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NSUKKA, NIGERIA

Educating Agricultural Engineers

Lesson from the Past and Trends/ Challenges for the Future

Stellenbosch
UNIVERSITY
IYUNIVESITHI
UNIVERSITEIT

Executive Director &
Chief Executive Officer

Emeritus Distinguished
Professor &
Former SARChI Chair

Umezuruike Linus Opara

75th Anniversry
Celebration of
Agricultural Engineering
@ UKZN, 29/10/25

Photo by Stefan Els

Congratulations

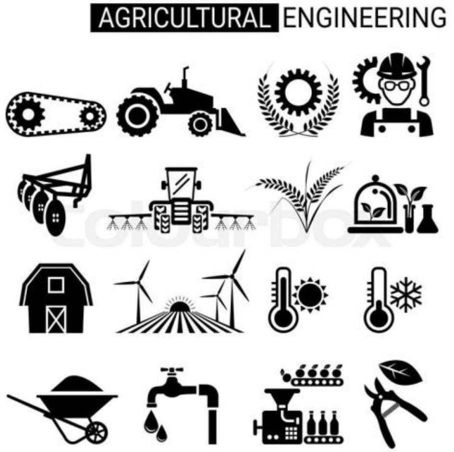
Congratulations

https://ww1.caes.ukzn.ac.za/events/engineering-banquet-celebrating-100-years-of-engineering-education/

Symbolisms of 75 Years Milestone of AgEng @ UKZN

- Rarity
- Strength
- Durability
- Eternity
- Exceptional long-term relationships
- Exceptional long-term accomplishments

❖ Diamond Jubilee
❖ Diamond Anniversary
❖ Septuagenerian



The Menu

- My Journey as an Agricultural Engineer
- Lessons from the Past
- Trends & Challenges
- Educating Agricultural Engineers for the Future
- Epilogue

My Journey as an Agricultural Engineer

BEng (AgEng, 1st Class Hons) 1987, MEng (AgEng, Cum Laude) 1989, PhD (AgEng) 1993


Food and Agriculture Organization of the United Nations
FIAT PANIS
Welcome to College of Agricultural and Marine sciences
جامعة السلطان قابوس
Sultan Qaboos University
NATIONAL CENTRE FOR AGRICULTURAL MECHANIZATION (NCAM) IDOFIAN P.M.B. 1525 ILORIN KWARA STATE
NCAM
UNIVERSITY OF NIGERIA
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SARChI Postharvest
South African Research Chair in Postharvest Technology
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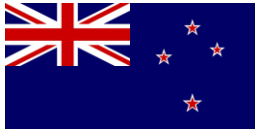
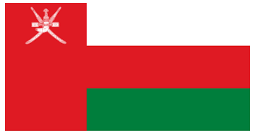
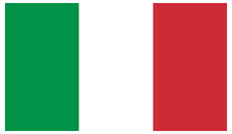
AfroAgEng
LINCOLN VENTURES LIMITED
MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND
Centre for Postharvest &
Refrigeration Research

						
Agricultural Mechanization Engineer Agricultural Development Planning (Mechanization) Livestock Development Planning Biotechnology Research and Training	Agricultural Engineer Postharvest Engineer Solar Energy for Refrigeration Packaging Technology Building Services Technology	Postharvest Technologist Agricultural Engineer Mechanical Engineer Food Scientist Horticultural Scientist Systems Engineer	Agricultural Development Agricultural Mechanization Agricultural Markets Postharvest Management Irrigation	Agricultural Engineer Postharvest Technologist Horticultural Scientist Food Scientist	Postharvest Technology Agricultural Mechanization Agricultural Development Planning	Agricultural Mechanization Agricultural Development Planning

Pursuing Education and Work for a Fuller Life

UNIVERSITY OF NIGERIA BEng Degree	MASSEY UNIVERSITY TE KUNENGA KI PŪREHUROA UNIVERSITY OF NEW ZEALAND PhD Degree/ Academic	جامعة السلطان قابوس Sultan Qaboos University
I. Sub-Editor, Irritrac Magazine II. Member, Irritrac Football Team III. Senator, Students' Union Government IV. President, Ngor Okpala Local Government Students' Association, University of Nigeria, Nsukka V. National President, Ngor Okpala Local Government Students' Association (NANS)	1. Captain and Manager, International Students' Football Team, Manawatu League 2. President, African Students Association, Massey University 3. President, African Students Association, New Zealand 4. President, International Students Association, Massey University 5. Executive Committee Member, Africa Association of New Zealand 6. Hostel Supervisor, Massey University 7. Coordinator, Palmerston North City International Cultural Festival 8. Church Warden, All Saints Anglican Church, Palmerston North 9. Member, Search Committee for Appointment of New VC 10. Elected Member, Massey University Governing Council i. Coordinator, BApplSc Programme ii. Coordinator, Agricultural Engineering Programme iii. Coordinator, Boproducts Quality Research iv. Management Committee Member, Centre for Postharvest & Refrigfertion Research v. Programme Director, Engineering Technologies	I. Coach, Mixed Children's Football Team, Muscat, Sultanate of Oman II. Member, University Academic Committee of Council III. Member, University Quality Audit Committee IV. Assistant Dean, Postgraduate Studies and Research V. Director, Agricultural Experiment Station

What Lessons from the Past?

Consider McGill University in Canada

- Agricultural Engineering took roots in 1907
- Department of Manual Training and Agricultural Engineering, 1914
- Department of Agricultural Engineering, 1917
- Department of Bioengineering, 2025

- The transition from Physics-based to Biology-based is complete
    - Biological, Bioresources, Biosystems, Bioengineering, etc
    - Additional word variants: Agricultural & Food, Agricultural & Environmental, Agricultural & Bio-Environmental

Lessons from the Past

Outlook for agricultural engineering education and research and prospects for developing countries

Linus U. Opara

Abstract: Agricultural engineering (AE) is one of the disciplines that have been adversely affected by declining enrolments and popularity among school leavers, especially in developed countries. Efforts to reverse the downward trend must consider curriculum changes, which broaden the currently narrow and shrinking sources and catchment areas of potential fresh student intakes, as well as providing them with skills for lifelong learning and employment opportunities beyond the agricultural sector. This article examines some of the current perceptions and trends in AE education, and proposes a global orientation to a curriculum that equips undergraduate students with integrative skills in applied sciences, engineering principles and emerging technologies. A triad of emerging technological innovations that are driving the knowledge economy is identified and recommended for inclusion in an AE educational curriculum. The new AE education paradigm will enable graduates and professionals to shift the historical emphasis from 'on-farm mechanization' to the development and application of new innovations to support knowledge-intensive and information-driven agriculture. Effective communication and dialogue with key stakeholders, and implementing adequate response to emerging technological, environmental and economic challenges facing agriculture are critical to winning public support and improving the appeal of AE among school leavers and industries. Strategies that include changing the current name of educational AE programmes and/or professional societies must be pursued with considerable caution if the profession is to remain truly global and to facilitate the international mobility of future agricultural engineers in an increasingly globalized labour market. The prospects for innovative engineering inputs for transforming smallholder agriculture in least developed countries are discussed.

Keywords: agricultural engineering; undergraduate education; curriculum reform; lifelong learning; innovation; LDCs

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Engineering and technological innovations have played significant roles in transforming agriculture and other land-based activities into modern industries that produce a diverse range of top-quality products and services. From the earliest beginnings as food gatherers and hunters, the use of improved hand-tools and cultivation techniques have enabled humans to influence and harness natural resources and exert better control over food and fibre supply. The limitations and drudgery of human (muscle) power were later overcome through the successful domestication of animals (such as oxen, buffalo and horses), which provided more efficient and reliable power sources for pulling farm implements and equipment for irrigation, transportation and

The International Journal of ENGINEERING EDUCATION

Special Issue Series: http://www.ijee.ie/contents/c220106.html

Agricultural/Biosystems/Biological Engineering Education

Guest Editors

Linus Opara: Sultan Qaboos University, Sultanate of Oman

Joel Cuello: University of Arizona

Covers
Covers & Abstracts

Part I

Special Issue I

a) Agricultural Engineering and the Emergence of Biological Engineering

M.S.Wald: Editorial
L.U.Opara and J.L.Cuello: Guest Editorial

Contents Volume 22 number 6

Special Issue

Trends in Agricultural, Biosystems and Biological Engineering Education (II)

Guest Editors
Joel Cuello
University of Arizona

Linus Opara
Sultan Qaboos University
Sultanate of Oman

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Opara — Editorial
Guest Editorial

Part I

Contents Volume 23 number 4

2007

Part I

Special Issue

Trends in Agricultural ,Biosystems and Biological Engineering Education (III)

Guest Editors

Linus Opara
Sultan Qaboos University
Sultanate of Oman

Joel Cuello
University of Arizona

Covers
Abstracts

Int. J. Engng Ed. Vol. 22, No. 6, pp. 1139–1148, 2006
Printed in Great Britain.
0949-149X/91 $3.00+0.00

The Evolution of Agricultural Engineering Education and Curriculum Reform at Sultan Qaboos University*

LINUS U. OPARA, JOHAN S. PERRET and DAVID B. AMPRATWUM
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The objective of this article is to describe the evolution of agricultural engineering education at Sultan Qaboos University, including curriculum changes and employment status of its graduates. The agricultural mechanization program was established in the Department of Mechanization in 1986. After a decade, the department name and program were changed to Bioresource and Agricultural Engineering (BAE). Most recently, the department has been merged with the Department of Soil and Water Sciences to form a new Department of Soils, Water, and Agricultural Engineering. The name change in 1996 was considered to represent a paradigm shift from a focus on 'technology' content to greater emphasis on 'engineering' content and this re-orientation was further reflected by changes in the curriculum to increase the content of

Int. J. Engng Ed. Vol. 22, No. 1, pp. 59–66, 2006
Printed in Great Britain.
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Student Perceptions of the Public Image of Agricultural Engineering and Their Preferred Name for the Discipline and Title Degree*

LINUS U. OPARA, SEIF S. AL-ADAWI and TALAL S. AL-SHUKEILI
Department of Bioresource & Agricultural Engineering, Sultan Qaboos University, PO Box 34, Al-Khod 123, Sultanate of Oman. E-mail: linus@squ.edu.om

During the past decade, there has been a worldwide debate on the future of Agricultural Engineering education. In a previous paper, we discussed the historical evolution of and curriculum reforms in agricultural engineering (AE) education at Sultan Qaboos University. Some of the significant changes implemented during the last decade have included renaming the department and degree major, and restructuring the curriculum to meet ABET's minimum requirements for

World Transactions on Engineering and Technology Education
Vol.3, No.1, 2004

Students' perceptions and attitudes towards agricultural engineering education in the Sultanate of Oman – Part 1: academic programme selection

Linus U. Opara, Seif S. Al-Adawi & Talal Y. Al-Shukeili

Sultan Qaboos University
Muscat, Sultanate of Oman

ABSTRACT: A written questionnaire, complemented by a focus group discussion, was used to assess the perceptions and attitudes of undergraduate students in bioresource and agricultural engineering (BAE) on degree programme and major selection, curriculum content and career preferences. The results showed that the College of Agricultural and Marine Sciences (which offers BAE) was not the preferred choice for over 78% of the students surveyed when they entered the University, and nearly 70% of this same group indicated that the College of Education or Engineering was their first choice. Once admitted in their present College, about 72% of those surveyed first chose the major in Bioresource & Agricultural Engineering from among the 10 academic programme majors

World Transactions on Engineering and Technology Education
Vol.3, No.1, 2004

Students' perceptions and attitudes towards agricultural engineering education in the Sultanate of Oman – Part 2: curriculum content and career preferences

Linus U. Opara, Seif S. Al-Adawi & Talal Y. Al-Shukeili

Sultan Qaboos University
Muscat, Sultanate of Oman

ABSTRACT: In part 1 of this article series, the authors reported on the low appeal of the agricultural and marine science academic programmes among the majority of students enrolled in a bioresource and agricultural engineering major. In the present article (part 2), the authors present students' attitudes towards the overall curriculum content in bioresource and agricultural engineering, their career preferences after graduation, and the skills they considered would enable them to meet the expectations of prospective employers. Students generally expressed apprehension towards basic science courses and core engineering courses, especially when offered by other colleges. Based on the total responses for various career and employment options, 48% of the responses preferred employment in a government ministry/department, 42% preferred employment in the private sector, while a negligible number of students (3%) wanted to start their own business after graduation. The high interest in private sector employment indicates a significant shift among students away from dependence on government ministries for employment. Most students expressed *moderate* to *high* confidence that their current educational programme would enable them to attain the critical skills required for success in their preferred workplace.

INTRODUCTION

to engineering and technology) [5]. On the other hand, those students also preferred to be considered as engineers

World Transactions on Engineering and Technology Education
Vol.2, No.3, 2003

From farmers to blue-collar professionals: agricultural engineering students' perspectives on their career prospects, critical skills and discipline name change

Linus U. Opara

Sultan Qaboos University
Muscat, Sultanate of Oman

ABSTRACT: There is an ongoing worldwide debate and dialogue on the future of the agricultural engineering (AE) profession and academic discipline, spurred in part by declining undergraduate enrolments, reduced sources of funding for traditional agricultural engineering research and development activities, and a poor public image of agriculture and other land-based industries. The article presents the outcomes of a survey of, and focus group discussion with, final year undergraduate agricultural engineering majors at Massey University, New Zealand. The issues explored included students' reason for choosing AE, perceived career options, skills required by potential employers and adequacy of the current academic programme to meet those expectations. Students also commented on their preferred professional affiliation and discipline name. The majority of students came from a rural farming background and chose to study AE because of their personal interest in the mechanical aspects of agriculture. The study also showed that most students preferred their academic programme to be more closely aligned towards the agricultural and horticultural sciences, but on the other hand, would prefer to be considered as engineers and affiliated to a professional engineering society after graduation.

INTRODUCTION

dominated by low-value products, and the industry is perceived as *rural* and *dirty* by young school leavers who want to get

World Transactions on Engineering and Technology Education
Vol.2, No.3, 2003 © 2003 UICEE

Image is everything: Undergraduate students' contributions towards a better understanding and improvement of public attitudes and perceptions of agricultural engineering

Linus U. Opara

Sultan Qaboos University
Muscat, Sultanate of Oman

ABSTRACT: Tertiary institutions, research organisations and professional agricultural engineering societies in developed countries have been restructuring their programmes in response to declining student enrolments and continuing reductions in research income from traditional sources. This study was carried out as part of an ongoing research programme in order to obtain students' input towards improving the appeal of future agricultural engineering (AE) academic programmes to more students, as well as to improve public perceptions regarding the image of agricultural engineering. The author has reported elsewhere on students' perspectives on their career prospects, critical skills for success and discipline name change. The present article presents a discussion of students' perceptions on the meaning of agricultural engineering, its past and future role in society, the image and profile of AE in the wider community, and the counter measures that could contribute towards a greater appeal of AE to young school leavers. Other feedback provided by students during a focused group discussion on the future of AE is also presented.

INTRODUCTION

Despite the fundamental importance of agriculture in the human

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Challenges for Bioresources Engineering Education in South Africa

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The objective of this paper is to illustrate the scope, uniqueness and opportunities for Agricultural Engineering and to present an overview of Agricultural Engineering education in South Africa. The need for engineers in South Africa is assessed, and the output from the schooling system in South Africa to meet this need is illustrated. Thereafter, the performance of engineering students at the University of Natal is analysed and selected challenges and opportunities for agricultural engineers in South Africa are summarized. From the results of the study it is evident that the performance of students in their final year of school is a poor indication of their performance in their first year of engineering studies and the standard of the school education system presents challenges to tertiary engineering educational institutions that need to focus on the retention and throughput of students.

Keywords: agricultural engineering; bioresources engineering; agricultural degree accreditation; GPA

INTRODUCTION

Engineers identify peoples' needs and use innovation, ingenuity, science and technology to provide optimum solutions for these needs. Various defini-

engineering' (AE) will be used, even though 'bioresources engineering' has been used since 1999 in marketing the degree at NU, and in the name of the school (Bioresources Engineering and Environmental Hydrology) through which the degree

Int. J. Engng Ed. Vol. 22, No. 1, pp. 71–78, 2006
Printed in Great Britain.

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Relevance of Agricultural Engineering Education against the Background of a Changing World—the Case of Southern Africa*

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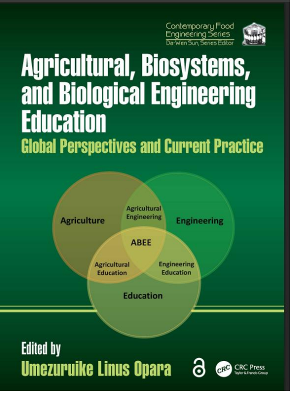
N. MOYO
Twujuone Investments, 702 Parirenyatwa Road, Old Windsor Park, Ruwa, Zimbabwe

I. SAMAKANDE
Zimbabwe Irrigation Technology Centre, P.O. Box BW330, Borrowdale, Zimbabwe

While training in traditional branches of agricultural engineering has never been in doubt in developing countries because of the agro-based economies, of late, the relevance of this training has come under scrutiny as the world order shifts towards more market-oriented economies with the resultant requirement of efficient resource utilisation, environmental integrity and social equity. Traditional programmes as previously designed based on developed country models are becoming marginal as most conditions do not obtain in developing countries. This paper analyses the relevance of tertiary agricultural engineering education in southern Africa in the face of world and regional dynamics taking place. It will be argued that traditional agricultural engineering education is becoming dated as there is a need for more dynamic programmes. On one hand, many



Trends/Challenges for the Future

Chapter

Introduction – Revisiting and Rethinking Agricultural, Biosystems, and Biological Engineering Education for Sustainable Development

By Umezuruike Linus Opara

Book Agricultural, Biosystems, and Biological Engineering Education

Edition	1st Edition
First Published	2024
Imprint	CRC Press
Pages	8

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Chapter

Emergence and Advancement of Agricultural Engineering Education, Research and Practice – A Historical Perspective

By Umezuruike Linus Opara

Book Agricultural, Biosystems, and Biological Engineering Education

Edition 1st Edition

Prospects for Agricultural, Biosystems, and Biological Engineering Education and Research for Knowledge-Intensive, Data-Driven, Climate-Smart, and Sustainable Agriculture

By Umezuruike Linus Opara

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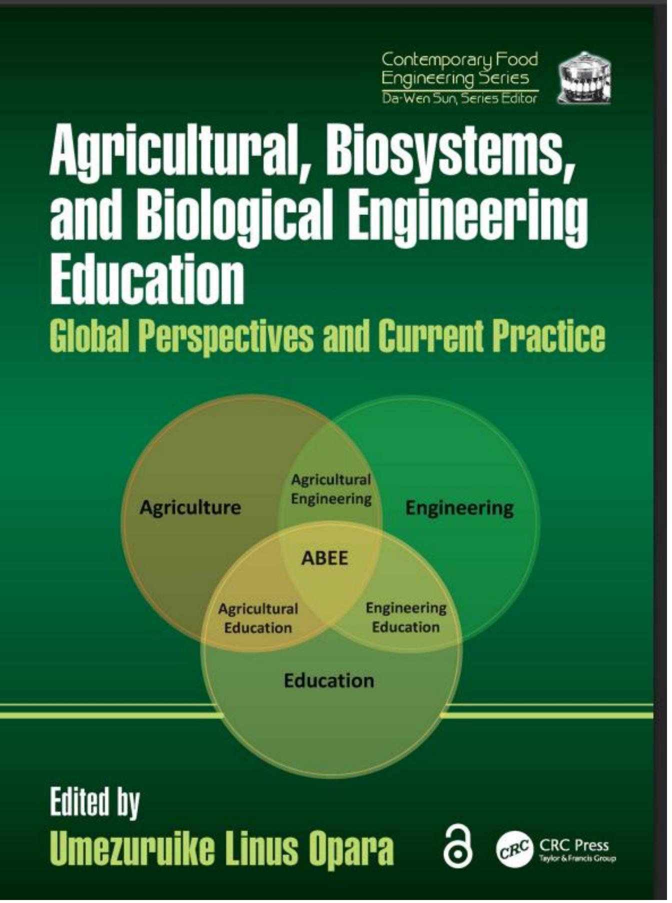

4

Top 100 Questions of Importance to the Future of Agricultural Engineering Education, Research, and Practice in Africa

Umezuruike Linus Opara

Introduction

The African continent's strategic plan for socioeconomic development, titled "Agenda 2063 – The Africa We Want" (African Union, 2022), was approved by the African Union in 2013. Agenda 2063's objectives, aspirations, and focus areas stress the necessity of modernising agriculture for higher output and productivity to create an Africa that is wealthy due to an equitable growth and sustainable development. At the African Union Summit in Malabo, Equatorial Guinea, in June 2014, heads of state and government established a remarkable set of realistic concrete targets for agriculture to advance Agenda 2063. The Malabo Declaration on "Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods" outlines a fresh set of goals that display a more focused strategy for achieving the agricultural transformation agenda for the African continent, which

various initiatives, including but not limited to promoting sustainable and dependable production methods, offering relevant knowledge, information, and skills to beneficiaries, improving water management systems with a focus on irrigation, ensuring accessible, dependable, and affordable mechanisation and energy resources, and reducing current postharvest losses by half.

To accomplish the ambitious goals set by transforming and modernising the continen food systems for inclusive growth and sus ment, Africa needs agricultural engineers a experts. No other academic discipline or oc equipped to lead the mechanisation, digitisa sation, and industrialisation of African agr a knowledge-intensive, profitable, and sust drive Africa's Green Revolution, there is a cant number of exceptional young male an

Agricultural Engineering in the Context of SDGs: A Quest for Global Relevance

By Kehdinga George Fomunyam, Umezuruike Linus Opara

Book Agricultural, Biosystems, and Biological Engineering Education

Edition	1st Edition
First Published	2024
Imprint	CRC Press
Pages	13

Sha

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Growing Agricultural Engineering in Africa: Students' Attitudes, Perceptions, and Expectations on Agricultural Engineering Education

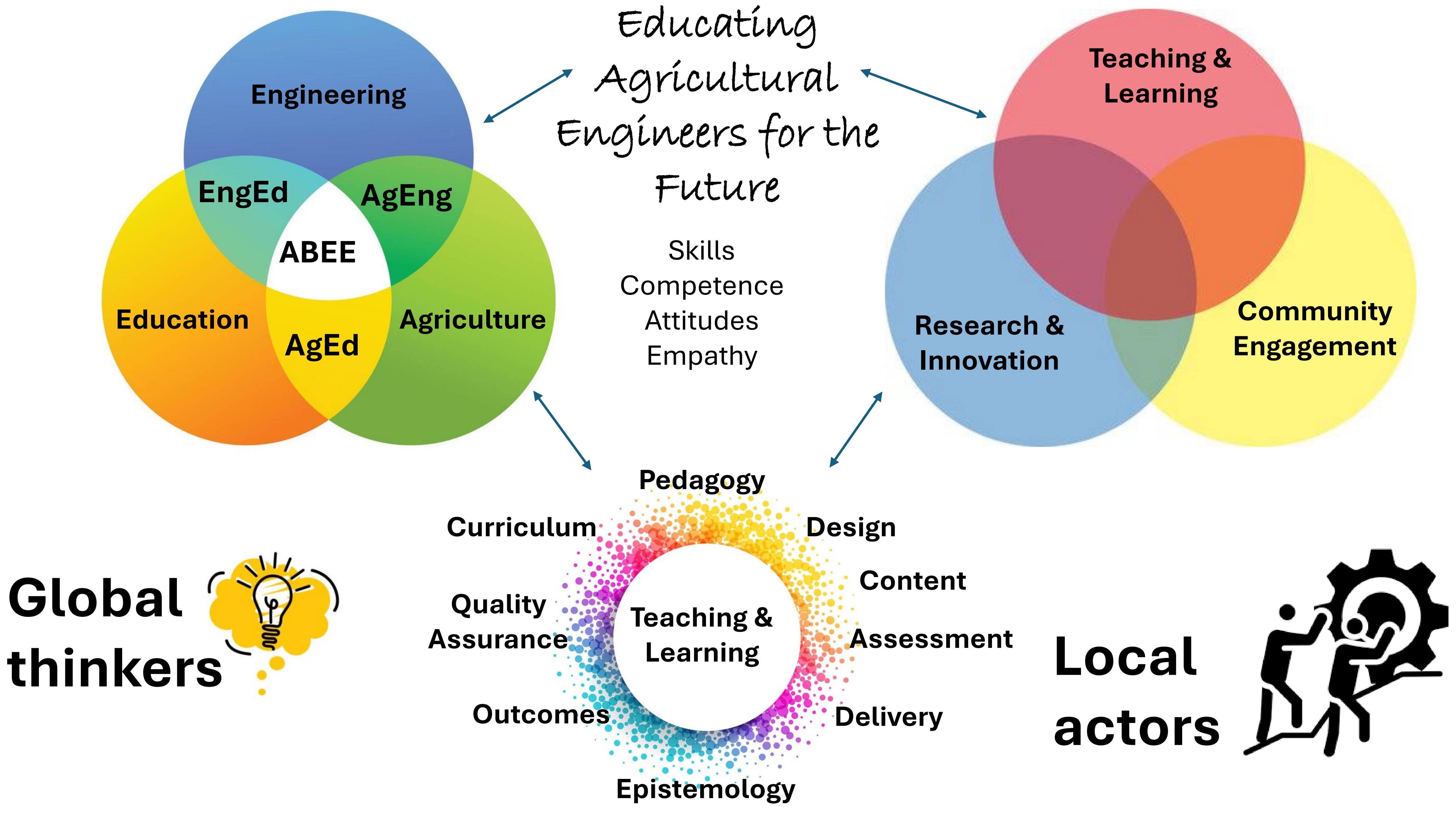
Umezuruike Linus Opara

Introduction

Agriculture is a critical component of the economy of many African countries, often contributing to over 45% of the gross domestic product (GDP) and providing a source of livelihood for over 70% of the population. Accordingly, the African Union's Agenda 2063 – the Africa We Want, the masterplan for transforming the continent into a global powerhouse of economic prosperity, has identified the modernisation of agriculture for increased productivity and production as a strategic goal. During the launch of the Comprehensive Africa Agriculture Development Programme (CAADP), the former President of Nigeria, His Excellency General Olusegun Obasanjo, noted that "Improving agricultural performance is at the heart of improved economic development and growth, and its role in poverty eradication and in the restoration of human dignity can never be over-emphasised". Agricultural engineering education and research have critical roles to play in achieving the aspirations of Agenda 2063 and the goals of CAADP.

academia, students, policy makers, the private sector, etc. Understanding the factors which drive student choices and those factors which enhance retention is essential. Studies in New Zealand (Opara, 2003a,b) and the Sultanate of Oman (Opara, 2006; Opara et al., 2006) have provided insights on student perceptions of the AgEng discipline and academic programmes, including curriculum content and attitudes towards professional identity. These studies highlighted the low preference for and poor image of the AgEng academic programme among students and a perceived low profile of the discipline among the public. Students also offered fresh insights on how to enhance the quality of AgEng education, including curriculum reform and implementing dedicated stakeholder awareness programmes to raise the profile of the discipline and profession.

The critical role of agricultural engineering education and research as a key driver in transforming and modernising African agriculture for socio-economic development cannot be over-emphasised. The relevance of agricultural engineering in achieving the United Nations Agenda 2030 Sustainable

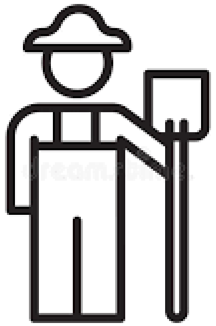


Educating Agricultural Engineers for the Future
Skills
Competence
Attitudes
Empathy
Engineering
EngEd
AgEng
ABEE
Education
Agriculture
AgEd
Teaching & Learning
Research & Innovation
Community Engagement
Pedagogy
Curriculum
Design
Content
Quality Assurance
Teaching & Learning
Assessment
Outcomes
Delivery
Epistemology
Global thinkers
Local actors

How Do You Know an Educated Agricultural Engineer?

Engineer?

Agriculturist?



Generalist/Others?

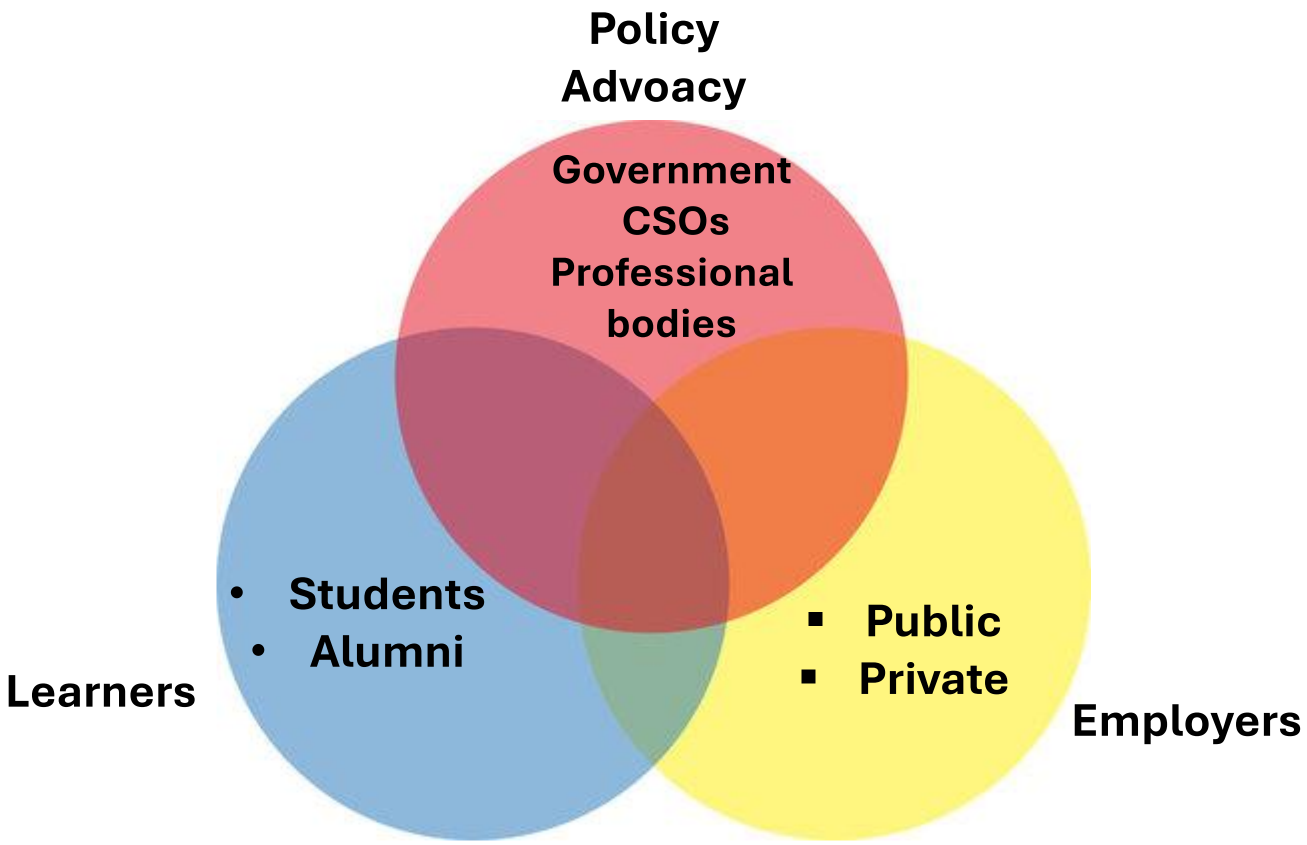
That 'drop down' menu problem!

- System Integrators
- Real Life Problem Solvers
- Life-long Learners

The Class of 1987 @ UNN: A Case Study

- Bachelor of Engineering (AgEng)
- Majors 1987
  - Farm Power & Machinery (FPM)
  - Soil & Water
  - Farm Structures & Environment (FSE)
  - Processing & Storage
- Careers in 2025
  - Professor of Postharvest Technology (FPM)
  - Professor of Industrial and Manufacturing Engineering ((FSE)
  - Professor of Food Engineering, Prof. of Biomedical Engineering (PS)
  - Highway Engineer (FPM)
  - Senior Executive/Manager, Heavy Machinery Company (SW)

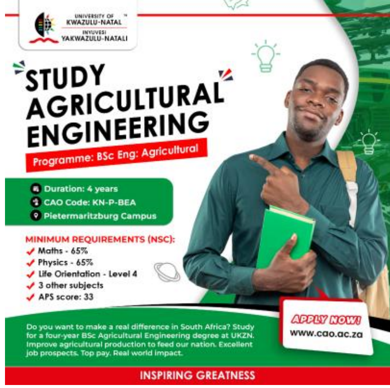
Engage the Multi-Stakeholders



As Key Issues Remain, New Ones Emerge

Challenges and Trends	Tech Innovation to the Rescue
○ Food systems failure ○ Climate change ○ Environmental degradation and pollution ○ Rising population and urbanization ○ Rising unemployment and under-employment ○ Labour shortages ○ Water and energy insecurity ○ Poor soil health ○ Declining agricultural terms of trade ○ The smallholder agriculture problem: why scale matters	✓ Information technologies ✓ Biotechnology ✓ Nanotechnology ✓ Mechanization, automation & robotics ✓ Alternative food sources ✓ Alternative production systems ✓ Computational thinking ✓ Artificial intelligence

The Class of 2025 AgEng @ UKZN: Tomorrow is Calling



May 9, 2012

The Top Majors For The Class Of 2022

Eight year olds of today, meet the college majors of tomorrow. Here's our predictions for the top majors for the high school class of 2022.

By Alex Knapp Forbes Staff Science May 9, 2012,02:18pm EDT

I write about the future of science, technology, and culture.

And now, without further ado, when you're thinking about majors, here are the ones to focus on:

1. **Math**
2. **Robotics**
3. **Agricultural Engineering**
4. **Hospitality Management**
5. **Health and Biotechnology**
6. **Pre-Law, With A Focus On Elder Law**
7. **Quantum Engineering**
8. **3-D Printing Design**
9. **The Liberal Arts**
10. **Aerospace Engineering**

The future of food is going to be a major challenge. Between climate change, population growth, and people thinking its a good idea to plant grass in desert cities, fresh water supplies will be increasingly scarce and the amount of land available to farming will shrink. In the meantime, as more and more countries get richer, they demand higher-priced, better tasting foods that in turn put even more pressure on a straining agricultural system. This will lead to the rise of Agricultural Engineering - a profession focused on developing better and more sustainable ways to grow food to meet the needs of the world. Just avoid working for the Soylent Corporation after you graduate.

https://www.forbes.com/sites/alexknapp/2012/05/09/the-top-majors-for-the-class-of-2022/?sh=6a89081a322f

OCCUPATIONAL OUTLOOK HANDBOOK

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Agricultural Engineers

PRINTER-FRIENDLY

Summary | What They Do | Work Environment | How to Become One | Pay | Job Outlook | State & Area Data | Similar Occupations | More Info

Summary

Quick Facts: Agricultural Engineers	
2024 Median Pay	$84,630 per year $40.69 per hour
Typical Entry-Level Education	Bachelor's degree
Work Experience in a Related Occupation	None

What Agricultural Engineers Do

Agricultural engineers solve problems concerning power supplies, machine efficiency, the use of structures and facilities, pollution and environmental issues, and the storage and processing of agricultural products.

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook,* Agricultural Engineers, at https://www.bls.gov/ooh/architecture-and-engineering/agricultural-engineers.htm (visited *October 27, 2025*)

Work Environment

Agricultural engineers work mostly in offices, but may spend time traveling to agricultural settings. Agricultural engineers typically work full time.

How to Become an Agricultural Engineer

Agricultural engineers typically need a bachelor's degree in an engineering field, such as agricultural or biological engineering.

Pay

The median annual wage for agricultural engineers was $84,630 in May 2024.

Job Outlook

Employment of agricultural engineers is projected to grow 6 percent from 2024 to 2034, faster than the average for all occupations.

About 100 openings for agricultural engineers are projected each year, on average, over the decade. Many of those openings are expected to result from the need to replace workers who transfer to different occupations or exit the labor force, such as to retire.

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Growing Agricultural Engineering By Building Africa's Capacity Through Postharvest Technology Research & Innovation

A Case Study on Value Chain Integration through AgEng Research and Capacity Building

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JOU KENNISVENNOOT • YOUR KNOWLEDGE PARTNER

South African Research Chair in Postharvest Technology

Innovation linking production to markets

SARChI Postharvest
South African Research Chair in Postharvest Technology

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- Postgraduate Studies
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- Events & Conferences
- Partners & Collaborator
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- Cape Town
- Stellenbosch
- Stellenbosch University
- Postharvest Technology
- Packaging Technology
- PRADA
- Postharvest Team

South African Research Chair in Postharvest Technology
Department of Horticultural Science
Faculty of AgriSciences
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home
research
training
events
partners
contact

SARChI Postharvest
South African Research Chair in Postharvest Technology

SARChI Postharvest @ Stellenbosch University

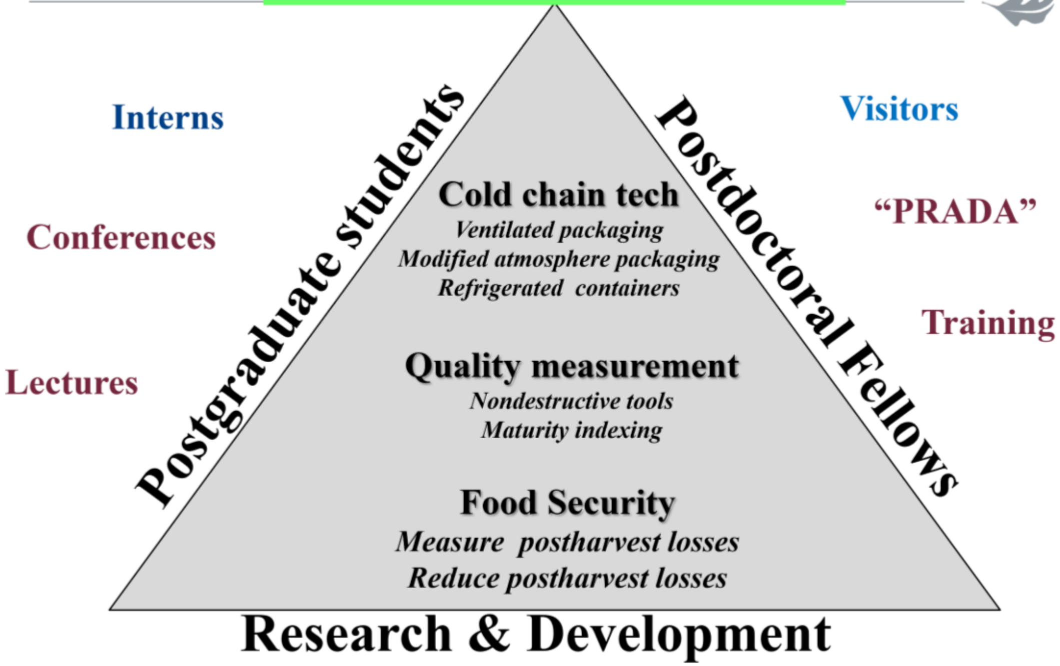
Vision

A leading international centre for postharvest technology research and innovation

What we will do

- Human capacity development
- Advanced research and publications
- Networking and knowledge exchange

How we will do it



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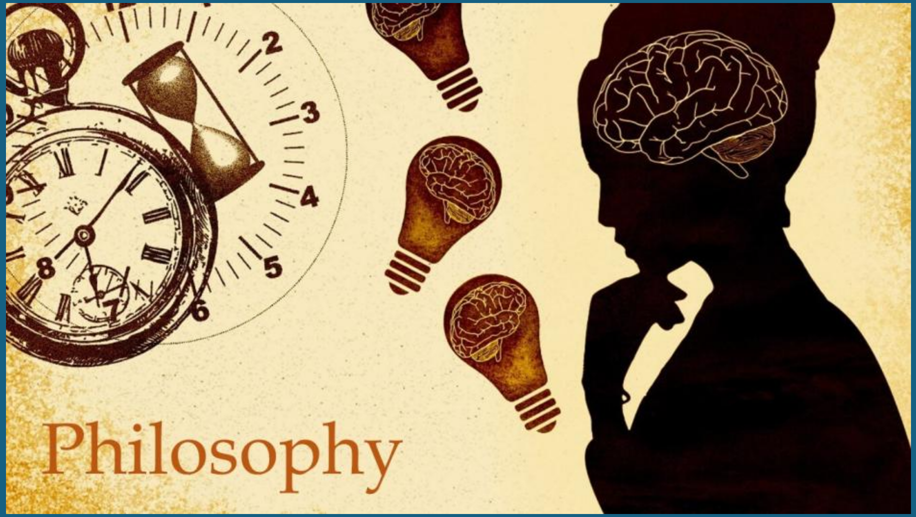
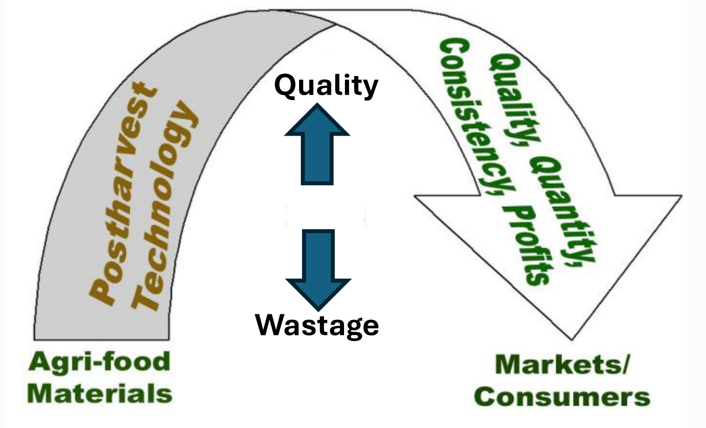
Our Philosophy & Approach



SARChI Postharvest

South African Research Chair in Postharvest Technology



- ✓ Relevance
- ✓ Quality, Excellence
- ✓ Socio-economic impacts
- ✓ Afro-centric, Pan Africa

Link production to markets

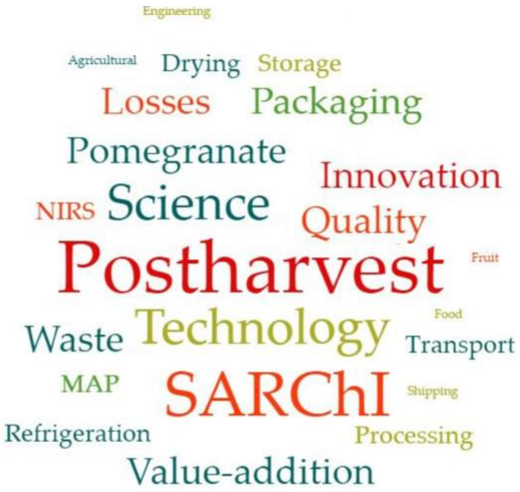
Integrated value chain approach

Partnerships

Make every harvest count

One crop at a time

Transdisciplinary



Collaboration

Build programmes and develop projects

One value chain at a time

Networks

Build capacity along the value chain

Vision

A leading international centre for postharvest technology research and innovation

SARChI Postharvest

South African Research Chair in Postharvest Technology

What we did

- Developed capacity: human, infrastructure & institutional
- Advanced research, publications, and technologies (solutions)
- Trained people: experiential learning
- Built partnerships and networks

From Vision to Action

Interdisciplinary Team Science (ITS)

Biochemistry
Microbiology
Botany
Chemistry & Polymer Science

- Microbial analysis
- Phytochemicals
- Edible coatings
- Nanoscience/fibers
- Analytical facilities

Mechanical & Mechatronic
Electrical & Electronic

- Mechanical damage
- Packaging technology
- Solar drying technology
- Reefer/Containerization
- Non-destructive testing
- Biosensors

Sustainability Institute

- Postharvest losses
- Food waste

SARChI Postharvest

Food Science
Horticultural Science
Plant Pathology
Genetics
Animal Science
Viticulture & Oenology
Sustainable Agriculture

- Food waste
- Postharvest losses
- Pomegranate diseases
- Drying technologies
- Non-destructive testing
- Sensory analysis

- Refrigerated storage
- Controlled atmosphere storage
- Ventilated packaging
- Modified atmosphere packaging
- Reefer/containerization
- Processing & value addition
- Pomegranate wine biotechnology

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Our Actions

I. Programming research

II. Building capacity

III. Building networks and partnerships

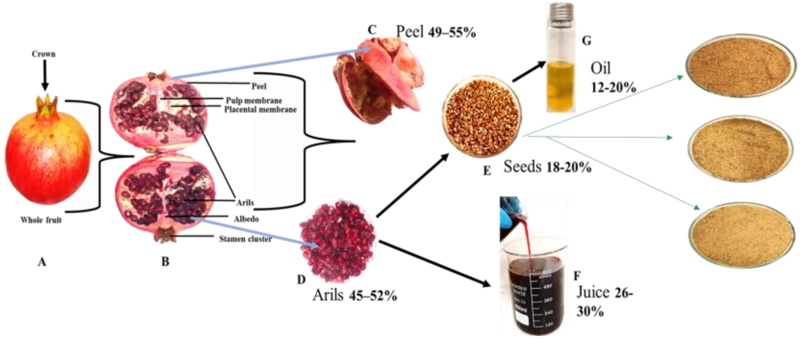
IV. Training & experiential learning

- Mapping & Reducing Postharvest Losses and Food Waste

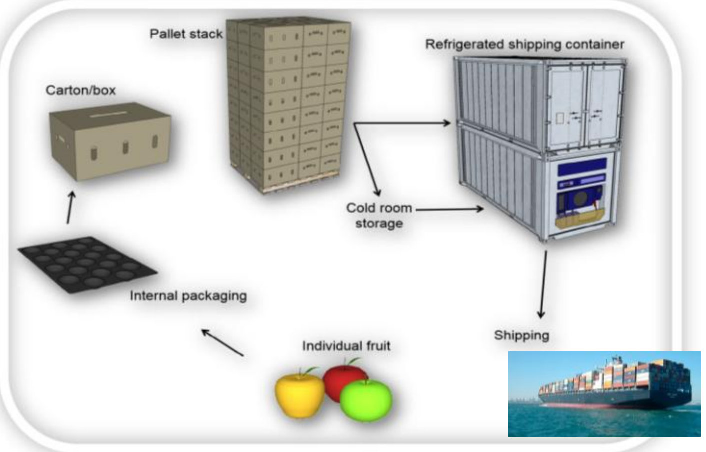
Research Programmes

- Maturity Indexing, Quality Measurement & Control

- Postharvest Technology & Volarisation of Pomegranates



- Packaging & Cold Chain Technologies



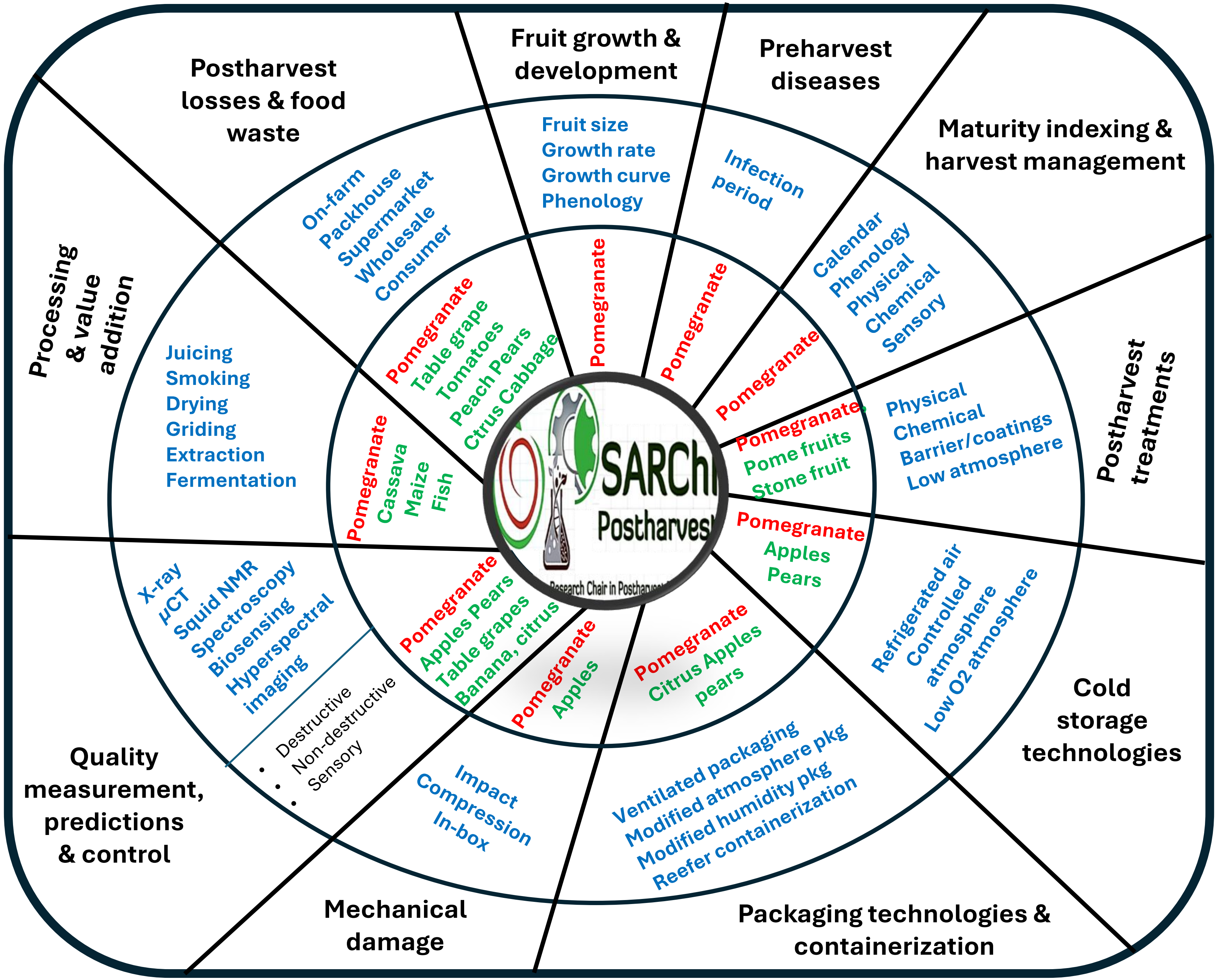
SARChI Proposal

Research Projects

Interdisciplinary

Integrated

Value chain



Building Capacity

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Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Building Africa's Science, Technology and Innovation Capacity

Umezuruike Linus Opara
DSI-NRF SARChI Chair

Laureate – IMPRESSA Award, RUFORUM
Laureate – AU Kwame Nkrumah Prize for Life & Earth Science
President, AfroAgEng – the Pan African Society for Agricultural Engineering

RUFORUM

RUFORUM Triennial Conference
Cotonou, Benin
8 December, 2021

unesco

Human Capacity

BSc/MSc/BEng/PhD Graduates

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Building Africa's Capacity to Reduce Postharvest Losses and Food Waste

Umezuruike Linus Opara

Distinguished Professor & SARChI Chair in Postharvest Technology
Laureate – AU Kwame Nkrumah Prize for Life & Earth Sciences

UNIVERSITY of GREENWICH

International Conference on Food and Nutrition Security in Africa
Food and Nutrition Security Initiative (FaNSI)
Natural Resources Institute (NRI)
20 February 2024

unesco
International Centre for Biotechnology, Nsukka

Institutional Capacity

Researchers, Lecturers, Postdocs, Technical Officers, PDF, AIPhT

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

SARChI Postharvest Technology at Stellenbosch University

Building Africa's Capacity in Postharvest Technology & Innovation

Transforming specific value chains through transdisciplinary research underpinned by capacity building

SARChI Postharvest

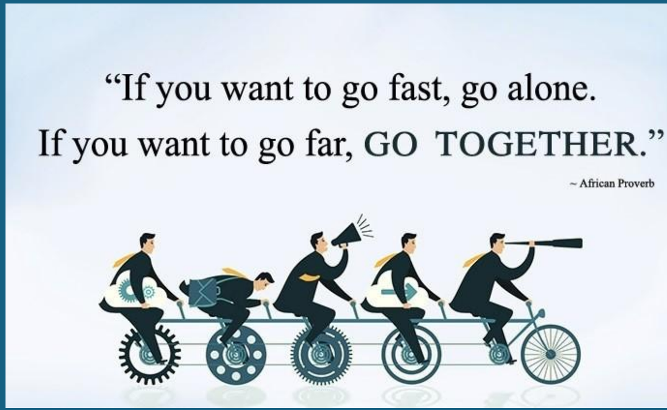
Infrastructural Capacity

Labs, facilities, equipment, protocols

Building networks and partnerships

- Private sector
- Public sector
- Private-public partners
- Development agencies
- Philanthropic organisations
- Professional bodies

- Research funding
- Scholarships/bursary
- Access facilities /equipment
- Research expertise/training
- Supply of raw materials
- Joint supervision
- Access information/experts



science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

NRF
National
Research
Foundation

PPECB

THE INNOVATIONHUB
Innovation Catalyst for Gauteng City Region
A subsidiary of the Gauteng Growth and Development Agency

the dtic
Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

POMASA
POMEGRANATE ASSOCIATION
OF SOUTH AFRICA

Alterna-FRUiT

EM
BIOGOLD
the variety network

CITROGOLD

CSIR
our future through science

SATI
SOUTH AFRICAN TABLE
GRAPE INDUSTRY

Nampak
packaging excellence

HORTGRO
Growing Fruit IQ
science

AGRI EDGE

Apples & Pears
Tru-Cape
SOUTH AFRICA

APL
CARTONS
NIKS IS ONMOONTLIK NIE
NOTHING IS IMPOSSIBLE

cri
citrus
research
international

POST-HARVEST
INNOVATION PROGRAMME
a public-private partnership between
science & innovation
fpef
FRESH PRODUCE
EXPORTERS' FORUM

UNIVERSITY OF JOHANNESBURG

KATHOLIEKE UNIVERSITEIT LEUVEN

ETH zürich

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

Cranfield University

IOWA STATE UNIVERSITY

UNIVERSITEIT-STELLENBOSCH-UNIVERSITY
HOPE PROJECT

Stellenbosch University Food Security Initiative (FSI)

UNIVERSITY OF SHANGHAI FOR SCIENCE AND TECHNOLOGY
1906
上海理工大學

Cape Peninsula University of Technology

THE UNIVERSITY OF SYDNEY

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

AAA Short Course in Post-harvest Management of Maize, Rice and Legumes. Australia Awards in Africa

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INTERNATIONAL CENTER FOR BIOTECHNOLOGY
NSUKKA, NIGERIA

CONSORTIUM
FOR
INNOVATION IN POST-HARVEST LOSS & FOOD WASTE REDUCTION
Preserving nutrients, improving livelihoods, and realizing an efficient food system

Build Research Capacity at the Agricultural Research Council of Nigeria through Postgraduate Education

World Bank West Africa Agricultural Productivity Programme (WAAP)

Sharing Capacity to Build Capacity for Quality Graduate Training in Agriculture in African Universities

European Commission - Intra Africa Mobility, 2012-2017

Professional Networks

Society/Association	Role
International Commission of Agricultural & Biosystems Engineering (CIGR)	EXCO, Presdent Honorary Vice President Section Chair: Postharvest & Bioprocesses
International Academy of Agricultural & Biosytems Engineering (iAABE)	Executive Secretary Fellow
International Society for Horticultural Science (ISHS)	EXCO Chair: Roots & Tuber Chair: Working Group on Quality in Chains
Institute of Food Technologists (IFT)	Certified Food Technologist
Pan Africa Society for Agrultural Engineering (AfroAgEng/PASAE)	Founding President
Institution of Agricultural Engineers (UK)	Fellow
South African Institution of Agricultural Engineers	Fellow
Nigerian Institution of Agricultural Engineers	Fellow
American Society of Agricultural & Biological Engineers	Life Member
Indian Society of Agricultural Engineers	Life Member
Asian Association for Agricultural Engineering	Life Member
Southern Africa Soc of Hort Sciences*, South African Assoc for Food Sci & Tech*, Institute of Packaging SA*	

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Our Outputs

I. Research and innovation

II. Capacity building

Building Capacity in Postharvest Science, Technology & Innovation

Food Packaging and Shelf Life 46 (2024) 101380

Contents lists available at ScienceDirect

Food Packaging and Shelf Life

journal homepage: www.elsevier.com/locate/fpsl

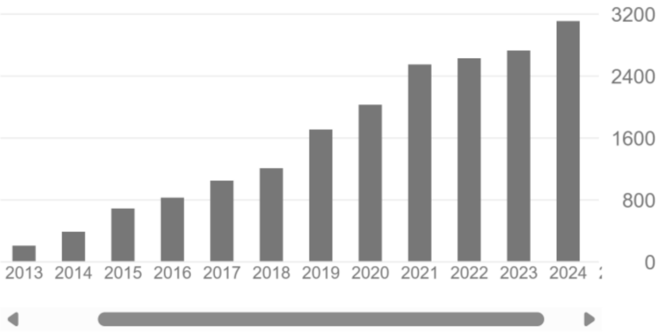
Sustainable package design for efficient pomegranate cold chain: Enhancing storage space, sea freight efficiency, material sustainability, and energy conservation

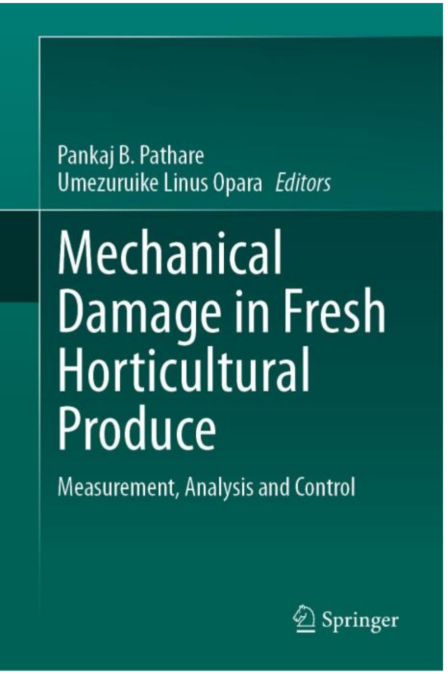
Matia Mukama [a,1], Alemayehu Ambaw Tsige [a,*], Robert Lufu [a], Umezuruike Linus Opara [a,b,**]

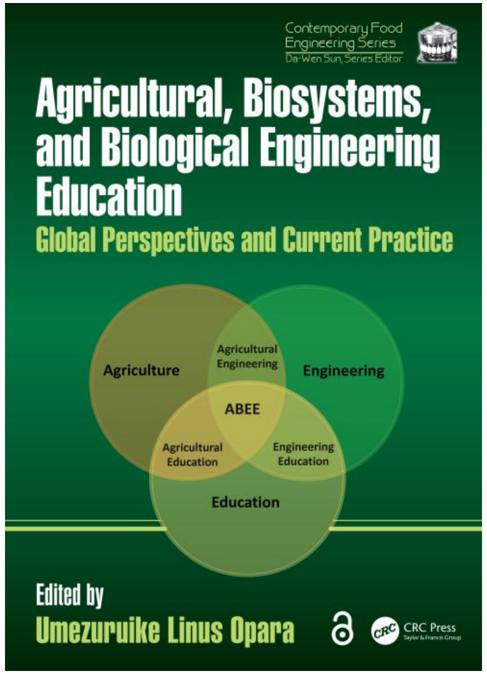
[a] Department of Horticultural Sciences, SARChI Postharvest Technology Research Laboratory, Africa Institute for Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Stellenbosch 7602, South Africa

[b] UNESCO International Centre for Biotechnology, Nsukka, Enugu 410001, Nigeria

	All	Since 2020
Citations	20105	13736
h-index	75	59
i10-index	234	215







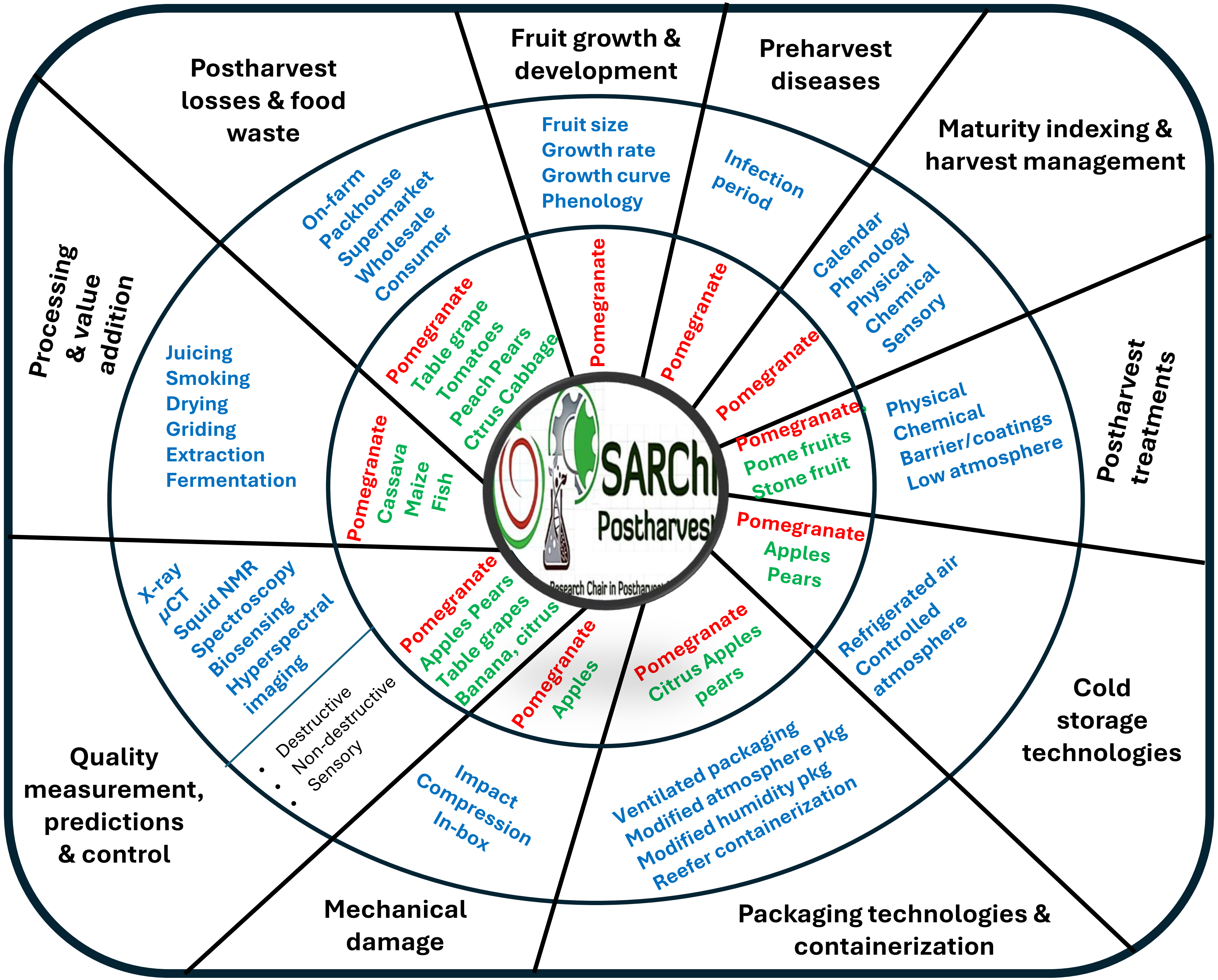
https://scholar.google.ca/citations?hl=en&tzom=-120&user=eNlSO_oAAAAJ

Research Projects

Interdisciplinary

Integrated

Value chain



The Pomegranate Story

- an integrated circular bioeconomy approach to R4I

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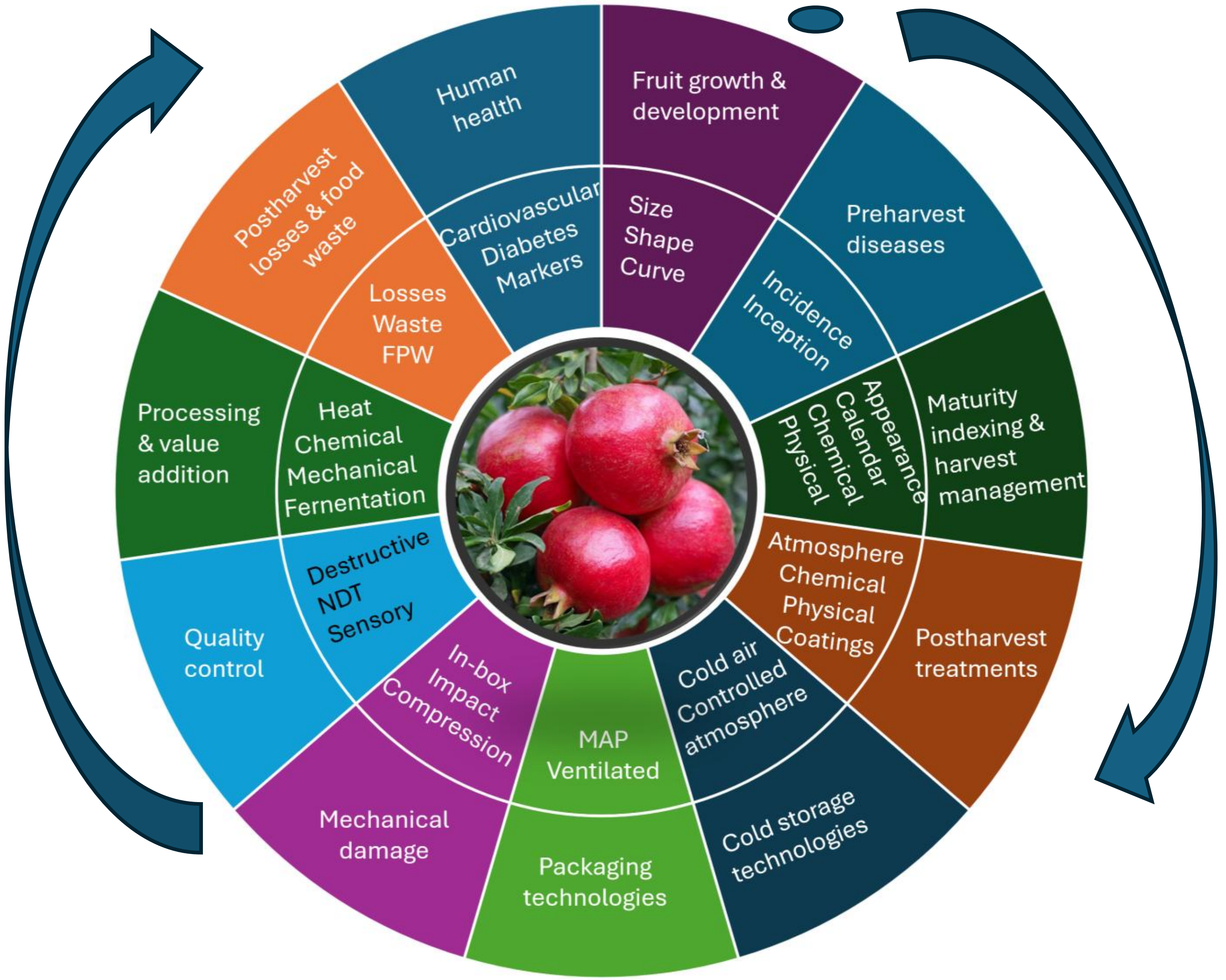
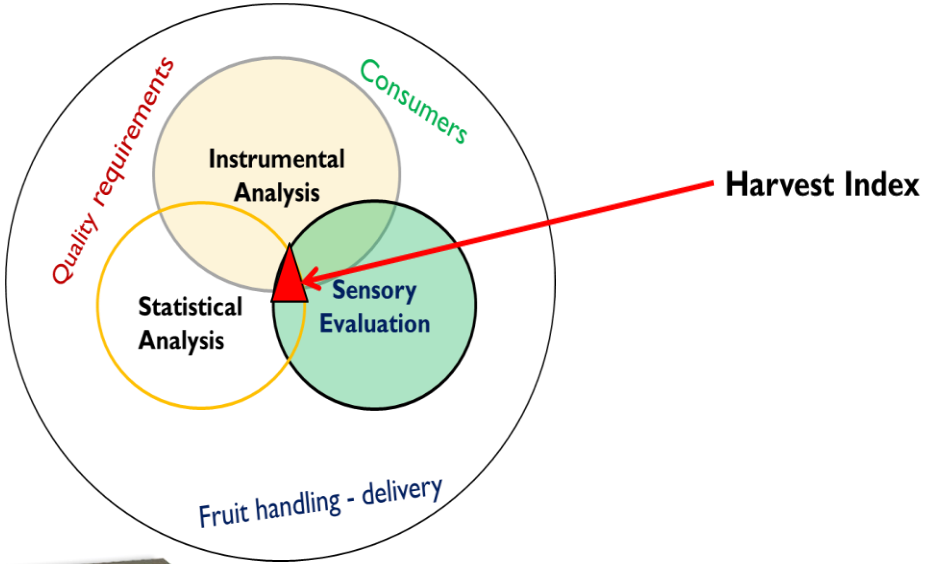
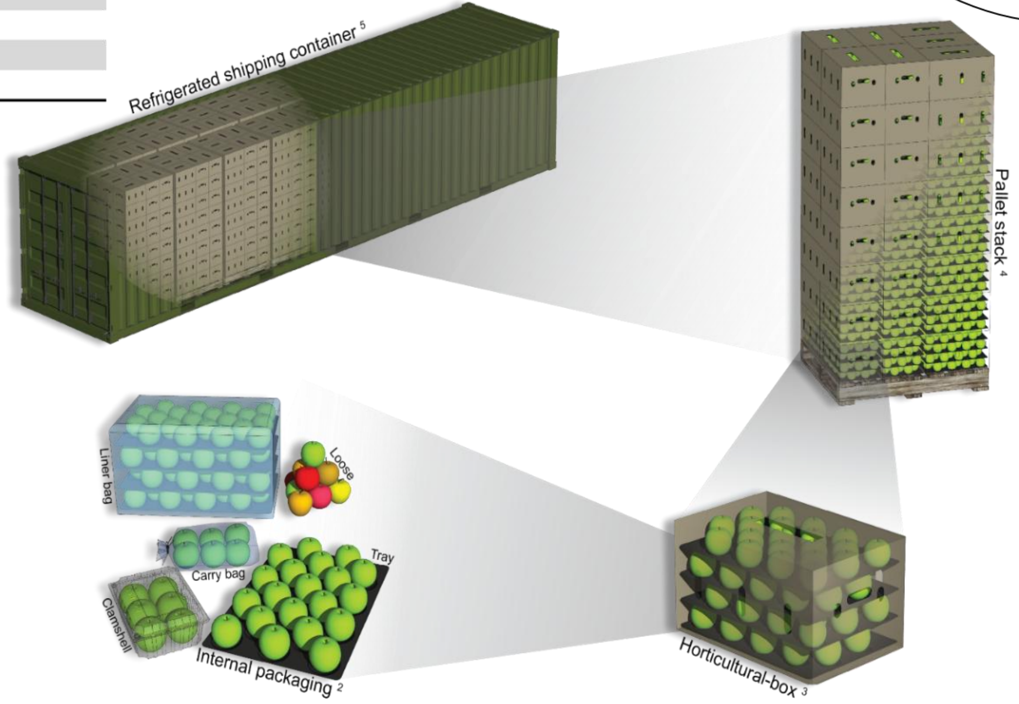
Saving the harvest and linking production to markets, one crop at a time



Point-to-point	Days to export markets
Orchard to Packhouse	3 – 7
Packhouse build-up for container	3 - 7
Stacks to departure	3
Voyage	24
Arrival to de-stuffing	1 – 5
Warehouse/Depot to supermarket	3 – 5
Best before days/Shelf life	5 - 7
Total days	42 - 58





Market-Inspired Research

Scientia Horticulturae 157 (2013) 90–98

Contents lists available at SciVerse ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Fruit growth dynamics, respiration rate and physico-textural properties during pomegranate development and ripening

Olaniyi A. Fawole, Umezuruike L. Opara*

Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa

ARTICLE INFO

Article history:
Received 7 December 2012
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Keywords:
Fruit growth
Pomegranate
Respiration
South Africa
Total colour difference

ABSTRACT

The time course and pattern of fruit growth and changes in physical, physiological properties and texture dynamics of pomegranate fruit (cvs. 'Bhagwa' and 'Ruby') along the days after full bloom (DAFB) were studied over two different year seasons. Significant variations in fruit growth, respiration rate and physico-textural properties of the fruit were found at five maturity stages (S1–S5). Fruit lineal dimensions (length and diameter) exhibited a linear growth pattern and the fruit weight followed a similar pattern. Both fruit cultivars showed a decline in respiration rate during fruit development, with the highest respiration rate measured in immature fruits ('Bhagwa', 66.83 mL CO_2 kg^{-1} h^{-1}; 'Ruby', 51.17 mL CO_2 kg^{-1} h^{-1}) and declining with maturity to minimum rates in fully ripe fruit (stage 5) (S5) ('Bhagwa', 23.84 mL CO_2 kg^{-1} h^{-1}; 'Ruby', 19.16 mL CO_2 kg^{-1} h^{-1}). No ethylene gas was detected throughout fruit development. Fruit pigmentation increased with advancing maturity and the lowest total colour difference (TCD) between fruit peel and arils was noted in immature fruit. Textural dynamics of aril revealed increasing trend in bioyield force and elasticity with advancing maturity. Overall, the study indicated that fruit reached mature stage between the 132–139 DAFB for 'Ruby' and 140–165 DAFB for 'Bhagwa'. This period could be regarded as the physiological mature stage of the fruits that would present the optimum values of harvesting properties desirable in the investigated cultivars. This information could be used as a tool to assist growers in assessing fruit readiness for harvest.

Table 1
Description of fruit maturity at different sampling stages along days after full bloom (DAFB).

Stage	DAFB (Month)		Description of maturity stages
	'Bhagwa'	'Ruby'	
S1	54 (January)	54 (January)	Immature: Green skin, immature white arils with immature kernels
S2	82 (February)	82 (February)	Mature/unripe: Light-red skin, mature white arils with mature kernels
S3	110 (March)	110 (March)	Mature/semi-ripe: Red skin, mature pink arils with mature kernels
S4	140 (April)	132 (April)	Mature/ripened: Red skin, mature red arils with mature kernels
S5	165 (May)	139 (April)	Mature/full-ripened: Deep-red skin, deep-red arils with mature kernels

Fruit growth characteristics of four pomegranate cultivars from northern Oman

Rashid AL-YAHYAI[1]*, Fahad AL-SAID[1], Linus OPARA[2]

[1] Dep. Crop Sci., Coll. Agric. Marine Sci., Sultan Qaboos Univ., PO Box 34, Al-Khoud 123, Oman
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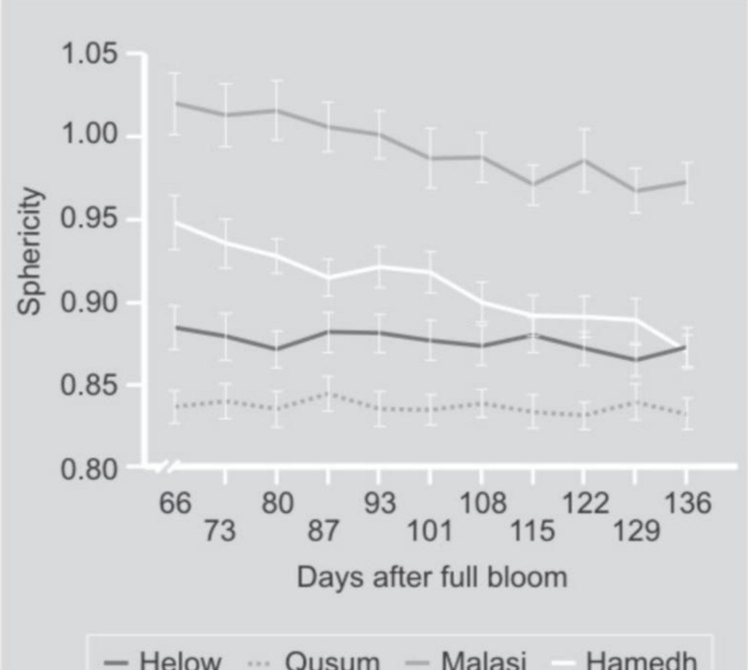
[2] Dep. Horticultural Sci., Fac. AgriSci., Univ. Stellenbosch., PB X1, Stellenbosch 7602, South Africa

Fruit growth characteristics of four pomegranate cultivars from northern Oman.

Abstract — Introduction. Pomegranate (*Punica granatum* L.) is the main and most valuable fruit crop of the northern mountainous region of Oman. Pomegranates are cultivated utilizing traditional farming methods including the determination of harvest dates, harvesting and postharvest handling. **Materials and methods**. Fruit of four native pomegranate cultivars ['Hamedh', 'Malasi', 'Helow' and 'Qusum', literally translated as sour, smooth, sweet and hard-seeded, respectively] were tagged and monitored for 3 months up to commercial harvest. Fruit length (L) and diameter (D) were measured at weekly intervals starting from 66 d after full bloom until harvest (136 d after full bloom). **Results and discussion**. During the time course of fruit growth and development, significant changes occurred in fruit shape assessed by the [fruit length / fruit diameter] ratio in two cultivars ('Malasi' and 'Hamedh'), but not in the 'Helow' and 'Qusum' cultivars, which also had larger fruit size at harvest. The lack of obvious changes in fruit shape during growth and development of 'Qusum' and 'Helow' pomegranate cultivars indicates that the attainment of characteristic fruit shape may not be a good indicator of their maturity for harvest management. Thus, fruit harvesting based solely on size and shape is not sufficient and other physico-chemical fruit attributes should be taken into account when assessing readiness to harvest to ensure optimum income returns to growers.

Oman / *Punica granatum* / fruits / growth rate / developmental stages / harvesting / development indicators

Figure 8.
Fruit shape index (sphericity) of four pomegranate cultivars grown in Oman measured from 66 d after full bloom until harvest (*N* = 15, data point average ± standard error).



Scientia Horticulturae 211 (2016) 126–139

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Review

Major diseases of pomegranate (*Punica granatum* L.), their causes and management—A review

Karen Munhuweyi[a], Cheryl L. Lennox[b], Julia C. Meitz-Hopkins[b], Oluwafemi J. Caleb[c], Umezuruike Linus Opara[a,d,*]

[a] Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa
[b] Department of Plant Pathology, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa
[c] Department of Horticultural Engineering, Leibniz Institute for Agricultural Engineering (ATB), 14469 Potsdam, Germany
[d] Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Science, Faculty of AgriSciences, Stellenbosch University, Stellenbosch 7602, South Africa

ARTICLE INFO

ABSTRACT

Postharvest Biology and Technology 129 (2017) 9–22

Contents lists available at ScienceDirect

Postharvest Biology and Technology

journal homepage: www.elsevier.com/locate/postharvbio

In vitro and *in vivo* antifungal activity of chitosan-essential oils against pomegranate fruit pathogens

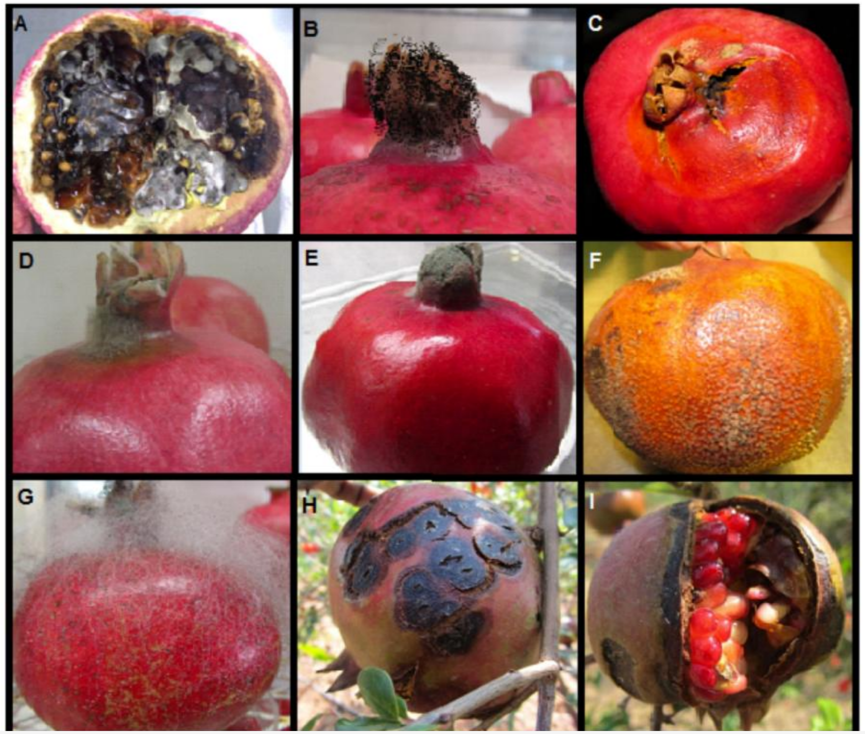
Karen Munhuweyi[a], Oluwafemi J. Caleb[b], Cheryl L. Lennox[c], Albert J. van Reenen[d], Umezuruike Linus Opara[a,e,*]

[a] Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Food Science, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa
[b] Department of Horticultural Engineering, Leibniz-Institute for Agricultural Engineering and Bioeconomy (ATB), Potsdam-Bornim, D-14469 Potsdam, Germany
[c] Fruit and Postharvest Pathology Research Programme, Department of Plant Pathology, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa
[d] Department of Chemistry and Polymer Science, Stellenbosch University, Private Bag X1, Matieland, South Africa
[e] Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Department of Horticultural Sciences, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa

ARTICLE INFO

Article history:

ABSTRACT



Highlights

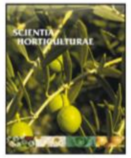
- Functional properties of chitosan films varied with molecular weight of chitosan.
- Essential oils showed inhibitory effects against fungal pathogens of pomegranate.
- Fruit decay inhibition was higher under direct coating than vapour treatments.
- Chitosan-essential oil matrices showed good application potential as active film.

Scientia Horticulturae 159 (2013) 152–161

Contents lists available at SciVerse ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti



Review

Developmental changes in maturity indices of pomegranate fruit: A descriptive review

Olaniyi Amos Fawole, Umezuruike Linus Opara*

Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa

ARTICLE INFO

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Days after full bloom
Harvest
Maturity indices
Total soluble solids
Pomegranate

ABSTRACT

During pomegranate fruit development, advancing maturity stages correspond to a number of coordinated physiological, biochemical, and structural processes that result in changes in size, colour and flavour, ultimately making the fruit desirable for consumption. Optimum fruit maturity is crucial for maintaining high total soluble sugar (TSS) content, good colour and overall fruit quality. Literature on quality indices of pomegranate fruit at commercial harvest is voluminous, but research on changes that occur during fruit developmental processes in terms of physico-chemical, physiological and sensory aspects also needs to be taken into consideration for the development of optimum maturity index for pomegranate cultivars. A few studies have reported on the effects of cultivar difference, growing region and maturity status on fruit harvest maturity and eating quality. This review attempts to discuss current knowledge on the changes which occur in fruit maturity indices during development of pomegranate cultivars.

A science-based maturity index for pomegranate cultivars other than 'Wonderful' is not currently available. Current scientific knowledge that has been accumulated on the physico-chemical and physiological attributes of fruit maturity needs to be harnessed towards the development of a reliable maturity indices by correlating changes in fruit physico-chemical attributes during maturation with optimum eating quality and postharvest storage performance of fruit. Extensive review of scientific literature showed that lack of publications in this area. This approach should be thoroughly studied to develop suitable tools for harvest maturity management of fruit to provide consumers with consistent supply of good quality, tasty, flavourful and healthful produce.

S: Sensory & Food

Harvest Discrimination of Pomegranate Fruit: Postharvest Quality Changes and Relationships between Instrumental and Sensory Attributes during Shelf Life

Olaniyi Amos Fawole and Umezuruike Linus Opara

Abstract: Harvest maturity discrimination was carried out for "Ruby" pomegranate cultivar in simulated handling conditions for long distant supply chains. Fruit were harvested at 3 different maturities along days after full bloom (DAFB); Harvest 1 (H1) at 133 DAFB, H2 at 143 DAFB, and H3 at 157 DAFB. The effects of harvest maturity and storage duration on fruit quality attributes during a 6-wk period of cold storage (5°C, 95% RH) and subsequent 5 d of shelf life (20°C, 75% RH) were investigated. Instrumental evaluation of aril color, juice content, juice absorbance (520 nm), total soluble solids (TSS), pH, titratable acids (TA), and phytochemical components including total phenolics, flavonoids, and anthocyanins were carried out. Textural properties of arils which included hardness, toughness, bioyield point, and Young's modulus were also investigated. During the shelf life period, arils from individual fruit were rated by a trained sensory panel based on appearance, taste, and texture. Relationships between the instrumental and descriptive sensory data were explored and fruit harvest maturities were discriminated using discriminant analysis. Among the attributes evaluated, TSS : TA, sweet taste, and the CIE hue angle ($h°$) were the most decisive attributes distinguishing the harvest maturities. The optimum time for harvesting was at 143 DAFB (H2) when fruit TSS : TA ratio was > 55, which coincided with significantly higher rating for sweet taste in fruit at H2 than at H1 and H3 during shelf life. The harvest index proposed in the current study could be used as a guide to establish a reliable harvest maturity index to assist in assuring fruit quality in consideration of long supply chains for the investigated cultivar.

Keywords: discriminant analysis, harvest index, pomegranate, sensory attributes, storage

Practical Application: The harvest index proposed in the current study could be used as a guide to establish a reliable harvest maturity index to assist in assuring fruit quality in consideration of long supply chains for the investigated cultivar. In addition, the current study provides a basis for future studies towards the development of science-based tools for determining optimum fruit maturity and postharvest handling protocols for pomegranate cultivars grown globally.

Journal of Food Science
Volume 78, Issue 8
Aug 2013
Pages i-iv, R1095-T1320

Modified Atmosphere Packaging (MAP)

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

- Early intervention to assure quality and reduce rejects during exp

Food Bioprocess Technol (2012) 5:15–30
DOI 10.1007/s11947-011-0525-7

REVIEW PAPER

Modified Atmosphere Packaging of Pomegranate Fruit and Arils: A Review

Oluwafemi James Caleb · Umezuruike Linus Opara · Corli R. Witthuhn

Received: 8 December 2010 / Accepted: 24 January 2011 / Published online: 12 February 2011

Abstract Ongoing global drive for a healthier diet has led to a rise in demand for convenient and fresh food produce, with high nutritional value and free of additives. Minimally fresh processed fruits and vegetables, satisfies the consumers' perception of a high nutritional quality and convenience produce. Minimally processed fruit and vegetables are susceptible to increased deterioration in quality and microbial infestation due to increase in endogenous enzymatic processes and respiration rate. Modified atmosphere packaging (MAP) technology offers the possibility to retard produce respiration rate and extend the shelf life of fresh produce. However, it is important to correlate the permeability properties of the packing films with the respiration rate of the produce, in order to avoid anaerobic conditions which could lead into fermentation of produce and accumulation of ethanol. Hence, mathematical prediction modelling is now widely applied in the design and development of effective MAP technology in both whole and minimally processed fresh produce. With increasing global interest in postharvest handling and nutrition value of pomegranate, MAP of minimally processed pomegranate arils offers additional innovative tool for optimal use and value addition, including the utilization of lower-grade fruit with superficial peel defects such as; cracks, splits, and sunburnt. This review paper highlights the current status and applications of modified atmosphere packaging in whole fruit and minimally processed pomegranate arils and identifies future prospects.

Introduction

During the last decade, there has been a remarkable increase in the commercial farming of pomegranates globally, due to the potential health benefits of the fruit (Hess-Pierce and Kader 2003; Holland and Bar-Ya'akov 2008) such as, its high antioxidant, anti-mutagenic, anti-hypertension activities, and the ability to reduce liver injury (Du et al. 1975; Tsuda et al. 1994; Lansky et al. 1998; Gil et al. 1996a). Pomegranate anthocyanins have been demonstrated to scavenge hydroxyl (OH^-) and superoxide (O^-) radicals, preventing lipid peroxidation in rat brain homogenates (Noda et al. 2002). Also, the plasma antioxidant status of humans fed pomegranate juice was observed to be higher than those of the control subjects (Seeram et al. 2005). This observation suggests that pomegranate polyphenolic compounds are able to elevate the antioxidant capacity of the body. Pomegranate fruit is also known for its anti-inflammatory and anti-atherosclerotic effect activity against osteoarthritis, prostate cancer, heart disease and HIV-1 (Malik et al. 2005; Neurath et al. 2005; Sumner et al. 2005). The edible portion of pomegranate is an excellent dietary source it contains a significant proportion of organic acids, soluble solids, polysaccharides, vitamins, fatty acids and mineral elements of nutritional significance (Ewaida 1987; Fadavi et al. 2006). Furthermore, different varieties of pomegranate fruit have been report to have a high content

Food Bioprocess Technol (2013) 6:303–329
DOI 10.1007/s11947-012-0932-4

REVIEW PAPER

Modified Atmosphere Packaging Technology of Fresh and Fresh-cut Produce and the Microbial Consequences—A Review

Oluwafemi J. Caleb · Pramod V. Mahajan · Fahad Al-Julanda Al-Said · Umezuruike Linus Opara

Received: 14 January 2012 / Accepted: 9 July 2012 / Published online: 27 July 2012

Abstract Modified atmosphere packaging (MAP) technology offers the possibility to retard the respiration rate and extend the shelf life of fresh produce, and is increasingly used globally as value adding in the fresh and fresh-cut food industry. However, the outbreaks of foodborne diseases and emergence of resistant food-borne pathogens in MAP have heightened public interest on the effects of MAP technology on the survival and growth of pathogenic organisms. This paper critically reviews the effects of MAP on the microbiological safety of fresh or fresh-cut produce, including the role of innovative tools such as the use of pressurised inert/noble gases, predictive microbiology and intelligent packaging in the advancement of MAP safety. The integration of Hazard Analysis and Critical Control Points-based programs to ensure fresh food quality and microbial safety in packaging technology is highlighted.

Introduction

Global drive for healthier diet, changes in consumer life style and the advancement of retail marketing have led to a remarkable increase in the demand for fresh, healthy and convenient food produce. Fruit and vegetables are often associated with high nutritional quality and freedom from synthetic additives used to preserve and enhance characteristics such as flavour and colour in industrially manufactured foods (Bruhn 2000; Rico et al. 2007; Gialamas et al. 2010). Fresh and fresh-cut fruit and vegetables continue all metabolic processes, and are susceptible to quality deterioration and microbial infestation due to increase in enzymatic activities, transpiration and respiration (Mahajan et al. 2008c; Caleb et al. 2012c). Modified atmosphere packaging (MAP) technology offers the possibility to extend the shelf life of fresh produce, by retarding produce respiration rate, and delaying enzymatic degradation of complex substrates (Kader 1986). Cost-effective MAP

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Food Science & Technology
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Original article

Evaluation of parameters affecting modified atmosphere packaging engineering design for pomegranate arils

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(Received 19 December 2012; Accepted in revised form 4 June 2013)

Summary This study evaluated the effects of passive modified atmosphere packaging design parameters as a function of the amount of product (g), temperature (°C) and time (days) on two pomegranate cultivars. Arils (75, 100 and 125 g) were packed in trays, heat sealed with polylid film and stored at 5, 10 and 15 °C for 14 days, and analysed for physicochemical parameters viz headspace gas composition, weight loss, total soluble solids, titratable acidity, pH, anthocyanin, aerobic-mesophilic bacterial and fungal load (log CFU g^{-1}). At the highest temperature and weight, O_2 concentration continuously decreased below the critical limit (2%) after 4 days, while at 5 °C, this lower limit was not reached. Shelf life of arils was limited to 10, 7 and 3 days by fungal growth ≥2 log CFU g^{-1} at 5, 10 and 15 °C, respectively. Using unsteady-state equation, a good agreement was found between simulated and experimental gas composition data.

Keywords Fruits, microorganisms, modified atmosphere packaging, postharvest.

Food and Bioprocess Technology (2018) 11:1478–1494
https://doi.org/10.1007/s11947-018-2119-0

ORIGINAL PAPER

CrossMark

Design of Active Modified Atmosphere and Humidity Packaging (MAHP) for 'Wonderful' Pomegranate Arils

Zinash A. Belay[1] · Oluwafemi J. Caleb[2,3] · Pramod V. Mahajan[2] · Umezuruike Linus Opara[1,4]

Received: 27 November 2017 / Accepted: 22 May 2018 / Published online: 31 May 2018

Abstract
Modified atmosphere packaging (MAP) systems have been shown as beneficial to prolong postharvest life of pomegranate arils. Current application of such system is limited due to a lack of appropriate packaging films which are able to control in-package moisture condensation. Therefore, the aim of this study was to design a MAP system to balance the optimum gas composition with packaging film permeability as well as optimum in-package relative humidity (RH). The following packaging materials design were used: (i) 100% cellulose-based film NatureFlex (NF), (ii) bi-axial-oriented polypropylene (BOPP)-based film PropaFilm (PF), (iii) NF-PF (66:33%) film, and (iv) PF-NF (33:66%) film. The effects of package design on quality attributes of pomegranate arils stored at 10 °C (91 ± 2% RH) for 9 days were investigated. Package design had significant ($p \leq 0.05$) impact in changing the in-package RH and gas composition. The 100% cellulose-based (NF) package created the lowest RH (60–66%) with highest reduction in O_2 concentration, highest total soluble solids (TSS), hardness, colour change, and high bacterial count. However, the 100% BOPP-based (PF) film resulted in highest in-package water vapour condensation and mould growth at the end of storage. The optimized packages using PF-NF and NF-PF films, respectively, maintained quality of pomegranate arils and minimized water vapour condensation. The results indicated that PF packaging film fitted with NF film window was the best to maintain the quality of pomegranate arils.

Keywords Water vapour condensation · Relative humidity · Sugars · Microbiology · Volatile organic compounds

Experimentation → **Design** → **Modelling/Prediction**

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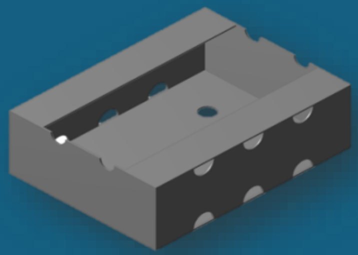
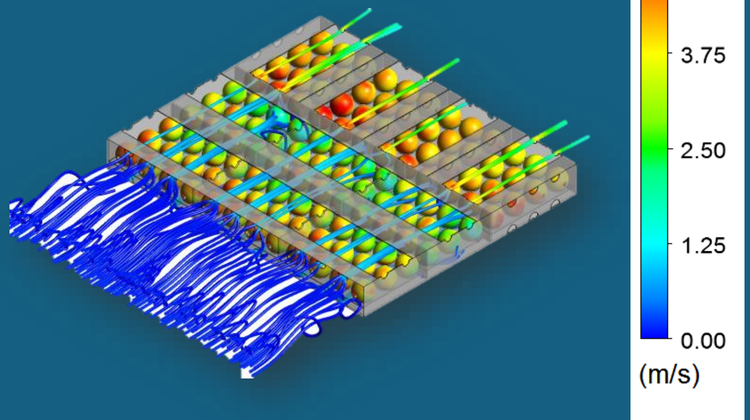
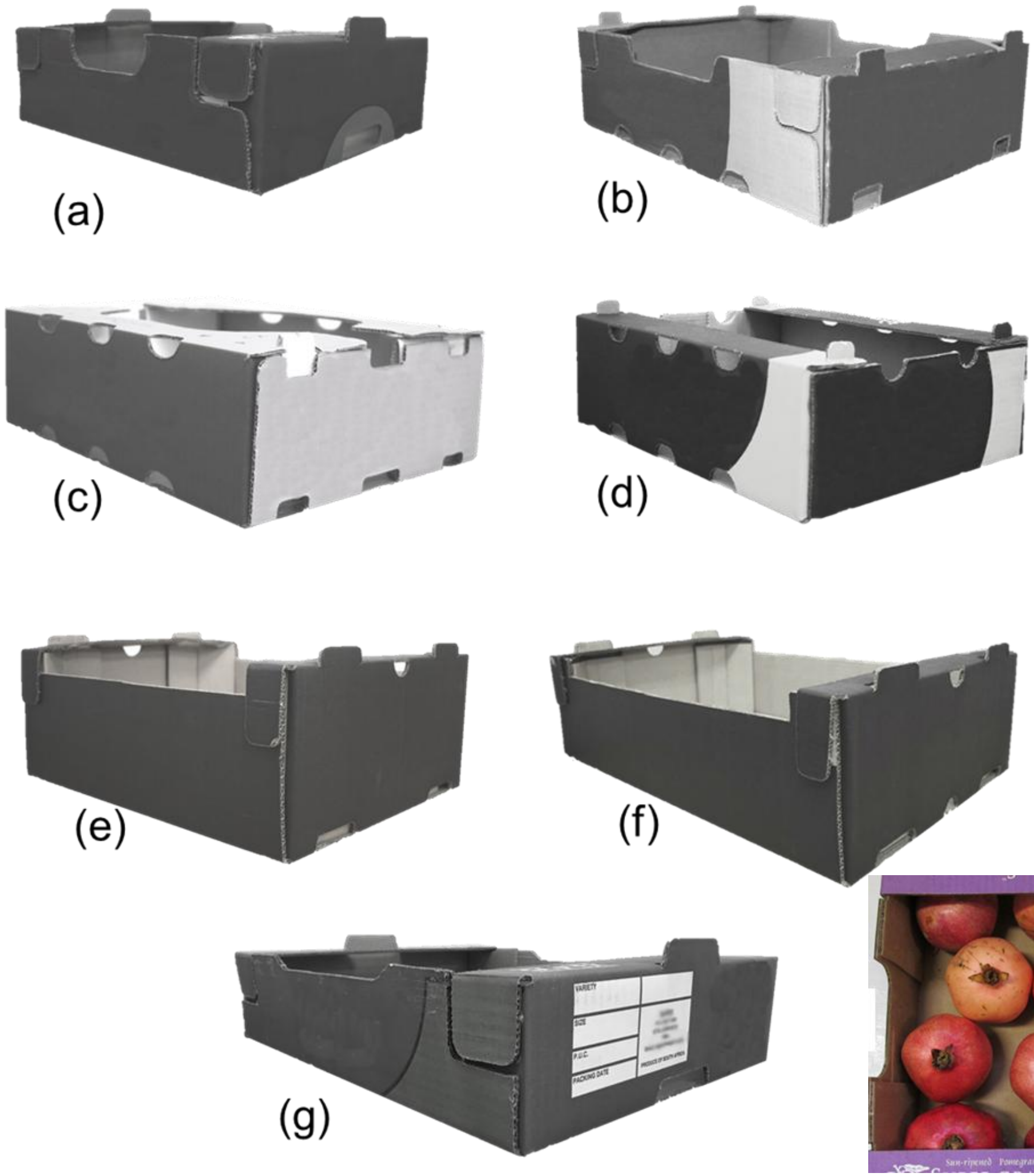
Fresh Mandate on Packaging of the Future

A Radical, Efficient & Sustainable Design



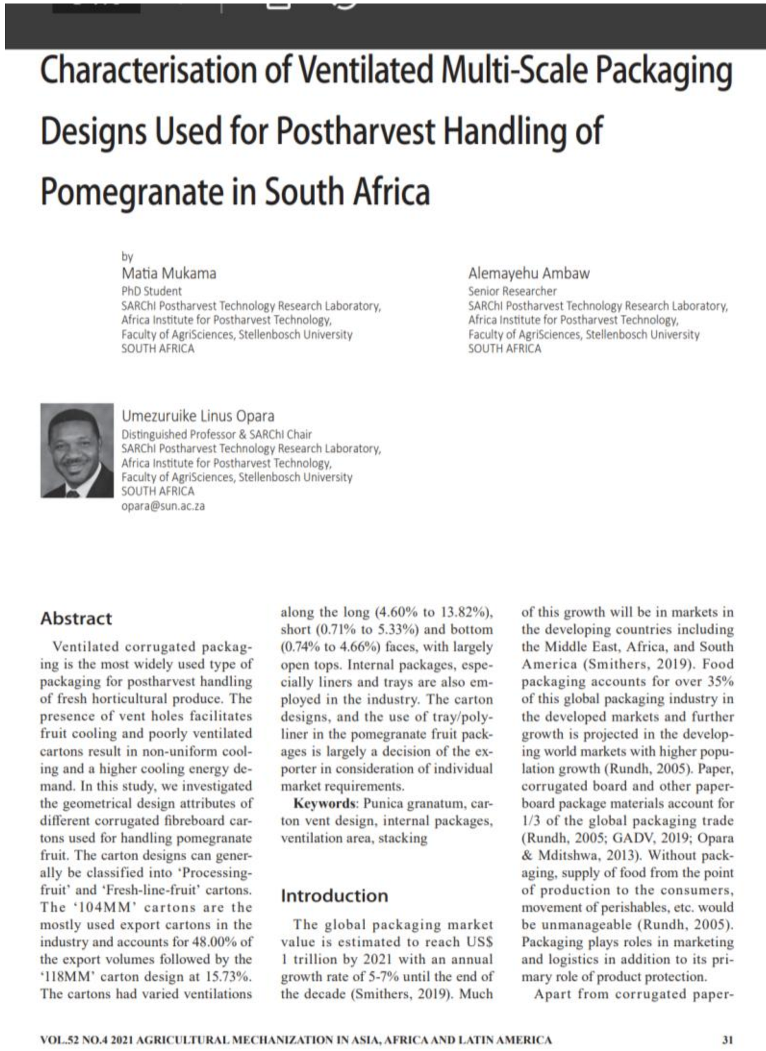


A Plethora of Ventilated Packaging Designs in the Pomegranate Industry



(a) '105MM'
(b) '104MM/118MM-Bini'
(c) '104MM/118MM-Agri-lock-B'
(d) '104MM/118MM-Agri-lock-A'
(e) '190MM'
(f) '170MM',
(g) '82MM'

No-liner vs liner



Characterisation of Ventilated Multi-Scale Packaging Designs Used for Postharvest Handling of Pomegranate in South Africa

by
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Abstract

Ventilated corrugated packaging is the most widely used type of packaging for postharvest handling of fresh horticultural produce. The presence of vent holes facilitates fruit cooling and poorly ventilated cartons result in non-uniform cooling and a higher cooling energy demand. In this study, we investigated the geometrical design attributes of different corrugated fibreboard cartons used for handling pomegranate fruit. The carton designs can generally be classified into 'Processing-fruit' and 'Fresh-line-fruit' cartons. The '104MM' cartons are the mostly used export cartons in the industry and accounts for 48.00% of the export volumes followed by the '118MM' carton design at 15.73%. The cartons had varied ventilations along the long (4.60% to 13.82%), short (0.71% to 5.33%) and bottom (0.74% to 4.66%) faces, with largely open tops. Internal packages, especially liners and trays are also employed in the industry. The carton designs, and the use of tray/polyliner in the pomegranate fruit packages is largely a decision of the exporter in consideration of individual market requirements.

Keywords: Punica granatum, carton vent design, internal packages, ventilation area, stacking

Introduction

The global packaging market value is estimated to reach US$ 1 trillion by 2021 with an annual growth rate of 5-7% until the end of the decade (Smithers, 2019). Much of this growth will be in markets in the developing countries including the Middle East, Africa, and South America (Smithers, 2019). Food packaging accounts for over 35% of this global packaging industry in the developed markets and further growth is projected in the developing world markets with higher population growth (Rundh, 2005). Paper, corrugated board and other paperboard package materials account for 1/3 of the global packaging trade (Rundh, 2005; GADV, 2019; Opara & Mditshwa, 2013). Without packaging, supply of food from the point of production to the consumers, movement of perishables, etc. would be unmanageable (Rundh, 2005). Packaging plays roles in marketing and logistics in addition to its primary role of product protection.

Apart from corrugated paper-

A Novel Design Framework for Future Packaging

Integrates computational modelling with experimental verification and commercial trials

Journal of Food Engineering 270 (2020) 109762

Contents lists available at ScienceDirect

Journal of Food Engineering

journal homepage: http://www.elsevier.com/locate/jfoodeng

A virtual prototyping approach for redesigning the vent-holes of packaging for handling pomegranate fruit – A short communication

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ARTICLE INFO

Keywords:
Punica granatum
Carton vent design

ABSTRACT

In a previous study, experimental analysis and computational fluid dynamics (CFD) modelling were used to analyse the cooling performances of two corrugated fibreboard package designs (CT1 and CT2) for handling pomegranate fruit. In these analyses, the performance of the CT1 carton was shown to be low compared to the ... ergy usage. The low performance of the CT1 carton ... the present communication, a virtual prototype ... as used to redesign the CT1 carton for improved ... performance of new vent-hole configuration which ... he new carton design. The new ventilation enabled ... $^{-1}$ (6.5%) in fruit loaded cartons.

Highlights

- Computational fluid dynamics helps perform important parametric studies.
- Fruit cooled in the new packaging design cooled faster than in commercial design.
- New design recorded 35.3 Pa m^{-1} lower pressure drop than commercial design.
- Fruit in polyliner took >8 h longer to cool.

Food Packaging and Shelf Life 32 (2022) 100858

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Food Packaging and Shelf Life

journal homepage: www.elsevier.com/locate/fpsl

Fresh fruit packaging design verification through virtual prototyping technique

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ARTICLE INFO

Keywords:
Postharvest
Container logistics
Space/volume usage
Computational method
Packaging technology

ABSTRACT

This study developed a holistic packaging design methodology in the fresh fruit postharvest handling system based on virtual prototyping approach. The method examines the cardboard box compressive strength and fruit cooling rate p... computational ... (CHT) methods ... airflow resistan... the cold chain ... designs perfor... compact, hence ... also enhanced ...

- ✓ **Computer aided graphics (CAG)**
- ✓ **Computational heat transfer (CHT)**
- ✓ **Computational fluid dynamics (CFD)**
- ✓ **Computational structural dynamics (CSD)**
- ✓ **Experimental compressive strength, cooling rate**

Highlights

- Virtual prototyping (VP) is used in fresh fruit package design.
- Carton compressive strength and fruit cooling performances estimated.
- The VP validates designs before committing to making a physical prototype.
- The VP accelerates the packaging design and development cycle times.

Virtual Prototyping Design Strategy

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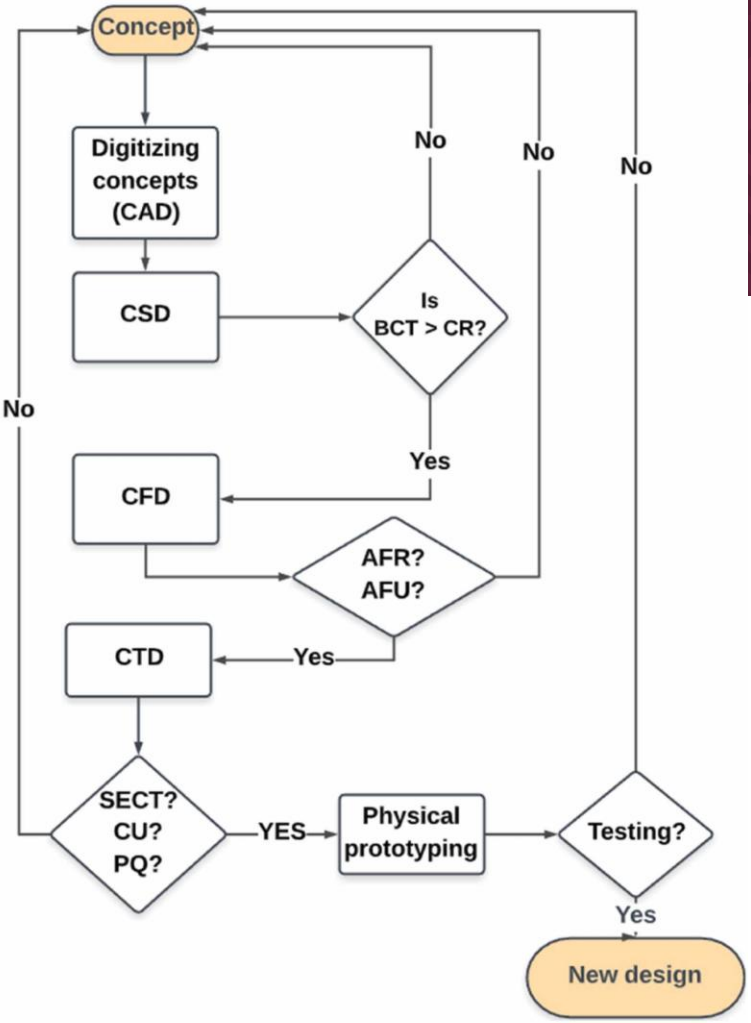

Fig. Schematic showing the virtual prototyping strategy for fruit packaging carton design. CFD – Computational Fluid Dynamics, CTD – Computational Thermodynamics, CSD – Computational Structural Dynamics, BCT – Box compression test, CR– Compression requirement, AFR– Air flow rate, AFU – Air flow uniformity, SECT – Seven eighths cooling time, CU – cooling uniformity, and PQ – Produce quality.

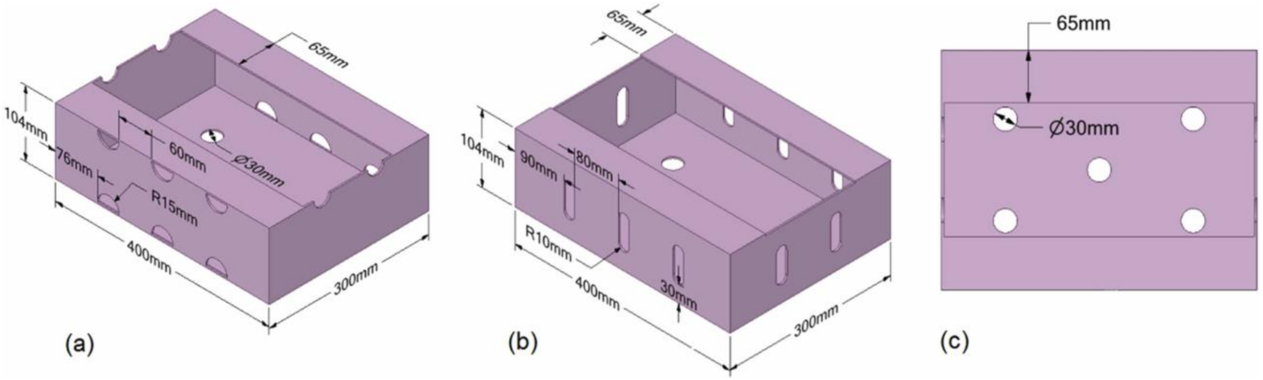

Fig. Size and vent-hole design of the commercial design (CD) (a) and vent only modified design (VOM) (b) of pomegranate packaging corrugated fibre board carton. Top view of the two designs showing the vent-hole pattern on the bottom side of the carton (c).

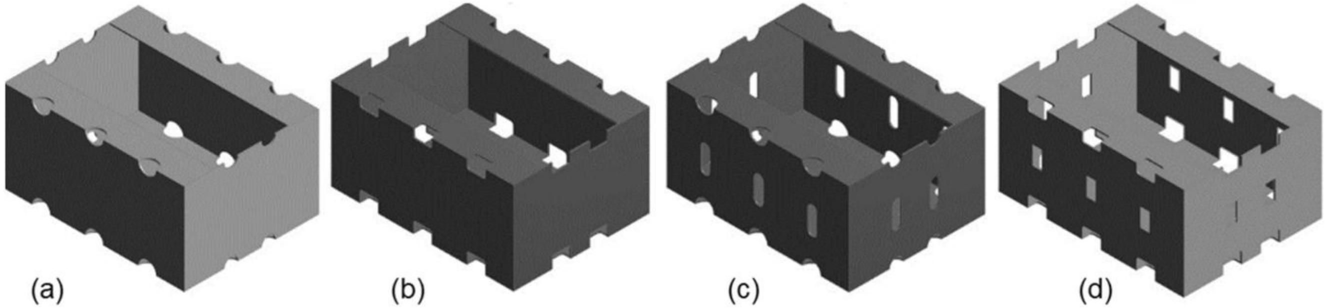

Fig. Schematic showing the 'Edgevent' and "Midvent" designs. Edgevent circular (EVC) (a), Edgevent rectangular (EVR) (b), Midvent circular (MVC) (c), and Midvent rectangular (MVR) (d).

Mechanical Handling Damage

Postharvest Biology and Technology 91 (2014) 9–24

Contents lists available at ScienceDirect

Postharvest Biology and Technology

journal homepage: www.elsevier.com/locate/postharvbio

Bruise damage measurement and analysis of fresh horticultural produce—A review

Umezuruike Linus Opara *, Pankaj B. Pathare

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A R T I C L E I N F O

Article history:
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Keywords:
Fruit
Mechanical damage
Bruise susceptibility
Bruise resistance
Bruise index
Instrumented sphere

A B S T R A C T

Bruising is the most common type of mechanical damage affecting fresh horticultural produce, and reduces quality to the consumer and income to fruit and vegetable industries. Bruising can occur during harvest and at all stages of postharvest handling, especially during packhouse operations, transport and storage, and is one of the major physical defects contributing to downgrading and postharvest loss of fresh horticultural produce. Understanding susceptibility or resistance of produce to bruising is important in developing strategies for reducing the problem. Bruise quantification can be carried out using destructive manual measurements and subsequent analysis, or using a range of non-destructive techniques. Novel and emerging non-invasive technologies for bruise measurement of fresh horticultural produce include near infrared spectroscopy, hyperspectral imaging, thermal imaging and nuclear magnetic resonance imaging. Various mathematical models used to estimate bruise size are discussed, including the use of instrumented spheres to characterise the bruise potential of postharvest handling systems. A wide range of indices based on mathematical expressions of the physical and mechanical properties of fruit, the bruised portion and the energy of the handling system causing the damage have been proposed and applied to quantify the intensity or potential to damage for different commodities and even for the same commodity. Standardisation of bruise measurement and analysis methods is warranted to permit comparison of research results on the effectiveness of pre- and postharvest treatments to reduce bruising, as well as facilitate inter-laboratory traceability of data.

Scientia Horticulturae 229 (2018) 45–58

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Review

Preharvest factors influencing bruise damage of fresh fruits – a review

Zaharan Hussein[a], Olaniyi Amos Fawole[b], Umezuruike Linus Opara[a,b,*]

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A R T I C L E I N F O

Keywords:
Bruise susceptibility
Fruit
Cultivar
Impact bruising

A B S T R A C T

Bruise damage of fresh fruits is a major problem in the horticultural industry, potentially occurring during preharvest, harvest and at all stages of postharvest handling chain. This damage can cause considerable postharvest and economic losses, reduce produce quality and result in serious food safety concerns. Understanding the factors influencing susceptibility or resistance of produce to bruising is important in developing strategies for reducing the problem. This review discusses main preharvest factors that could be manipulated by producers

January 2020. Horticultural Plant Journal, 6 (1): 1–13.

CSHS

Horticultural Plant Journal

Available online at www.sciencedirect.com

The journal's homepage: http://www.keaipublishing.com/en/journals/horticultural-plant-journal

Harvest and Postharvest Factors Affecting Bruise Damage of Fresh Fruits

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Available online 4 September 2019

A B S T R A C T

Fresh fruits are susceptible to bruising, a common type of mechanical damage during harvest and at all stages of postharvest handling. In quest of developing and adoption of strategies to reduce bruise damage, it is of utmost importance to understand major factors influencing bruise susceptibility of fresh produce at these stages. This review presents a critical discussion of factors affecting bruising during harvest and postharvest handling of fresh fruits. Excessive compression forces during harvesting by handpicking or machines, and a series of impacts during harvesting, transport and packhouse operations can cause severe bruise damage. The review has further revealed that bruising is dependent on a number of other factors such as produce maturity, ripening, harvest time (during the day or season) and time lapse after harvest. The

Quality Measurement, Prediction & Control

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Food Bioprocess Technol
DOI 10.1007/s11947-011-0533-7

COMMUNICATION

Chemical and Phytochemical Properties and Antioxidant Activities of Three Pomegranate Cultivars Grown in South Africa

Olaniyi A. Fawole · Umezuruike L. Opara · Karen I. Theron

Received: 9 December 2010 / Accepted: 1 February 2011

Abstract A comparative study of chemical contents and antioxidant activities of three pomegranate cultivars ('Arakta', 'Bhagwa' and 'Ruby') grown in South Africa was conducted. Fresh pomegranate juice (PJ) of each cultivar were assessed for soluble solid contents (SSCs), pH and titratable acidity (TA), while extracted juice samples were evaluated for total phenolic (TP), including total tannins (TT), proanthocyanidins (Pcy), total flavonoids, anthocyanins and gallic acids (GA) using spectro-

Introduction

Several epidemiological and intervention studies have reported positive correlations between fruit and vegetable intake and prevention of non-communicable diseases such as cardiovascular disease, many forms of cancer, type 2 diabetes mellitus and slowing of the ageing process (Lampe 1999; World Cancer Research Fund/American Institute for Cancer Research 2007). Scientific

Scientia Horticulturae 150 (2013) 37–46

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Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Changes in physical properties, chemical and elemental composition and antioxidant capacity of pomegranate (cv. Ruby) fruit at five maturity stages

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ARTICLE INFO

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Accepted 30 October 2012

Keywords:
Pomegranate
Maturity
Antioxidant capacity
Anthocyanins

ABSTRACT

This study was conducted to investigate the physical and compositional changes as well as antioxidant properties of pomegranate fruit (cv. Ruby) at five distinct maturity stages between 54 and 139 days after full bloom (DAFB). Physico-chemical properties such as fruit mass, size, juiciness, colour, total soluble solids (TSS), pH, titratable acidity (TA), individual organic acids and sugars, and phenolic composition were investigated. Mineral element concentrations were determined using inductively coupled plasma optical emission spectrometry (ICP-OES) while total antioxidant capacity was measured by DPPH scavenging activity (DPPH) and ferric ion reducing power (FRAP). Results showed that major compositional changes in fruit are developmentally regulated. Significant increases in total soluble solids (TSS), sugars (glucose and fructose) and anthocyanins composition, coupled with significant decline in titratable acidity (TA), organic acids and total phenolics occurred with advancing maturity. Principal component analysis (PCA) showed that fruit at advanced maturity stages (132 and 139 DAFB) were characterized by intense peel and aril pigmentation and better juice quality. PCA results also showed that peel and aril colour attributes and indices of sugar/acid ratio (TSS/TA and BrimA index) could be useful measures of fruit maturity and ripeness for 'Ruby' pomegranate cultivar, and therefore might be suitable for the development of reliable

agriculture MDPI

Review

Pomegranate Quality Evaluation Using Non-Destructive Approaches: A Review

Emmanuel Ekene Okere [1,2], Ebrahiema Arendse [1], Alemayehu Ambaw Tsige [1,*], Willem Jacobus Perold [2] and Umezuruike Linus Opara [1,3,*]

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2 Department of Electrical and Electronic Engineering, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa
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check for updates

Citation: Okere, E.E.; Arendse, E.; Ambaw Tsige, A.; Perold, W.J.; Opara, U.L. Pomegranate Quality Evaluation Using Non-Destructive Approaches: A Review. *Agriculture* 2022, 12, 2034.

Abstract: Pomegranate (*Punica granatum* L.) is one of the most healthful and popular fruits in the world. The increasing demand for pomegranate has resulted in it being processed into different food products and food supplements. Researchers over the years have shown interest in exploring non-destructive techniques as alternative approaches for quality assessment of the harvest at the on-farm point to the retail level. The approaches of non-destructive techniques are more efficient, inexpensive, faster and yield more accurate results. This paper provides a comprehensive review of recent applications of non-destructive technology for the quality evaluation of pomegranate fruit. Future trends and challenges of using non-destructive techniques for quality evaluation are highlighted in this review paper. Some of the highlighted techniques i imaging-based approaches, spectroscopy-based approaches, the electronic n imaging technique. Our findings show that most of the applications are f pomegranate fruit using machine vision systems and the electronic nose soluble solids (TSS), titratable acidity (TA) and pH as well as other phytoc have also been reported. Value-added products of pomegranate fruit su arils, pomegranate juice and pomegranate seed oil have been non-destr

Pankaj B. Pathare
Umezuruike Linus Opara *Editors*

Mechanical Damage in Fresh Horticultural Produce

Measurement, Analysis and Control

Springer

NIR Spectroscopy for Internal and External Quality Measurement and Analysis of Thick Rind Fruits

Chapter | First Online: 18 November 2022

pp 189–210 | Cite this chapter

- Umezuruike Linus Opara,
- Ebrahiema Arendse &
- Lembe Samukelo Magwaza

Near-Infrared Spectroscopy for Pomegranate Quality Measurement and Prediction

Chapter | First Online: 18 November 2022

pp 211–232 | Cite this chapter

- Umezuruike Linus Opara &
- Ebrahiema Arendse

Fruit Quality Control and Assurance

Developed techniques to detect and predict internal quality

Postharvest Biology and Technology 95 (2014) 1–6

Contents lists available at ScienceDirect

Postharvest Biology and Technology

journal homepage: www.elsevier.com/locate/postharvbio

Investigating non-destructive quantification and characterization of pomegranate fruit internal structure using X-ray computed tomography

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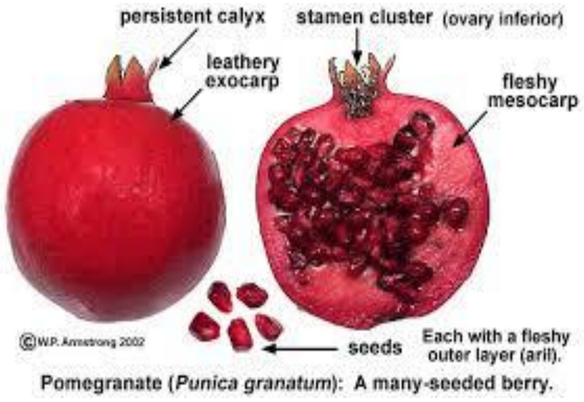
ARTICLE INFO

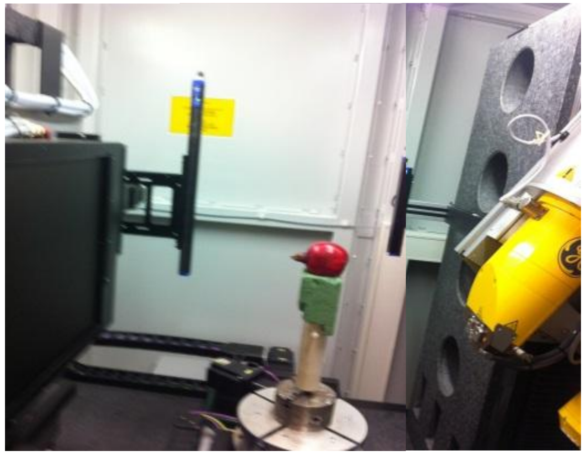
Article history:
Received 17 January 2014
Accepted 25 March 2014

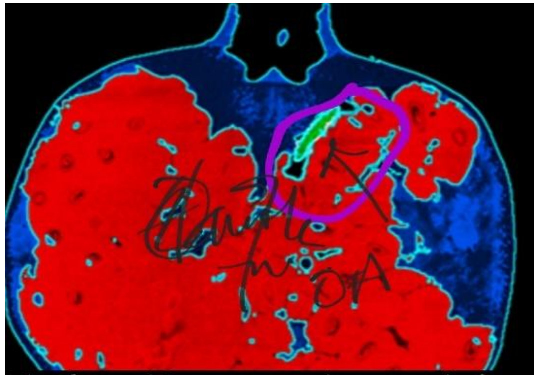
Keywords:
Fruit quality
Image analysis
Punica granatum L.
Air space
Fruit fractions
Non-destructive testing

Highlights

- X-ray CT was used to non-destructively evaluate internal structures of pomegranate fruit.
- Image analysis algorithm to compute volume of arils, albedo and air spaces was developed.
- Characterization of fruit with and without chilling injury was achieved using X-ray CT.







Microfocused X-ray computed tomography for non destructive detection of false codling moth in pomegranate fruit.

Processing and Value Addition

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Fawole, O.A. & Opara, U.L. 2022. Recent developments in the value-addition of pomegranate fruit in South Africa: from edible to non-edible fruit parts. *Acta Horticulturae*, 1349: 593-600

FOOD PACKAGING AND SHELF LIFE 2 (2014) 30–37

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Bioactive compounds and quality attributes of pomegranate arils (*Punica granatum* L.) processed after long-term storage

Lizanne O'Grady[a], *Gunnar Sigge*[a], *Oluwafemi J. Caleb*[b], *Umezuruike Linus Opara*[b,*]

[a] *Department of Food Science, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, South Africa*

[b] *Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, South Africa*

ISHS Acta Horticulturae 1225: III All Africa Horticultural Congress

Value-addition of sunburned pomegranate fruit to reduce postharvest losses: a cosmeceutical perspective

Authors: O.A. Fawole, U.L. Opara

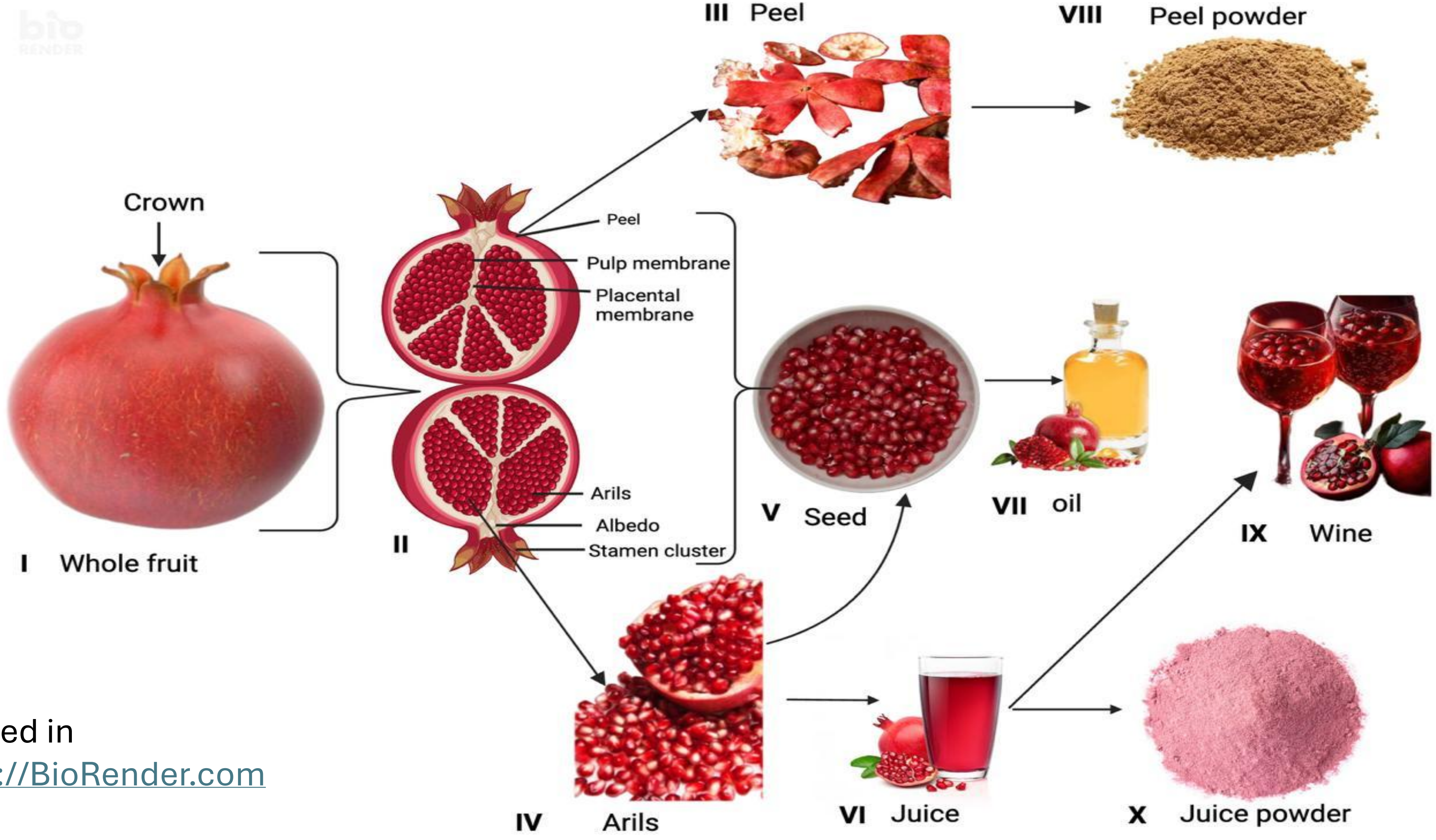
Keywords: fruit, bioactives, functional ingredients, functional foods

DOI: 10.17660/ActaHortic.2018.1225.30

Abstract:
Sunburn renders 15% of pomegranate fruit production unmarketable in fresh fruit and juice industries. Uses for these fruit are scarce and their disposal represents an environmental problem. This work presents a comparative study on the composition and bioactivities of oils extracted from pomegranate seeds of sunburned fruit (SBF) and healthy fruit (HF) for value-adding potential of fruit representing postharvest losses. Oil samples were extracted with petroleum ether by ultrasonification after drying using different drying techniques (freeze-, sun- and oven-drying). Compositional analysis included p-anisidine value, total phenolic content (TPC) as well as essential oils and sterols while the investigated bioactivities included DPPH radical scavenging ability (RSA) and tyrosinase enzyme inhibition ability. Results showed that oven-dried seeds, regardless of seed source (SBF or HF), yielded higher oil ranging from 20.20 to 24.35% of dry matter. However, regardless of drying method, oil obtained from SBF contained higher TPC (1.4-2.8 mg g^{-1} of oil GAE) than those obtained from HF. A total of 17 compounds were identified by GC-MS analysis with the predominant being 9,12,15-Octadecatrienoic acid, a conjugated linolenic acid, constituting 70-72% of total essential oils. Gamma-tocopherol constituted 95% of total tocopherol while β-sitosterol constituted between 85-87% of total sterols. Overall, good RSA was exhibited by all the investigated oil samples with IC_{50} ranging from 34.77 to 59.29 µg mL^{-1} AAE. RSA was influenced by seed source (p=0.006) and drying method (p=0.025). All the oil samples showed good ability to inhibit tyrosinase enzyme regardless of seeds source and drying method, with monophenolase and diphenolase IC_{50} ranging between 0.31 and 0.49 mg mL^{-1} and 0.64 and 2.43 mg mL^{-1}, respectively. This study indicates that seeds of sunburned pomegranate fruit can be exploited for high quality oil due to similar yield and bioactive composition compared to oil extracted from healthy fruit. In general, regardless of drying method, oils from seeds of SBF and HF both had good antioxidant activity and tyrosinase enzyme inhibition ability, which is applicable in skin care and nutraceutical industry.

Volarising Pomegranate Fruit

A Circular Bio-Economy Approach



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Review

Processing Factors Affecting the Phytochemical and Nutritional Properties of Pomegranate (*Punica granatum* L.) Peel Waste: A Review

Tandokazi Pamela Magangana [1,2], Nokwanda Pearl Makunga [1], Olaniyi Amos Fawole [3] and Umezuruike Linus Opara [2,*]

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2 Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology,

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Article

Antioxidant, Antimicrobial, and Metabolomic Characterization of Blanched Pomegranate Peel Extracts: Effect of Cultivar

Tandokazi Pamela Magangana [1,2], Nokwanda P. Makunga [1,*], Olaniyi Amos Fawole [3,*], Maria A. Stander [4] and Umezuruike Linus Opara [2,5,*]

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2 SARChI Postharvest Technology Research Laboratory, Faculty of AgriSciences, Africa Institute for Postharvest Technology, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa

antioxidants MDPI

Article

Blanching Pre-Treatment Promotes High Yields, Bioactive Compounds, Antioxidants, Enzyme Inactivation and Antibacterial Activity of 'Wonderful' Pomegranate Peel Extracts at Three Different Harvest Maturities

Tandokazi Pamela Magangana [1,2], Nokwanda P. Makunga [1], Chris la Grange [1], Maria A. Stander [3], Olaniyi Amos Fawole [4,*] and Umezuruike Linus Opara [2,5,*]

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* Correspondence: olaniyif@uj.ac.za (O.A.F.); opara@s
+27-21-808-4064 or +27-21-808-3743 (U.L.O.)

check for updates

Citation: Magangana, T.P.; Makunga, N.P.; la Grange, C.; Stander, M.A.; Fawole, O.A.; Opara, U.L. Blanching Pre-Treatment Promotes High Yields, Bioactive Compounds, Antioxidants, Enzyme Inactivation and Antibacterial Activity of 'Wonderful' Pomegranate Peel Extracts at Three

Abstract: 'Wonderful' pomegranate (*Punica granat*
icals including vitamins, dietary fibre, phenolic c
often used as animal feed or discarded in landfills
this phenolic-rich bioresource. Finding novel ways
a more profitable and eco-friendlier alternative th
a blanching pre-treatment step at optimal conditio

processes MDPI

Article

Effect of Solvent Extraction and Blanching Pre-Treatment on Phytochemical, Antioxidant Properties, Enzyme Inactivation and Antibacterial Activities of 'Wonderful' Pomegranate Peel Extracts

Tandokazi Pamela Magangana [1,2], Nokwanda P. Makunga [1], Olaniyi Amos Fawole [3,*] and Umezuruike Linus Opara [2,4,*]

1 Department of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, South Africa; tkmagangana@sun.ac.za (T.P.M.); makunga@sun.ac.za (N.P.M.)
2 SARChI Postharvest Technology Research Laboratory, Africa Institute for Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Private Bag X1, Stellenbosch 7602, South Africa
3 Postharvest Research Laboratory, Department of Botany and Plant Biotechnology, University of Johannesburg, P.O. Box 524, Auckland Park, Johannesburg 2006, South Africa
4 UNESCO International Centre for Biotechnology, Nsukka 410001, Enugu State, Nigeria
* Correspondence: olaniyif@uj.ac.za (O.A.F.); opara@sun.ac.za (U.L.O.)

Abstract: 'Wonderful' pomegranate (*Punica granatum* L.) peel is rich in phytochemicals which are responsible for its strong antioxidant and antimicrobial activities, but it has low economic value as it is mainly discarded, causing an environmental waste management problem. To examine the best processing regime for pomegranate peel wastes, different solvents (ethanol, methanol and acetone) at various concentrations (50%, 70% and 100%) and blanching at 60, 80 and 100 °C for 1, 3 and 5 min, for each temperature, were tested. Ethanol at 70% (v/v) provided the highest extract yield, total phenolic and total tannin content at 29.46%, 10.61 ± 0.15, and 0.76 ± 0.02 mg GAE/g DM, respectively. Antioxidant activity using the 2,2 diphenyl-1-picryl hydrazyl assay (DPPH), ferric-reducing antioxidant power assay (FRAP) and 2,2-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid

Scientific African 5 (2019) e00145

Contents lists available at ScienceDirect

Scientific African

journal homepage: www.elsevier.com/locate/sciaf

Drying kinetics of pomegranate fruit peel (cv. Wonderful)

Rebogile R. Mphahlele[1], Pankaj B. Pathare[2], Umezuruike Linus Opara*

Department of Horticultural Science, Faculty of AgriSciences, Postharvest Technology Research Laboratory, South African Research Chair in Postharvest Technology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa

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ABSTRACT

Pomegranate juice processing produces large amount of peel as by-product or waste which is a potential source of raw material for food and other bioprocessing industries. Drying the peel offers opportunities for value addition into novel products, thus reducing waste from the fruit processing operations. This study presents the mathematical models of thin layer drying behaviour of pomegranate peels (initial thickness 5.00 ± 0.05 mm and moisture content 70.30% wet basis) using three air temperatures (40 °C, 50 °C and 60 °C) at a

fermentation
MDPI

Review

Pomegranate Wine Production and Quality: A Comprehensive Review

Kasiemobi Chiagozie Ezeora [1,2], Mathabatha Evodia Setati [3], Olaniyi Amos Fawole [4] and Umezuruike Linus Opara [1,5,*]

1 SARChI Postharvest Technology Research Laboratory, Africa Institute for Postharvest Technology, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, South Africa; 26824620@sun.ac.za
2 Department of Food Science, Stellenbosch University, Private Bag X1, Matieland, Stellenbosch 7602, South Africa
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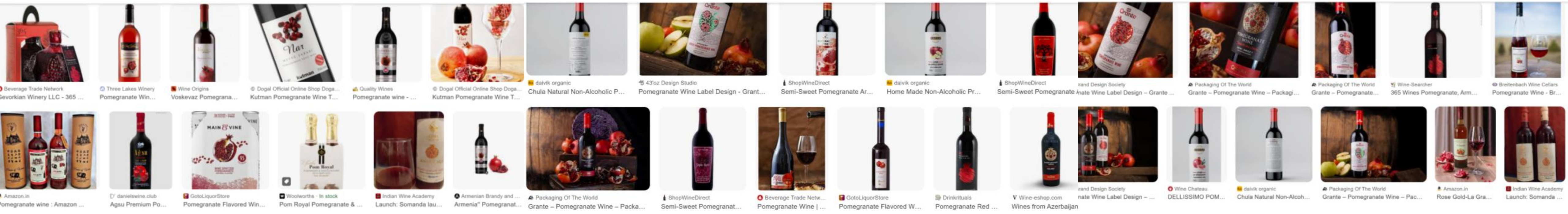
4 Postharvest and Agroprocessing Research Centre, Department of Botany and Plant Biotechnology, Faculty of Science, University of Johannesburg, Johannesburg 2006, South Africa; olaniyiif@uj.ac.za
5 UNESCO International Centre for Biotechnology, Enugu 410001, Nigeria
* Correspondence: opara@sun.ac.za or unesco.icb.nigeria@gmail.com; Tel.: +27-60-326-6564

Abstract: Food and beverages with healthy and functional properties, especially those that prevent chronic diseases, are receiving considerable interest among consumers and researchers. Among the products with enhanced properties, fermented beverages from non-grape wines have a high potential for growth. Pomegranate (*Punica granatum* L.) is a super fruit known for its richness in bioactive compounds that have been reported to have several therapeutic properties against non-communicable diseases. Diverse products can be obtained from the valorization of pomegranate

- Global wine market US$336.03 billion in 2023, projected to reach $462.2 billion by 2030 (Market Research Reports, 2024).
- Fruit wine segment US$724.1 million in 2022, anticipated to grow to $1,464.1 million by 2030.
- Global pomegranate wine market US$1,841.5 million, expected to grow at a CAGR 5.35%, potentially reaching $2,517.55 million by 2030.

https://www.google.com/search?q=pomegranate+wine+brands&sca_esv=8112e37800fc550f&rlz=1C1GCER_enZA1094ZA1094&sxsrf=AHTn8zoy7xYuMNZuLM4PHJivEJrWPIaJ3Q:1742741398979&udm=2&fbs=ABzOT_A1aq79iS84nP6J0j1icOz8E4PXtd5lN0hHDdQTkFtVfuUQLdGrqx1p-vQoNfBi2qFR4LI-fW6X8YT4CqQbkzmQY3AO1w8qaUVi4f_xDTgYwKB4j35p11D2RKtJSG6uY1mhJ-a4lPWM4ht42DA9T16sFdYgk2NZqEV6F5_Kogf16fwaE9mYzKLQKvqOW4g0yDJkPQ7Xgb5OXXInyEx3Rs5Iu2T1Zqc67hgJLl2qBVkH5osBM6M&sa=X&ved=0ahUKEwiFzpXQuaCMAxV5YEEAHfalHpkQtKgLCLAC&biw=1280&bih=585&dpr=3



Postharvest Losses and Waste

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Pomegranate production and export during the past decade in South Africa and incidence of postharvest losses – a review

I.K. Opara[1], O.A. Fawole[2] and U.L. Opara[1,3,a]

[1]SARChI Postharvest Technology Research Laboratory, Africa Institute for Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Stellenbosch 7600, South Africa; [2]Postharvest Research Laboratory, Department of Botany and Plant Biotechnology, University of Johannesburg, PO Box 524, Auckland Park, Johannesburg, 2006, South Africa; [3]UNESCO International Centre for Biotechnology, Nsukka 410001, Enugu State, Nigeria.

Abstract

Pomegranate (*Punica granatum* L.) is an important fruit due to its high nutritional content and economic value, hence its rapid increase in production and demand globally. In the past decade, production has significantly increased, with a corresponding economic contribution to the South African gross domestic product (GDP). The objectives of this review are to highlight the production pattern of pomegranate fruit in South Africa during the past decade and to discuss the incidence of postharvest fruit losses and waste. Historical industry production and export data (2012 to 2021) were sourced from the Pomegranate Association of South Africa (POMASA) and other relevant literature. The results revealed that the total planted area increased by about 28%, from slightly below 800 ha in 2012 to 1,099 ha in 2021. During this period, total fruit export volume increased from 483,609 to 1,664,717 equivalent cartons (3.8 kg), with the majority destined for the Middle East and Europe. Based on case studies in the major pomegranate producing area (Western Cape), reported incidence of postharvest fruit wastage at the farm and packhouse levels were 15.3-20.1% and 6.74-7.69%, respectively. Environmental factors such as sunburn, crack and split were the major cause of losses and waste at the farm level, while downgraded fruit that did not meet the high market standards in the importing countries caused wastage at the packhouse level. Therefore, with the increase in fruit production and export, there is a need for more proactive measures to reduce postharvest loss and waste at the farm and packhouse levels.

ISHS

Acta Hortic. 1349. ISHS 2022. DOI 10.17660/ActaHortic.2022.1349.45
Proc. V IS on Pomegranate and Minor Mediterranean Fruits
Eds.: O.A. Fawole and L. de Kock

sustainability MDPI

Article

Quantification of On-Farm Pomegranate Fruit Postharvest Losses and Waste, and Implications on Sustainability Indicators: South African Case Study

Ikechukwu Kingsley Opara [1], Olaniyi Amos Fawole [1,2], Candice Kelly [3] and Umezuruike Linus Opara [1,*]

1 Africa Institute for Postharvest Technology, SARChI Postharvest Technology, Postharvest Research Laboratory, Faculty of AgriSciences, Stellenbosch University, Stellenbosch 7602, South Africa; ikekings101@gmail.com (I.K.O.); olaniyif@uj.ac.za or olaniyi@sun.ac.za (O.A.F.)
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* Correspondence: opara@sun.ac.za; Tel.: +27-21-8084068

Abstract: While there is a growing body of scientific knowledge on improved techniques and procedures for the production and handling of quality pomegranate fruit to meet market demand, little is known about the magnitude of losses that occur at the farm and post-farmgate. This study revealed the amount of pomegranate fruit lost on the farm and the causes of loss and estimated the impacts of losses. The direct measurement method, which involved sorting and counting of individual fruit, was used since physical identification of the causes of fruit losses on individual fruit was necessary for data collection. Furthermore, qualitative data were collected by physical observation during harvesting and interaction with farm workers. At the case study farm in Wellington, Western Cape Province of South Africa, a range of 15.3–20.1% of the harvested crop was considered lost, as the quality fell below marketable standards for retail sales. This amounted to an average of 117.76 tonnes of pomegranate fruit harvested per harvest season in the case study farm, which is removed from the value chain and sold mainly at a low value for juicing and other purposes and translates to an estimated R10.5 million ($618,715.34) economic loss to the farmer. Environmental factors are the main causes of on-farm fruit losses. In the three pomegranate cultivars studied, sunburn and crack were identified as the leading cause of fruit loss, accounting for about 43.9% of all on-farm fruit losses. The lost fiber, carbohydrate, protein, iron and ascorbic acid contents associated with lost fruit were estimated to meet the daily recommended nutrition intake of 2, 9, 4, 2 and 24 people, respectively. Strategies to control and reduce pomegranate fruit losses and waste at the farm level should focus on environmental factors and mechanical damage since they account for the highest sources of fruit losses. This will ensure improved revenue to farmers, sustainable use of natural resources, reduction of the environmental impacts of the fruit industry, and more availability of quality fruit for nutritional security.

check for updates

Citation: Opara, I.K.; Fawole, O.A.; Kelly, C.; Opara, U.L. Quantification of On-Farm Pomegranate Fruit Postharvest Losses and Waste, and Implications on Sustainability Indicators: South African Case Study. *Sustainability* **2021**, *13*, 5168. https://doi.org/10.3390/su13095168

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Article

Postharvest Losses of Pomegranate Fruit at the Packhouse and Implications for Sustainability Indicators

Ikechukwu Kingsley Opara [1], Olaniyi Amos Fawole [1,2] and Umezuruike Linus Opara [1,*]

1 SARChI Postharvest Technology Research Laboratory, Africa Institute for Postharvest Technology, Faculty of AgriSciences, Stellenbosch University, Stellenbosch 7600, South Africa; ikekings101@gmail.com (I.K.O.); olaniyif@uj.ac.za (O.A.F.)
2 Postharvest Research Laboratory, Department of Botany and Plant Biotechnology, University of Johannesburg, Johannesburg 2006, South Africa
* Correspondence: opara@sun.ac.za; Tel.: +27-21-808-4064

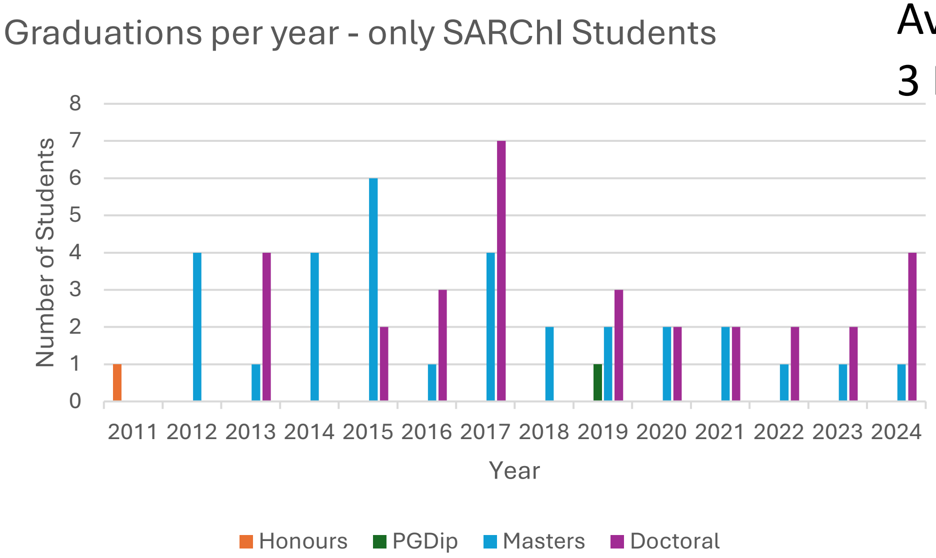
Abstract: Pomegranate fruit, like other types of fresh horticultural produce, are susceptible to high incidence preharvest and postharvest losses and waste. Several studies have been done to improve the production and handling of pomegranate fruit to meet market standards, but little has been done in loss quantification, especially in the early stage of the value chain such as the packhouse. Therefore, the aim of this study was to quantify the magnitude of pomegranate fruit losses at the packhouse, identify the causes, and estimate the impacts of losses. The study was conducted on a case study packhouse in the Western Cape Province of South Africa from February to March 2020. The direct measurement method, which involved physical identification of the causes of loss on individual fruit, was used for data collection. Loss quantification involved the calculation of lost fruit proportional to the amount put in the packhouse processing line. The results showed that losses ranged between 6.74% to 7.69%, which translated to an average of 328.79 tonnes of pomegranate fruit removed during packhouse operation per production season at the investigated packhouse. This magnitude of lost fruit was equivalent to over ZAR 29.5 million (USD 1,754,984) in revenue, in addition to the opportunity costs of resources used to produce lost fruit.

Keywords: pomegranate; losses; nutrition; environmental; resources; packhouse; postharvest; im-

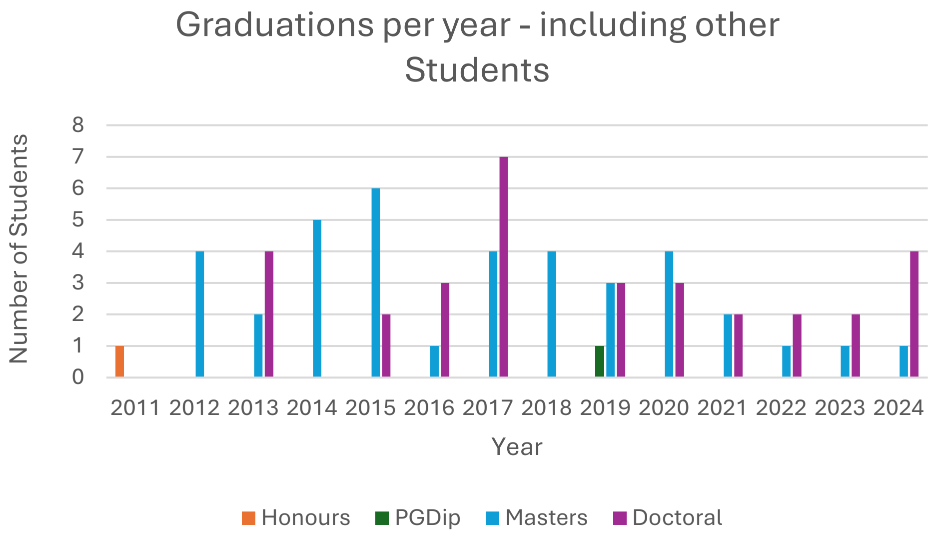
check for updates

Citation: Opara, I.K.; Fawole, O.A.; Opara, U.L. Postharvest Losses of Pomegranate Fruit at the Packhouse and Implications for Sustainability Indicators. *Sustainability* **2021**, *13*, 5187. https://doi.org/

Graduates



Average 3 Masters and 3 Doctoral per year



1 Hons, 1 PGD, 36 MSc, 33 PhD, 10 Postdocs

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Our Impacts

I. Research and innovation

II. Capacity building

The Research Enterprise

Stellenbosch
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- ❖ Highly cited researcher, 2019, 2021
- ❖ Several "highly cited" papers
- ❖ Laureate of the Inaugural AFRICA RESEARCH EXCELLENCE AWARD by the Forum for Agricultural Research in Africa (FARA) and the African Export-Import Bank (AFREXIMBANK), which "acknowledges and honors individuals, agencies, or institutions that have conducted impactful research with the potential for scalability and significant positive impact, June 2024
- ❖ Laureate of the African Union Kwame Nkrumah Continental Scientific Award in Life & Earth Science. January 2016
- ❖ IMPRESSA Award (Impact Research and Science in Africa) by The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for "Excellence in Research & Building Africa's Human Resources Capacity", June 2015

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Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF KWAZULU-NATAL™ INYUVESI YAKWAZULU-NATALI

RESPICE PROSPICE UNIVERSITY of the WESTERN CAPE

UNIVERSITY OF MPUMALANGA

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad
SPES BONA

Cape Peninsula University of Technology

LIMPOPO PROVINCIAL GOVERNMENT REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT

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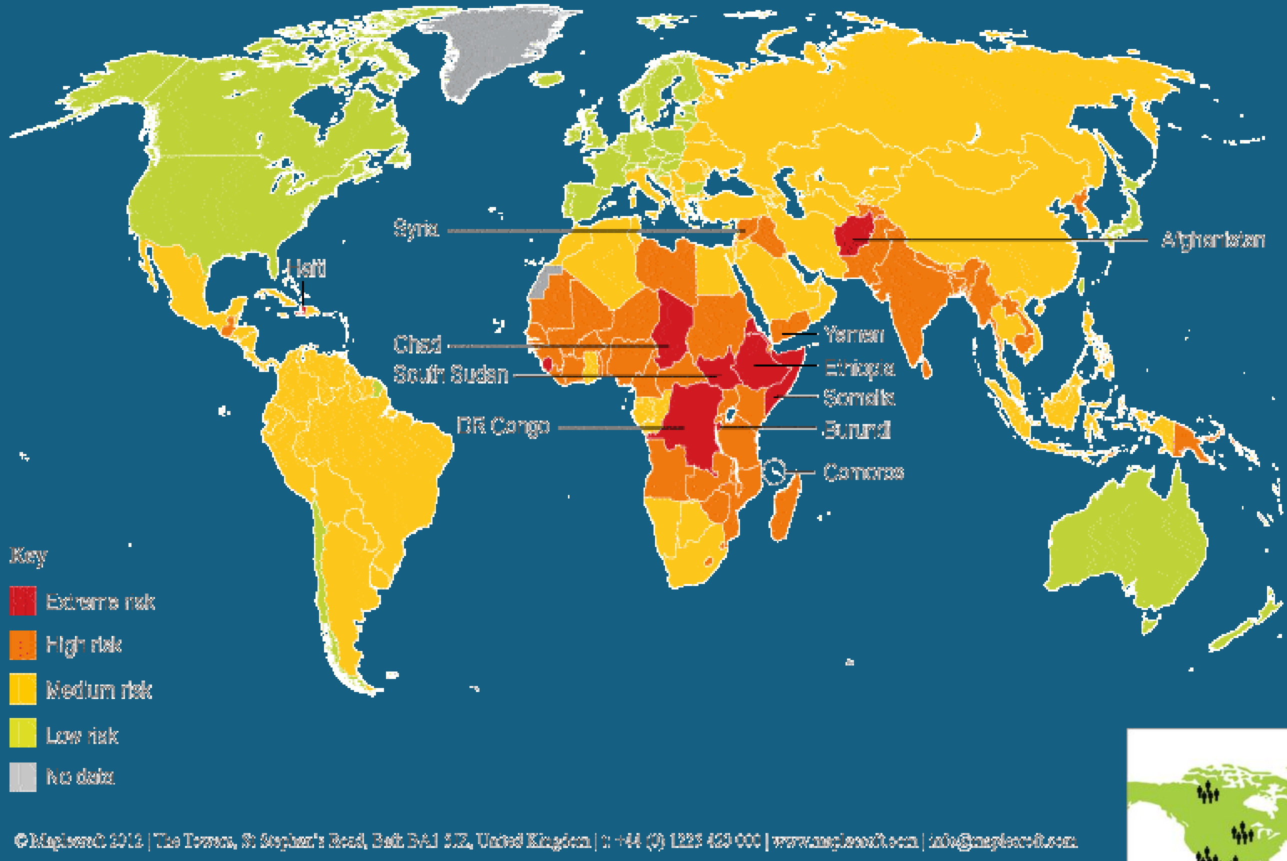
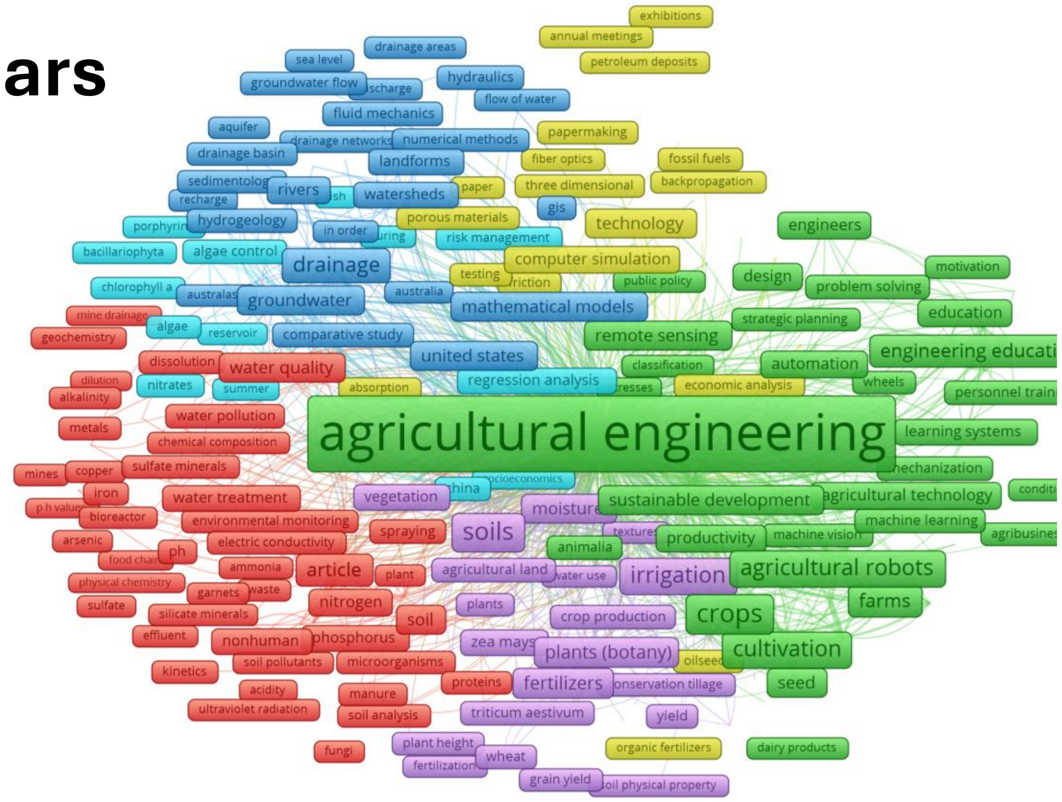


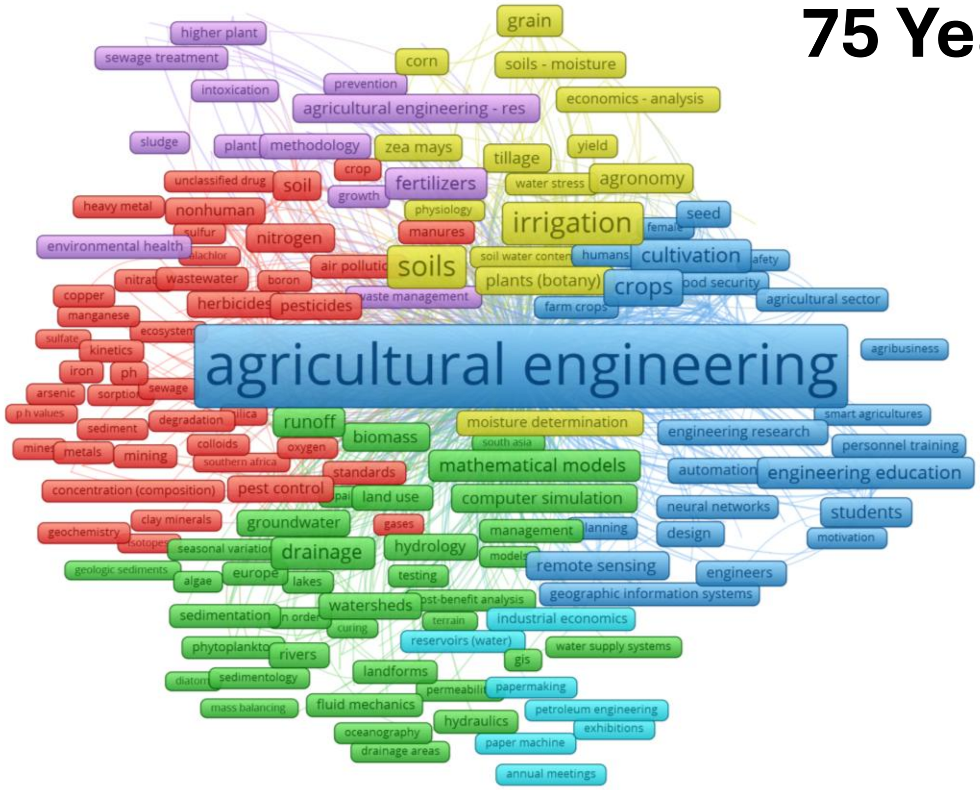
What Future for Agricultural Engineering Education & Research?

A Bibliometric Analysis and Visualisation of Agricultural Engineering

25 Years

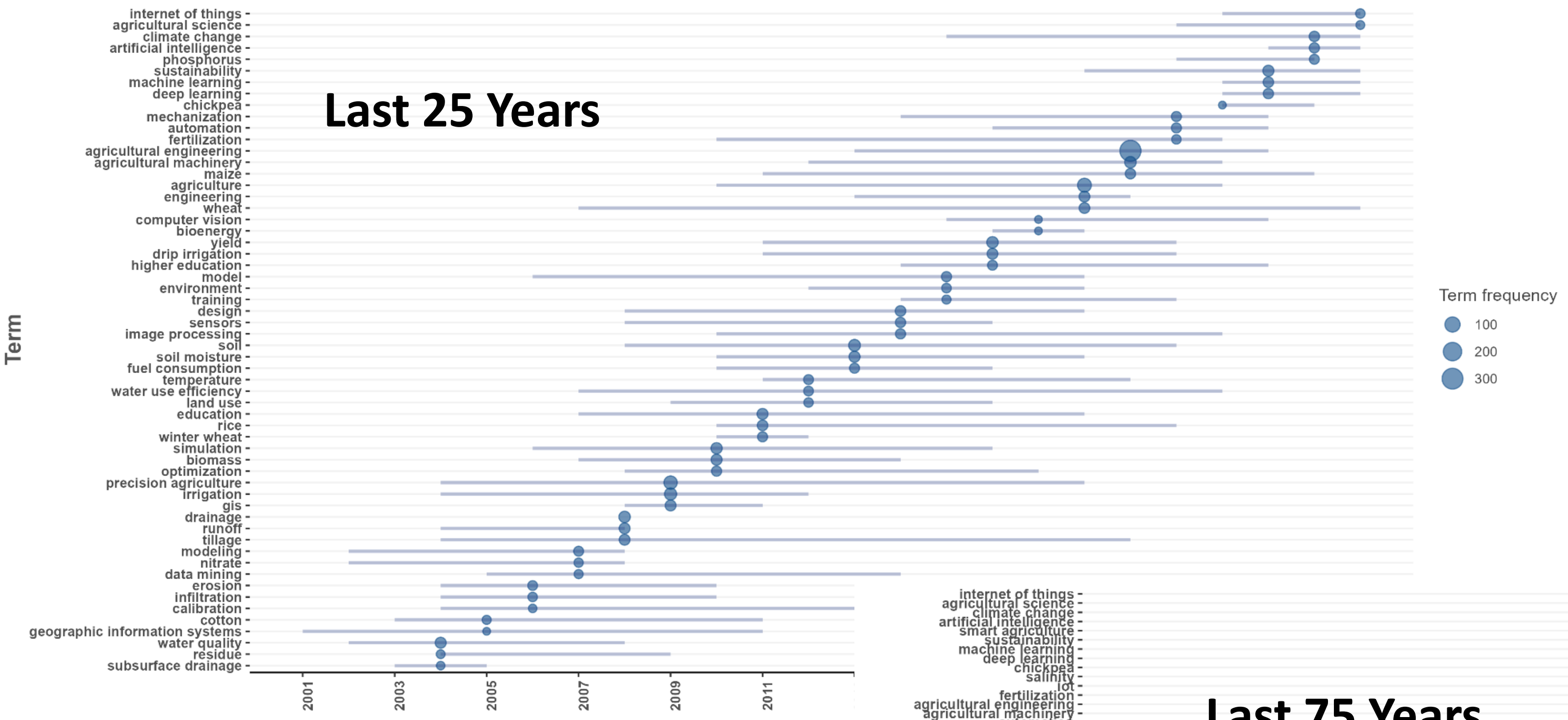


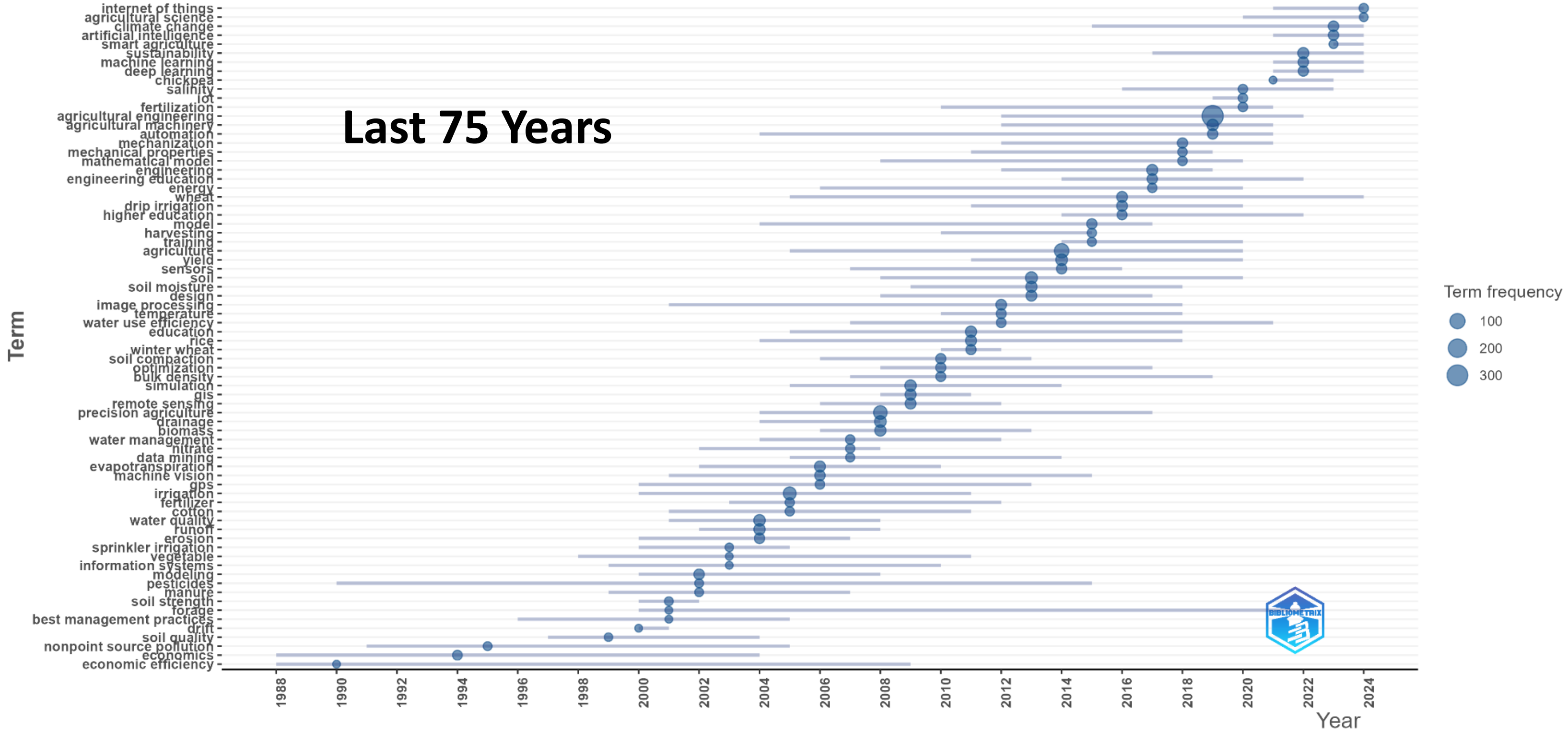
75 Years



VOSviewer

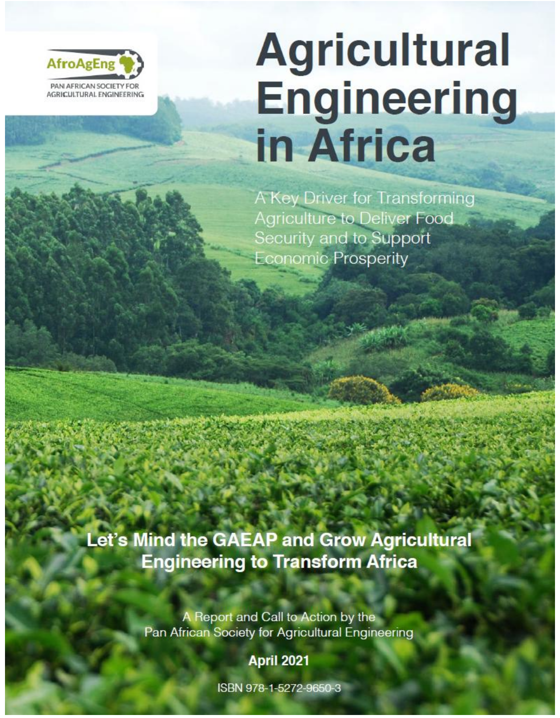
Co-occurrence all keywords





Trend topics based on author's keyword

Growing Africa’s Capacity in *Agricultural Engineering*



POSTHARVEST AFRICA 2012

7th International CIGR Technical Symposium

The Future

- More uncertainty
- Higher rate of change
- More demand for diverse, quality, safe food, feed, fibre
- Higher demand for sustainability and traceability
- Competition for limited resources
- Fewer people in direct food production
- Climate change
- PANDEMICS

AgrEng Responses

✓ Reform education and training: relevance, impact

✓ Intensify research and innovation: solving real problems

✓ Thought leadership: policy, bills to NASS, lobbying

✓ Build capacity long the value chain

✓ Sicience, engineering and technology diplomacy

Epilogue

- The future of South Africa and Africa is tied to the future of our agriculture
- South Africa and Africa needs MORE well educated, skillful and competent agricultural engineers. Global competition for talent has intensified
- At 75 and still running hot, vintage AgEng @UKZN has demonstrably acquired the knowledge, experience, capacity and expertise to lead, at local and continental levels
- The significant contribution of AgEng @ UKZN, by partnering with SARChI Postharvest Technology @ Stellenbosch University, in the formation and operation of PASAE/AfroAgEng is a superb example.

Epilogue

- If South Africa aspires to become a developed country/region, in line with the Africa We Want, its agrifood system must be transformed, modernized and mechanized at all levels:
  - Higher productivity
  - Value addition
  - Create new and quality jobs
  - Market-oriented
  - Knowledge-driven
  - Technology-enabled
  - Sustainable production and consumption

To achieve these, **Agricultural Engineering** must take the center stage as the **SYSTEM INTEGRATOR**

- Modernizing smallholder agrifood systems into profitable businesses and linking them to markets should be a priority for AgEng and other stakeholders.