

History, Capacity Development, Research Outputs: Discipline of Agricultural Engineering School of Engineering, University of KwaZulu-Natal

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Aidan Senzanje, Alaika Kassim and Ashiel Jumman

29 October 2025



Outline

- History timeline
- Capacity development
- Power, traction and alternative fuels research
- Hydrological research
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- Postharvest technology and food engineering



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History Timeline



Faculty of Agriculture
established
Mr. Geiger – services
course



Prof Mering-
Lecturer
First graduate
(Mr C Stephens)



Prof Schulze
acting HoD
(up to 1992)



Prof Smithers
HoD (up to 2012)



Prof Smithers
PC (up to 2018)



Dr Kassim
acting PC

1948

1950

1956

1976

1991

1993

2002

2012

2018

2019

2025

Prof Vorster
HoD (up to 1973)
5-year Ag Eng degree
programme



Prof Meiring
HoD (up to 1990)



Prof Peter Lyne -
HoD (up to 2002)



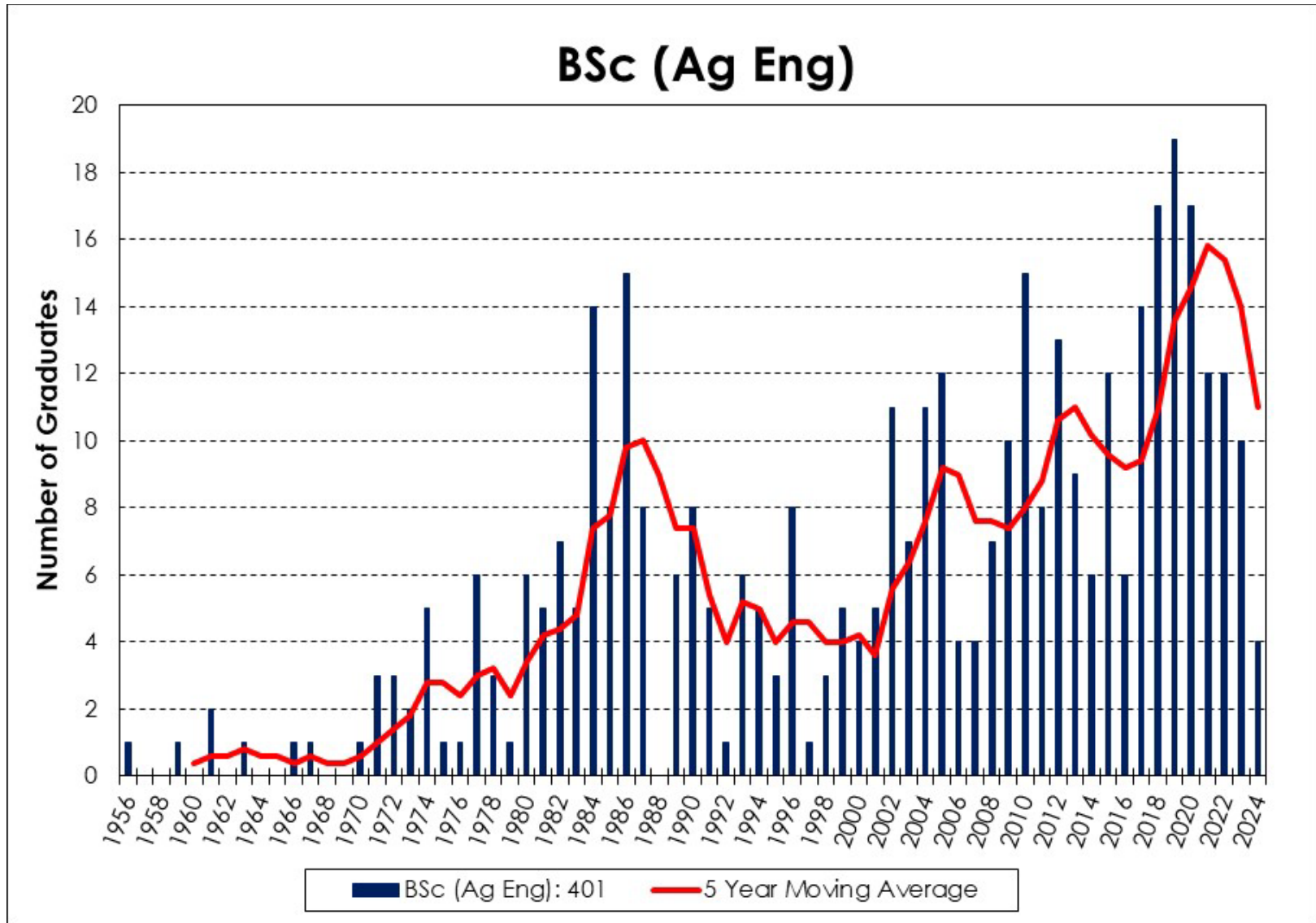
Dr Senzanje
PC (up to 2015)



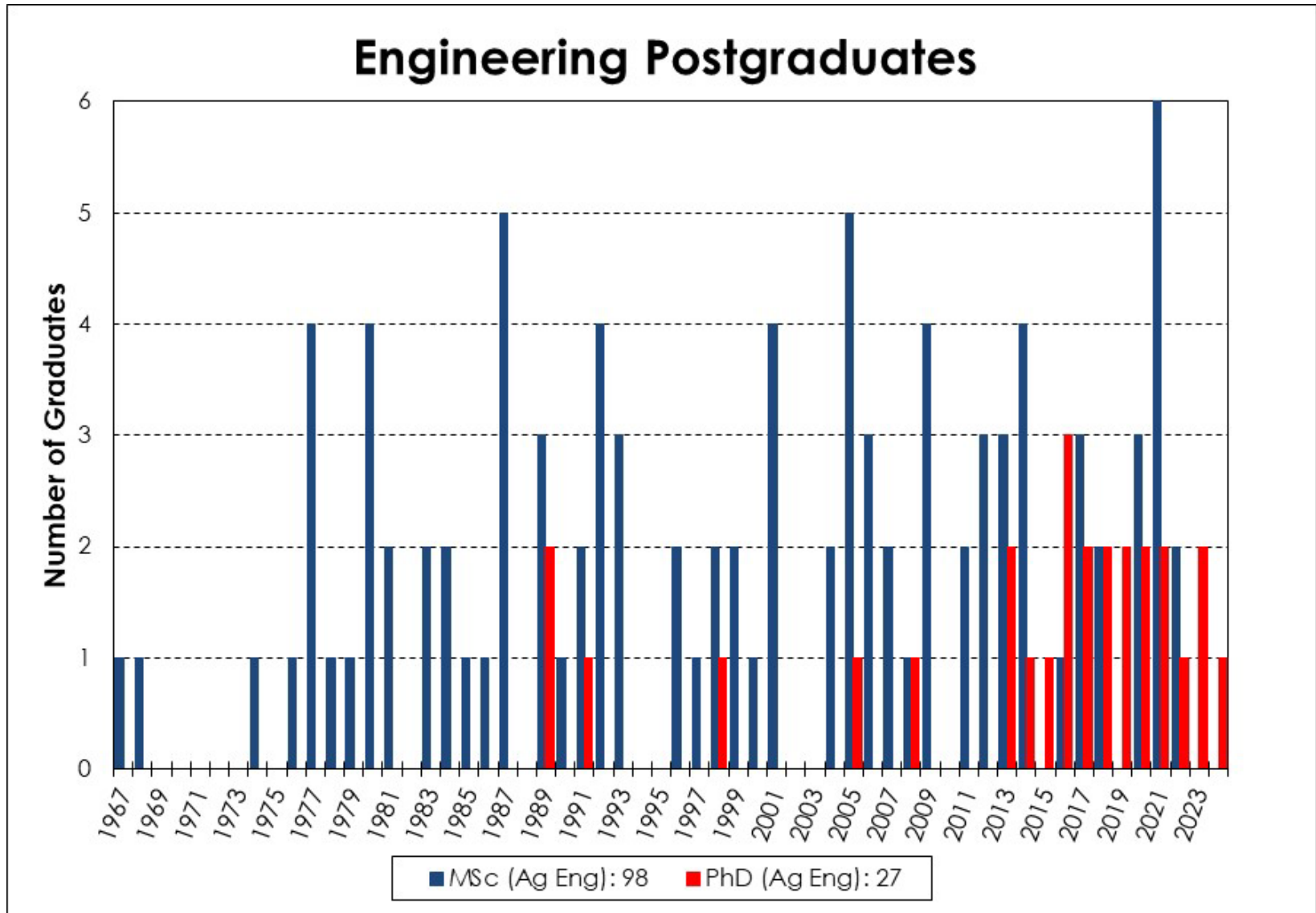
Prof. Workneh
PC



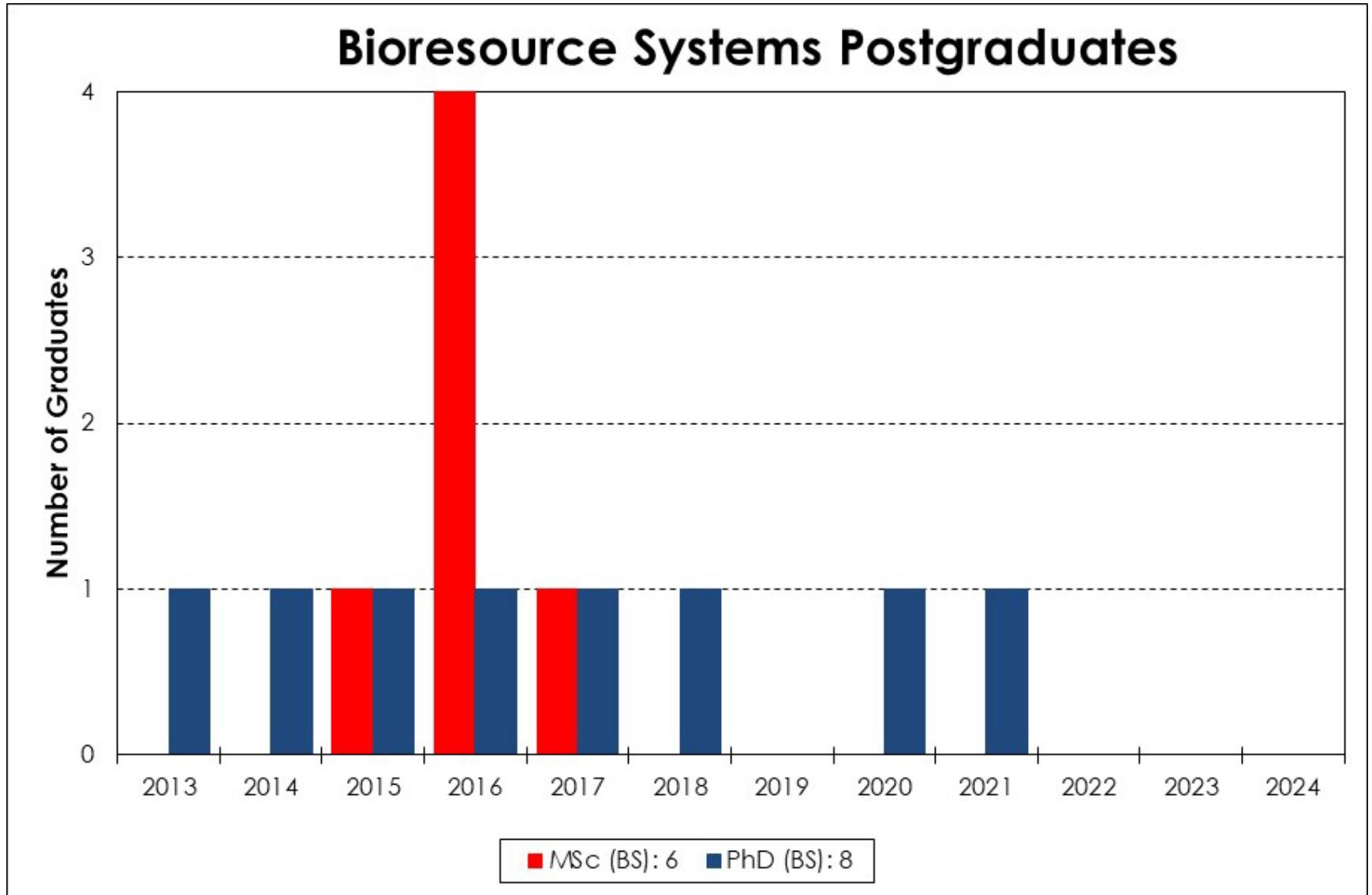
Capacity Development



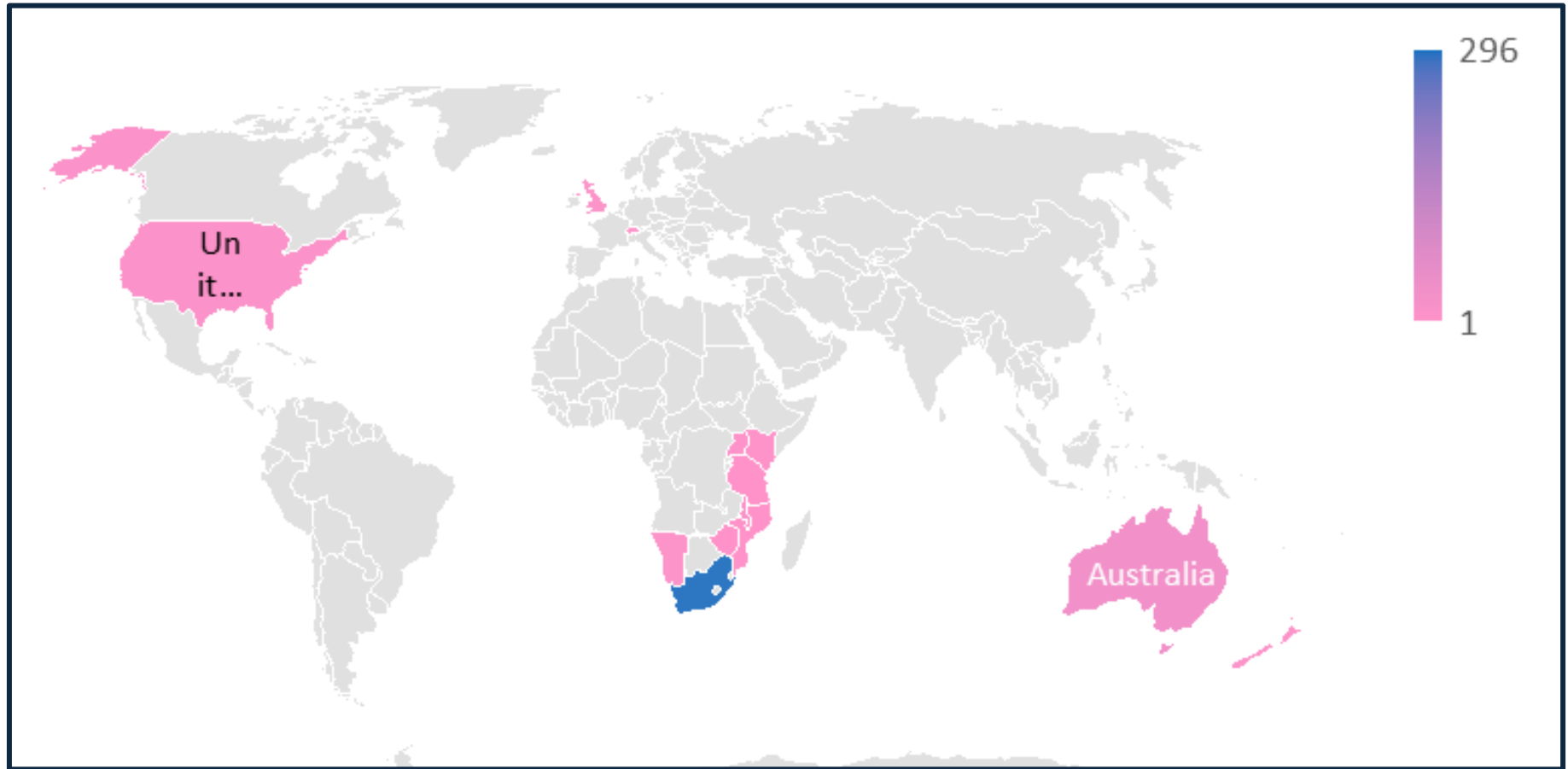
Capacity Development



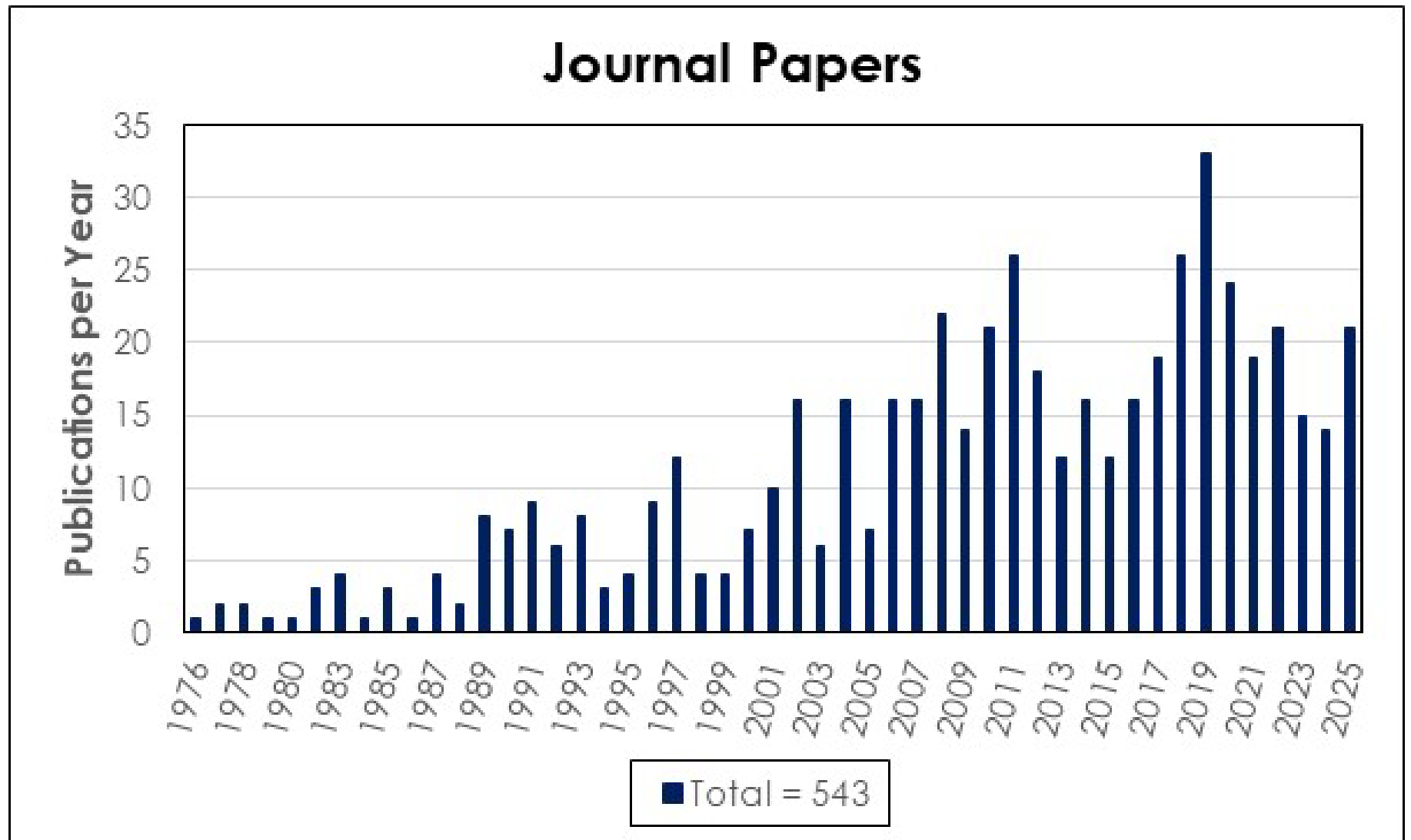
Capacity Development



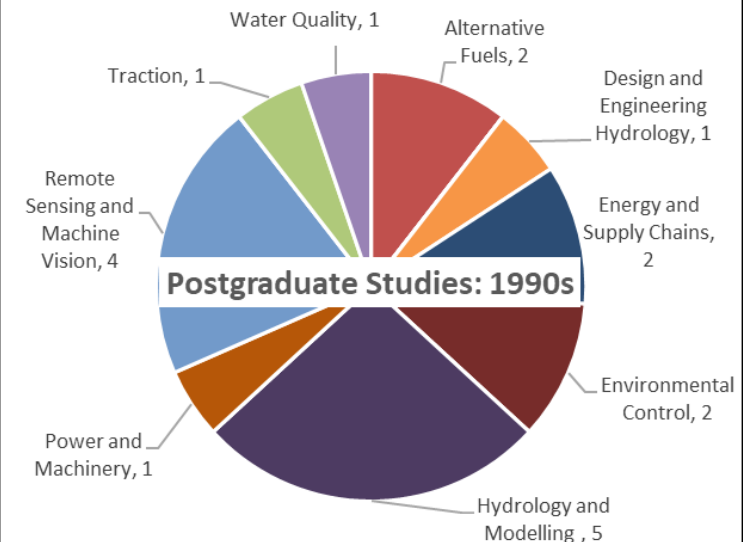
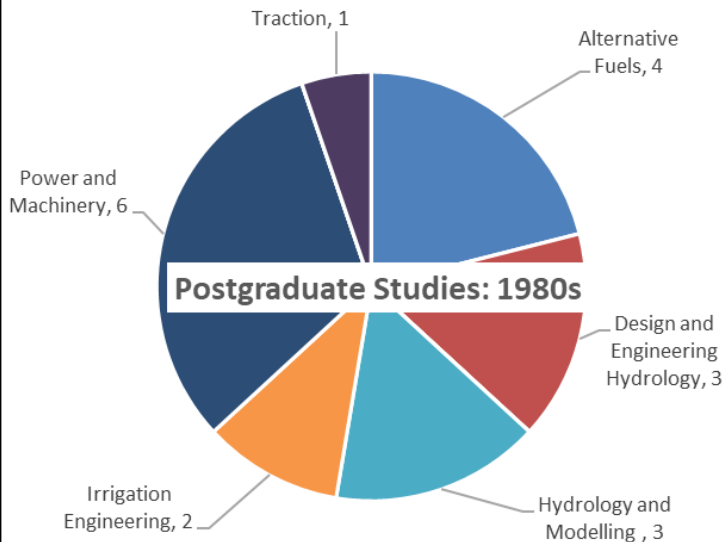
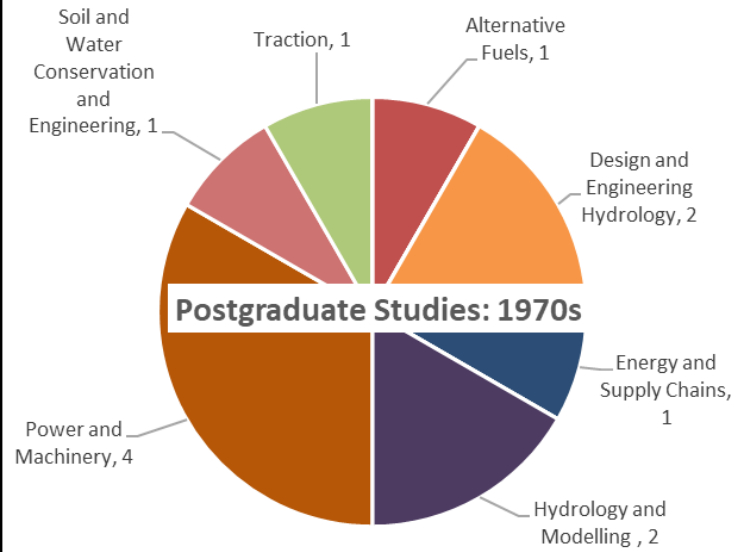
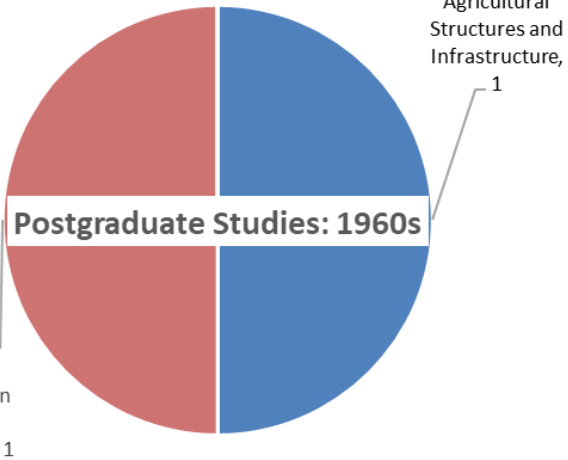
Where are the Graduates?



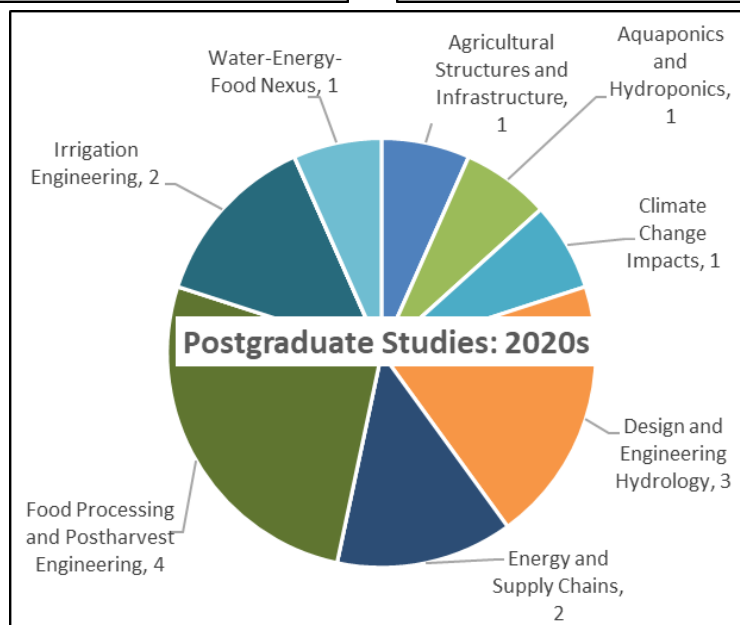
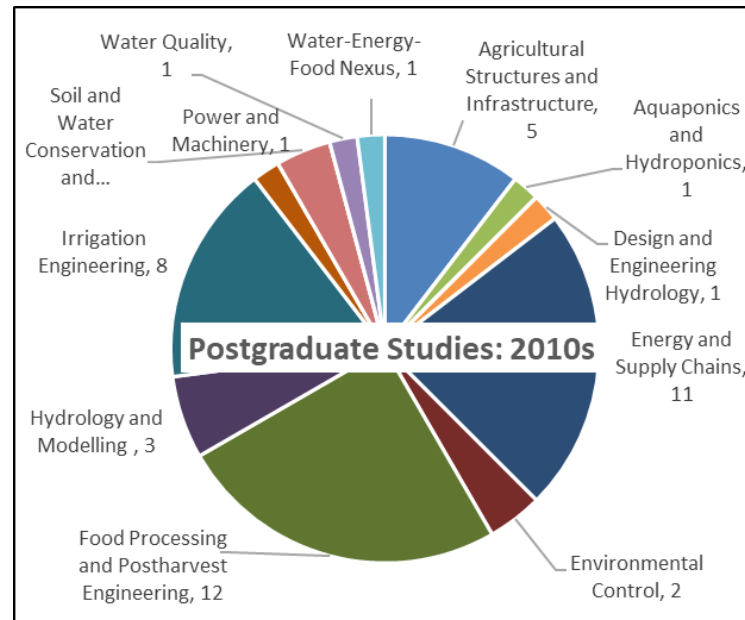
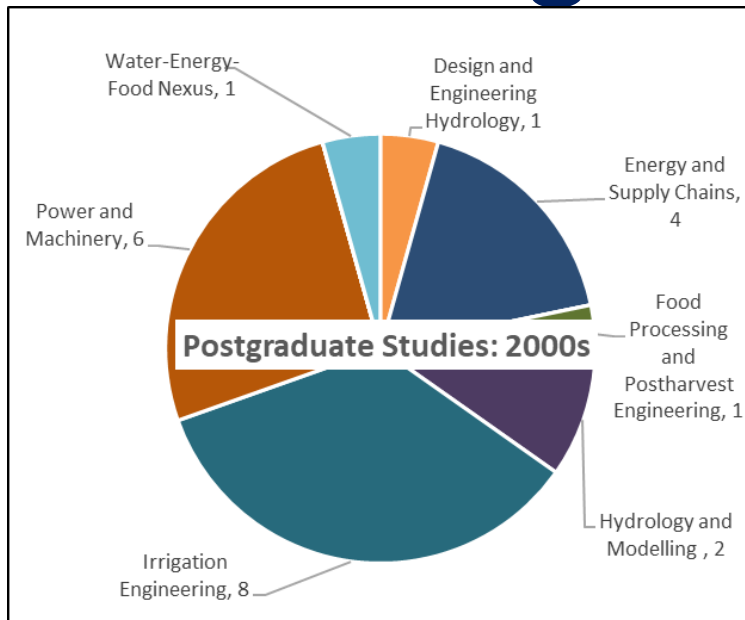
Research Publications



Evolving Research Fields



Evolving Research Fields



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Mechanisation Programme



Contents

- “Fuel Crisis”
- Sasol Diesel
- Costs of Ag Production
- Soil Compaction
- Post-harvest deterioration

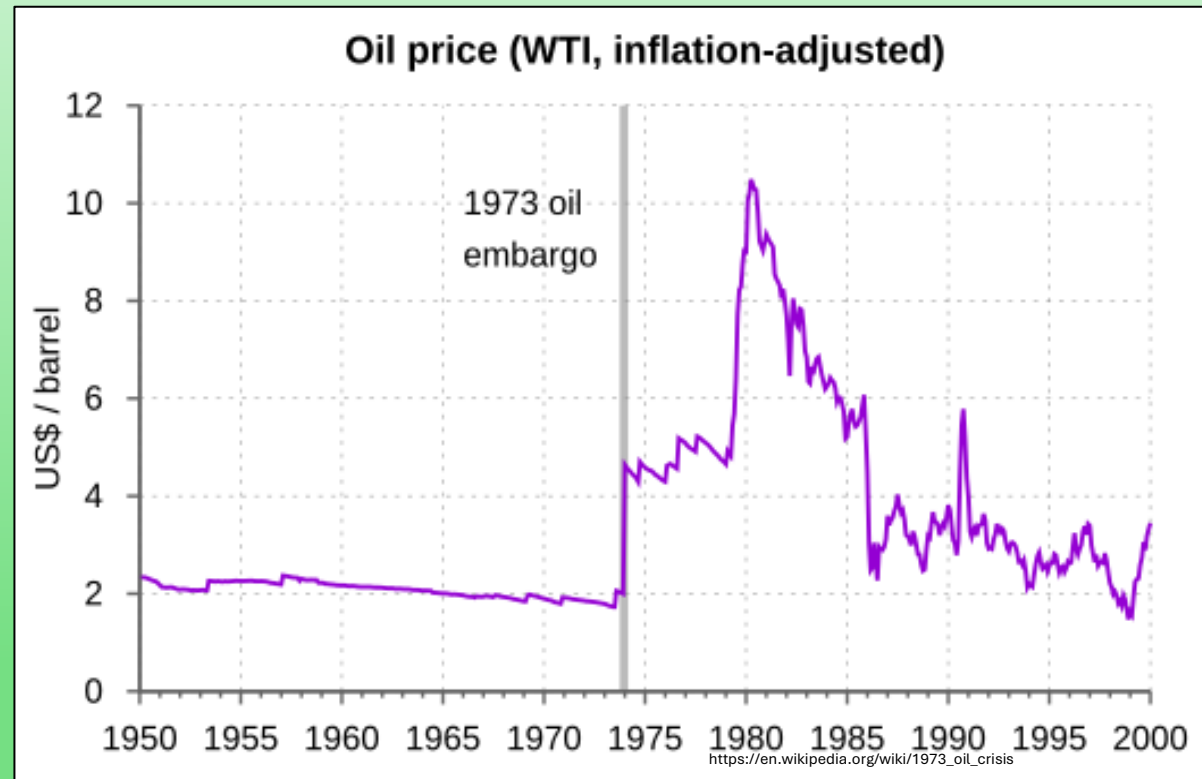
1970's Fuel crisis

Liquid Fuel

Daily fuel rationing
from 6 pm. to 6 am

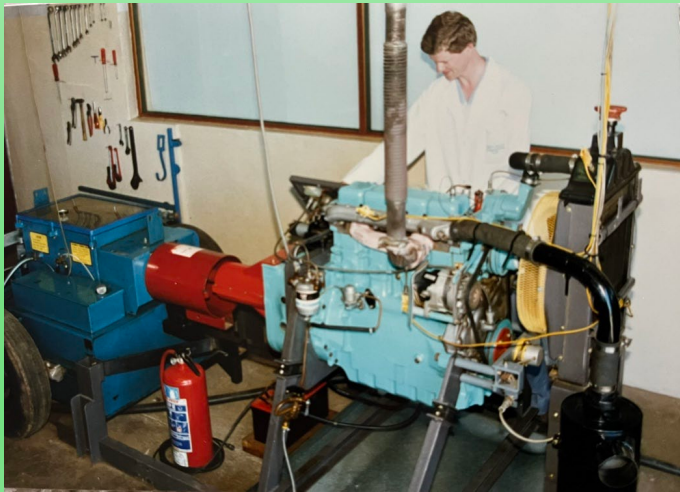
Weekend restrictions

Reduction in the
speed limit to 80
km/h



Alternative Fuels Research

- UKZN focus on Ethanol for Diesel
- Ag Eng Collaboration with
 - MB (Germany)
 - Perkins (UK)



Tractors running on Ethanol

Combustion expertise

- Fuel Burning Process
- Engine Durability



Sasol Diesel



Durability test rigs

Altitude simulator



Agricultural Production Costs

- Machine efficiency
- Supply Chains
- Vehicle Scheduling



Optimising Supply Chains in Sugarcane

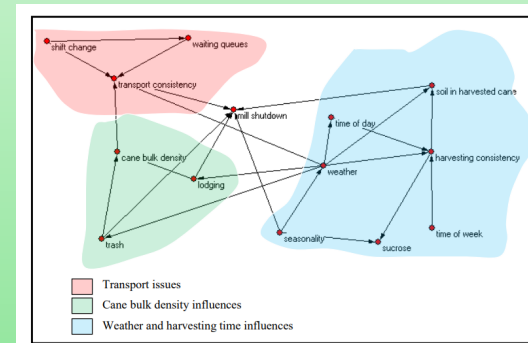
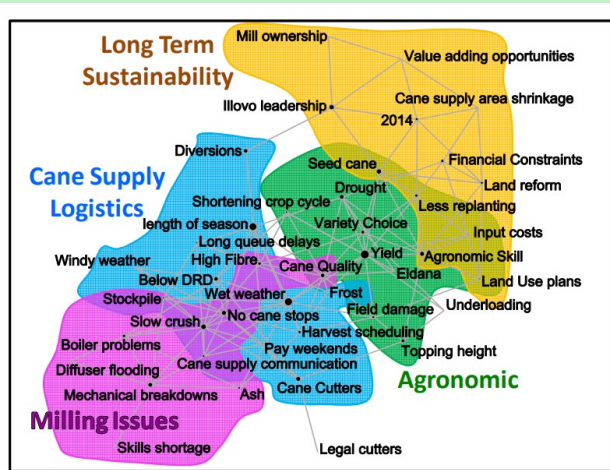


Figure 2.4 A cause-and-effect network of the factors that impact on cane flow consistency



Vehicle Scheduling

Vehicle queues reduced to almost zero

Vehicles from 70 to 25

Reliability of cane supply, no-cane stops from 600 h to 150 h



National
Gold
Logistics
Award

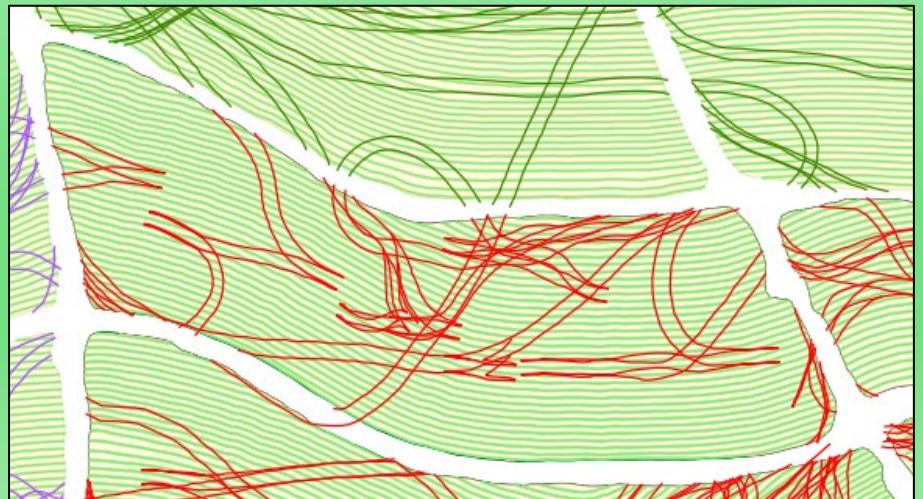
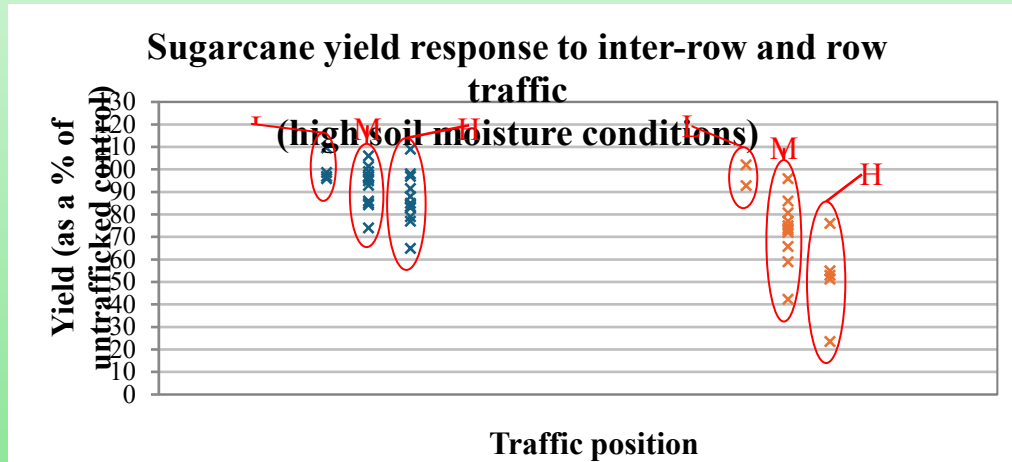


Compliance in transport systems

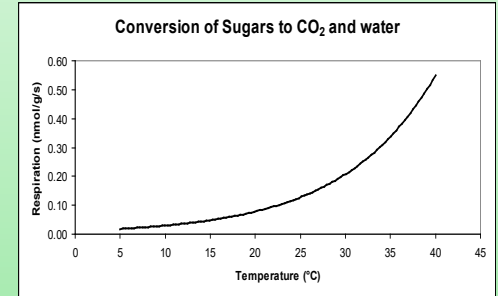
- Road Traffic Management System. (RTMS)
- 396 Depots
- > 17000 Vehicles
- Performance Based Standards (PBS)
- 2000 Vehicles
- 600 M km
- 20% improvement in metrics



Traffic Induced Compaction and Yield decline



Harvest to crush delay



$$\text{Revenue} = \text{RV Price} * \text{RV\%} * \text{Tons at weighbridge}$$



Ag Eng 75th

Thank you



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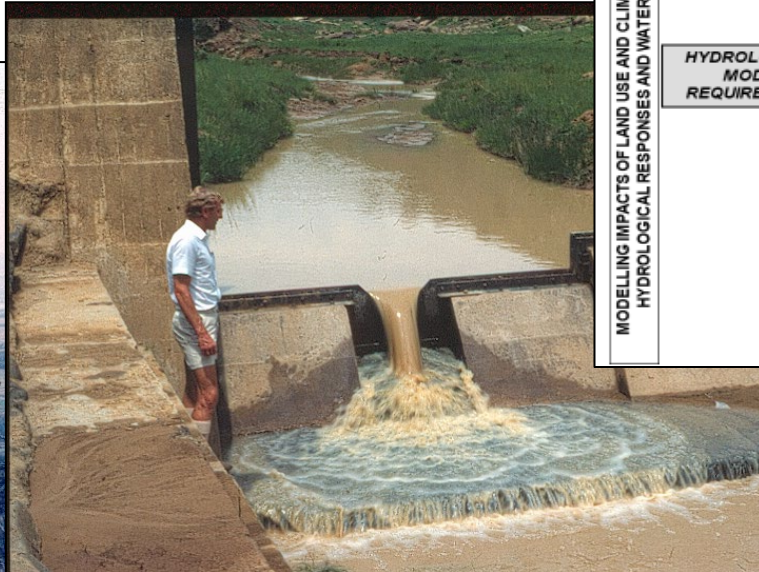


Phase 1: From Measuring to the Beginning of Modelling to the Birth of Hydrology as a Discipline

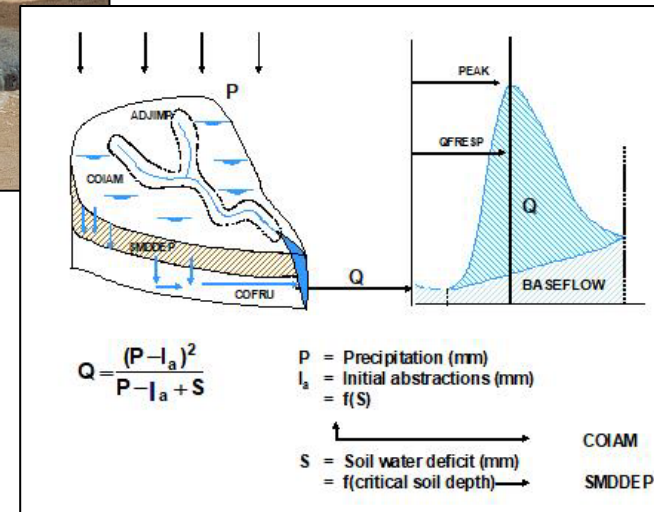
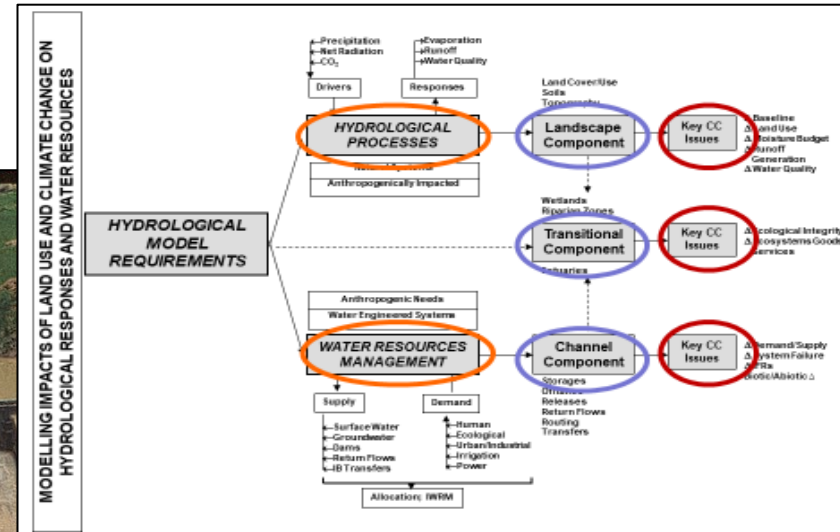
Phase 1: From Measuring to the Beginning of Modelling to the Birth of Hydrology as a Discipline

Modelling to the Birth of Hydrology as a Discipline

Discipline

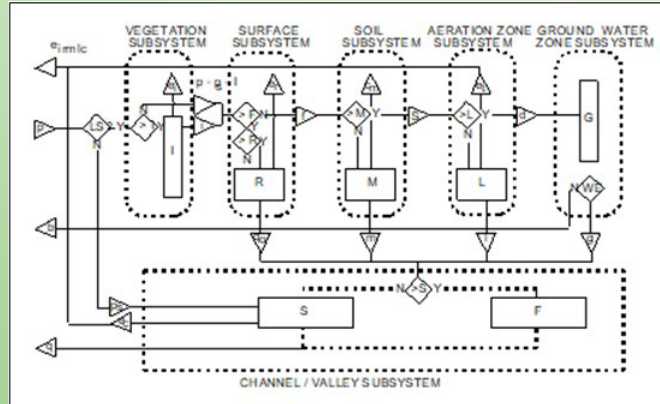


After 2 Years, the Principal Calls Me In 1982... re. Hydrology as a Discipline



Hydrological Research...1975-2025: A Personal Journey

Phase 2: Development of the **ACRU** Agro-Hydrological Modelling System

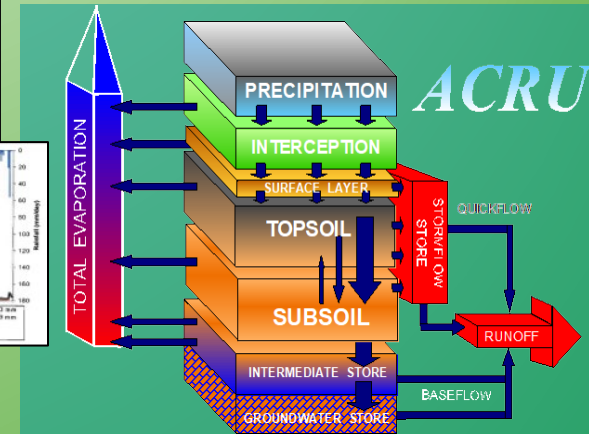
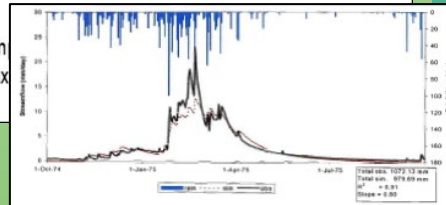


INPUTS	LOCATIONAL	CATCHMENT	CLIMATIC	HYDROLOGICAL	LAND CHANGE	AGRONOMIC		
	SOILS	RESERVOIR	LAND USE	IRRIGATION SUPPLY	IRRIGATION DEMAND			
MODEL	ACRU MODEL							
OPERATIONAL MODES	SOIL WATER BUDGETING/ TOTAL EVAPORATION MODELLING			POINT or LUMPED or DISTRIBUTED MODES or G.I.S. LINKED		DYNAMIC TIME or ANNUAL CYCLIC CHANGE		
SIMULATION OPTIONS / COMBINATIONS	RUNOFF COMPONENTS	RESERVOIR STATUS	SEDIMENT YIELD	IRRIGATION DEMAND	IRRIGATION SUPPLY	LAND USE IMPACTS	CLIMATE CHANGE	CROP YIELD
OUT:	/	/	/	/	/	/	/	/
	/	/	/	/	/	/	/	/
PUT:	/	/	/	/	/	/	/	/
	/	/	/	/	/	/	/	/
	/	/	/	/	/	/	/	/
	/	/	/	/	/	/	/	/
SPECIFIC OBJECTIVES / COMPONENTS	Stormflow Baseflow Peak Discharge Hydrograph - generation - routing EV analyses	Outflows: - overflow - normal flow - seepage - acid actions Interbasin transfers Off-channel storage	Sediment - generation Reservoir - siltation	Crop Demand and Application - on demand - fixed cycle - fixed amount - deficit	From - reservoir - river and - evaporation - off channel storage Return flows	Gradual change Abrupt change Total evaporation Tillage practices Wetlands	A CO ₂ A E A P	Maize Wheat Sugarcane Primary productivity - dryland - irrigated - profit / loss

$$q_p = 0.2083Q_s A / 1.83 L$$

where

- q_p = peak discharge ($m^3 \cdot s^{-1}$),
 - Q_s = stormflow depth (mm) from an individual catchment,
 - A = catchment area (km^2),
 - L = catchment lag (response) time (h)
- $$= \frac{A^{0.35} MAP^{1.1}}{41.67 y^{0.3} j^{0.87}} \text{ and}$$
- 1.83 = a multiplier which was com associated with annual max catchments,



... Including the 'Alien' Scientist Being the AgEng HoD for 2 Years

HYDROLOGY and AGROHYDROLOGY

A TEXT TO ACCOMPANY THE ACRU 3.00
AGROHYDROLOGICAL MODELLING SYSTEM

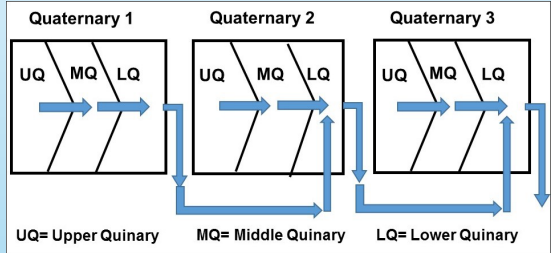
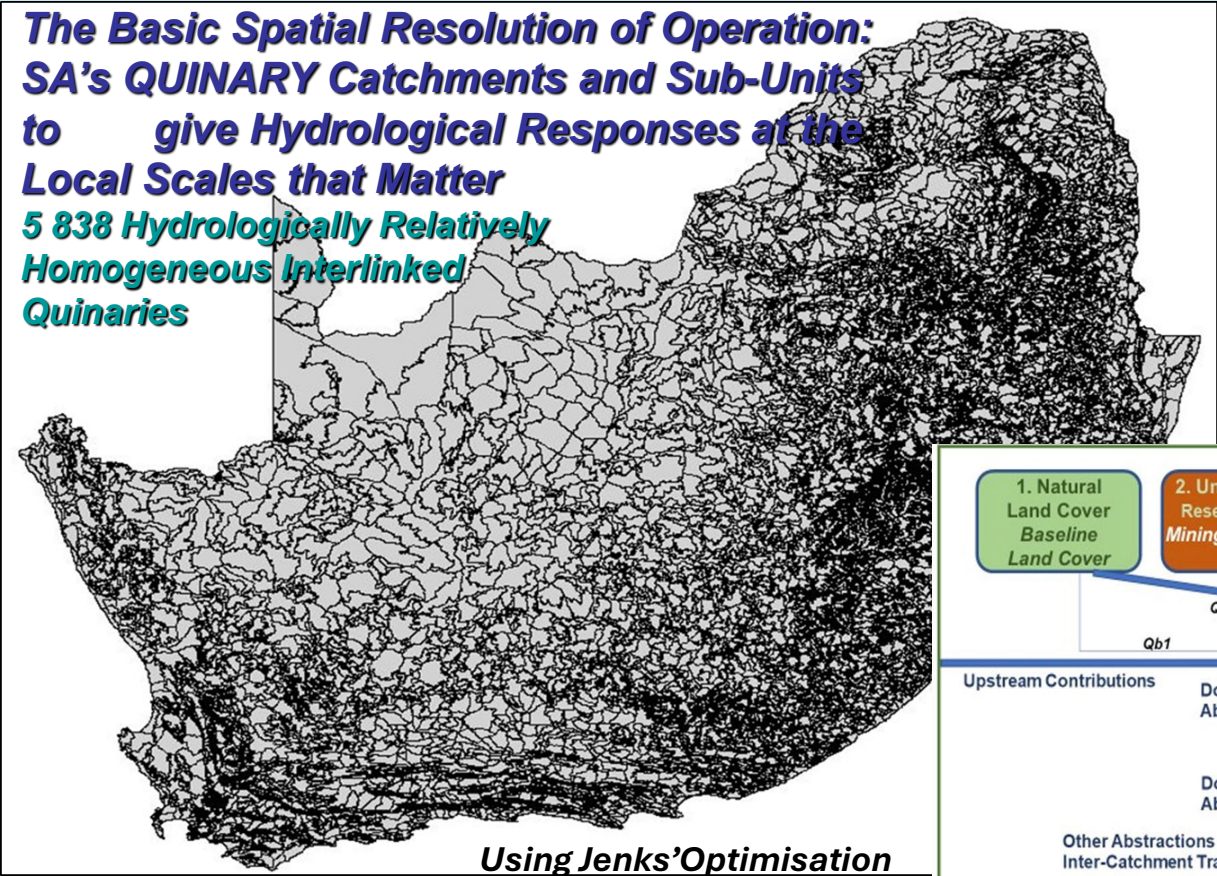
ACRU AGROHYDROLOGICAL MODELLING SYSTEM

USER MANUAL
VERSION 3.00

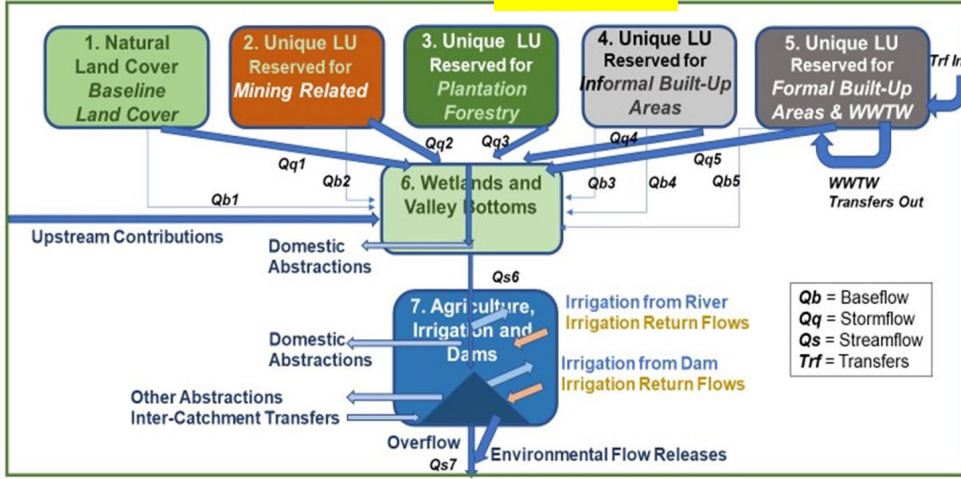
R. SCHULZE

JEFF SMITHERS and ROLAND SCHULZE

Phase 3: Development of the National Level Databases and Modelling

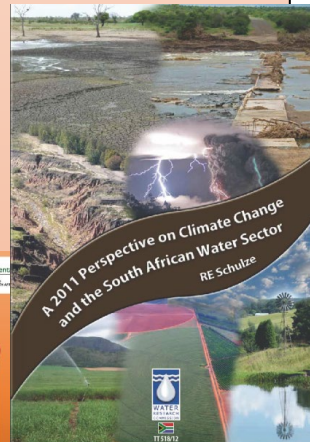
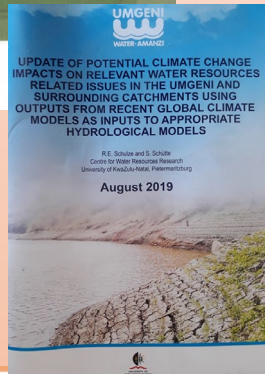
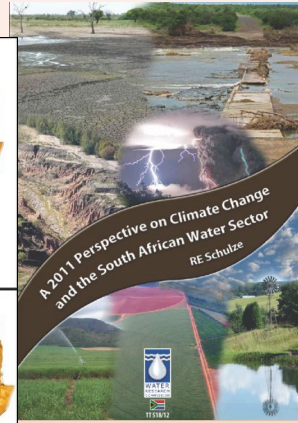
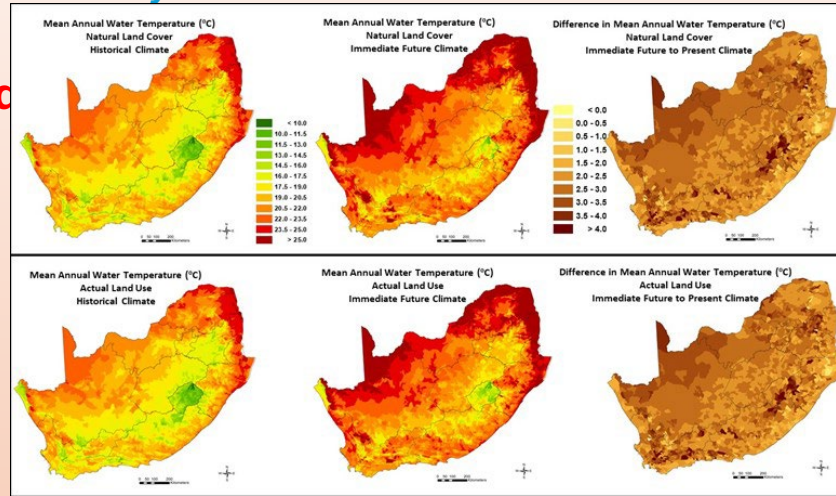


We now Model 40866
Spatial Units across
RSA, Lesotho &
Eswatini

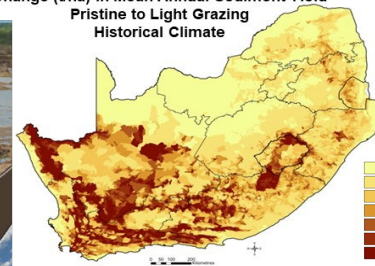


Hydrological Research...1975-2025: A Personal Journey

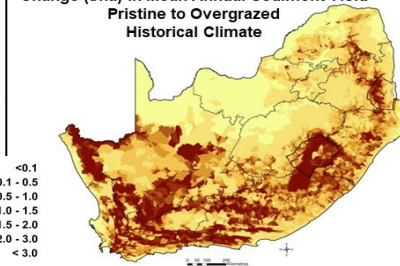
Phase 4: 1990s...Climate Change Rears its Head



Change (t/ha) in Mean Annual Sediment Yield
Pristine to Light Grazing
Historical Climate

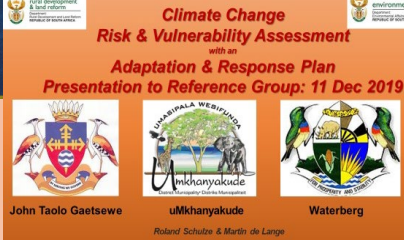


Change (t/ha) in Mean Annual Sediment Yield
Pristine to Overgrazed
Historical Climate



**Involvement in Local, National
& International Committees**

**Author/Co-Author to 137
Publications on Climate Change**



Hydrological Research...1975-2025: A Personal Journey

Phase 5: Post-Retirement... Addressing Issues of the Real World

a. Detailed Regional/Local Studies, e.g.

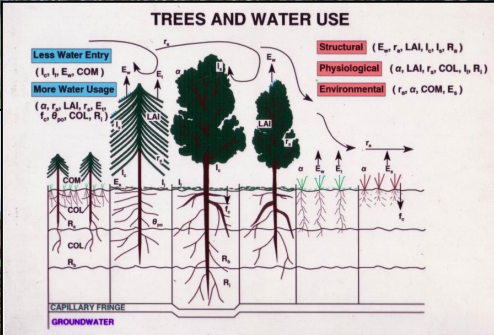
- Waterberg
- Komati System
- City of Tshwane
- QwaQwa
- uMngeni-uThukela System
- Berg System

b. Impact Studies... Afforestation, Overgrazing, Veld Burning, Tillage Practices, WWTW, Alien Invasives, Urban Systems

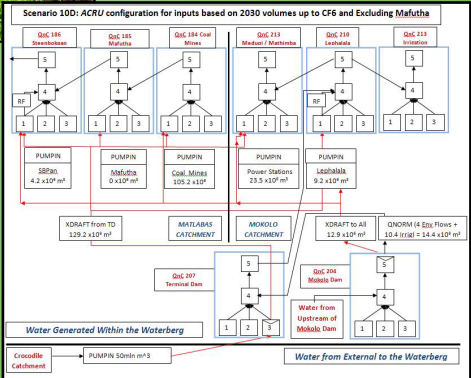
c. The April 2022 Durban Floods

d. The Era of Internationalisation

- Member of the IPCC, e.g. Austria, Australia
- Annual International Post-Grad Lecturing, e.g. IHE, SMHI
- International Accreditations, e.g. Kenya, Columbia



Including Learning New Skills en route



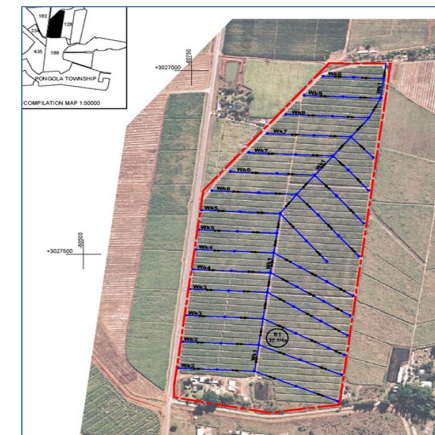
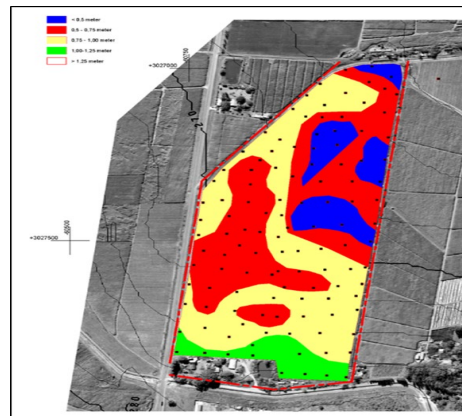
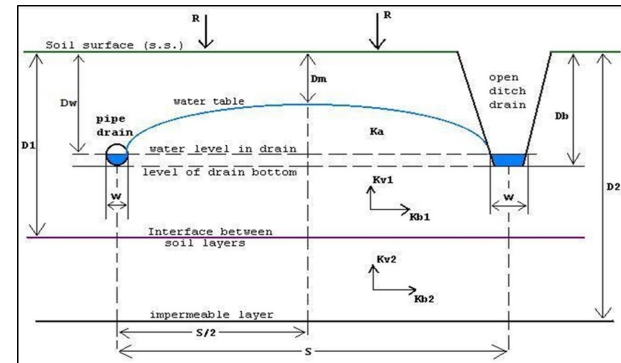
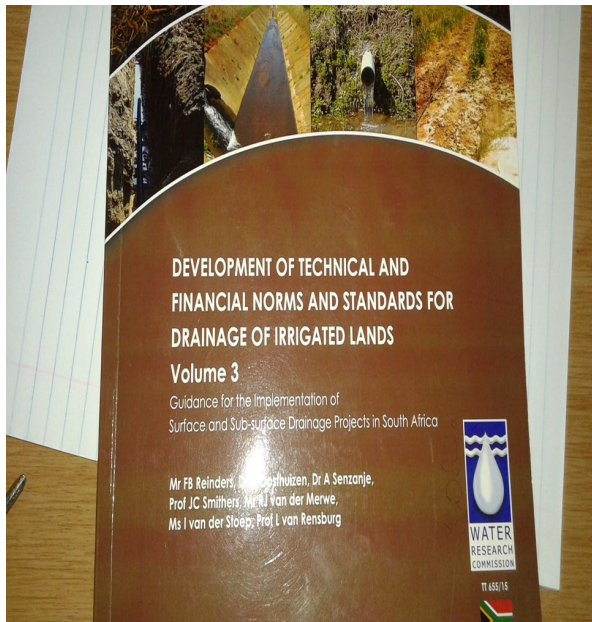
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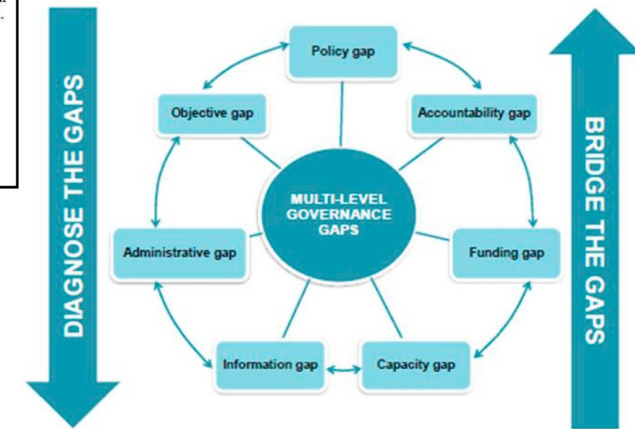
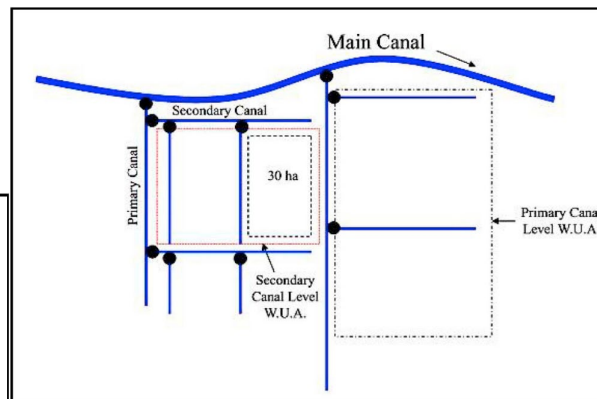
Irrigation and Soil and Water Conservation Engineering

- Development of Technical and Financial Norms and Standards for Drainage of Irrigated Lands



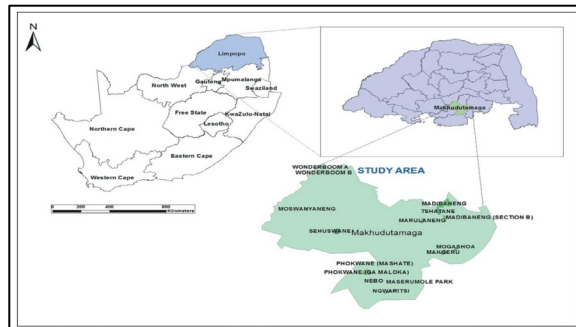
Irrigation and Soil and Water Conservation Engineering

- Irrigation infrastructure performance in smallholder irrigation in South Africa

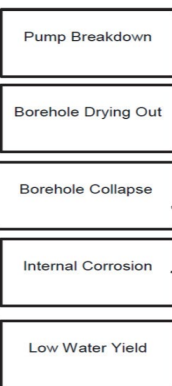


Irrigation and Soil and Water Conservation Engineering

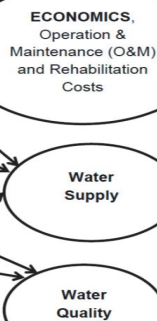
- Rural water supplies infrastructure management in South Africa and the sub-region
- Short furrow irrigation system



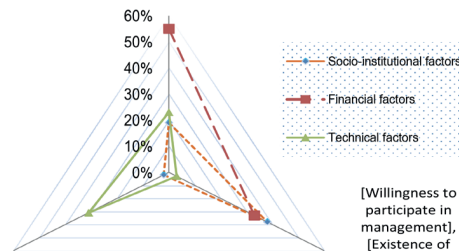
MAJOR PROBLEMS



IMPACTS

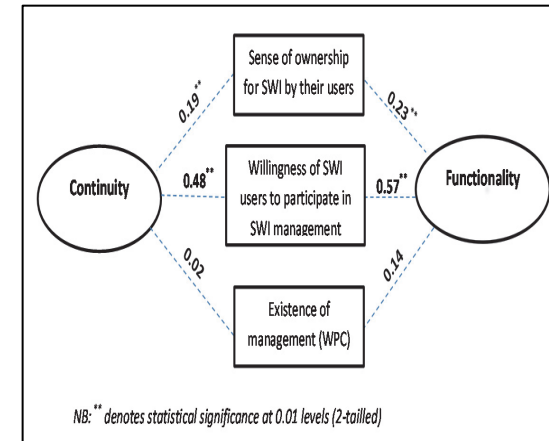


[Sense of ownership],
[Willingness to pay],
[Robustness of SWI hardware]



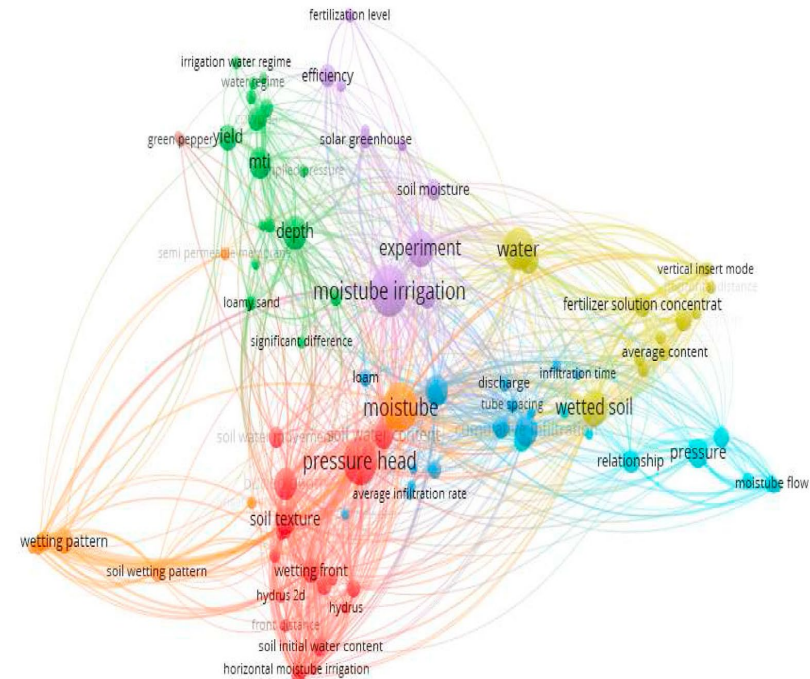
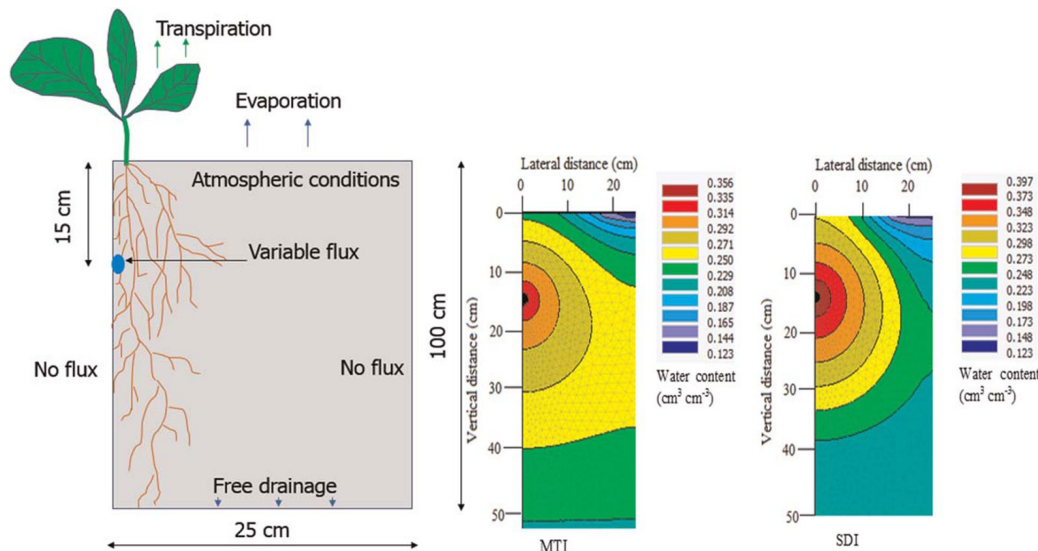
[Existence of management structures],
[Availability of maintenance personnel]

[Willingness to participate in management],
[Existence of financing mechanism],
[Availability of spare parts]



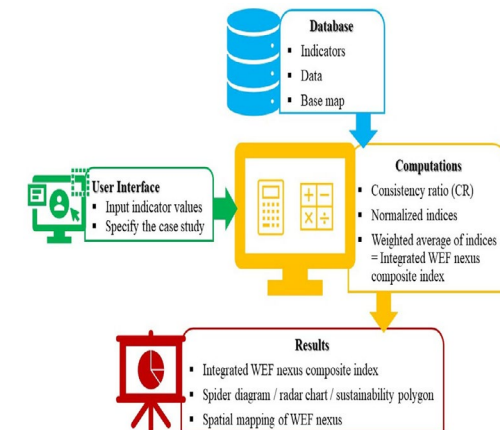
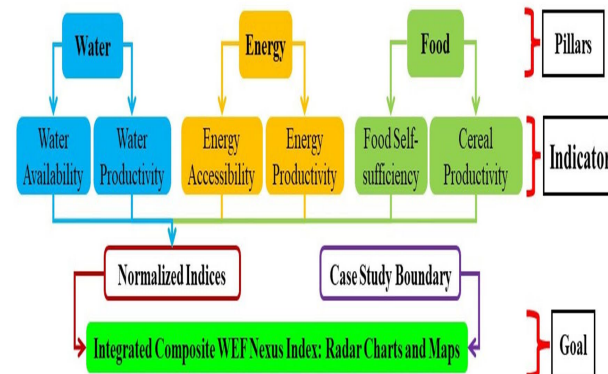
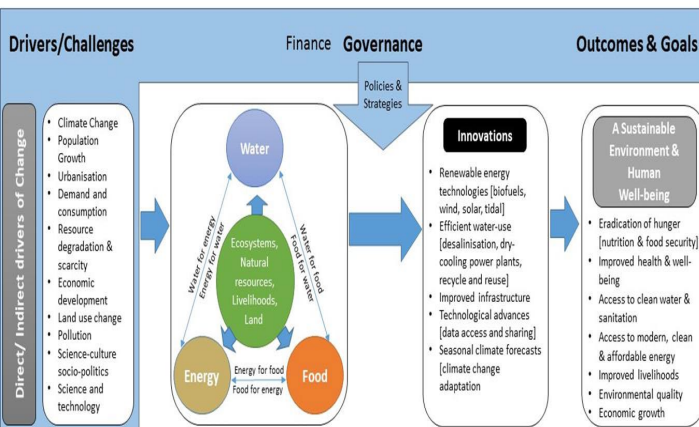
Irrigation and Soil and Water Conservation Engineering

- Moistube irrigation technology research – characterization, soil water dynamics, and crop response to Moistube irrigation



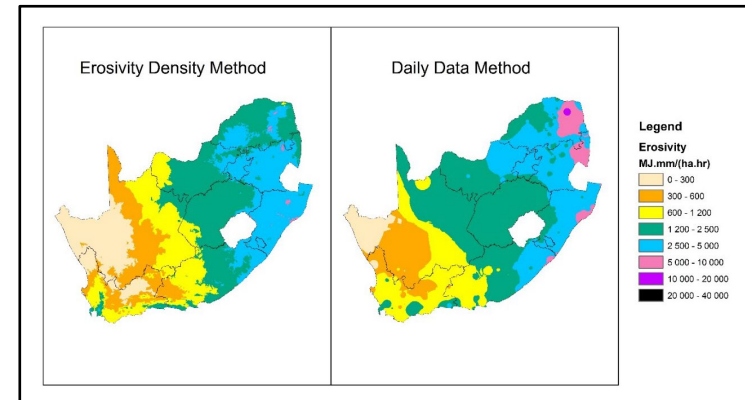
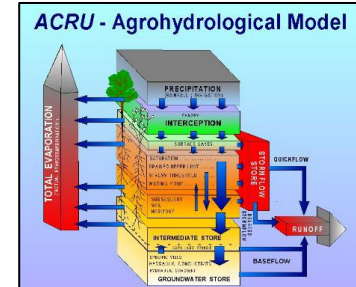
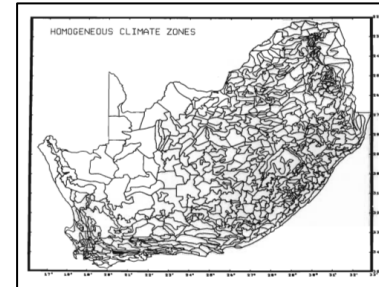
Irrigation and Soil and Water Conservation Engineering

- Water-energy-food (WEF) nexus characterization, applications and development of the iWEF model



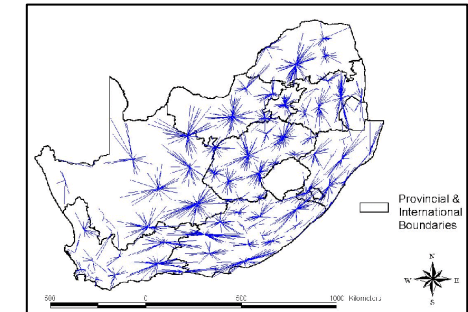
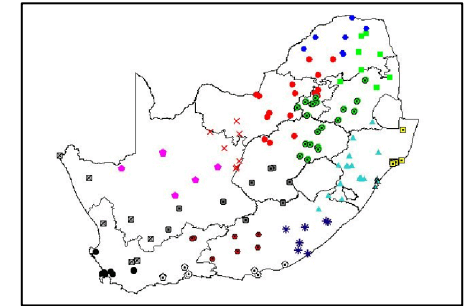
Irrigation and Soil and Water Conservation Engineering

- Crop water requirements
- Irrigation scheduling tools
- Soil and Water Conservation Engineering
 - Rainfall erosivity
 - CoSDT development & software



Design Rainfall Estimation

- DRE-SA software
 - Regionalised approach
 - 5 min – 7 days
 - 2 – 200 year RP
 - Software: 1'x1' resolution
 - Recommended by SANRAL DM
 - Widely used



Design Rainfall Estimation in South Africa (Ver 3)

Search Method

☐ Search by Latitude and Longitude

☐ Search by Rainfall Station

Duration

☐ 5 min ☐ 4 hour ☐ 1 day

☐ 10 min ☐ 6 hour ☐ 2 day

☐ 15 min ☐ 8 hour ☐ 3 day

☐ 30 min ☐ 10 hour ☐ 4 day

☐ 45 min ☐ 12 hour ☐ 5 day

☐ 1 hour ☐ 16 hour ☐ 6 day

☐ 1.5 hour ☐ 20 hour ☐ 7 day

☐ 2 hour ☐ 24 hour ☐ All

Return Period

☐ 2 Year

☐ 5 Year

☐ 10 Year

☐ 20 Year

☐ 50 Year

☐ 100 Year

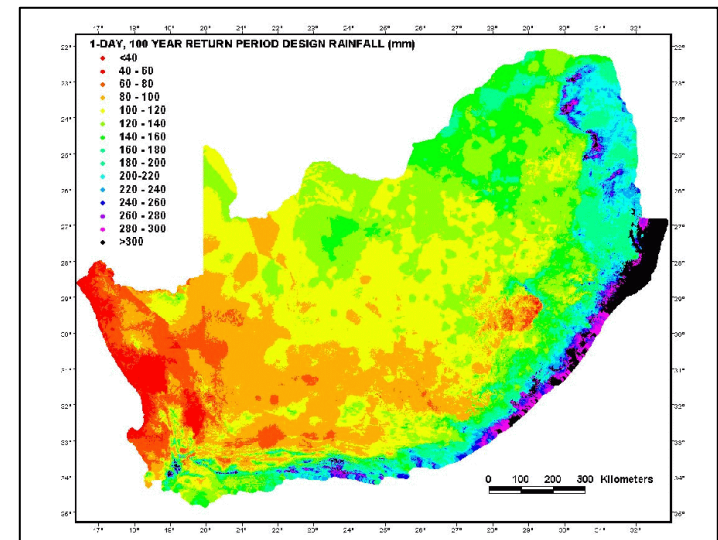
☐ 200 Year

☐ All

Block Size

Proceed

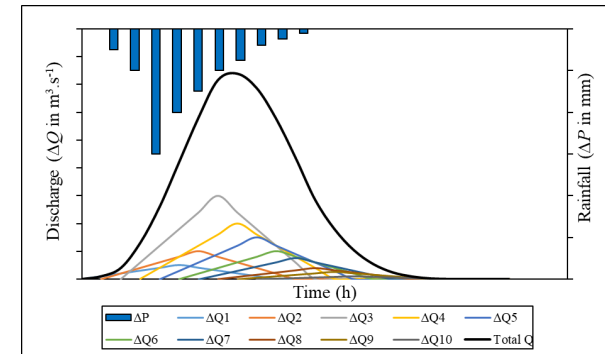
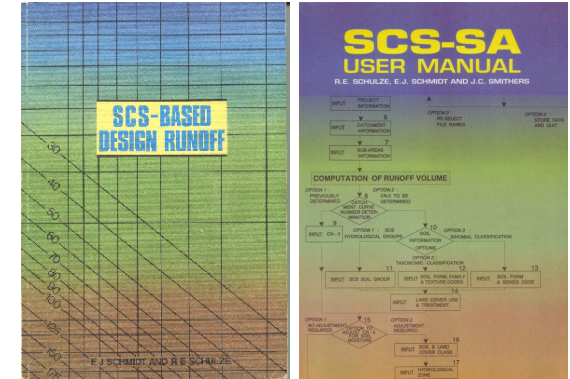
Exit



Design Flood Estimation

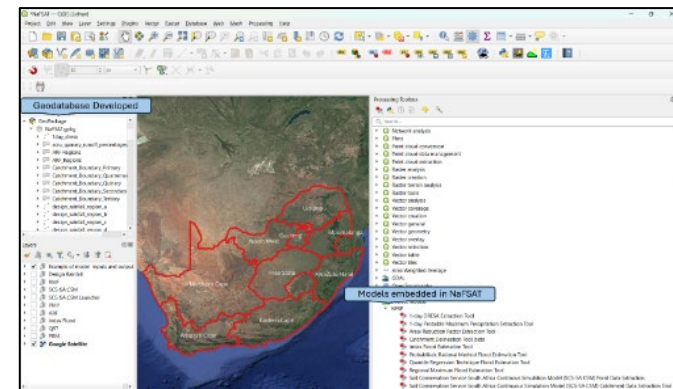
- SCS-SA

- Modified and adapted for local conditions
 - S-S lag estimation equation
 - Expanded HSGs
 - Regionalised accounting for AMC
 - Design hyetographs
- Production of user manuals
- SCS-SA software (> 700 sold)
- Many courses
- Recommended for use in SA
- Further development – CSM



- NFSP

- New developments
- NaFSAT

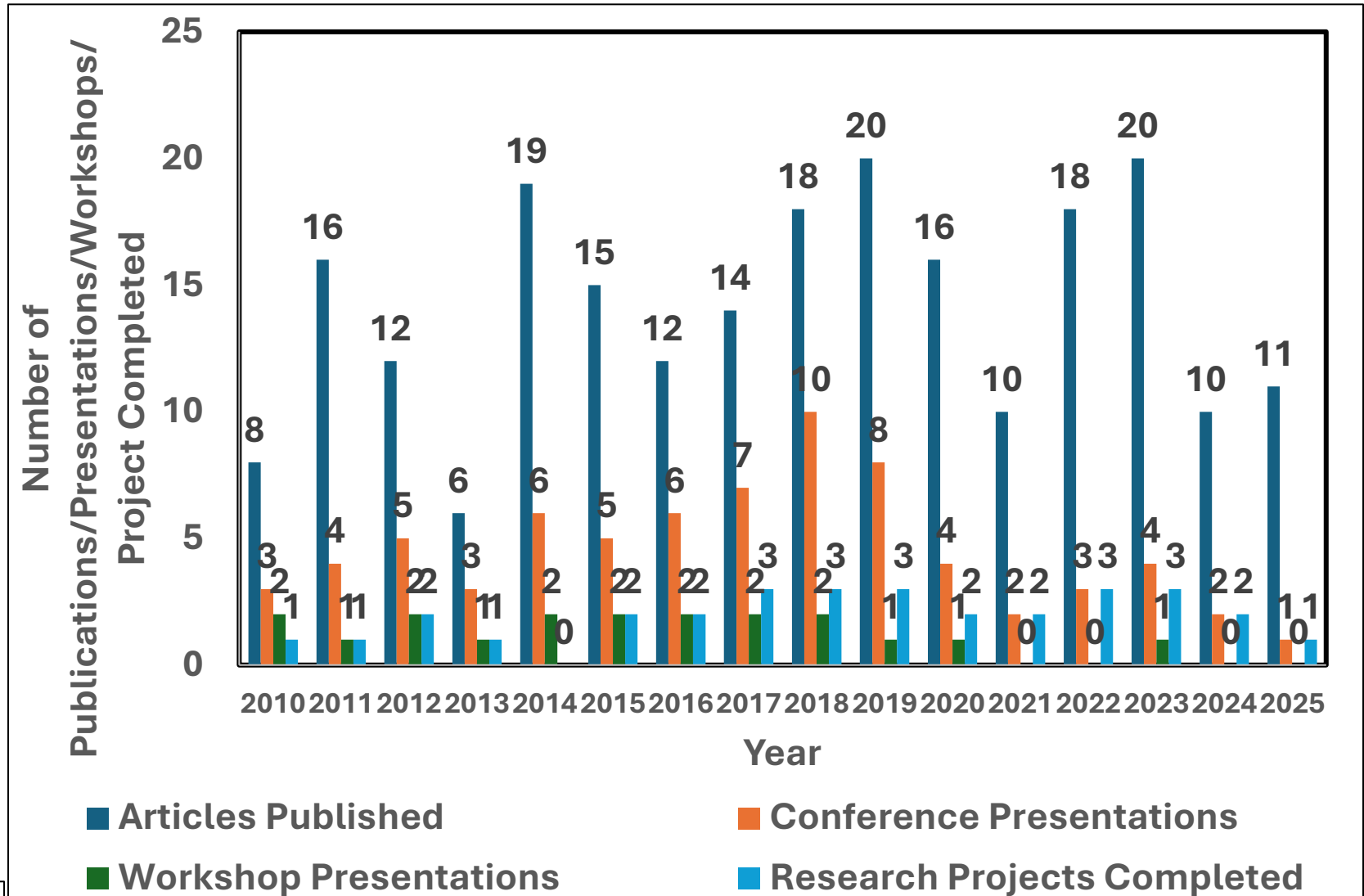


Outline

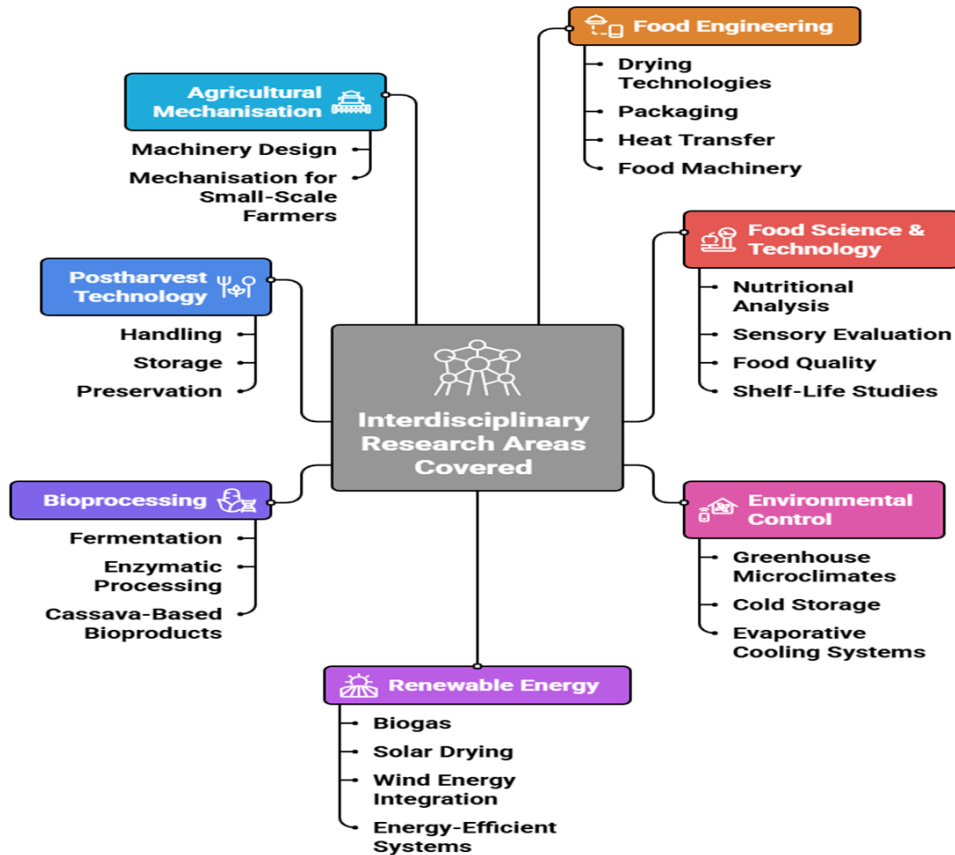
- History timeline
- Capacity development
- Power, traction and alternative fuels research
- Hydrological research
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- **Postharvest technology and food engineering**



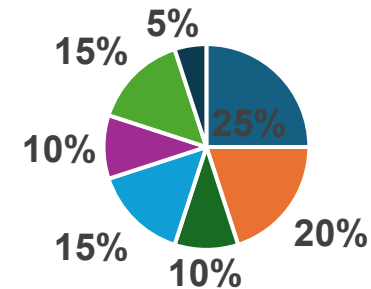
Applied Agricultural and Food Systems Engineering



Major and Specific Areas Covered



Applied agricultural and food systems engineering Percentage of Total Publications

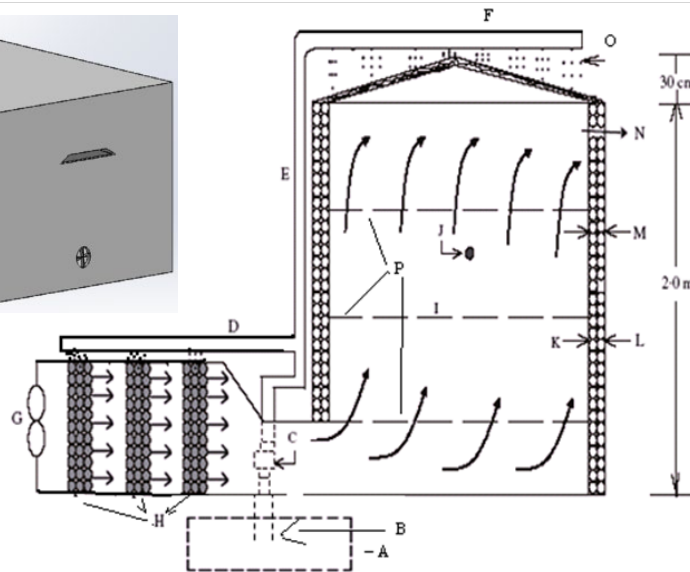
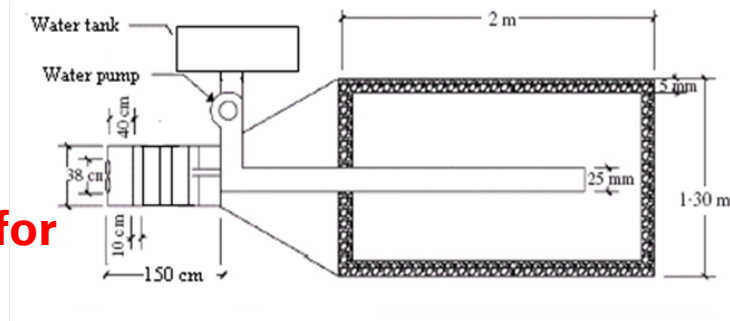
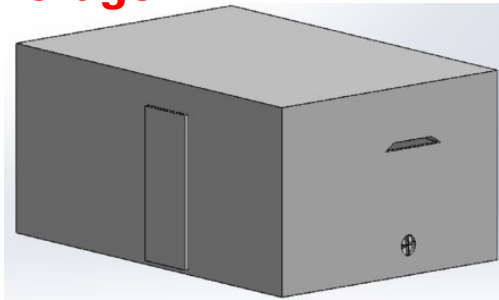


- Food Engineering
- Food Science & Technology
- Environmental Control
- Renewable Energy
- Bioprocessing
- Postharvest Technology
- Agricultural Mechanisation



Impact

**Evaporative
cooling
technologies for
fresh produce
storage**



**Smoothing tomatoes' bumpy
ride to market**



Thank you for your attention!

