lycopersicon esculentum</i>). A case study of greenhouse farming in Kenya	2013	JKUAT*	4,495,700
3	Dr. Leonard Gitu	Analysis and Assessment of potential pesticides residues in tomatoes and tomato products in Kenya	2012	JKUAT	3,588,200
4	Prof. Gatebe Erastus	Development of nano structured smart delivery systems for fertilizer and pesticides	2010	JKUAT	4,500,000
5	Prof. Gatebe Erastus	Epidemiology of <i>Sclerotinia sclerotiorum</i> , A fungal plant pathogen	2009	NACOSTI	1,310,000
					15,393,900

3. Natural products

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Prof. Patrick Kareru	Development of cellulose –based water filters, encapsulated fertilizers and super absorbent polymers from lingo-cellulosic wastes	2015	JKUAT*	2,100,000
2	Prof. Patrick Home	Studies on the availability, propagation, biochemistry of plant based anal cleansing materials for manufacture of affordable toilet paper for rural & poor urban Kenya	2014	JKUAT	4,500,000
3	Wanjiru Wanyoike	Prospecting for bio - active potential of endophytes associated with medicinal forest trees in Kenya, and their efficacy against pathogenic fungal pathogens	2014	JKUAT	2,907,000
4	Wanjiru Wanyoike	Bioactive potential of extracts from mangroove endophytes and their efficacy against common fish pathogens in Kenya	2014	NACOSTI	1,800,000
5	Everlyne Kareji Amadi	Characterization and evaluation of selected herbal drugs used to treat fungal and bacterial infections in Mbeere, Eastern Province ,Kenya (Post graduate student)	2014	NACOSTI	750,000
6	Fredrick Kiangu	The effects of <i>Aloe secundiflora</i> on <i>Eimeria tenella</i> in broiler and indigenous chicken in kenya (Post graduate student)	2014	NACOSTI	700,000
7	Erastus Mwangi	Bacteria diversity associated with marine macro algae from Kenyan coast and their bioactive metabolites (Post graduate student)	2014	NACOSTI	180,000
*JKUAT funded Innovation projects.					

8	Prof. Hellen Kutima	Developing phytomedicines and pharmaceuticals products against Malaria using selected medicinal plants from Kenya and Nigeria	2012	Grand Challenges Canada	9,605,000
9	Dr. Francis Njonge	Evaluating nutritional value of <i>Moringa oleifera</i> in the management of asymptomatic HIV/AIDS patients.	2012	JKUAT	4,500,000
10	Prof. Grace Njoroge	Production of supplements from wild food plants for alleviating malnutrition in children under 5 years in Ithanga Division, Kenya	2012	NACOSTI	3,000,000
11	Patrick Korir	Extraction, characterization and value addition of <i>Malva verticillata</i> through pharmaceutical and medicinal exploitation (Post graduate student)	2012	NACOSTI	958,000
12	Jackson Mutembei	Processing and evaluation of anthelmintic drug from <i>Entada leptostachya</i> harms (Mimosaceae) (Post graduate student)	2012	NACOSTI	189,900
13	Patrick Were	Developing phytomedicines and pharmaceuticals against malaria using <i>Zanthoxylum usambarensis</i> and <i>Warburgia ugandensis</i> (Post graduate student)	2011	NACOSTI	1,105,000
14	Kowanga Keno	Purification of turbid water and biosorption of heavy metals using natural coagulants: <i>Moringa oleifera</i> and <i>Maerua subcordata</i> (Post graduate student)	2011	NACOSTI	200,000
15	Maina Joseph Karanja	Standardization profiles of selected herbal drugs in the Kenyan market used in the treatment of diabetes and malaria (Post graduate student)	2011	NACOSTI	195,000
16	Prof. Mabel Imbuga	Bio-aromatic perfumes from selected Kenyan medicinal plants	2010	JKUAT*	2,500,000
17	Susy Muchika	Antischistosomal and anti-molluscicidal effects of extracts of selected medicinal plants (Post graduate student)	2010	NACOSTI	1,200,000
18	Dr. Mwangi Muturi	Environmentally cleaner utilization of cashew nut shell liquid (CNSL) as an industrial raw material	2009	JKUAT	3,182,306
19	Dr. Naomi Wangari	Safety and toxicity of selected herbal preparations in use in Kenya	2009	NACOSTI	1,098,725
20	Prof. Joseph Keriko	Development and evaluation of anti-ageing cosmetic products derived from plants and animal's ruminant's oil extracts – PHASE 2 & Biodiesel/yellow oleander	2009	JKUAT*	801,680
21	C. K. Njoroge	Formulation of innovative processing technology for herbal medicine and fabrication of allied equipment	2008	JKUAT	2,583,500
22	Prof. Hellen Kutima	Antischistosomal activity of medicinal plants from Kakamega in laboratory mice infected with <i>Schistosoma mansoni</i> .	2008	JKUAT	1,084,750
23	Prof. Vivian Matiru	Prospecting for a biofertilizer in banana endophytic bacteria	2007	JKUAT	4,230,000
*JKUAT funded Innovation projects.					

24	Prof. Hamadi Boga	Isolation of antibiotic and enzyme producing bacteria from termite guts	2007	JKUAT	3,206,000
25	Prof. Victoria Ngumi	Propagation, Molecular Characterization and Ethnobotanical Survey of <i>Strychnos henningsii</i>	2007	JKUAT	1,507,000
26	Prof. Christine Onyango	Evaluation, documentation of indigenous plants used in processing and preservation of the livestock products amongst the pastoral communities in Kenya	2007	JKUAT	942,040
27	Prof. Joseph Keriko	Development and evaluation of anti-aging cosmetic product derived from plants and ruminant oil extracts	2006	JKUAT	706,030
28	E. B. Oluoch	Utilization of natural products from tropical plants biodiversity in the control of HIV-1 infection	2006	JKUAT	600,000
29	Prof. Esther Magiri	Screening of medicinal plants for the activity against human ineffective trypanosomes	2006	JKUAT	488,290
30	Prof. Patrick Kareru	Screening and analysis of herbal plants traditionally used in Helminth parasite control in ruminants: a case study of Embu and Mbeere districts in Eastern Province.	2006	JKUAT	400,000
31	Prof. Joseph Keriko	Utilization of Yellow Oleander (<i>Thevetia peruviana</i>) as a source of bio-diesel in Kenya.	2005	JKUAT	8,000,000
32	Prof. Grace Njoroge	Research and possible commercialization of Kenyan medicinal plants for management of HIV/AIDS, Malaria and crop pests.	2005	JKUAT	2,080,000
					67,300,221

4. Human and Animal Health Sciences

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Dr. Christine Ong'ayo Wangia	Development of a topical analgesic and anti-arthritic formulation from selected Kenyan <i>Ruellia</i> species.	2016	JKUAT	4,239,888
2	Dr. Opondo Everisto	Dietary calcium levels, physical activity and association with osteoporotic fractures in Kiambu county, Kenya	2016	JKUAT	3,000,000
3	Dr. John Gachohi	Developing a simulation model of zoonotic <i>Leptospira</i> population dynamics in an urban slums house hold in Kenya	2015	JKUAT*	4,145,000
4	Dr. Kenneth Ngure	Acceptability, uptake and barriers to HIV-1 self-testing among HIV-1 uninfected individuals using pre-exposure prophylaxis in Kenya.	2014	Bills & Melida Gates	7,701,595
5	Dr. Fred Wamunyokoli	Experimental validation of <i>Glossina morsitans morsitans</i> Odorant Receptors	2014	JKUAT	4,500,000
6	Dr. Mutinda Kyama	To evaluate small nerve fibres as biomarkers for the semi-invasive diagnosis of endometriosis.	2014	JKUAT	4,500,000
*JKUAT funded Innovation projects.					

7	Dr. John Kagira	Improvement of dairy goats' health through control of gastro-intestinal nematodes by utilization <i>FAMACHA</i> ® system & urea molasses blocks supplemented with pineapple by-products.	2014	JKUAT	4,499,220
8	Dr. Patrick Mburugu	Use of mobile phone call reminders to improve linkage and retention to care for HIV-infected adolescents.	2014	National Institute of health	3,422,700
9	Dr. Kenneth Ngure	Post-partum family planning uptake among HIV infected and uninfected women at Thika sub-county hospital. Gaps and opportunities for health systems.	2014	APHRC	2,426,920
10	Lenny Mwangandi	Antileishmanial, leishmania enzymes and genes inhibitory activities of annonaceae fruits extracts (Post graduate student)	2014	NACOSTI	1,191,000
11	Pamela Khakasi Butalanyi	Development of fibre optic nano chemical sensor for selected carcinogenic compounds' vapours	2014	NACOSTI	1,100,000
12	Lawrence Guatia	Association of specific helicobacter <i>Pylori cagA</i> and <i>vacA gene polymorphism</i> with clinical outcome in patients with Dyspepsia at KNH, Kenya (Post graduate student)	2014	NACOSTI	800,000
13	Elizabeth Luvia	Evaluation of predators of HIV/AIDS treatment failure in a cohort (Post graduate student)	2014	NACOSTI	200,000
14	Ali Juma Kangu	Evaluation of measles immunity among children aged 9-59 months at selected health facilities in Kwale, Narok and Lamu counties of Kenya, 2013 (Post graduate student)	2014	NACOSTI	199,500
15	Fona Wacera Wahinya	Perceived factors that influence breast cancer screening in persons attending Nyeri provincial hospital, Nyeri county (Post graduate student)	2014	NACOSTI	190,000
16	Stephen Wefwafwa	Prevalence and intensity of soil-transmitted helminthiases and schistosomiasis in infants and pre-school children in Mwea, Central Kenya and their possible effect on physical growth (Post graduate student)	2014	NACOSTI	187,000
17	Langat Charles Kipkoech	Prevalence of and Occupational risk factors of low back Pain among Tea Pickers in Tea Estates of James Finlay (K) Ltd in Kericho County (Post graduate student)	2014	NACOSTI	134,900
18	Ms. Maryrose Wambui	An assessment of occupational health related problems with quarrying activities in Kenya: A case study of Mutonga Quarry, Meru County (Post graduate student)	2014	NACOSTI	130,000
19	Dr. Gideon Kikvi	Socio-economic and health effects of miraa chewing among persons aged 10-65 years in selected counties in Kenya 2012-2013	2013	NACOSTI	1,000,000
*JKUAT funded Innovation projects.					

20	Dr. Caroline Ngugi	Determining the feasibility and accuracy of <i>P16INK4a/Ki-67</i> biomarker detection for cervical dysplasia among women in Thika, Central Kenya	2012	NACOSTI	8,175,000
21	Dr. Peter Lomo / Dr. Steven Nyanjom	Characterization and functional analysis of tricorn protease from <i>Trypanosoma brucei</i>	2012	JKUAT	4,500,000
22	Dr. J. K. Ng'ang'a	Chemical synthesis and antimalarial evaluation of hybrid drugs using artemisins, quinolines, anilines and cyclopentanediol pharmacophores as scaffolds.	2012	JKUAT	4,290,000
23	Prof. Ann Muigai	Exploring natural ways to exceptional long health span – the naked mole-rat case	2012	JKUAT	1,639,326
24	Hassan Mohammed Adbdi	The risk of Gastritis among <i>Catha edulis</i> and the role of <i>Catha edulis</i> chewing in the development of Sero-positive h. <i>Pylori gastritis</i> . A case control study in Nairobi Country (Post graduate student)	2012	NACOSTI	1,196,000
25	Joseph Mbugua Kabogo	Prevalence and patterns of HIV-1 drug resistance among children in Nairobi (Post graduate student)	2012	NACOSTI	1,090,000
26	Edinah Gechemba Ongaga Ongaga	Characterization and antifungal susceptibility patterns of yeasts from stool samples of HIV positive and HIV negative individuals (Post graduate student)	2012	NACOSTI	199,050
27	Leah Wairimu Ng'anga'	Factors influencing the uptake of family planning among sexually active women living with HIV attending comprehensive care clinic at Pumwani Maternity Hospital, Nairobi (Post graduate student)	2012	NACOSTI	190,000
28	Maina Ayub Kiprotich	The feasibility of using depeptidyl peptidase <i>IV CD26</i> as a surrogate marker in monitoring anti-retroviral drug therapy (Post graduate student)	2012	NACOSTI	181,500
29	Simon Karanja	Epidemiology and clinical characterization of toxoplasmosis in animals and humans: The case for Thika District	2011	JKUAT	3,500,000
30	Dr. Rebecca Waihenya	Characterization of <i>T. Parva</i> specific T. cells	2011	NACOSTI	2,500,000
31	Dr. Gideon Kikuvi	Screening <i>Bacillus</i> species from <i>Rastrineobola argentea</i> (omena) for production of bacteriocins active against bovine mastitis pathogens	2011	JKUAT	1,600,000
32	James Maina Ichagichu	Co-infection of toxoplasmosis and HIV/AIDS prevalence in Thika District and characterization of the disease	2011	NACOSTI	1,100,000
33	Dr. Steven Ger Nyanjom	Genomic and proteomic Characterization of olfactory proteins in tsetse flies vectors of African trypanosomiasis	2011	NACOSTI	995,000
34	Dennis Magu	Substance abuse and HIV / STD related risky sexual behaviours among students in Kenyan Universities (Post graduate student)	2011	NACOSTI	800,000
*JKUAT funded Innovation projects.					

35	Ogembo Joab Nyamagiri	Ligand receptor process in pregnant olive baboons infected with <i>Plasmodium knowlesi</i> (Post graduate student)	2011	NACOSTI	188,000
36	Joyce Kirui	Factors influencing tuberculosis control among Masai of Narok district – Kenya (Post graduate student)	2010	NACOSTI	200,000
37	Eddie Machache	Health effects associated with occupational exposure to organic solvents among construction company painters in Kenya (Post graduate student)	2010	NACOSTI	200,000
38	Prof. Ziporah Nganga	Socio-economic effect of HIV/AIDS on households and its impact on nutrition of people living with HIV/AIDS and orphaned and vulnerable children in Thika district, Kenya	2009	JKUAT	3,200,000
39	Prof. Naomi Maina	In search of Biomarkers for Diagnosis and Staging of Human African Trypanosomiasis	2009	JKUAT	2,601,600
40	Dr. Joseph Gikunju	Toxicological characterization of snake venom from snake parks in Kenya with a view to development of an effective antivenin	2009	JKUAT	2,000,000
41	C. Mwabu	Health Information Technology in Kenya. A simulated model for computer aided home based health system	2009	JKUAT	143,875
42	Prof. Justus Onguso	Controlling Rift Valley Fever Virus Using RNA Silencing	2008	JKUAT	4,500,000
43	Prof. Patrick Kareru	Development of anthelmintic drug for ruminant animals	2008	JKUAT*	4,500,000
44	Prof. Eng. Stephen Maranga	Controlling the Bont Tick, <i>Amblyomma variegatum</i> using Pheromone- baited trap	2008	JKUAT*	3,945,000
45	Dr. Johnson Kinyua	Experimental & Computer Assisted Drug Design Against Tropical Diseases (Malaria, Schistosomiasis Leishmaniasis & trypanosomiasis)	2008	JKUAT*	3,503,350
46	Dr. Francis Njonge	Epidemiological survey and control strategies of gastrointestinal nematode (GIN) of cattle in Kirinyaga District.	2006	JKUAT	600,000
		Total			101,105,424

5. Water resources

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Dr. Joseph Sang	Quantifying sedimentation rates and sources in Ruiru dam using vibro-coring and field assessment techniques (JKUAT contribution was in-kind)	2015	JKUAT/NCWSC	8,016,823
*JKUAT funded Innovation projects.					

2	Charles Nduhiu	Piloting Payment for Ecosystem Services in Sasumua Catchment, Kenya	2015	MENR	600,000
3	Stanley Ng'ang'a	Groundwater mapping, quality assessment & hydro geophysical modelling in Makueni County, Eastern Kenya.	2014	JKUAT	2,075,849
4	Lorraine Karimi	Assessing the transferability of SWAT model parameters for streamflow generation in ungauged watersheds of Upper Tana Basin, Kenya (Post graduate student)	2014	NACOSTI	149,000
5	Dr. Joseph Sang	Reservoir survey using Multi-frequency acoustic profiling system for sustainable watershed management and development	2013	JKUAT	4,497,048
6	Prof. Bancy Mati	Water Resource Users association capacity building in the Tsavo River Sub-catchment in Kenya	2013	World Wide Fund (WWF-EN)	631,125
7	Dr. Thomas Ngigi	Towards achieving vision 2030: production of 3D digital topographical / thematic maps of Kenya	2012	JKUAT	2,726,490
8	Francis Kigira	Modelling Water Quality Using Soil and Water Assessment Tool (SWAT) "Case Study Mara River Catchment" (Post graduate student)	2012	NACOSTI	707,500
9	Paul Kahiga	Development of a Decision Support Tool for Sustainable Land Management technologies for Enhanced Eco-system Services and Climate Change Adaptation in the Upper Tana Catchment	2012	SIDA/PRESA	500,000
10	Lilian Khavayi Mulimi	Wastewater remediation using electrochemically produced layered double hydroxides (Post graduate student)	2012	NACOSTI	180,000
11	Beatrice Wambui Mwega	Geo-electric investigation of aquifer characteristics and groundwater potential in the Lake Chala Watershed (Post graduate student)	2012	NACOSTI	165,000
12	Dr. Joseph Sang	Reservoir Sedimentation Measurement and Assessment in Kenya: Pilot Project	2011	USAID / Baylor	1,955,000
13	Daniel Siringi	Optimization and remediation of wastewater by electrocoagulation, case study: Chicken plant remediation	2011	NACOSTI	1,200,000
14	Raphael Wambua	Impact of climate change induced risk on water, sediment yield and biomass in Mara River basin , Kenya (Post graduate student)	2011	NACOSTI	930,000
15	Hannah Ngugi	Evaluation of the impacts of WASH activities on the environment in the upper Mara basin using the WEAP model (Post graduate student)	2011	DAAD / GLOW	381,990
*JKUAT funded Innovation projects.					

16	Hosea Mwangi	Evaluation of impacts of soil and water conservation practices on ecosystem services in Sasumua Watershed, Kenya, using SWAT model (Post graduate student)	2010	JKUAT	150,000
17	Dr. R. Matthews	Building Ecosystem Services Capacity for Semi-Arid Africa (BESSA)	2009	ESPA	2,000,000
18	Dr. Tom Colledge	Low Cost Water Drilling Rig.	2009	NCIIA	1,000,000
19	Stanley Kang'au	Evaluation of Technical and economic performance of smallholder pumped irrigation systems (Post graduate student)	2009	CHE	150,000
20	Dr. Joseph Sang	Assessing basin scale potential impact of conservation agriculture in the Mara River Basin	2008	IFS	1,100,000
21	Gibson Kiragu	Assessment of suspended sediment loadings and their impact on environmental flows of upper transboundary Mara river, Kenya	2008	GLOWS	200,000
22	E. C. Mwachiro	Aquaculture Dynamics in selected Reservoirs of Kenyan highlands and its effects from Feeder Streams.	2007	JKUAT	1,291,975
23	Prof. John Gathanya	Development of alternative irrigation technologies for higher water, labour and nutrient efficiency in water scarce areas of Kenya.	2006	CHE	3,000,000
24	Stanley Ng'ang'a	Application of GIS-based models for water resources management in Kaiti watershed	2005	JKUAT	150,000
25	Francis Kigira	Modelling the influence of land use changes on soil erosion and dam siltation in Thika River catchment (Post graduate student)	2005	JKUAT	90,000
26	Prof. Wambua Kaluli	Integrated Water Resources Management for Makueni District	2003	AICAD	1,000,000
		Total			34,847,800

6. Information and Communication Technology (ICT)

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Dr. Ann Kibe	Development and use of online technologies for improved social-economic welfare and food security of agribusiness groups in Kenya	2016	JKUAT	4,125,000
*JKUAT funded Innovation projects.					

2	Dr. George Okeyo	Deploying interactive online network platform for improving quality and relevance of African University graduates to labour markets	2014	EDULINK	7,081,250
3	Henry Kiracha Kamau	A cloud computation adoption capability maturity model for SMEs: A Case of Kenya (Post graduate student)	2014	NACOSTI	160,000
4	Prof. Ronald Waweru	Investigating maize farmers information gaps across the crop cycle in order to develop an appropriate ICT solution	2013	JKUAT	4,500,000
5	Philip Oyier	Kenyan-German data analytics project	2013	DAAD	3,639,320
6	Antony Ochieng Onim	Medical Information Management System	2013	JKUAT*	2,973,000
7	Paul Mwaniki	Intrusion IP monitoring with GSM MMs alert	2013	JKUAT*	1,087,290
8	Dr. Stephen Kimani	PANCAKE (Portal for Free and Appropriate Computer Science Research Resources for Kenyans).	2012	JKUAT	2,317,500
9	Mr. Edwin Otieno	The computer plough and planter (Post graduate student)	2012	NACOSTI	700,000
10	Dr. Stephen Kimani	StoreRooms (Science and Technology opportunities and resources portal for Kenyan female University students)	2012	SIRCA II	700,000
11	Antony Ochieng Onim	An optimization approach for base station location in 3G networks (Post graduate student)	2012	NACOSTI	140,000
12	Isaac Mwangi	Simulating and modelling of the growth of M-commerce in Kenya due to mobile phone usage. A systems dynamics approach (Post graduate student)	2012	JKUAT	101,800
13	Dr. John Kihoro	E-learning eco system for implementation of mobile learning	2011	KENET	850,000
14	Prof. Ronald Waweru	Developing a research management that is user centred	2010	JKUAT*	2,572,000
15	Prof. Ronald Waweru	Developing an intelligent automated teller machine (ATM) using learning and pattern machine learning matching	2010	NACOSTI	1,050,000
16	Dr. Stephen Kimani	CORPUS (Computer Science opportunities and resources portal for Kenyan University students)	2007	Engineering Information Foundation	500,000
17	Mr. Pius Thuku	Application of biometrics authentication and audit trial to cub cheating in online examinations (Post graduate student)	2004	DAAD	618,740
		Total			33,115,900
*JKUAT funded Innovation projects.					

7. Engineering Technologies and Industrial Development

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Prof. Eng. Bernard Ikua	Capacity building for climate mitigation in the maritime shipping industry	2016	KMA	110,000,000
2	Prof. Eng. Bernard Ikua	Chair - Engineering c/o NACOSTI	2016	NACOSTI	75,000,000
3	Dr. Onesmus Muvengei	Development of a small scale stone crusher	2015	JKUAT*	3,760,000
4	Dr. Hiram Ndiritu	Improving comminution for Artisanal and Small scale gold miners in Kenya	2015	JKUAT*	2,670,400
5	Material Science	Material for watercraft construction	2015	KMA	2,642,000
6	Bruno Roberts Mose	Development of recycle friendly aluminium alloys for automotive & structural applications	2014	JKUAT	4,500,000
7	Dr. Stephen Ondimu	Development of a self-powered algae photo bioreactor	2014	JKUAT*	2,557,905
8	Kennedy Owuor Olale	Fruit quality assessment using Fourier transform infrared spectroscopy: Case of mango (<i>Mangifera indica L.</i>)	2014	NACOSTI	1,043,550
9	Mildred Makhoha	Enhancement of long term stability and dye-sensitized solar cells by structured modification using neodymium iron boron magnet as a sealant (Post graduate student)	2014	NACOSTI	170,000
10	Brian Jacks Odero	Physical and mechanical properties of normal concrete with coarse aggregate partially replaced with recycled clay products (Post graduate student)	2014	NACOSTI	163,000
11	Samuel Kanyi	Investigation of magneto hydrodynamics fluid flow problem past a porous contracting surface with mass and heat transfer (Post graduate student)	2014	NACOSTI	117,000
12	Macben Mutua	Design and development of a semi-autonomous robotic manipulator for three dimensional surface coating of small and medium scale objects	2013	JKUAT*	1,813,400
13	Simon Njuguna	Developing a Macadamia Shelling Machine	2013	JKUAT*	1,344,000
14	Dr. John Githiri	Establishment of absolute gravity stations at referenced to IGSN 71 datum levels at county levels in Kenya	2012	JKUAT	1,552,100
15	Prof. Christopher Kanali	Design and development of rice combine harvester for small holder farmers in Kenya	2012	NACOSTI	1,000,000
16	Dr. Duncan Mbuge	Construction and testing of mechanical shaker prototypes for coffee harvesting	2011	JKUAT*	4,135,500
*JKUAT funded Innovation projects.					

17	Mr. Samuel Karanja	Design & Development of a Precision Plastic Blow Moulding Machine	2011	JKUAT*	2,530,000
18	Eng. Clement Nduati	Power Driven Block Press	2011	JKUAT*	1,500,000
19	Anthony Muchiri	Development of Integrated maintenance optimization model for improving Kenyan maintenance Practices (Post graduate student)	2011	NACOSTI	800,000
20	Wekesa David Wafula	Micro controller based data logging instrumentation system for wing speed and direction measurements (Post graduate student)	2011	NACOSTI	200,000
21	Maurine Wafula	Investigation of magneto hydrodynamic fluid in slider bearing (Post graduate student)	2011	NACOSTI	150,000
22	Dr. George Nyakoe	Developed of a vision guided autonomous mobile robot with wireless communication capacity	2010	JKUAT*	2,014,000
23	Eng. Clement Nduati	Innovation project geared towards simplified concrete handling techniques.	2010	JKUAT*	2,000,000
24	Dr. Wakarani Njogu	Three wheeler car	2010	JKUAT*	1,500,000
25	Dr. Geoffrey Kihara	Design and application of an experimental set up for producing embossed holograms	2009	NACOSTI	2,873,110
26	Dr. Geoffrey Kihara	Design and fabrication of a cost effective high power industrial carbon dioxide Laser system	2008	JKUAT*	4,500,000
27	Prof. Bernard Ikuu	Development of an Electrical Discharge Machine	2008	JKUAT*	2,176,260
28	Prof. Christopher Kanali	Design and development of a rice harvester for Kenya: Phase 1- design of cross cutting and windrowing mechanism	2008	JKUAT*	1,370,600
29	J. R. Akanga	On the spectra of triangular and almost triangular matrices as operators on bvo, by and c spaces.	2006	JKUAT	600,000
30	Dr. John Githiri	Gravity and magnetic investigations of greater Magadi area (Post graduate student)	2006	JKUAT	150,000
		Total			234,832,825

8. Built Environment and Infrastructure Technologies

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Ms. Jane Aduda	The real estate market in Kenya – if not a bubble, then what?	2016	JKUAT	4,500,000
2	Prof. Bernard Moirongo	The effect of climate change on the current planning structure of the city of Nairobi	2016	JKUAT	3,841,560
3	Prof. Bernard Moirongo	Safer Cities Initiative: Urban Programming	2014	World Vision Kenya	1,820,540.00
*JKUAT funded Innovation projects.					

4	Dr. Stephen Diang'a	Laboratory for an Integrated African Network for the Built Environment (LIANE)	2013	German Government	30,000,000
5	Dr. Stephen Diang'a	JENGA - Joint development of course for Energy - Efficient and sustainable housing in Africa	2013	EDULINK	52,848,840
6	Dr. Gerryshom Munala	Documentation and analysis of historic buildings in Nairobi.	2012	JKUAT	4,461,795
7	SABS	Promoting Energy Efficiency in Buildings in East Africa	2012	UN-Habitat	2,100,000
8	Dr. Susan Kibue	Post occupancy evaluation of slums upgrading projects: A comparative study between self-help initiatives and Government sponsored initiatives	2011	NACOSTI	3,000,000
9	Prof. Zachary Gariy	Nairobi – Thika Highway improvement Project	2011	Centre for Sustainable Urban Development	1,360,000
10	Gideon Kidegho	Electronic power generation enhancement in using urban domestic integrated grid solar PV electricity (Post graduate student)	2010	NACOSTI	200,000
11	Dr. Kivaa Mbiti	Developing a method for setting long term targets of annual construction output in Kenya	2009	JKUAT	2,524,277
12	Eng. Maina Kiambigi	Enhancing travellers' safety and comfort: planning of rest stops on Kenyan highways	2008	JKUAT	1,463,000
		Total			108,120,012

9. Institute of Biotechnology Research (IBR)

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Dr. Remmy Kasili	Upscaling the JKUAT developed aflatoxin and Striga-resistant transgenic maize towards potential commercialization in Kenya through further rigorous testing in a will be established BSL 2 facility at JKUAT	2015	JKUAT*	4,500,000
2	Dr. Remmy Kasili	Analysis of genetic diversity within & among indigenous & imported rabbit breeds in Kenya	2014	JKUAT	4,500,000
3	Dr. Alakonya Amos	Determination of molecular basis of synergistic virus interactions leading to Maize lethal necrosis disease in Maize	2014	The World Academy of Sciences	1,200,000
*JKUAT funded Innovation projects.					

4	Patricia Beverly Aswani	Characterization of candidate genes of indigenous chicken in Kenya for functional polymorphisms towards increased meat and egg production (Post graduate student)	2014	NACOSTI	200,000
5	Dr. Sheila Ommeh	Characterization of indigenous poultry and wild relatives from different agro ecological zones in Kenya towards genetic improvement.	2013	JKUAT	4,490,000
6	Dr. Silvester Anami	Enhancing drought stress tolerance in tropical sweet potatoes	2013	ICGEB	4,320,000
7	Dr. Silvester Anami	Tropical maize for food and income: Improving draught stress tolerance in tropical maize through silencing maize PARPI gene	2013	IFS	1,000,000
8	Dr. Amos Alakonya	Characterization and management of the new maize lethal necrosis disease outbreak in Kenya	2012	Bill & Melinda Gates Foundation	8,500,000
9	Dr. Shadrack Muya	Development and implementation of the Rhinoceros DNA Index Register (rhodir) database as a tool to protect and manage the Kenyan Rhinoceros	2012	JKUAT	4,692,578
10	Prof. Marion Mutugi	Genetic profiling of rapists	2012	JKUAT	4,500,000
11	Dr. Amos Alakonya	Transformation of maize with efficient phosphorus genes for increased grain yield and <i>Striga hermonthica</i> suppression.	2012	JKUAT	4,490,000
12	Prof. Hellen Kutima	Molecular epidemiology of cryptosporidium in rural setting	2012	NACOSTI	1,500,000
13	Kimani Shadrack Kanyonyi	Investigation of molecular basis associated with pyronaridine resistance in <i>Plasmodium berghei</i> ANKA isolates	2012	NACOSTI	1,000,000
14	Wekesa Richard	Effect of 2,4-dichlorophenoxy acetic acid and naphthalene acetic acid concentration on Callogenesis, somaclonal variation and performance of three sugarcane varieties in Western Kenya (Post graduate student)	2012	NACOSTI	800,000
15	Caroline Wanjiku	In vitro selection of artemisinin resistant <i>Plasmodium falciparum</i> isolates and determination of molecular basis of resistance (Post graduate student)	2012	NACOSTI	191,595
16	Julius Kinuthia	Development of micro satellite DNA markers for application of wildlife forensics in Kenya	2011	JKUAT	4,000,000
17	Dr. Mercy Mwaniki	Use of DNA markers in wildlife forensics for conservation in Kenya	2011	NACOSTI	2,200,000
18	Dr Amos Alakonya	Characterization and bioactivity determination of wild <i>Psidium guajava</i> accessions in Shimba Hills and Yala swamp in Kenya	2011	NACOSTI	1,000,000
19	Dr. Justus Onguso	Development of food supplements comprising of algae and aloe	2011	NACOSTI	800,000
*JKUAT funded Innovation projects.					

20	Dr. Justus Onguso	Collection and molecular characterization of wild edible mushrooms in Kenya	2010	NACOSTI	955,000
21	Prof. Hamadi Boga	Functional screening of soda lake microbial communities for bio actives metabolites	2009	NACOSTI	3,000,000
22	Ms. Cecilia Mbithe	Characterization regeneration and agrobacterium tumefaciens-mediated transformation of <i>Jatropha curcas</i> (Physcis nut) for Biofuel	2009	NACOSTI	1,600,000
23	Purity Kenya	Antimicrobial and cytotoxic effects of secondary metabolites from endophytic and epiphytic bacteria and fungi from marine algae of the Kenya coast	2005	NACOSTI	1,000,000
		Total			60,439,173

10. Energy, climate and Environmental Sciences (IEET)

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Prof. Robert Kinyua / Prof. Esther Kahangi	Renewable energy	2015	EU	13,000,000
2	Dr. Agnes Naliaka	Mazingira App-mobile / web application based on Wireless Sensor Network for Environmental Safety Monitoring	2015	JKUAT*	1,500,000
3	Mathew Kiura	Forest cover changes in Mau Forest Complex, Kenya and the implications of carbon dynamics and climate variability (Post graduate student)	2014	NACOSTI	912,000
4	Cecilia Wangeci Muriuki	Adsorption of chromium loss from tannery wastewater using pumica, charcoal and banana peels (Post graduate student)	2014	NACOSTI	200,000
5	Zacharia Njogu Benson	Bio sorption Studies of selected heavy metal using roger mushroom biomass (Post graduate student)	2014	NACOSTI	170,000
6	Dr. JohnBosco Njoroge	Rehabilitation of post-quarried sites as a function of management regime, landscape bio-geophysical variables and visual preference of emerging habitats.	2013	JKUAT	4,492,160
7	Dr. Paul Njogu	Converting waste polythene into energy sources	2013	JKUAT*	4,375,000
8	Prof. Christopher Kanali	Noise pollution in Nairobi: sources, effects and control.	2013	JKUAT	1,481,800
9	Prof. Charles Mundia	Climate change and food security: Capturing impacts of climate change mitigation measures in forecasting and crop disease control	2012	JKUAT	4,385,000

*JKUAT funded Innovation projects.

10	Dr. M. M. Ngigi	Climate change impacts on distribution and abundance of wildlife species in the Mara Ecosystem: An analytical approach using GIS	2012	JKUAT	1,920,000
11	Ismail Onchoke	Development of System for Producer Gas Powered CI Engine (Post graduate student)	2012	NACOSTI	700,000
12	Nyakundi Abel Ogari	Retrofit of pressure lamp to handle vegetable oil (Post graduate student)	2012	NACOSTI	158,900
13	Obasi, Jacob Ondabu	Development of control strategies for pensionable hybrid energy system through design and simulation at Maji mazuri school (Post graduate student)	2012	NACOSTI	105,000
14	Roy Samuel Orege	Impacts of integrating wind power generation on the transient stability of the Kenyan power system (Post graduate student)	2012	NACOSTI	60,000
15	Prof. Robert Kinyua / Prof. Esther Kahangi	Renewable energy	2011	JICA	188,000,000
16	Francis Xavier Ochieng	Study, development and standardization of a locally manufactured and low small wind turbine for water pumping and electricity generation in semi-arid region.	2011	NACOSTI	6,500,000
17	Agatha Wagutu	Conversion of biomass wastes to Butanol fuel for petrol engines and domestic cooking application	2011	NACOSTI	1,800,000
18	Justus N Omari	The current status of electronic waste and management in Kenya (Post graduate student)	2011	NACOSTI	180,000
19	Levi Ng'ang'a Mbugua	The future of energy demand in Kenya : A non - parametric model approach	2010	NACOSTI	1,200,000
20	Aloys Mosima Osano	Cellulosic ethanol synthesis as a bio-fuel from locally available agricultural weeds and residues using indigenous basic -acidic mineral salt hydrolytic regimes	2010	NACOSTI	1,200,000
21	Peter Odhiambo	Harnessing yellow oleander seeds for vegetable oil and protein production in Kenya : A community based approach for poverty reduction and bio-diesel production	2010	NACOSTI	1,000,000
22	Prof. Glaston Kenji	Regeneration of bamboo to diversify the food-base and help stem the tide of deforestation in Kenya (Post graduate student)	2010	NACOSTI	745,000
23	Lina Atieno Owino	Optimization of fuel consumption in hybrid wind-diesel -storage system using a Neuro-Fuzzy controller (Post graduate student)	2010	NACOSTI	200,000
24	Eng. Sylvia Kahiu	Waste water to energy; A study of the convention of the organic component of municipal solid waste to electricity	2009	NACOSTI	2,915,520
25	Prof. Douglas Shitanda	Explore the utility of low cost seed oils as potential feedstock biodiesel fuel production	2009	NACOSTI	1,500,000
*JKUAT funded Innovation projects.					

26	Dr. Gabriel Magoma	Diversity and pesticide-Biodegradation potential of microorganisms in horticultural farms in Rift Valley and Central Kenya	2008	JKUAT	1,881,000
27	Prof. George Thiong'o	Biodiesel Production Technology	2008	JKUAT*	1,215,200
28	Dr. Hunja Murage	Conversion of wastewater into safe and commercially usable biomass (Post graduate student)	2008	NACOSTI	700,000
29	Prof. David Mulati	Design of solar cells for charging cell phones and other low power electronic devices	2006	JKUAT	2,833,440
30	M. K. Muuo	The use of Satellite Remote Sensing (SRS) and Geographic Information Systems (GIS) to map the trend of spread of invasive tree species, Prosopis ssp. (Post graduate student)	2005	JKUAT	133,220
		Total			245,463,240

11. Sino Africa

No	Principal Investigator	Title of project	Year	Donor	Amount
	Prof. Robert Gituru	JKUAT Botanical Garden & Sino-Africa Joint Research Centre	2014	Government of The People's Republic of China	137,096,755

12. SMARTEC

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Prof. Wambua Kaluli	Appropriate materials to stabilize expansive clay for low cost urban roads construction: Enterprise Road, Nairobi case study.	2013	JKUAT	1,164,625
2	Prof. Walter Odhiambo Oyawa	Development of sustainable construction materials and technologies for Eco-housing infrastructure	2008	JKUAT*	4,500,000
		Total			5,664,625
*JKUAT funded Innovation projects.					

13. Extension and technology transfer

No	Principal Investigator	Title of project	Year	Donor	Amount
1	Mr. Jeremiah Nyori	Baobab project: Enhancing Local Food Security and Nutrition through Promoting the use of Baobab (<i>Adansonia digitata L.</i>) in Rural Communities in Eastern Africa	2015	German Federal Ministry of Food Agriculture	8,600,000
2	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2015	JICA	19,989,500
3	DVC, RPE and Extension staff	Shows and exhibitions	2015	JKUAT	6,329,200
4	Mr. Jeremiah Nyori	Cow milk value chain	2015	ASDVP	3,800,000
5	Mr. Jeremiah Nyori	Broiler value chain	2015	ASDVP	2,400,000
6	Dr. David Kagima	Urban and Peri-Urban Agricultural Project	2015	Kiambu County	993,120
7	Mr. Jeremiah Nyori	Training of PLWD	2015	JKUAT	200,000
8	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2014	JICA	25,299,844
9	DVC, RPE and Extension staff	Shows and exhibitions	2014	JKUAT	12,079,200
10	Dr. David Kagima	Mkulima TV	2014	JKUAT	250,000
11	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2013	JICA	25,299,844
12	DVC, RPE and Extension staff	Shows and exhibitions	2013	JKUAT	11,749,100
13	Mr. Jeremiah Nyori	Developing a Curriculum for Actors and Service Providers in the Fruit and Vegetable Value Chain in Kenya	2013	KAPAP	4,900,000
14	Dr. David Kagima	Mkulima TV	2013	JKUAT	250,000
15	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2012	JICA	22,322,900
16	DVC, RPE and Extension staff	Shows and exhibitions	2012	JKUAT	11,579,200
17	Dr. David Kagima	Mkulima TV	2012	JKUAT	250,000
18	DVC, RPE and Extension staff	Shows and exhibitions	2011	JKUAT	14,102,975
19	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2011	JICA	9,989,500
20	Dr. David Kagima	Mkulima TV	2011	JKUAT	250,000
*JKUAT funded Innovation projects.					

21	DVC, RPE and Extension staff	Shows and exhibitions	2010	JKUAT	15,000,000
22	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2010	JICA	7,543,950
23	Prof. Esther M. Kahangi	Farmers Voice Radio	2009		45,000,000
24	DVC, RPE and Extension staff	Shows and exhibitions	2009	JKUAT	15,000,000
25	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2009	JICA	7,543,950
26	Prof. S. M. Maranga	Gemmology course for small scale gemstone miners in Taita Taveta	2009	JKUAT*	3,375,000
27	DVC, RPE and Extension staff	Shows and exhibitions	2008	JKUAT	15,000,000
28	Prof. Esther M. Kahangi	Improvement of dairy breed and management in Kenya.	2008	Kilimo trust	5,686,500
29	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2008	JICA	5,250,000
30	DVC, RPE and Extension staff	Shows and exhibitions	2007	JKUAT	15,000,000
31	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2007	JICA	4,672,000
32	DVC, RPE and Extension staff	Shows and exhibitions	2006	JKUAT	15,000,000
33	DVC, RPE and Extension staff	In-country women (incubating grass root women)	2006	JICA	4,672,000
34	DVC, RPE and Extension staff	Shows and exhibitions	2005	JKUAT	15,000,000
35	Dr. Mwikamba Kaibui	Social economic impact of unemployed agricultural extension workers: A case study of Thika district in Kenya	2005	JKUAT	600,000
		Total			354,977,783
*JKUAT funded Innovation projects.					