Faculty of AgriSciences

ANNUAL REPORT 2013

UNIVERSITEIT
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CONTENTS

PREFACE

In 2013 the Faculty again performed well on most of the University's strategic management indicators. Our emphasis remains on quality teaching and applied research in agricultural sciences and related domains. To continue attaining this we had to stem our recent growth in student numbers to focus on quality of output in terms of the success rates of our students, and on enhancing our postgraduate performance. We have managed to sustain academic output whilst incrementally improving our financial sustainability.

In addition, we made important contributions to the HOPE Project through the Stellenbosch University Food Security Initiative and the Standard Bank Centre for Agribusiness Leadership and Mentorship Development.

The Faculty of AgriSciences comprises 11 departments: Agricultural Economics, Agronomy, Animal Sciences, Conservation Ecology and Entomology, Food Science, Forest and Wood Science, Genetics, Horticultural Science, Plant Pathology, Soil Science, and Viticulture and Oenology. Several research institutes, centres and chairs resort under these departments.

Our research profile is progressing steadily, as we are benefitting from our relations with industry bodies and government. The Faculty now has four government-funded chairs as part of the South African Research Chairs Initiative (SARChI) – in postharvest technology, plant biotechnology, meat science and integrated wine science. The accelerated outputs achieved in conservation ecology, food science, animal sciences and plant pathology are testimony to our advances in both traditional and emerging fields of study. Our postgraduate emphasis brought unprecedented numbers of master's and PhD degree graduates.

We continue to maintain productive relations with the public sector, including the Departments of Science and Technology, Trade and Industry, and Agriculture, Forestry and Fisheries, as well as the Agricultural Research Council and several other bodies. Our third-stream income continues to grow. We also maintain good relations with agricultural

industries, which generously fund research programmes or match state funding in our Faculty.

Our strategic association with the Elsenburg Agricultural College has gone from strength to strength. Our Faculty now has seating in the Elsenburg Council. We have thus grown into the role of advancing academic quality through various forms of academic and professional exchanges without affecting their autonomy. Our collaboration with the Western Cape Department of Agriculture remains a priority.

Our diversity profile shows a gradual improvement among students and academic staff. Black students now constitute more than 20% of undergraduate numbers and more than 30% of postgraduates. Staff appointments from the designated groups also enhanced our diversity profile, but more should be achieved at senior levels. Our efforts to entice learners to the agricultural sciences through schools partnerships are beginning to show dividends as we recruit more students from the designated groups. Postgraduate students from other African countries have become a significant component of our student body and also serve to extend our African footprint.

AgriSciences is committed to the development challenges of our times and pays much attention to community interaction initiatives. These relate to poverty alleviation, food security, biodiversity, sustainability, the rural economy, postharvest technology, pests and diseases, water management, food processing, rural development and the agribusiness complex. Several national and international meetings and conferences have been hosted on our campus and supported by staff in the various agricultural disciplines.

Our marketing efforts in the year under review included industry liaisons, a dynamic first-year welcoming programme, schools programmes, recruitment drives, dedicated bursaries, fundraising events, alumni events, student achievement ceremonies, and an annual staff day for all our valued employees. Student support is a high priority and special attention is paid to students with learning, language, social and personal challenges. Through classroom and wider engagements our administrative and academic staff remain in touch with the special needs of our students.

The Faculty has extended its global network of collaboration to more universities and research institutes in various African countries and countries in the East, where our academic interests have continued to grow. Our staff and students have gained tremendously from such international exchanges. Renowned scholars from abroad continue to grace our campus and enrich our academic environment. Several international staff appointments also served to enhance our academic offering and international exchanges.

Our staff and students remain our greatest assets. Many of our senior staff play strategic and pivotal roles in providing thought leadership to agricultural industries and the public sector, aimed at pushing knowledge and social frontiers. Our students are encouraged to join this tradition.

Dean: Faculty of AgriSciences

STUDENT STATISTICS

Degrees awarded 2013*

BAgric	70
BAgricAdmin	6
BSc Conservation Ecology	44
BSc in Forest and Wood Science	11
BSc in Food Science	31
BScAgric	77
BAgricAdminHons	3
BScAgricHons	1
BScHons	6
MAgricAdmin	2
MSc	10
MSc in Conservation Ecology	9
MSc in Forest and Wood Science	8
MSc in Food Science	11
MScAgric	35
PhD	25
Postgraduate Diploma	4

* 2013 statistics based on the degrees awarded at the December 2013 and April 2014 graduation ceremonies

TOTAL 353

Department of

AGRONOMY

Introduction

If predictions of the growth of the world population are correct, global food production will have to be doubled within the next 40 years. Like most other countries on the African continent, South Africa is already importing large volumes of important food crops, such as wheat, as well as plant oils for human consumption, and sharp increases in the production of these crops will be needed. However, the increase in food production must be attained without a negative effect on the environment. Agronomists therefore face the formidable challenge of increasing the production of most food and fibre crops consumed and utilised by people and livestock in the face of obstacles such as climate change, dwindling water supplies and pesticide resistance. In addition, increasing amounts of field crops are used annually to produce biofuels. The mission of the Department of Agronomy therefore is to focus on the development of technologies for sustainable increases in food production through relevant research projects, and the transfer of these technologies through teaching, presentations and publications at the scientific and semi-scientific levels. The structuring of the Department into various disciplines facilitates research, teaching and community service.

Beautiful but dangerous – weeds like Anagallis arvensis *(pimpernel) may look beautiful, but can cause crop losses*

Agronomy students busy trellising plants in the greenhouse during a practical class

Agronomy students testing the quality of irrigation water for the hydroponic cultivation of different crops

Overview

The Department's research is focused on soil-less production

Agronomy students in a canola field during a practical outing

systems; climate management in greenhouses used for vegetable, herb and flower production; sustainable production systems for winter cereals and oilseed crops; and the management of herbicide resistance in field crops. With the emphasis on sustainability, all research projects strive to minimise inputs such as water (greenhouse production), nutrients (greenhouse and field production) and pesticides (greenhouse and field production), while aiming to increase productivity. The main contributors to research projects through funding are the Protein Research Foundation (PRF) and the Winter Cereal Trust (WCT). Other contributors include Potatoes South Africa, which sponsored research on sustainable production methods for potatoes, Kynoch Fertilizer, which sponsored chemical fertilisers for greenhouse research projects, Sakata and Hygrotech, which sponsored vegetable seeds, and Agri-Organics, which sponsored various organic pest- and disease-management products.

Training in agronomy provides students with the skills to deal with the sustainable production of field crops, pastures, vegetables and greenhouse crops – skills essential to providing innovative solutions to the challenges discussed above. In 2011 an integration process that aims to provide Agronomy and Horticulture students with more exposure to the two disciplines was initiated. The two disciplines were considered mutually exclusive in the past, which meant that Agronomy students could not enrol for Horticulture modules and *vice versa*, but since 2011 students in both disciplines may attend modules of the other discipline, with the result that students in both disciplines now have a broader knowledge foundation.

In 2013, scientific contributions were made at the Combined Congress hosted by the Soil Science, Weed Science, Horticultural Science and Crop Science Societies in Durban. Prof André Agenbag visited Australia to study canola production practices. Dr PJ Pieterse and Prof Andy Cairns attended and presented papers at the Global Herbicide Resistance Challenge in Freemantle, Australia.

The Department is also closely involved with the industry. Members of the Department are involved in the following institutions: Protein Research Foundation (Prof André Agenbag and Dr PJ Pieterse), Winter Cereal Trust (Prof André Agenbag), National Small Grain Cultivar Evaluation Task Team (Prof André Agenbag), Canola Planning Task Team (Prof André Agenbag), Canola Working Group (Prof André Agenbag), ARC Small Grain Institute Research Task Team (Prof André Agenbag), Intensive Agriculture South Africa (IASA) (Estelle Kempen), Herbicide Resistance Action Committee (Dr PJ Pieterse), South African Society of Crop Production (Estelle Kempen), Southern African Weed Science Society (Dr PJ Pieterse), and Potatoes South Africa (Estelle Kempen).

Partnerships also exist with the ARC (Small Grain Institute, Bethlehem and Infruitec-Nietvoorbij, Stellenbosch) and the Department of Agriculture: Western Cape.

Research

In the disciplines of winter cereals and oilseed crops, the focus is on determining the optimal fertilisation levels of wheat and canola. In a project funded by the Winter Cereal Trust, differences in soil chemical and physical characteristics were used to develop a mathematical model to predict the nitrogen mineralisation potential of the soil. In a follow-up study, the efficiency of different

Gerbera flowers being cultivated in a greenhouse

application methods and nitrogen fertiliser rates are being evaluated at four localities in the Swartland and Rûens. The nitrogen-use efficiency of different nitrogen sources on wheat was also studied. The effect of boron nutrition, of applied growth regulators and of different temperatures on the growth and production of canola cultivars in the South-Western Cape were projects funded by the Protein Research Foundation (PRF). The effect of vine management on hops production was also investigated. Another study was the investigation of the effect of paraffin on the germination of several crop species because claims have been made in the past that paraffin could protect seeds and seedlings from predation by insects and animals.

In the discipline of weed science, the main focus is on the herbicide resistance of weeds and the management thereof. Seed and plant samples received from farms where herbicide efficacy has not been satisfactory were tested for herbicide resistance. In a project funded by the PRF, the effect of sowing density of canola on the crop's weed-suppression ability was investigated. The objective was to identify techniques for weed management other than chemical control that can be used in conjunction with chemical control in an integrated weed control programme. Integrated weed control programmes can decrease reliance on herbicides, thereby reducing herbicide use, which can lead to a cleaner environment and a longer life for the herbicides – in short, increase sustainability in cropping systems. Different herbicide mixtures that can be used to obtain satisfactory weed control in genetically modified canola and a newly introduced grass herbicide, flucarbazone sodium (Everest®), were investigated on wild oats under field conditions.

Postgraduate Agronomy students doing weed counts in the field

Agronomy students in a canola field

In the discipline of pasture science, a study was carried out on the Elsenburg Experimental Farm to investigate optimal nitrogen fertiliser applications on three different planted pastures, viz. a pure grass mixture, a grass/clover mixture and a grass/lucerne mixture. This project was carried out in conjunction with Dr Johan Labuschagne of the Department of Agriculture: Western Cape and was funded by the Western Cape Agricultural Research Trust. In another study, in collaboration with Dr Johann Strauss of the Department of Agriculture: Western Cape and funded by the Western Cape Agricultural Research Trust, the effect of different levels of crop residues in a rotational system on the successful establishment, growth and production of medic pastures in conservation agriculture in the Western Cape was investigated.

The research emphasis in the discipline of intensive plant production systems is on improving

the efficiency of resource use. Research is being conducted to investigate the water and nutrient use of various greenhouse crops to enable an increase in the application efficiency of water and fertilisers and also to enable the re-use of drained nutrient solutions. A re-circulating hydroponic system for growing tomatoes has been implemented at the experimental farm and is currently being tested and adjusted as part of a PhD study. The effect of different nutrient mixtures on the marketability and vase life of local greenhouse-grown tulips and the efficiency of a novel method for the production of seed potatoes using aeroponics were investigated. Another project investigated the effect of varying light quality on the growth and production of vegetable seedlings. Research was conducted for Potatoes South Africa to determine the effect of different calcium and boron application rates during crop growth on the quality and disease resistance of tubers during storage.

Agronomy staff sowing trials with a plot seeder

Trials were also done to compare different organic production/ fertilisation practices, including the use of vermicompost, to compare crop yields as well as the plants' resistance to pests and diseases. In collaboration with researchers in the aquaculture division and the restaurant group Moyo, agronomy students were involved in the testing of an aquaponics system.

Community service

The Department of Agronomy is involved in various projects aimed at technology transfer and the support of local producers and the community as a whole. These include lectures at the Roodebloem pre-planting information day and Langgewens "SKOG" day to provide information to commercial and

Community interaction project in Eerste River in which postgraduate Agronomy students were involved - at the start, and below...

... approximately six months later

Young wheat fields are subject to competition from weeds

Wheat is the most important cereal crop in the Winter Rainfall Region

developing producers regarding the fertilisation of crops. Weeds brought in by the agricultural community are regularly tested for resistance to herbicides. Various cultivar evaluations and other trials are conducted on a continuous basis for seed, chemical and other agricultural companies. These include trials on both the experimental farm and at other localities in the region, and these trials are also incorporated into farmers' days and other public training sessions. The staff frequently provide support and guidance to producers and prospective producers and also to local school children who are involved in projects such as the Eskom Expo for Young Scientists.

Community outreach projects include support to a project where deaf people will be trained in agriculture, a vegetable garden project where vegetables are provided to a soup kitchen on the Cape Flats, and a project in which vegetables and protein are supplied to poor communities by way of a low-cost recirculating system. The postgraduate students of the Department founded a movement called DVG (Developing Vegetable Gardens) that is also involved in community outreach projects. Two of these projects are the establishment and management of an organic vegetable garden for the Rastafarian community at Jamestown outside Stellenbosch, and the planning of a vegetable garden and aquaponics production system at Rietenbosch Primary School in Cloetesville, Stellenbosch.

ASNAPP (Agribusiness in Sustainable Natural African Plant Products), a registered NGO, is striving in collaboration with the Department of Agronomy to help create and successfully develop African agri-businesses in the horticultural sector in several African countries. Currently, ASNAPP has been promoting greenhouse and open field vegetable production in rural areas

Aquaponics community project in Knysna in which lecturers from Agronomy and Aquaculture are involved

Agronomy students collecting weeds in a lupine field

in Zambia and Southern Africa. ASNAPP builds the capacity of small farmers/greenhouse producers, provides training and mentoring to the people involved in the project, and also provides linkages with the local and retail markets in the area to which these growers can supply their produce.

The projects that ASNAPP is involved in are:

- CASH Project (Commercial Agribusiness for Sustainable Horticulture) in Lusaka, Zambia, with technology transfers to small farmers to improve on agricultural practices.
- Expansion of the Tshwaraganang hydroponics project in the Northern Cape, with another multispan tunnel of 3 000 square metres to increase cucumber production.
- Establishing 2 100 square metres of tunnels on Langboom Farm, Nduli, Ceres for tomato, sweet pepper and pea production.
- The Sokhulumi Project in Gauteng, to resuscitate an agricultural project previously initiated but never implemented. With the assistance and guidance of ASNAPP the small farmers are producing hydroponically grown vegetables in open fields under shade netting.
- Dysselsdorp, Oudtshoorn will receive a 5 000 square metre multispan tunnel to produce greenhouse vegetables.

Community interaction project by postgraduate Agronomy students (Developing Vegetable Gardens (DVG)) in Jamestown: A) Starting phase, B) Training of community with regard to cultivation of vegetable plants, C) Postgraduate Agronomy students helping members of the local community to establish vegetable plants and D) Success!

AGRONOMY STAFF

ACADEMIC

Prof GA Agenbag (Winter Crops, Soil Tillage)
E Kempen (Greenhouse Production)
Dr PJ Pieterse (Chairperson; Weed Science, Pasture Science)

LECTURERS EXTRAORDINARY

Prof ALP Cairns (Weed Science)
Dr NJJ Combrink (Greenhouse Production and Hydroponic Feeding Solutions)
Prof MB Hardy (Winter Crops, Rotational Cropping)
Dr E Reinten (Cultivation of Herbs)

ADMINISTRATIVE

S Alexander (Secretary)

TECHNICAL

RL Oosthuizen (Senior technician)
MF la Grange (Technical manager)

SUPPORTING

L Berner#
S de Vries#
J Goosen
LR Nicke
KP Williams
FD Casper*
J Goosen#
M la Grange*
CF Oosthuizen#

**Permanent staff paid from outside funds*
#Temporary staff paid from outside funds

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Department of

CONSERVATION ECOLOGY AND ENTOMOLOGY

Research Day 2013 –
Department of Conservation
Ecology and Entomology

Introduction

Departmental vision

"To be a world centre of excellence for teaching, research and technology transfer in the field of conservation of natural resources."

Departmental mission

"To undertake teaching, research and technology transfer in ecology, conservation and management of utilised landscapes and their surrounds."

Conservation Ecology and Entomology (ConsEnt) brings together teaching and research in the rapidly growing and important field of conservation of utilised landscapes and their surrounds. The focus of the Department is on the study and development of management plans for agricultural and forestry production without compromising biodiversity and ecosystem processes. Expertise ranges from integrated pest management, conservation of natural communities and the management of living resources to conservation policy formulation and technology transfer, so as to develop a forward-thinking, dynamic department with a distinct agricultural and forestry address. This contributes to meeting the demands of the outside world for trained personnel and research findings in the area of conservation production.

Overview

The research focus falls into two areas: area-wide pest management and conservation biology. The use of entomopathogenic ('insect eating') nematodes for the control of moth pests received considerable attention under the leadership of Dr Antoinette Malan. This research sits alongside the use of parasitoids and ladybirds to control various pests in a way that does not affect the environment adversely – work being spearheaded by Dr Pia Addison and Dr Ken Pringle. Area-wide pest management also uses the sterile insect technique, which involves irradiating the males, releasing them into orchards and allowing them to mate with the wild females, leading to sterile offspring and hence control of the pest population. Mr Matthew Addison has tested this in the field with great success. He has also developed a functional and operational commercial unit for doing this on the University's experimental farm.

This research on pest management is complemented by the work of Prof John Terblanche on insect physiology. Among other areas of research, John has been studying thermal stress in insects and has thrown considerable new light on how thermal tolerance determines the geographical distribution and abundance of insects. This research also has made inroads into understanding the weak spots of pests from a control point of view, giving pest management a new approach. Most of the work from Stellenbosch focuses on deciduous fruit and citrus, but work is also

Palmiet wetland research study

undertaken by Prof Des Conlong, who is a Professor Extraordinary in the Department, on sugar pests, especially the sugarcane borer moth.

The conservation work in the Department has wide implications across a whole range of disciplines. Ms Rhoda Malgas, for example, has been undertaking social studies in relation to the production of rooibos tea. The point is that the tea must be produced without doing harm to the environment. Prof Karen Esler has also been active in social studies, as well as studies on the restoration of systems. She has paved the way for more effective restoration of Karoo and fynbos ecosystems in the Western Cape. Dr Shayne Jacobs, in turn, has been studying the dynamics of Western Cape and Kruger National Park river systems, particularly with respect to the impacts of invasive alien plants that capitalise adversely on our river systems. He has been unravelling why it is that these aliens can be so invasive and therefore so noxious.

Dr Francois Roets has made great progress in understanding the mutualistic relationships between fungi, plants and mites, as well as certain insects. He has shown just how important these interactions are, and that much of the world as we see it depends on understanding these mutualisms, where organisms working together enhance ecological function and evolutionary processes. Dr Sonja Matthee has also been working on interactions, especially between fleas and rodents, and has found how important these interactions are for driving the evolutionary development of both.

Dr Alison Leslie has been focusing on the ecology of various large vertebrates, from crocodiles to rhinos, to gain an understanding of how to maintain their populations at current levels. Dr James Pryke and Prof Michael Samways, in turn, have been focusing on developing landscapes for the future, especially in the context of timber forestry. New approaches have been found that not only feed into the South African National Biodiversity and Strategic Action Plan, but also into the internationally-agreed Aichi Targets for biodiversity conservation. Michael has also been working intensively on the restoration of the Seychelles islands.

Research

Agricultural landscapes offer opportunities for integrating conservation into production activities. Natural pest control is favoured by rooibos farmers, and the work in this regard is now being expanded to assess the benefits of organic farming in vineyards. The Department assisted decision makers on how to implement conservation activities. Conservation mapping was used in collaboration with various organisations to identify farmers offering the best opportunity for designing and mapping conservation corridors across the Langkloof, and to prioritise Working for Water's alien plant-clearing activities on wine farms after fire. These analyses optimise each programme's effectiveness and cost efficiency. Furthermore, the Department assessed the plant resources and social networks of the ≠Khomani Bushmen in the Kgalagadi Transfrontier Park to determine levels of sustainable plant use and the maintenance of biocultural traditions. Research was also conducted in the Baviaanskloof World Heritage Site to examine how people's meaningful experiences of nature can be used to improve environmental education programmes.

Ecological restoration in the Department has several links to national bodies (e.g. ASSET research). One project, on restoring natural capital, found clear evidence that restoration practitioners are failing to signal links between ecological restoration, society and policy, and are underselling the evidence of the benefits of restoration as a worthwhile investment for society. The Department is concerned with bridging the 'knowing-doing' gap in invasion biology and in conservation planning.

Recent collaborative research investigated the extent to which literature on invasion ecology contributes to the implementation of the knowledge. The findings were then compared with the information needs of conservation practitioners. Adverse human-induced changes have impacted heavily on how species interact with their environment and on the services these ecosystems supply. Locally, changing water availability, modified fire regimes and land-use changes have had a big impact on riparian ecosystems. A pernicious threat is woody invasive species, which have replaced many native species, disrupting water and nutrient cycles. Ongoing research has provided new insights that will improve restoration activities in these sensitive ecosystems. Other research has investigated native riparian species for their potential value as species for restoration after alien control.

Seed harvesting (Photo: Nannike Esterhuizen)

With loss of biodiversity and deteriorating ecosystem services, there has been an increasing push for research on improving the design and management of the landscape to improve conditions for 'the little things that run the world' – the invertebrates. Activities have taken place across South Africa and on certain Western Indian Ocean islands on the removal of alien plants; the conservation of pollinators in the fynbos; the conservation of invertebrates in the grassland biome; the development of new monitoring methods and the development of organic farming; the restoration of the Seychelles; and the improved development of monitoring methods to assess how successful conservation activities have been. One of the most astounding results has been just how well rare endemic species can recover when alien trees are removed. Organic farming also benefits indigenous biodiversity. Invertebrates are protected well when good-quality corridors are placed between patches of plantation forestry. A further development has been the design and implementation of an easy-to-use index for measuring freshwater health, which is now being used effectively across a wide range of water systems and has been developed into a handbook for end-users.

The vertebrate conservation projects compile management plans for Government Departments of Wildlife and other relevant wildlife conservation bodies and, in the case of the warthog, a sustainable use programme for game and stock farmers. Projects range from general ecology, physiology and behaviour, to human-wildlife conflict issues relating to crocodiles, various antelopes, rhinos, elephant and buffalo. The Malawi research programme monitors, understands and manages the impact of mammal reintroductions in Majete Wildlife Reserve. This involves student exchanges and incorporates a capacity-building programme in the Chikwawa District. This collaboration conducts and facilitates the development of research, training and extension among faculties, departments and centres of Stellenbosch University and the University of Malawi, and the directorates, centres, units and stations of African Parks Majete

Life conquered the planet by networking. With increased global anthropogenic threats to natural environments there are increased disruptions to interactions between various organisms. Many of these interactions, particularly those between smaller organisms, are not clearly understood. The

research on these aspects focuses on describing some of these interactions, as well as identifying anthropogenic influences on such specialised systems. One mandate of the research group is to understand problems encountered concerning native tree health caused by mutualistic associations between insects and fungi. We also aim to understand the evolutionary principles underpinning these multi-organism interactions.
For example, a new fungus was identified as a model organism to identify determinants of the spread of sexually transmitted diseases. Parasite research focused on the effects of habitat fragmentation on parasite diversity and species assemblages on *Rhabdomys pumilio*. Studies on *R. pumilio* using evolutionary genetics of parasite taxa are ongoing and were extended to helminth parasites associated with *R. pumilio*. Key findings include novel parasite/rodent associations and evidence that habitat fragmentation results in the loss of host species and higher parasite loads. Climate change and habitat transformation may thus have strong consequences for current biodiversity, with possible risks of disease transmission and the development of new diseases, especially where wildlife and domestic animals occur together.

Integrated pest management aims to integrate area-wide pest management in deciduous fruit, citrus and wine grapes. This multidisciplinary approach employs basic research, such as pest identification, advanced molecular methods for species identification or tracking dispersal, population dynamics, insect physiology and ecology, population monitoring, and applied research. Field research uses biological control agents for managing arthropod pests, postharvest control, and optimising the sterile insect technique (SIT). This enables decisions to be made about when and where to focus control efforts to sustainably manage pests while reducing synthetic chemical input. Entomopathogenic nematodes are also used for controlling various insect pests, with novel methods that have been developed for applying these nematodes. With supporting basic research, efforts have now shifted to the mass culture of nematodes for commercial application. Research on the applied aspects of the SIT in codling moth and the sugar cane stalk borer is well advanced. There has also been a focus on quarantine pests, and developing environmentally-friendly and effective mitigation measures. Collaborative inputs regularly assist Plant Health in international negotiations with other plant protection organisations.

There is increasing interest in the influence of temperature and the availability of water on insects. This arises from growing concern about the effects of climate change on biodiversity, invasive species movement, pest outbreaks affecting food security, and variation in zoonotic disease distribution and transmission risk. Applied physiological

Millennium Seed Bank Initiative and CIB research (Photo: City of Cape Town)

ecology research spans a range of interlinked topics of significance to biological and physiological diversity. This work explores the links between physiological processes and animal ecology and evolution in terrestrial environments, and focuses on a range of organisms of agricultural, evolutionary or medical importance. The research includes global climate change; physiological responses to environmental conditions; mechanisms underlying environmental tolerance; and comparative and integrative biology. Importantly, this work also focuses on the principles and applications of physiological ecology to broader issues such as the conservation of rare species and the management of outbreak or pest species. Significant progress has recently been made through experimental and modelling approaches in understanding tsetse fly and mosquito responses to climate change. Also, studies on physiological ecology have contributed novel techniques to improve the field performance of lab-reared codling moth in the SIT programmes. Finally, several valuable insights were gained into invasive fruit fly thermal biology and population dynamics.

Entomopathogenic nematode infection of a codling moth larva

Community interaction

Initiatives undertaken in the Department are used to demonstrate the close link between the health of the environment and human wellbeing to school learners. These initiatives involve visits to schools and visits by learners to the Department. Furthermore, the Department hosts and supports a diverse group of learners from local schools at the annual SANBI Biodiversity Expo – creating opportunities for staff and students to showcase features of the Department to potential future students. A day before the Expo, learners are invited to the Department, where students and staff speak to them about Conservation Ecology as a subject and as a potential career. The Department also links up with

other role players, such as civil society and NGOs, to increase knowledge sharing between the University and holders of indigenous knowledge on the ecology of the region, adaptation to disturbances, wise use of natural resources, and sustainable agriculture. The interaction is formalised by involving members of civil society in teaching. Students carry out assignments and activities to ensure interactive learning and to improve overall student graduate quality.

The Department has consolidated a monitoring, research and training collaboration with Robben Island Management. Currently, the island is listed as a UNESCO World Heritage Site. Impacts on the island's biodiversity have been many, with introductions of invasive species that have significantly altered the island's natural ecosystems. Aspects of the recovery trajectory of the ecosystem are monitored, contributing to the future management of the island.

Setting aside natural grassland to mitigate the effects of plantation forestry

Conserving animals across the agroforestry landscapes

Paracilacris: *A new technique has been developed by the Department of Conservation Ecology and Entomology, using the sounds of insects and frogs for measuring the success of restoration programmes across landscapes (Photo: P Nascrecki)*

Researchers collecting blood samples from lions for a research study being undertaken in the Kruger National Park (Photo: Stephanie Edwards Caruana)

STAFF

ACADEMIC

Dr P Addison (Insect Diversity, Integrated Pest Management)
Prof KJ Esler (Plant Ecology)
Dr S Jacobs (Ecology)
Dr AJ Leslie (Ecology)
Dr A Malan* (Nematology)
R Malgas (Sustainable Natural Resource Management)
Dr S Matthee (Parasitology)
Dr James Pryke (Landscape Ecology and Invertebrate Conservation Biology)
Dr F Roets (Ecology)
Prof MJ Samways (Chairperson; Insect Conservation Biology and Sustainable Landscape Development)
Prof JS Terblanche (Physiological Entomology)
** Part time*

PROFESSORS EXTRAORDINARY

Prof DE Conlong (Habitat and Integrated Pest Management)
Prof B Reyers (Biodiversity and Ecosystem Services)

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Dr M de Villiers (Citrus Research)
Dr JM Heunis (Integrated Pest Management)
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Dr KL Pringle (Integrated Pest Management)
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Department of

FOREST AND WOOD SCIENCE

Introduction

The Department of Forest and Wood Science (DFWS) has strengthened its original mandate, of enriching forest and wood science through basic and applied research, teaching at under- and postgraduate levels, and community outreach, and is recognised as an international leader in forest and wood science. Teaching, research and development services are provided to a full spectrum of stakeholders, both locally and internationally, which include the South African and international commercial forestry sector, government and other public forestry branches, NGOs, and society. The DFWS has a small team of dedicated lecturers and researchers, supported by knowledgeable and experienced technical and administrative staff. The Department's strength lies in the fact that it is the only tertiary education institution in South Africa to provide an educational offering at BSc, MSc and PhD levels in both Forest and Natural Resource Science and Wood Products Science. The presence of these two major disciplines under one roof enables the DFWS to address the full forestry value chain, from forest establishment and silviculture, forest management, timber harvesting and transport, to secondary processing for bioenergy, lumber, furniture, and pulp and paper production.

Overview

The year 2013 was a productive one for the DFWS. The Department hosted several workshops with international participation, dealing with climate change and other topical issues. Three staff members participated in three EU COST Actions (European Cooperation in Science and Technology). Several short courses were presented to the South African forest industry. Considerable collaborative work was done with partner institutes in Botswana, Mozambique, Namibia, Zambia and Malawi, which resulted in common proposals, projects and postgraduate supervision. International links and extended collaboration were maintained with partner institutions in Finland, Sweden, Canada, Germany, Australia and the USA.

The 'Climate-Fit Forests', an EU-financed Marie Curie IRSES mobility programme that was launched in 2011, gained further momentum in 2013. The programme links the DFWS's efforts to a broad spectrum of climate change-related research activities with partners in Germany, Italy and Switzerland. Topics addressed ranged from wood quality to carbon reduction in timber harvesting.

The DFWS increased its access to state-of-the-art technology and world-class equipment for the non-destructive testing of wood and other materials. An industrial microcomputer tomograph (micro-CT scanner) valued at R7.6 million was purchased by the Central Analytical Facility (CAF), based on a successful RISP application to the DST/NRF large equipment programme in 2011. The CT scanner officially started operating in 2013. A high-resolution multispectral sensor was developed in a joint venture with the Agricultural Research Council and has triggered great interest in the field of applied remote sensing for agriculture and forestry.

The Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) has been established as a networking project across Angola, Namibia, Botswana, Zambia and South Africa. The DFWS plays the lead role in one of the SASSCAL projects that kicked off in 2013, namely the development of an MSc in Dryland Forestry at Stellenbosch University. The programme will allow for the training of specialised postgraduate students and will ensure improved networking between southern African countries in the field of climate change and forestry research.

Conventional tree breeding has also been successfully established as a research field in the Department. The research entails

the breeding of pathogen-resistant genotypes, but also the assessment of breeding success in terms of growth and wood quality. The programme has been strengthened with the appointment of Professor Bill Dvorak, the director of CAMCORE, as a professor extraordinary.

There was significant growth in research on biomass and bioenergy, spearheaded by an existing DFWS initiative, “Power SA”. Among the projects were research on the harvesting productivity of alien invasive species, the testing of calorific values of indigenous and exotic shrubs and trees, and the development of biomass models for pines and eucalypts.

The Department’s interest in plantation forestry was documented through several industry-related projects on wood quality, growth and intensive silviculture and timber harvesting productivity studies. These new projects show, amongst others, a continued trend in widening a primarily plantation forestry focus to incorporating research on woodlands and indigenous high forests.

Multiple land use in Southern KwaZulu-Natal

Research

Scientific work at the DFWS is characterised by a healthy blend of basic and applied research. The five research fields are (i) Precision Forestry (PF), (ii) Integrated Land Use Management, (iii) Biomass and Biofuel Production, (iv) Wood Quality from the Plant to the Product, and (v) Climate Change.

Precision forestry provides for additional and sufficient quality information about forests and the manufacturing of forest products. It facilitates planning, site-specific forest management activities and operations to improve wood product quality and fibre utilisation, to reduce waste and to increase profits. Furthermore, PF makes use of several key technologies, such as geographic positioning systems (GPS), geographic information systems (GIS) and remote sensing (RS).

The Integrated Land Use Management Initiative, or “Green Landscapes”, is a concept that spatially integrates different strategies and economic demands within the same region and includes all land use. In this context it plays a fundamental role in Africa, as it is understood that not only one, but a variety of treatment options or “management paths”, potentially may be suitable for each individual land parcel in the landscape. Each path is characterised by a succession of specific management activities, and the ultimate aim is to identify an optimum combination of management paths for the landscape as a whole. This form of adaptive management provides a suitable basis for designing forested landscapes.

The Biomass and Biofuel Production Initiative, or “Power SA”, aims at providing all the necessary information on biomass

and biofuel production in a South African and African context. It covers the value-added chain of production, from the plant to the product of biomass and biofuels. This entails a wide range of expertise, from remote sensing, stand management for biomass production in plantations, agro-forests, harvesting and transport logistics, processing technology and raw material quality considerations, to ecological implications on the local and global level as well as socio-economic implications. The Department will focus future research work on the integration of these fields of expertise for the precise management of biomass and biofuel production. The aim is to contribute to the optimisation of resource use and the mitigation of climate change.

Wood quality is an important aspect of the value-added chain of wood production. The optimisation and effective management of the value-added chain and its individual links are only possible with knowledge of the factors influencing wood properties during tree growth, harvesting, storage, drying and subsequent conversion processes. A holistic approach is therefore required, one that includes modelling, simulation and novel methods of wood quality determination and product performance testing. Thus, the overriding objective is to understand and optimise wood quality throughout the value-added chain of wood production. With the addition of conventional tree breeding as a focus area, the Department is now able to monitor wood quality throughout the lifecycle, from the tree and to the timber product.

To effectively address the five interdisciplinary research fields mentioned above, each staff member focuses on his/her specific discipline while also participating in collaborative projects within the DFWS.

Ms Hannél Ham focuses on forest ecology, tree improvement and nursery practices. Her projects included the propagation of *Pinus maximinoii,* viability testing of interspecific hybridisation and investigating the reproductive barriers of *Pinus radiata.*

Dr Ben du Toit and his postgraduate students continued to focus on forest nutrition and nutrient dynamics during 2013. MSc candidates and their assistants monitored the nutrient uptake, leaf area development and growth responses in experiments in which (a) controlled-release fertilisers and (b) wood ash residues in combination with fertilisers were applied to subtropical eucalypt stands. The silviculture research

First-year practical work in Cape pine at Grabouw

group also continued work on regeneration research. Within this focus area, one study investigated the effect of intensive silvicultural treatments on tree survival and the early growth of eucalypts on cool temperate sites in KwaZulu-Natal, while a second study investigated growth responses and (predominantly below-ground) carbohydrate storage in *Pterocarpus angolensis* (kiaat) trees under varying fire regimes in the dry tropical forests of northern Namibia.

In forest management, Prof Thomas Seifert focused on CT scanning of wood, forest growth simulation under climate change, and the evaluation of drought-resistant tree species to alleviate poverty in South Africa's arid regions. He also traced the effects of anthropogenic forest habitat change on diversity and pathogen prevalence in bats, and the effects of fire damage on the growth and survival of native and commercial trees in South Africa. Mr Cori Ham investigated aspects of enterprise development, forestry promotions and rural forest use. He also specialised in strategy development. Projects included the Payment for Environmental Services as an alternative income source for commercial multiple land-use farms in South Africa. He assessed fuel wood use and sources in remote and adjacent-urban areas in Namibia, investigated the demand, supply and local valuation of *Pterocarpus angolensis* and *Baikiaea plurijuga* timber in the Kavango Region, and developed forest-sector strategies for governments.

Mr Pierre Ackerman continued his research in the field of the optimisation of the wood procurement value and supply chains from stump to mill for the South African forestry industry. Projects included the modelling of both primary and secondary roundwood transport haulage travel speeds, the assessment of the logistics supply chain and systems for bioenergy harvesting, the use of on-board computing systems to optimise mechanised harvesting systems, and productivity studies for the mechanised harvesting of *Eucalyptus* pulpwood pine sawtimber stands. Ground-breaking research on the effects of mechanised cut-to-length harvesting systems on chip quality, purity and fibre losses in hardwood pulpwood revealed astonishing results and has re-shaped the South African pulp and paper industry's approach to wood procurement. In addition, Mr Ackerman is leading the development of a country-wide drive for productivity improvement through the development of a state-of-the-art time and productivity protocol. He is also involved in a study on the assessment of the financial viability of local and international harvesting and transport contractors with the Finnish Forestry Institute METLA, the Swedish University of Agriculture (SLU), and the University of Helsinki. He is an active member of the Cost Action FP 0902 dealing with the 'Development and Harmonisation of New Operational Research and Assessment Procedures for Sustainable Forest Biomass Supply', and took the lead

Door manufacturing from Pterocarpus angolensis *timber, Namibia*

Hardwood log deck, northern Mozambique

within this group in developing an internationally agreed on business (machine costing) protocol.

On the wood science side, Mr Brand Wessels looked at primary wood processing, with studies on non-destructive timber testing, prediction of timber quality, sawmill processing, and the effect of silviculture on mechanical wood properties. Projects included the effect of planting density on the flexural properties of young SA pine structural timber, wood properties of some drought-resistant *Eucalyptus* species, the prediction of the mechanical properties of young *P. patula* from standing tree information, an investigation into the variation of microfibril angle in *Pinus patula,* development of board products from young *Eucalyptus grandis* timber and an investigation of selected mechanical and physical properties of young, unseasoned and finger-jointed *Eucalyptus grandis* timber.

Dr Martina Meincken focused on wood physics, with studies on surface degradation, biofuels and fibre analysis. Her projects included the effect of climate change on wood quality, wood-plastic composites, hand-made safety charcoal, and bioenergy systems.

In wood chemistry, Dr Luvuyo Tyhoda worked on the Bio-refinery Concepts for Wood Processing in a South African Pulp and Paper Industry project, which is funded by THRIP and undertaken in collaboration with the Paper Manufacturers Association of South Africa (PAMSA). The project arose from the critical need for both technology and human resources to improve the industry's international competitiveness. The focus is to train tomorrow's decision makers in the pulp and paper industry in biomass processing and bio-refining. A PhD student in Chemical Engineering focused on the extraction of xylan from South African-grown *Eucalyptus grandis*, giant bamboo and sugarcane bagasse prior to Kraft and sodaAQ pulping to produce paper pulps, value added biopolymers and fermentable sugars. The factors that influence the adhesive bond quality and performance of finger-jointed SA pine are also being investigated. Dr Tyhoda is involved in the elucidation of the properties that increase the resistance of *Eucalyptus cloeziana* to marine borers. The properties that give the woody species their resistance have not yet been described fully.

Mr Philip Crafford addressed topics within secondary wood processing, such as furniture design and construction, wood manufacturing

Measurement of the dynamic modulus of elasticity of wood

Final-year industry tour in Zululand hardwood plantations

technology and wood finishing. His work included the investigation of green building by using timber and timber-based materials as opposed to conventional building materials in construction.

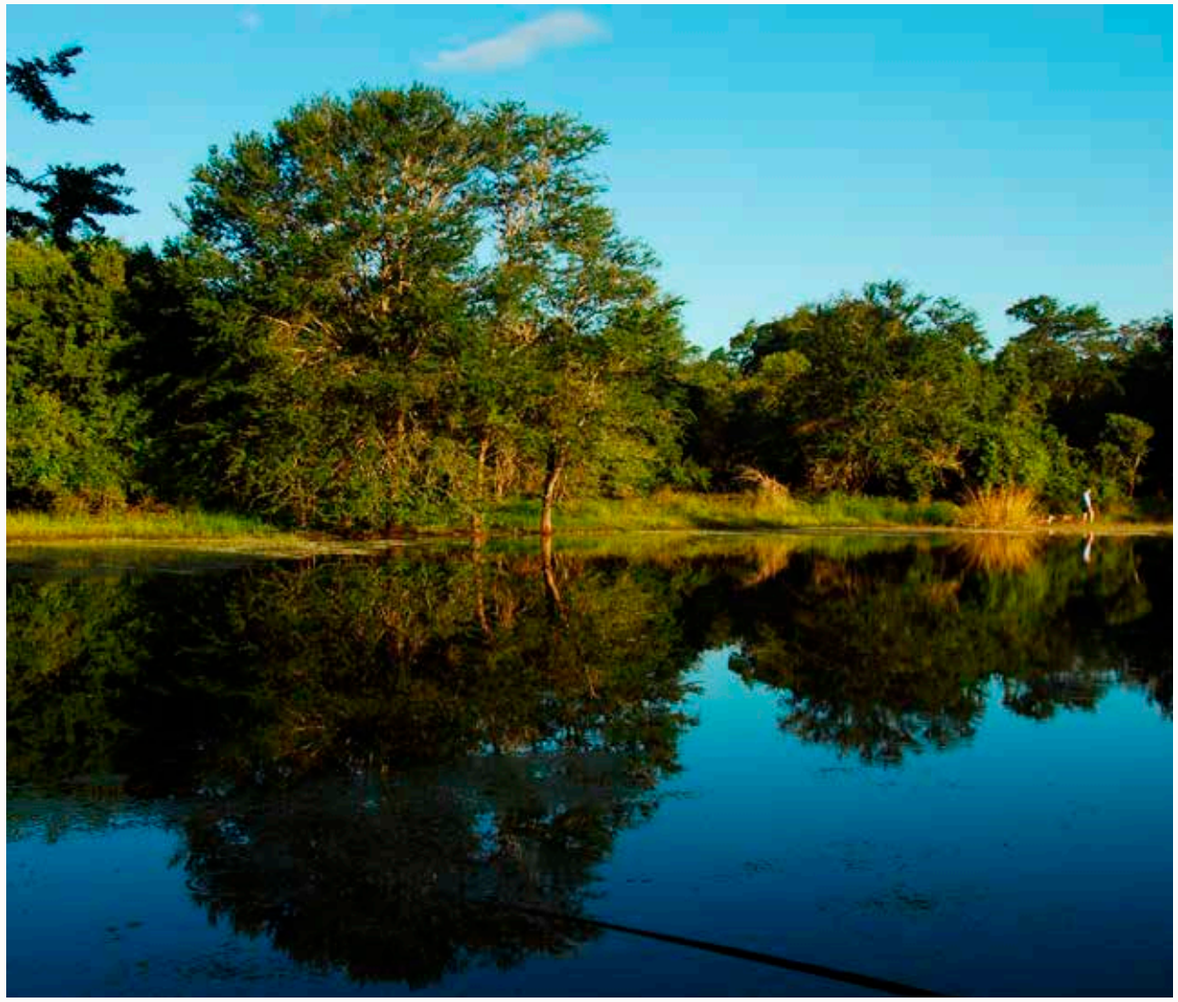
Community service

The Forest and Wood Science Department is heavily involved in projects aimed at community development within its realm of expertise. To date, 30 projects undertaken by staff members within the Department have been registered on the Stellenbosch University community interaction database. The project described below is an example of the projects. The Department has partnered with the Kwanothemba Carpentry Workshop in Khayelitsha through funding provided by the FP&M Seta with the goal of assisting the workshop to become a sustainable and profitable business. In doing so the workshop could become a cornerstone of the community, teaching woodworking and production skills to the disabled and the youth, and generating income for those involved in production.

The workshop has the potential not only to generate additional income for people with disabilities, but also to be a place where skills can be learnt and passed on. Dr Brand Wessels and Mr Philip Crafford are responsible for driving the project for Stellenbosch University.

Most lecturing staff served on scientific editorial committees related to their specific fields of interest and are either co-ordinators or members of specific divisions within the International Union of Forest Research Organisations (IUFRO). Staff members retained close ties with the industry through a number of completed and work-in-progress projects. With the successful Marie Curie IRSES "Climate-Fit Forests" mobility application, the DFWS continues to influence climate change-related issues, both locally and with three European institutions. Three staff members, Prof Thomas Seifert, Pierre Ackerman and Ms Hannél Ham, are involved with three Cost Actions within the EU Framework 7 initiative.

Furniture production in Wood Product Science undergraduate programme



Miombo woodland in northern Mozambique

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C Ham (Forest Management)
H Ham (Forest Genetics and Forestry Development)
Dr M Meincken (Wood Physics)
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B Wessels (Mechanical Properties)

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Prof C Geldenhuys (Forest Ecology and Management)
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Department of

GENETICS & THE INSTITUTE FOR PLANT BIOTECHNOLOGY

Overview

The vision of the Department of Genetics is to develop and promote Genetics as a cornerstone of biological science at Stellenbosch University through quality research, creative teaching, and outstanding and responsible service delivery to our community and environment. In order to realise this vision, the Department of Genetics consists of a group of diverse lecturers, researchers and postgraduate students who focus on research opportunities in animal, human and plant genetics that include studies in the quantitative (including biometry), population and molecular genetic fields.

The Department started life as a plant-breeding environment with four academic staff members more than 80 years ago, and was joined by the Institute for Plant Biotechnology (IPB) in 2007. During 2013, the Department (including the IPB) comprised 16 full-time academics and a total staff component of 56 individuals (including research contract staff).

Further to this, our postgraduate numbers are in excess of 80 students, and we service several hundreds of undergraduate students through the various undergraduate courses presented by the Department and the IPB in both the Faculties of AgriSciences and Science.

It was another exceptional year, with Prof Louise Warnich who

A record number of 18 Honours students graduated in 2013

became dean of the Faculty of Science and two new academic staff appointments, Dr Clint Rhode and Ms Johanè Nienkemper. Once again, the Department excelled in local and international conference participation, with a total of 66 poster and oral contributions.
A record number of 18 Honours students graduated, of which three received their degrees with distinction. Genetics also produced six master's and two doctoral graduates in 2013. Several staff members received the Rector's Award for Excellence in Service during the year.

Activities and achievements

The Department of Genetics can be proud of its accomplishments in 2013. Besides the record number of postgraduate students produced, the following staff members received the Rector's Award for Excellence in Service during 2013: Dr J Lloyd of the IPB, and Mr T Pepler, Ms A Ellis, Ms T Allison, Ms M Kannemeyer and Mr E Titus of the Department of Genetics. Stellenbosch University was well represented as students and researchers travelled from Accra to Yokahama, attending conferences as well as collaborating and sharing knowledge with various institutions. Another indicator of the Department's success in 2013 was the 23 scientific articles that were published. International conferences attended included the 8th International Triticale Symposium in Ghent, Belgium; the 12th International Wheat Genetics Symposium in Yokahama, Japan; the 2nd Conference of Cereal Biotechnology and Breeding (CBB2) in Budapest, Hungary; the International Plant & Animal Genome XXI in San Diego, USA; the Conference on Water Quality & Agriculture Food Security in Santa Fe, Argentina; the African Society of Human Genetics Meeting (AfSHG) in Accra, Ghana; the Association for the Advancement of Animal Breeding and Genetics (AAABG) conference in Napier, New Zealand; the 9th International Symposium on Grapevine Physiology and Biotechnology in La Serena, Chile; the 19th Conference of the International Organisation of Citrus Virologists (IOCV) in Skukuza, South Africa; the 10th International Congress of Plant Pathology in

Michelle Coffee, an M student, took part in an exchange programme to Heidelberg in Germany supported by the DAAD-NRF

Beijing, China; the 7th Australasian Virology Society Meeting in Queenstown, New Zealand; the South African Society for Human Genetics (SASHG) in Johannesburg; the Southern Africa Sharks & Rays Symposium, Mossel Bay; and the 55th Annual South African Statistical Association (SASA) Conference in Limpopo.

For workshops, Willem Botes and Corneli Smit from the Plant Breeding Laboratory (PBL) travelled to Bangkok, Thailand to attend the AC21 International Graduate School. The Academic Consortium for the 21st Century (AC21) is an international network comprised of educational, research and industrial organisations that aims to promote cooperation between education and research. The summer school focuses on cutting-edge research dealing with global issues, such as energy technology and global warming. The topic of the AC21 Summer School of 2013 was "Green Science and Technology for a Sustainable Future". Willem Botes was invited to present a workshop in the Agricultural Sciences and Food Production section. His workshop dealt with the bridging of the divide between academia and the industry, particularly from a plant breeder's perspective. One of our postgraduate students, Michelle Coffee, took part in an exchange programme supported by the DAAD-NRF. She had the opportunity to travel to Heidelberg, famous not only for being a scenic town, but also for hosting the oldest university in Germany. She visited the Theoretical Bioinformatics division of the German Cancer Research Institute (DKFZ). The programme consisted of four months of bio-informatics training, focusing on the identification and analysis of variants in regulatory regions. Another postgraduate student, Kelly Breeds, was awarded the Hofmeyr van Schaik medal in 2013. This award is given to the best fourth-year student in Genetics (BScHons or BSc Agric) by the South African Genetics Society annually. Kelly obtained her Honours degree in Genetics *cum laude*. She is currently enrolled as an MSc student in the Cereal Genomics Research Group of the Department of Genetics at Stellenbosch. Tarryn Haikney, one of our Honours students, received the Merck Award for the best final-year Molecular Biology and/or Biotechnology student and Dr Leon van Eck received the 2013 Young Science Communicator Award.

Research

Genetics

The research focus areas of the Department follow the matrix structure according to which the Department operates. Focus areas within animal, human and plant genetics include studies in the molecular (biotechnology), population and quantitative (breeding) genetic fields. In Animal Genetics research is conducted on various aquatic and other livestock animals and involves determining genetic diversity and population dynamics for better management and conservation of these species. Projects aim to genetically characterise a number of marine species important to various fisheries and aquaculture sectors, including molluscs (abalone and scallop), teleost fish (yellowtail and kob) and various shark species (e.g. hound sharks, hammerheads and shy sharks). Understanding the micro-evolutionary and demographic dynamics of these species elucidates species biology and subsequently leads to the sustainable utilisation of these marine resources.

Kelly Breeds receives the Hofmeyr van Schaik Medal for the Best BScHons Genetics student

In Human Genetics, research focuses on the analysis of genetic variation in genes involved in the metabolism of medication and the pharmacogenetic application of this in South African populations (e.g. schizophrenia and variegate porphyria); the analysis of genes implicated in oesophageal cancer, iron regulation, the haem biosynthetic pathway and drug metabolism; and bioinformatic identification and characterisation of genes involved in apoptosis resistance, as well as the metabolic pathways involved. In Plant Genetics, research includes the molecular epidemiology of grapevine virus disease complexes; molecular interactions between viruses; phytoplasms and their respective grapevine hosts; the genetic modification of grapevines for enhanced virus resistance; molecular breeding of fruit cultivars; molecular interactions between the wheat host, the aphid and endosymbiont; the genetic modification of wheat for enhanced pest resistance and drought tolerance; wheat pre-breeding for improved wheat rust resistance; the triticale breeding programme, which focused on increased bio-ethanol yields; and a rye-breeding programme focused on improved cultivars for animal feed.

Staff of the PBL during harvesting of the University's new rye cultivar, US3010

The triticale cultivar, US2007, is commercially available via the PBL's licensee partner, Overberg Agri

Institute for Plant Biotechnology

The Institute for Plant Biotechnology (IPB) specialises in the characterisation and manipulation of primary carbon metabolism in plants. The ultimate goal is to manipulate the relevant metabolic pathways to either improve yield and/or quality, or to produce novel, high-value products in plants. Some projects are aimed at the genetic manipulation of carbon partitioning within plant organs, such as sugarcane culms, grape berries and potato tubers. Our approach is to first get a better understanding of the control of carbohydrate metabolism in these important sink tissues and then to genetically manipulate apparent key enzymes to investigate the effect of these modifications on metabolic flux. In addition to our work on the partitioning of endogenous compounds, we also

focus on the improvement of these compounds and the introduction of completely new ones. As part of several international collaborative projects, the IPB has, for example, developed transgenic plants that produce novel, high-value products, i.e. neutraceuticals and pharmaceuticals or biopolymers for industrial application. Finally, we are trying to understand plant growth in relation to abiotic stress factors with the aim of breeding or engineering plants that are more productive with less input.

Community interaction

Besides the numerous services of staff members on boards and committees, e.g. the Advisory Committee of Genetically Modified Organisms, community-based services include the PBL, which performs a marker-assisted selection (MAS) service for wheat-breeding programmes, forensic DNA analyses of confiscated material associated with abalone poaching, and a service run by Mandi Engelbrecht of the Vitis group (Vironostix) that tests samples for viruses and phytoplasms. In 2013, the latter service screened samples for the vegetable, fruit and grapevine industries. Staff members of the Department participated in workshops to promote the teaching of Genetics as subject in schools, and seven staff members were involved as evaluators during the Eskom Expo for Young Scientists. During the year, school learners visited the Department for job-shadowing and were mentored by staff of the Department.

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PT Pepler (Biometry)
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Department of

SOIL SCIENCE

Introduction

Soil is the extremely thin but precious skin covering our planet that sustains all terrestrial life forms and contributes nutrients to aquatic and marine environments. Soil Science focuses on the importance of soils as very slowly renewable natural resources. It involves the study of the properties and processes that occur in soils, as well as the sustainable use and management of soils for the benefit of humankind. Soil Science is an indispensable field of study for sustainable food production into the future.

The Department of Soil Science teaches and conducts research in all the major sub-disciplines of Soil Science, which include soil formation and classification (pedology), soil chemistry and fertility, soil physics and soil water management, soil hydrology and remote sensing, soil biology and soil ecology. Undergraduate students are equipped with fundamental scientific knowledge of soils, but also practical experience. This includes learning how to classify soils in the field, and how to conduct and compile a land and soil suitability survey; how to sample soils and determine soil chemical and physical properties in the field and laboratory; and how to interpret the results of the analysis and write up scientific reports. The students are also taught how to plan efficient irrigation and fertilisation schemes for soils by way of assignments. Students who follow Soil Science as their major subject also study more specialised techniques and methods in advanced modules. In the comprehensive, specialised postgraduate modules, students are offered enriching scientific soil research knowledge and skills.

Overview

Various staff members of the Department made important contributions to industry- and subject-related organisations. Dr W de Clercq serves as a member of the steering committee of several Water Research Commission (WRC) projects. Dr JE Hoffman is Chairperson of the Winetech technical working group assessing soil research projects, a member of the academic evaluation panel of SACNSP (Soil Science), a member of the peer review group of the Hortgro Science peer review group, and serves as a member of the steering committee of several Water Research Commission assessment panels. Dr AG Hardie is a council member of the Soil Science Society of South Africa. Dr C Clarke was appointed as a new member of the Soil Classification Working Group that currently is revising the Soil Classification Taxonomic System of South Africa. Prof JJN Lambrechts also makes a significant contribution to this endeavour. A number of postgraduate students and academic staff of the Department presented their research at the annual Combined Congress of the Soil Science Society of South Africa in Durban in January 2013.

The irrigation scheduling of tree crops is investigated in detail

Water quality for sustainable irrigation forms part of our research programme

Wheat fields in the Rûens area. Research is being done on different crop rotation systems to determine their effect on the water balance of conservation tillage.

Research

The research focus of the Department is not only on evaluating or improving soil management practices or soil amendments, but also on elucidating soil processes in natural, agricultural and industrial environments. Research projects include: understanding the impact of global climate change on water resources and the capacity of society to respond to it; modelling the effect of soil type on groundwater recharge; and improving water and fertiliser retention in sandy soils using biochar. A bilateral research project to generate a bridge between the well-established AgriSciences Faculty of Stellenbosch University and its young counterpart at the Eduardo Mondlane University in Mozambique aims at strengthening academic support to the Eduardo Mondlane University to such an extent that it will be able to do world-class research related to the EAU4Food programme. There also are projects that examine the impact of soils on ecosystems and biodiversity; compare the water balance of irrigated and dry-land crops; investigate the effect of long-term conservation tillage practices on the sustainability of crop-rotation agriculture in the Western Cape; and investigate the cause of yield decline in rooibos tea production.

The Department of Soil Science has been running a biochar research programme funded by the Food Security Initiative of the Stellenbosch University HOPE Project since 2009. Biochar is pyrolysed biomass produced with the aim of application in soils as a slowly degradable carbon amendment. The project has involved collaboration with the Departments of Process Engineering, Microbiology and Botany at Stellenbosch University. Five MSc studies have been completed thus far, and a PhD research project investigating the molecular interactions of N fertiliser and different biochars produced from various wastes is on-going.

A collaboration with Prof Yakov Kuzyakov (Karl-August University, Göttingen, Germany), an expert in stable isotope tracer techniques in soils, and Prof Bruno Glazer (University of Halle, Germany), one of the initiators of global biochar research, was established within the NRF-German South African Year of Science Initiative. As part of this project, a successful Soil Carbon Day workshop was held at Stellenbosch University, attended by more than 150 role players from Germany and across South Africa.

In 2013, two new projects on biochar research were initiated. Mr OF Madiba from the University of Limpopo has registered for PhD study at Stellenbosch University under the supervision of Dr DA Rozanov and Dr AG Hardie. He will be conducting research on the red/oxide reactions of biochar in soils, funded by the NRF Thuthuka programme. This is a bilateral programme with the University of Limpopo, in collaboration with and at the study sites of the EU4FOOD programme led by Dr WP de Clercq.

The other biochar research project started through the TRECCA Africa interdisciplinary programme, which supports a new PhD student, OP Umeugochukwu from Nigeria, who is working on the sorption of pollutants by biochar from oil-mill waste and possible applications in

An example of the irrigation control system that is used to manage the irrigation of the different treatments in orchards

Irrigation scheduling is an important component of every research programme

olive oil and palm oil production under the supervision of Dr A Rozanov.

Two collaborative research projects between Elsenburg, the Western Cape Department of Agriculture and the Department were initiated in 2012 and completed in 2013. The one project investigated the long-term effects of conservation tillage crop rotation practices on soil organic matter stabilisation, and the other project investigated the long-term effect of different soil tillage practices and cropping rotation systems on the water balance and yield of winter wheat in the Swartland area. Two MSc studies were completed on these projects, with insightful results.

A research project that was started in December 2012 to investigate the effect of long-term rooibos tea cultivation on soil quality and rooibos plant quality in the Clanwilliam area was completed successfully. This project involved collaboration between the Departments of Soil Science and Microbiology. The aim of the project was to identify the soil and plant quality factors behind the decline in rooibos production on older rooibos lands by comparing soil and plant quality on recently cleared fynbos soils and long-term cultivated rooibos soils in the area. It was found that P accumulation in the soil and depletion of organic matter appeared to be the dominant factors. Soil P increased with continuous cultivation, as did plant foliar P content. A negative correlation was found between foliar P content and the aboveground biomass yields (R^2 = 0.52), as well as tea quality (R^2 = 0.64). For the second part of the study, the effect of soil organic amendments and plant foliar sprays on rooibos growth and yields and soil quality were investigated. An MSc study was completed on these projects.

The international research collaboration project between the Department and various participants from the European Union (EAU4Food) is now in its third year of operation. This project, focusing on optimising the use of scarce supplies of irrigation water for the sustainable production of vegetable crops in areas with meagre resources, is being undertaken with partners in Wageningen in the Netherlands. The project will focus on developing and testing innovative, robust and affordable methods that are suitable for local conditions. Newly developed irrigation technology, supported by locally existing traditional practices used by small-scale farmers, will be used. The information will be presented simply and in an easily understandable manner for effective use by unskilled people. The project is currently being carried out with farmers in the Giyani District of Limpopo Province.

EAU4Food is expected to have significant positive impacts on agricultural production at farm level for many years to come, and on wider policy processes at the national and trans-national levels. To enlarge and maintain the impact of EAU4Food, capacity-building programmes are developed at different levels, from farmer-to-farmer exchanges up to the exchange of scientific personnel. Moreover, further exploitation of the results of EAU4Food is supported via things such as ‘songs

Preparation of a soil sample for soil physical analysis in the laboratory. This soil sample will be used to determine the water-holding capacity of the soil at different soil water potentials. This information will be used to determine the optimum irrigation scheduling regimes for this soil.

An undisturbed soil sample clearly showing old root canals

of successes', documentaries, school programmes, policy briefs, fact books and scientific publications and presentations. An MSc study on this was completed and another has just started.

Two soil pollution research projects, funded by the NRF and Inkaba ye Africa, are currently in progress. The first study looks at the weathering of soil minerals exposed to acid mine drainage for extended periods of time. This project is located at Nababeep in the Northern Cape and forms part of a larger project that aims to assess the mobility of metals in the arid soil system of the Okiep Copper District. This project currently supports four MSc students from the Departments of Soil Sciences and Earth Sciences. The second project looks at the effects that mineral surfaces have on the breakdown of the commonly used pesticide, atrazine. This project has provided more insight into the fate of the agrochemical under various environmental conditions.

As part of the Stellenbosch University Trans-disciplinary Studies, one student completed his PhD at the Department of Soil Science working on the relationship between indigenous vegetables, soils and human health. The study was supervised by Dr WP de Clercq. The Department also has a long history of WRC research, and one such project, which finished in 2013, related to the impact of land use and land-use change on the threat of dryland salinity to rivers in the Western Cape. This project produced two successful PhD studies supervised by Dr WP de Clercq.

Community interaction

Staff members of the Department are involved in several community service activities. The Department continued its involvement with the study group that investigates the Table Mountain aquifer and monitors the groundwater content of several marshlands. Organisations were assisted through environmental impact studies, and the suitability of soils for irrigation use to dispose of effluent was investigated. Dr Hoffman served as main judge in the Agricultural category at the regional Expo for Young Scientists. Staff members of the Department of Soil Science contributed to the wider agricultural community during various farmers' days of the Western Cape Department of Agriculture, and by presenting workshops on surface water management in collaboration with the WRC. The EAU4Food research programme conducted in Giyani held a number of farmers' days, during which information

Students doing a laboratory experiment in which they determine the rate of water movement through a soil column. They use the results to model how fast contaminated liquids or fluids can move through the soil profile.

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Department of

HORTICULTURAL SCIENCE

Introduction

The export-focused fruit and cut-flower industries play a key role in the South African economy and provide an important source of foreign exchange, while offering sustainable and stimulating employment to large numbers of people in the rural areas. In addition, the growth in the local demand for fresh and processed fruit products and cut flowers results in an increasing support base for many local agrochemical, packaging, transport and export companies. To ensure that these horticultural industries remain competitive in the overseas markets, it is critically important that new technologies are continuously researched and developed. Enhanced profitability is largely dependent on sufficient volumes of high-quality products reaching their target markets without forfeiting environmental sustainability.

Challenges faced by these industries are sub-optimal and increasingly limited environmental resources, such as suitable agricultural soil, access to high-quality water and changing climatic conditions, as well as the need for sustained, cutting-edge research to ensure postharvest product quality during prolonged storage and shipping periods.

The solution to these challenges lies within scientific research that addresses scholarly issues while supplying trained and technically proficient manpower to the fruit and cut-flower industries. As a tertiary institution we strive to be a centre of excellence that offers support to the South African and international horticultural industries.

The Department of Horticultural Science aims to:

1. Develop, test and improve technologies for the enhancement of pre- and postharvest fruit and cut-flower quality;
2. Introduce and transfer the developed technologies to growers and other horticultural companies for commercial implementation;
3. Supply skilled manpower to the horticultural industries by aiming to deliver graduates, also from the designated groups, as well as five to eight postgraduate students annually.

Overview

The Department can boast a number of achievements by both its staff and students. During 2013, 49 subsidised and non-subsidised articles were published. Five students completed their Master's studies and three students obtained their doctoral degrees.

Ms Lazani du Plessis admires a Phalaeonopsis *orchid (moth orchid) collection at Sky Services on the Joostenberg Vlakte during a third-year excursion to view potted plant production*

Elri Franken, under the guidance of Dr Lynn Hoffman and Prof Karen Theron as supervisors and with the flowering time of Disa as a research topic, received the award for best presentation by a Master's student at the Combined Congress of the South African Society for Horticultural Sciences. During the Postharvest Innovation Programme Symposium, a poster presentation by Dr Mulugeta Delele, Prof Linus Opara, Dr Mduduzi Ncgobo and Tarl Berry, focusing on the modelling of enhanced airflow within fruit packaging, was awarded first prize. Third prize went to Tavagwisa Muziri, Prof Karen Theron and Dr Elke Crouch, for a presentation focusing on the occurrence of mealiness in 'Forelle' pears.

Cut tulips are evaluated for extended vase life in the Flower Laboratory of the Department of Horticultural Science. These stems have been treated with various foliar nutrients under hydroponic production conditions as a remedy for the postharvest disorder of stem toppling.

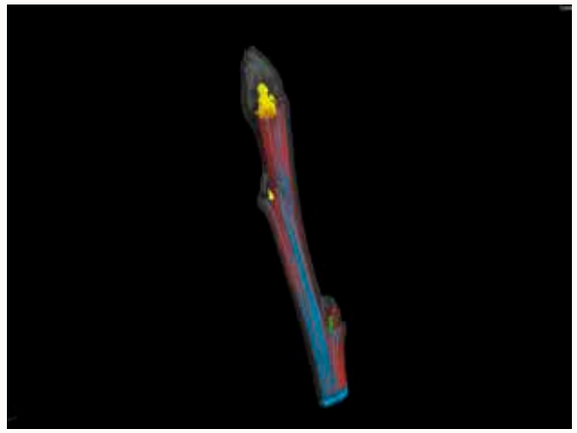
Dr Esmé Louw was the recipient of the Hortgro Best Article in a Scientific Publication award. The article, dealing with the volatile profiles of Japanese plums, appeared in the *Journal of Agricultural Science*.

Drs Elke Crouch and Sandy Turketti visited Zambia as part of the development plan within the Commercial Agribusiness for Sustainable Horticulture (CASH) project. The current situation of smallholder farmers was assessed and insight was obtained on the optimisation of the local postharvest chain of fresh produce.

The Agricultural Research Council (ARC) Infruitec hosted a short course for new producers joining the Protea industry. Dr Lynn Hoffman was invited to give a lecture on the manipulation of the flowering time of *Proteaceae*, which would allow for greater access to the more lucrative marketing windows throughout the year.

Prof Linus Opara, the holder of the South African Research Chair (SARChI) in Postharvest Technology, was the inaugural recipient of the Certified Food Scientist professional designation from the Institute of Food Technologists, USA. In November, Prof Opara was a guest professor at the Shanghai University of Science and Technology, and he was also invited to be a member of the ad hoc panel of experts for the 5th Sustainability Development Report of the United Nations Economic Commission for Africa. He delivered keynote speeches in various countries, including Belgium, China, Kenya, Spain and Uganda, throughout the year.

Dr Wiehann Steyn attended the International Society for Horticultural Sciences (ISHS) Symposium on Plant Bioregulators in the USA, where Prof Karen Theron presented a lecture on the use of 2,4-D to reduce the occurrence of fruit split in mandarin fruit. The symposium was followed by a fact-finding visit



Apple bud research makes use of CT scan imaging to study the physiology of dormancy. Vascular bundles are indicated in colour.

to the apple production regions of Washington state. Prof Theron was also invited to attend the annual Euferin thinning workshop in Lisbon, Portugal.

During the Cold Chain World Conference, Dr Malcolm Dodd gave a presentation titled 'Identifying and rectifying temperature and humidity abuse in various fruit supply chains from South Africa to the United Kingdom', which was received very well.

The Department presented the 4th Postharvest Physiology and Technology short course at STIAS in Stellenbosch with great success

Mechanical thinning of nectarine trees using the Bonner Ausdünnungs machine

in June. Twenty-two lectures were presented, ranging from basic postharvest physiology to the impact of postharvest technology on water loss, temperature management, relative humidity and atmospheric composition in the postharvest chain.

As a finalist in the award category of human resource development under the National Research Foundation (NRF) THRIP programme, the Department was invited to exhibit its programme on competitive horticulture in Durban. The prestigious exhibition, which was open to university students as well as the general public, was aimed at introducing the role of innovative science to society.

Three international visitors were hosted by the Department. The visit by Dr Fernando Alfereze of the CISC-IATA in Spain was aimed at improving cooperation in citrus research. Prof Wannes Keulemans from Belgium investigated the possibility of a student exchange programme in deciduous fruit research, and Dr Jeff Brandenburg from the USA presented a postharvest lecture titled 'Modified atmosphere packaging, science and sustainability'.

Research

The Department of Horticultural Science conducts dynamic research for the deciduous fruit, citrus, ornamental cut flower and potted plant industries, providing value-adding technology for industry partners and lending support to new horticultural industries focusing on alternative crop production. A few of the highlights from 2013 are discussed below:

Ornamental cut flower and potted plant research

Extended storage periods of approximately 21 days associated with the sea freight of Fynbos products increases the risk for postharvest disorders such as chilling injury, desiccation and losses due to pathogens such as *Botrytis*. A study initiated by Dr Lynn Hoffman and funded by the Protea Producers of South Africa (PPSA) and Productschap Tuinbouw (PT) in the Netherlands aimed to establish the optimum picking and maturity stages of selected *Leucospermum* (pincushion) cultivars so that products of high quality can be delivered to export markets. This project formed part of an existing study by Heleen van Zyl (MScAgric), in which the long-term storage conditions for Fynbos products are optimised.

In view of the predicted temperature increase associated with climate change in the Western Cape, research was conducted by Annaline Smith (MScAgric), together with Drs Hoffman and Wiehann Steyn, to study the role of water stress in the development

The brown spots present on the fruit are an example of the postharvest physiological skin defect known as 'postharvest pitting'

Final-year students visiting the 'In2Food' facility in Somerset West as part of a practical excursion on postharvest physiology and technology in fresh cut produce

of bract browning on the involucral bracts of *Protea* 'Pink Ice'.

A project on production techniques for tulips in hydroponics under protection has been completed by Geline Derbyshire (MScAgric) under the supervision of Ms Estelle Kempen (Department of Agronomy) and Dr Hoffman. This study focused specifically on optimising the nutrient solution within the hydroponics, as well as the application of various calcium and boron foliar nutrients to enhance vase life.

Citrus research

It was determined that the shipment of citrus fruit in refrigerated containers leads to variations in temperature if the fruit were loaded with pulp temperatures equal to the ambient air. The practice called 'ambient loading' is therefore not viable for use in markets that demand a cold sterilisation protocol.

A field visit during the produce-handling workshop that was presented for small-scale farmers in Lusaka as part of the CASH project initiative

Fruitsplit in citrus fruit decreases the export quality and value of the fruit. In his MSc study, Jakkie Stander found that applying 15 mg/L 2,4-D after fruit fall in November to December can reduce the occurrence of fruitsplit.

Chilling injury (CI) develops in the rind of citrus fruit if the fruit are stored for a particular period at a temperature below the threshold for a specific cultivar. The MSc study of Jeanine Hordijk, under the guidance of Dr Cronje, indicated that the incidence of CI is related to rind condition. Chilling injury in 'Star Ruby' grapefruit is largely eliminated if only fruit with good rind colour are subjected to a cold sterilisation protocol. Lembe Magwaza has successfully completed a PhD project that focused on the use of NIR spectroscopy to evaluate citrus fruit quality.

Deciduous fruit research

Dr Elmi Lötze is researching the root growth dynamics of apple trees to quantify effects on the uptake of nutrients, tree growth and fruit quality. Another aspect of her research evaluates the effect of high soil temperature on the growth of different apple rootstocks.

MSc (Food Science) student, Arina Cronje, under the supervision of Dr Wiehann Steyn, Prof Karen Theron and Ms Nina Muller (Department of Food Science), set out to determine how canopy position influences fruit quality and consumer preference for the eating quality and appearance of 'Forelle', 'Bon Chrétien' and 'Bon Rouge' pears. In 2011, consumers preferred the eating quality of inner-canopy pears that had been subjected to 12 and 16 weeks of cold storage, while inner-canopy pears in general were preferred in 2012. This study supports the mandatory 12 weeks' cold storage of 'Forelle'

Ms Melrose Ramokonyane explains the importance of the postharvest determination of gas exchange in apples to visitors to the Durban Exhibition Centre, where the Competitive Horticulture research programme was selected as a finalist in the Capacity Building category of an NRF THRIP competition

Tavagwisa Muziri, a PhD student in Horticultural Science, taking notes during a visit to a trial site

pears. Arina also investigated whether harvest maturity within the commercial picking window influenced the quality attributes and consumer preferences for 'Forelle' pears. Inner-canopy

Harvesting plums at Welgevallen, the University's experimental farm

pears of harvest 1 (23 February) and harvest 2 (27 February) were significantly preferred over outer-canopy pear in terms of eating quality. Our results suggest that harvesting 'Forelle' pears at a firmness of ≈6.2 kg will ensure that both inner- and outer-canopy pears have acceptable eating quality.

Increasing production costs are forcing deciduous fruit producers to be more cost effective. Research done by Prof Theron and Gielie de Villiers (MScAgric) shows that mechanical thinning of plums and nectarines during bloom can reduce costs, while improving fruit quality. This research has also been extended to pome fruit, and data on 'Forelle' pears appears very promising. In addition, a new chemical thinning agent is being evaluated on plums, nectarines and peaches by Prof Theron and Gustav Lötze.

Dr Steyn, Dr Jan Lombard (Department of Agricultural Economics), Prof Theron and Gerrit van der Merwe (MScAgric) initiated a project to determine the efficacy of platforms and mechanical harvesting systems. Mechanical harvesting systems can possibly reduce injuries to fruit during harvesting, as the fruit are handled less frequently.

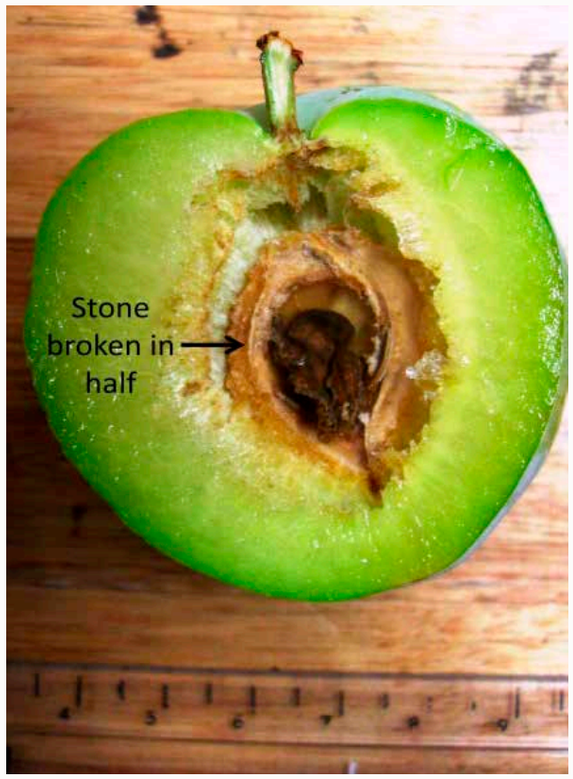
Alternative fruit crops

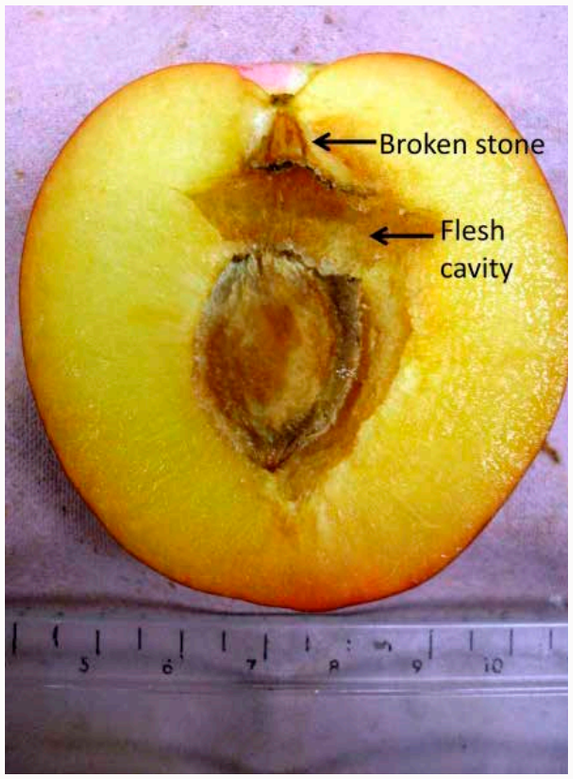
Smaller fruit industries, e.g. olives, persimmons, blueberries and macadamia, are also supported through research projects. These projects aim to reduce alternate bearing in olives, improve the postharvest quality of persimmons, develop fertilisation and harvest scheduling technology for blueberries, and improve low cracking percentages in macadamia nuts.

Dormancy research

Bud dormancy progression and rest breaking are important factors to any fruit producer. The deciduous fruit industry has indicated that

Mealy 'Forelle' pears are currently being studied in the PhD project of Tavagwisa Muziri under the supervision of Dr Elke Crouch



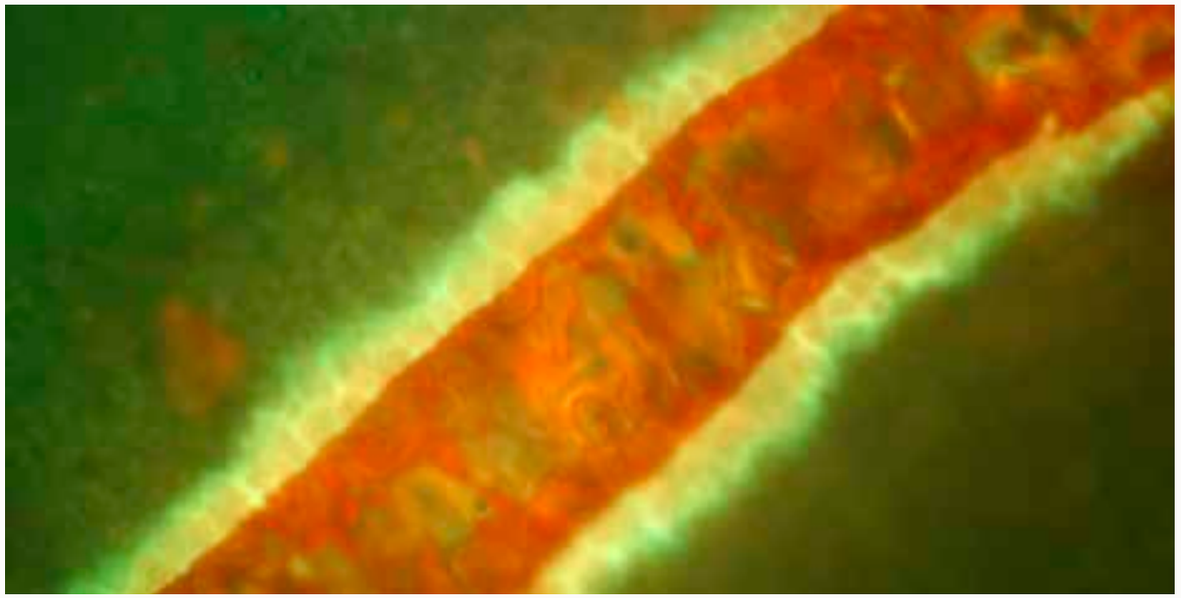


Typical broken stones with a cavity inside a young and more mature 'Laetitia' plum. Broken stones in plums cause the fruit to be marked down from Class I to Class II, causing a significant reduction in revenue earned by the producer.

it needs scientific questions answered on the production of varieties with a low chilling requirement in warm winter areas. This initiated the reviving of dormancy research as a focus area, and capacity was increased with the appointment of Dr Esmé Louw, who will head a dormancy research team comprising three postgraduate students. This research aims at contributing to the fundamental understanding of plant-environment interactions and will provide insight into the sustainable production of deciduous fruit in a sub-optimal climate.

Postharvest research

Heat waves occurring just prior to or during the harvesting window of various plum cultivars hamper the production of premium quality plums by causing heat damage. In a study conducted by Brian Makeredza under the supervision of Drs Mariana Jooste and Wiehann Steyn, the aim was to determine the effect of heat wave conditions in the orchard on fruit respiration rate and internal fruit quality.



Fluorescence microscope image of a micro-crack in the skin of an 'African Delight' plum. Micro-cracks are usually not visible to the human eye. 'African Delight' plums are very susceptible to moisture loss and hence shrivel after cold storage. The aim of the study is to determine if there is a relationship between moisture loss and the existence of micro-cracks in the cuticle of 'African Delight' plums.

CT scanning can detect mealiness in fruit at harvest and before ripening, proving that the occurrence of mealiness is inherent in fruit and not caused by ripening techniques.

Contrary to Australian research findings, the internal browning of South African 'Cripps Pink' cannot be linked to the growing degree days. A study found that apples harvested from young trees and those planted in sandy soil had a greater chance of developing internal browning during long-term storage.

The retail value of tomatoes is directly proportional to the colour of the fruit flesh, with greener, champagne-coloured fruit fetching higher prices and very red fruit being discarded or sold for canning. The application of 1-MCP (SmartFresh™) plays a significant role in the colour development of tomatoes and in ensuring that the fruit reach their target market with a more favourable colour. As a result, tomatoes that ripened too quickly in the past can now also be exported. This study also provided insight into quality retention in mixed loads during logistics and storage, when optimal temperatures cannot be provided for each product. 1-MCP (SmartFresh™) reduces the sensitivity of products to ethylene, enabling products to endure higher temperatures without compromising the eating quality. Quality retention is essential not only for local consumers, but also when exporting produce to the greater African community.

Community interaction

All academic and research staff members are actively engaged in the transfer of technology by presenting seminars or talks during technical field days and farmers' days. In February, Dr Paul Cronje presented a lecture on the aspects influencing the postharvest rind condition of citrus fruit, while a presentation on pre-harvest aspects influencing fruit quality was made in April. Dr Lynn Hoffman participated in a producers'

workshop and presented a lecture entitled 'Leaf blackening in Protea: what do we know and where are we going?'. At the Stems Open Day Dr Mariana Jooste hosted a talk about the important factors influencing the management of postharvest quality, good postharvest practices for stone fruit and the management of moisture loss. In June and December Dr Elmi Lötze lectured on plant nutrition and the usage of calcium to control the occurrence of bitter pit in apples. Dr Wiehann Steyn gave valuable input on a number of occasions, including the HortGro & Prohyto Young Tree Training Field Day, the HortGro Technical Symposium, the HortGro & Wetcit Crop Protection Seminar, and the AgriWorks Farmers Expo.

Technology transfer also took place on a national level by means of talks presented on Radio Elsenburg in association with *Radio Sonder Grense*. Dr Jooste gave a talk on the occurrence of chilling injury in plums during cold storage and Dr Lötze discussed the role of compost.

A project in which learners from local schools visit the Department is managed together with HortGro, an industry partner. During these visits, which are directed at Grade 9 and 11 learners, an effort is made to introduce learners to Horticultural Science as a field of study. Grade 11 learners are provided with further information on career opportunities in Horticultural Science, the minimum admission requirements for the Plant and Soil Sciences programme, the subjects offered by the Department and opportunities for financial assistance. The programme is aimed particularly at schools from disadvantaged areas, including Ceres, Grabouw, the Koue Bokkeveld and Khayelitsha.

Prof Karen Theron participated in a training session for workers actively involved in deciduous fruit production that took place at the Koue Bokkeveld Training Centre in September. The session was attended by 35 individuals and rest breaking, flower development, pollination, fecundation and fruit development in deciduous fruit crops were discussed.

The staff of the Department are also involved as members of various industry bodies, e.g. the Southern African Society for Horticultural Sciences (SASHS), Agribusiness in Sustainable Natural African Plant Products (ASNAPP), Citrus Research International (CRI) and the South African Protea Producers and Exporters (Sappex). Staff members also served on the editorial boards of various issues of *Acta Horticulturae*, which is a peer-reviewed publication of the ISHS. In addition, Prof Theron served on the Management Board of the *South African Journal of Plant and Soil* and is a member of the Research, Development and Environmental Committee of Hans Merensky Holdings, the EUFERIN Working Group on Fruit Thinning and the International Scientific Advisory Committee of the International Horticultural Congress planned for 2014. Dr Steyn was a member of the Acta Horticulturae Scientific Committee.

Mr Willem Joubert of the Novo Packhouse in Paarl explaining the handling chain and procedures within a packaging line

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Dr L Hoffman (Fynbos and Cut-flower Production and Postharvest Physiology)
Dr E Lötze (Pome Fruit Quality)
Dr E Louw (Plant Physiology)
Prof L Opara (Postharvest Technology)
Dr M Schmeisser (Plant Ecophysiology and Stress Physiology)
Prof K Theron (Chairperson; Tree Physiology)

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Prof M Huysamer (Postharvest Physiology)
Dr W Steyn (Tree Physiology)

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Department of

AGRICULTURAL ECONOMICS

Overview

One of the biggest highlights of 2013 was the alumni function that was held in honour of Professor Eckart Kassier, who was appointed a lecturer in our Department in 1965 and served as professor and chair of the Department until his retirement in 1992. The alumni function was to celebrate his 80th birthday, and his long connection with the Department and with agriculture in the Western Cape generally. The function was attended mostly by former students of his, and represented a veritable who's who of Western Cape and South African agriculture. Prof Kassier has had an abiding influence on agricultural policy in South Africa, largely as a result of his chairpersonship of the Kassier Committee of Inquiry into the Marketing Act in 1992. After the publication of the Committee's findings, he was also granted the opportunity to implement his own proposals when, after his retirement from the Department, he was asked by the new government to become the first chairperson of the new National Agricultural Marketing Council.

Another highlight of the year was the award of the Western Cape as well as the National Agriculturalist of the Year award to Prof Nick Vink, Departmental Chair, by Agricultural Writers SA. The national award was presented at a function in Pretoria, where the winners of the South African Farmer of the Year, the New Entrant to Commercial Farming and the Agriculturalist of the Year awards were all from the Western Cape – a reflection of the quality of agriculturalists in this province!

Activities and achievements

The Bureau for Food and Agricultural Policy

The Bureau for Food and Agricultural Policy (BFAP; www.bfap.co.za) is a virtual network linking individuals with multidisciplinary backgrounds to a coordinated research system that informs decision making within the food system. The core analytical team consists of researchers who are affiliated with the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria, the Department of Agricultural Economics at Stellenbosch University, and the Directorate of Agricultural Economics at the Provincial Department of Agriculture, Western Cape. BFAP is the first of its kind in South Africa and has become a valuable resource to government, agribusiness and farmers by providing analyses of future policy and market scenarios and measuring their impact on farm and firm profitability.

As early as in 2009, BFAP, along with other regional policy institutes, recognised that although countries in the region were benefitting from the activities of emerging agricultural policy research institutes, their research activities were not coordinated, the institutions largely did not speak to each other or share information, and they were not collaborating on the common problems facing

Peter Dall, ex-student, well-known fruit farmer and colleague in the Agricultural Marketing Council in Prof Kassier's time, speaking at the alumni meeting

the region. As a result, a group of national institutions, through the coordinating efforts of Michigan State University, began informal discussions centred on the establishment of a regional network of policy institutions. By November 2012, the national policy institutions initiated the Regional Network of Agricultural Policy Research Institutes (ReNAPRI) in order to more effectively coordinate the national policy institutions, share data, collaborate on common problems facing the region and enable national policy makers to learn from the experiences of other countries in the region. The institutions involved include BFAP, the CEPPAG Project of Mozambique, the Centre for Agricultural Research and Development (CARD) in Malawi, the Tegemeo Institute at Egerton University in Kenya, the Department of Agriculture at the University of Kinshasa in the DRC, Bunda College of Agriculture in Malawi, Sokoine University of Agriculture (SUA) in Tanzania, and the Indaba Agricultural Policy Research Institute (IAPRI) in Zambia.

The overall goal of ReNAPRI is to contribute to increased agriculture-sector growth and integration in eastern and southern Africa (ESA) through active collaboration between independent national and regional research institutes. The network is built on strong collaborative links with international (e.g. Michigan State University, Missouri State University, FAO) and national universities. In 2013, ReNAPRI conducted a maize cost-of-production (COP) study in Zambia that will be continued in 2014. The scope of the study involves two complementary approaches: (1) the agri benchmark approach, which utilises a consistent methodology for measuring costs of production for vastly different maize production systems in the region; and (2) the survey-based approach, which complements the agri benchmark approach by constructing estimates of maize production costs and marketing margins for specific regions and production systems, using large-scale farm survey data and key informant surveys of market participants.

Hortgro Services is responsible for the funding of the modelling of the apple and pear industries, while SATI (the South African Table Grape Industry) is responsible for the table grape industry. The information generated by the medium- to long-term projections from these models can be utilised on different levels and by various role players in quantitative analyses and in evaluating scenarios for the different industries, and for typical farms in various production regions. The farm-level FinSim model of BFAP for apples and pears is linked to the BFAP macro-model and the BFAP sector-level model, and is applied to simulate and project performance measures for typical farms in the different apple- and pear-production regions. This is one of the Department's

Prof Mohammad Karaan, ex-student and current Dean of the Faculty of AgriSciences, telling jokes about his time as a student at Stellenbosch

community interaction projects, since the producers can incorporate findings into their strategic planning.

The annual launch of the BFAP agricultural outlook for various agricultural commodities is another community interaction project. The launch is hosted in the Western Cape in conjunction with the launch in Pretoria, with the express purpose of catering to the specific needs of the producers, agribusinesses and other role players in the Western Cape. Other community interaction projects include the Joint Agribusiness and Department of Agriculture Forum for Africa (JADAFA) project to promote and develop bi-directional trade between South Africa and the rest of Africa, and to increase agricultural and agro-industrial investment and partnerships in Africa.

Other activities

Prof Vink delivered his Presidential Address to the African Association of Agricultural Economists in Hammamet, Tunisia in September. The title of his address was "Commercialising agriculture in Africa: economic, social and environmental impacts". Here he argued against the prevailing view that African agriculture was practised by smallholder farmers on the one hand and large corporate farms on the other. In contrast, Africa's agriculture has shown strong economic growth over the past decade and longer, with the additional production coming largely from commercial farmers, and markets are growing strongly, which is causing structural changes that cannot be ignored. The world has had a lot of experience with intervention in agriculture, and the lessons must be learned. Prof Vink was also appointed editor of the Association's journal, the *African Journal of Agricultural and Resource Economics* (AfJARE), during the conference.

Prof Vink also attended the European Association of Wine Economists conference in Talca, Chile, where he presented a paper on "Mountains, vineyards and SMEs – marketing wine from the Cape Floral Kingdom at the southern tip of Africa", which he wrote together with Ms Karin Alant.

Prof Vink and Dr Cecilia Punt served on the local organising committee for the seventh annual conference of the American Association of Wine Economists that was hosted at Spier, Stellenbosch, in June 2013. Eighty-seven papers were presented on a wide range of topics by presenters mostly from America, and some from Europe and South Africa.

The teaching staff took part in several other national and international conferences and forums. Lulama Traub attended the 2013 World Agricultural Outlook Conference in China and did a presentation on "ReNAPRI: Towards an African Outlook". Dr Jan Lombard visited a number of institutions and farmers in

Prof Philip Spies, former colleague in the Department of Agricultural Economics, Director of the Institute for Futures Research and farmer, pays homage to Prof Kassier

Germany and Italy as part of the cooperation on the agri benchmark project. The purpose of the project is to calculate and compare financial performance indicators for apple, pear and wine grape production systems in different countries. The feasibility of the National Development Plan proposals for employment in agriculture was also presented at a session sponsored by FNB at the annual Megaweek in Bredasdorp.

Dr Willem Hoffmann completed a course in Quantitative Land Use Analysis at the University of Wageningen in the Netherlands. This is partly in preparation for contributions towards the Master's Programme in Sustainable Agriculture that will be offered at Stellenbosch University from 2014.

Prof Kassier in full stride – as many of his students remember him

Research

The Department's two full-time PhD students, Jan Greyling and Khaya Sotsha, made good progress with their studies. Jan spent some months doing coursework at the University of Wageningen in the Netherlands, while Khaya spent a large part of the year reading up on experimental economics, a methodology that he expects to use in his research.

A research project focused on the financial vulnerability of farming systems to climate change in parts of South Africa is part of a PhD study supervised by Dr Jan Lombard. He has also conducted research to describe and analyse four typical farms (two for apples and two for wine grapes) as part of his cooperation with the international agri benchmark project, which is managed from the Thunen Institute of Farm Economics in Braunschweig, Germany.

Dr Cecilia Punt conducted research in collaboration with tralac, the Trade Law Centre, to determine the fiscal implications of Tanzania's inclusion in the Tripartite Free Trade Agreement (FTA) between the Common Market for Eastern and Southern Africa (Comesa), the East African Community (EAC) and the Southern African Development Community (SADC).

Dr Cecilia Punt also completed her PhD study under the supervision of Prof Scott McDonald from Oxford Brookes University in the United Kingdom. The study aimed to enhance the quality of results of a computable general equilibrium (CGE) model for South Africa to reflect more realistically the supply responses of agricultural industries to changes in the relative prices of products. The enhanced CGE model was used to analyse the socio-economic implications of selected issues raised in the National Development Plan of 2011.

Community interaction

The Department registered five community interaction projects during 2013. Three of the projects are mentioned in more detail above and relate to the JADAFA project, the annual launch of the BFAP baseline outlook to role players in agriculture, and the BFAP project related to farm-level modelling for the apple and pear industries, with the results of the analysis frequently being

disseminated to farmers. Staff members also have an impact on communities indirectly by playing an active role in external decision-making committees, such as the Centre for Rural Legal Studies, the Methyl Bromide Technical Options Committee under the Montreal Protocol for Substances that Deplete the Ozone Layer, and the Water Research Council. Furthermore, staff members interact with farming communities as guest speakers during farmers' days. Prof Vink addressed a total of 25 such farmers' days in the course of 2013.

Prof Vink currently serves on the NRF Rating Panel for Economics, Management, Administration and Accountancy. He also has the following journal editorial duties:

- Member of the editorial board, *Development Southern Africa*, 1996 to present
- Member of the editorial board, *The South African Journal of Economic History*, May 2001 to present
- Member of the editorial advisory board, *Journal of Wine Economics*, 2006 to present
- Member of the editorial board, *Journal of Agribusiness in Developing and Emerging Economies*, 2012 to present
- Editor: *African Journal of Agricultural and Resource Economics*, April 2013 to present

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Dr JP Lombard (Production Economics)
Dr C Punt (International Trade, Macroeconomic Modelling)
LN Traub (Agricultural Development)
Prof N Vink (Chairperson; Agricultural Policy)

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Department of

PLANT PATHOLOGY

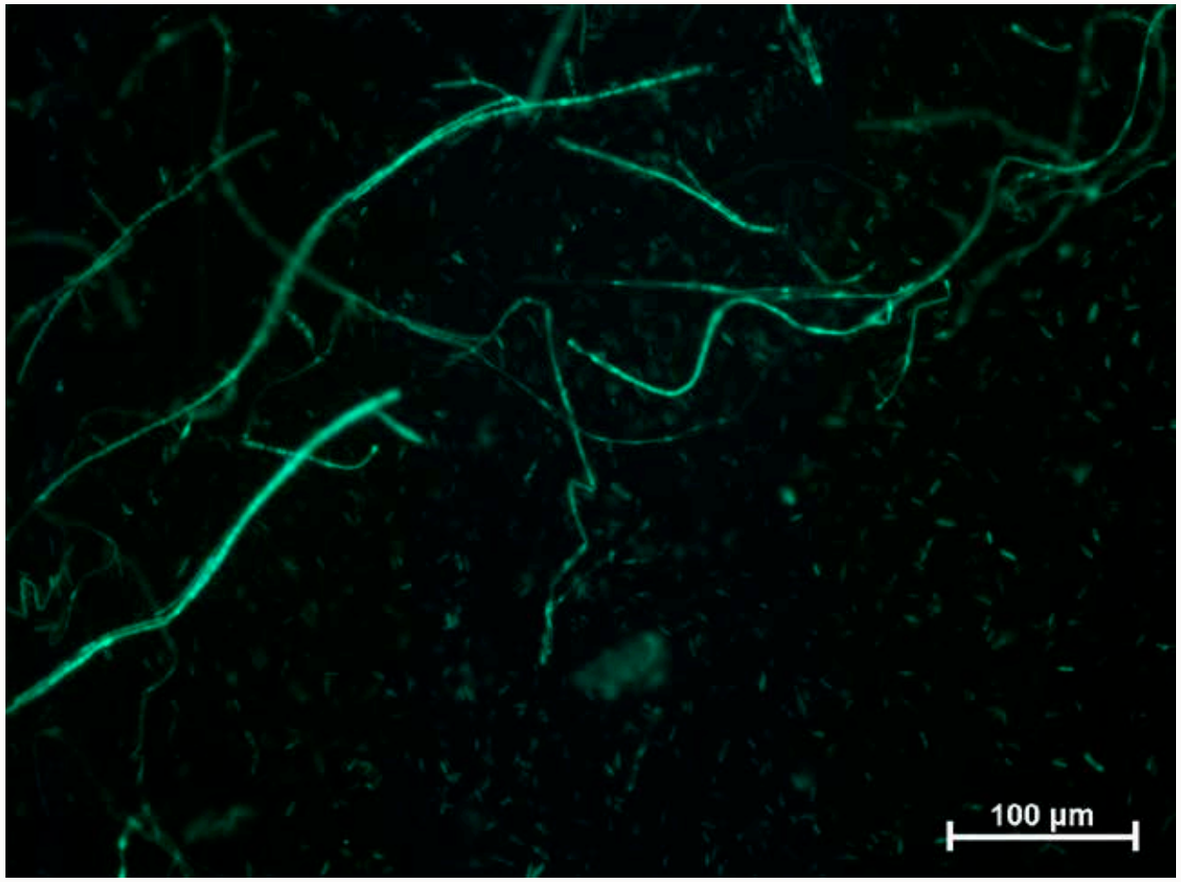
Introduction

Welcome to the Department of Plant Pathology. Plant Pathology is the study of plant diseases. In order for a disease to occur, there must be a susceptible host plant, a pathogen able to cause disease and an environment conducive to disease. In our Department we study the components of the disease triangle (host, pathogen and environment) in order to manage plant diseases. Our Department, established in 1918, is the oldest Plant Pathology department in South Africa. We are involved in the teaching and training of students for careers in plant pathology, and offer degrees at both the undergraduate and postgraduate level. Our students are the 'plant doctors' of the future. Besides our teaching role, we are actively involved in research addressing issues of plant pathological importance. Considering that an estimated 14% of crops are lost to plant diseases before harvest, and a further 6% to 12% are lost after harvest, research that helps us to understand the nature and biology of plant pathogens, how diseases spread, and what we can do to manage them, is vital for sustainable crop production today. Our research findings are published in some of the top international journals and therefore have an impact both nationally and internationally. Our researchers also regularly present their findings at local and international conferences. Another important aspect of the Department of Plant Pathology is our interaction with producers (farmers), the agricultural industries (pack-houses) and agro-chemical industries, to name but a few. These interactions involve sharing information, training and collaboration, and providing access to the services of the Disease Clinic in the Department.

Overview

The mission of the Department of Plant Pathology is to be recognised nationally and internationally as an academic department noted for quality training and research in Plant Pathology by creating an environment that supports and encourages the development and productivity of students and staff members; establishing and maintaining alliances with industry through strategically focused research programmes and service delivery; and fostering national and international collaboration for innovative and cutting-edge research aimed at sustainable food production.

The Department has a holistic and interdisciplinary approach to research and training, and makes use of the latest technologies available to reduce the impact of pathogens on plants; to manage these pathogens; and to increase plant resistance to pathogens. Conventional and molecular



Green fluorescing vegetative structures of a green fluorescent protein (GFP) gene-transformed Fusarium verticillioides *isolate*

techniques are used to identify and control plant pathogens that are considered a threat to local crops and export markets in a sustainable and economical way. Students are trained in the detection, characterisation and epidemiology of plant pathogens, and in the use of integrated disease control strategies to control them. Current research programmes focus on diseases occurring in apples, pears, citrus, banana, grapevines, vegetables and cereal crops. Focus areas for research include pathogen identification and detection; integrated disease management (including the optimisation of fungicide application, and sanitation); postharvest pathology of fruit crops (including chemical and biological control); in-field management of mycotoxin production in grain crops; and the understanding of plant-microbe (beneficial and detrimental) interaction.

MSc student Meagan Vermeulen planting maize trials

Research funding is obtained from national grower organisations, including Citrus Research International (CRI), Hortgro Science, the Maize Trust, the Winter Cereal Trust and Winetech, as well as the Bill & Melinda Gates Foundation and the South African Table Grape Industry (SATI). Additional funding is obtained from the National Research Foundation (NRF), THRIP and the Agricultural Research Council (ARC).

Staff and postgraduate students of the Department of Plant Pathology attended two national conferences and 11 international meetings during 2013. Twenty-nine contributions were made at national and 22 at international meetings. In the same period, staff, in collaboration with postgraduate students, published 19 articles in scientific journals rated by the Institute for Scientific Information (ISI).

Vertically split grapevine wood showing a sucker wound with brown discolouration and streaking originating from the wound. Two trunk disease fungi, Phaeomoniella chlamydospora *and* Phomopsis viticola*, were isolated from the infected wood. The MSc study of Gugulethu Makatini showed that sucker wounds can also be infection ports for trunk disease pathogens.*

The Department has a considerable number of cooperative agreements at national and international level. Nationally, these include cooperation with Hortgro Science (phytosanitary pathogen lists for deciduous crops); the Department of Agriculture (pathogen lists for deciduous crops); plant quarantine services on an *ad hoc* basis (quarantine pathogens); the Agricultural Research Council (ARC) Infruitec-Nietvoorbij (grapevine research projects and postharvest diseases of pome fruit); ARC Grain Crops Institute and Plant Protection Research Institute (PPRI) (toxin-producing *Fusarium* species in maize and wheat); Elsenburg Agricultural College (*Fusarium* diseases of wheat); University of Cape Town (genetic manipulation of maize), and Experico (postharvest diseases of pome and stone fruit).

At the international level there is collaboration with the following: CBS, the Netherlands (characterisation of grapevine trunk disease pathogens, characterisation of apple core rot pathogens, characterisation of *Neofabraea* species on pome fruit); Lallemand Group, Belgium (biological control agents for postharvest disease management); Lincoln University, New Zealand (characterisation of *Cylindrocarpon* isolates); Department of Botany and Plant Pathology, Oregon State University, USA (the Fungal Tree of Life (AFTOL) project); School of Botany and Zoology, Australian National University, Australia (characterisation of *Plasmopara viticola* and *Phytophthora* populations in South Africa); USDA-ARS, Wenatchee, USA (the role of *Pythium* and *Phytophthora* in the decline of grapevines, as well as the aetiology of apple replant disease in South Africa); Department of Plant Pathology, Cornell University, USA (the stable transformation of *Phytophthora* species); Department of Botany and Plant Pathology, Oregon State University, USA (the aetiology of apple core rot diseases); Bioversity International, NARO (Uganda) and ISAR (Rwanda) (control of Fusarium wilt of bananas in Africa); Genetwister, Wageningen, the Netherlands (genetic manipulation of maize); International Institute for Tropical Agriculture, Nigeria and Uganda (Plant Health for Africa); Bioversity International, France, the Philippines and Uganda (Fusarium wilt of bananas), and the Guangdong Academy of Agricultural Sciences in China (Fusarium wilt of bananas).

One postgraduate student obtained his PhD(Agric) degree, two students their MScAgric degrees and one student his BScHons degree in Plant Pathology in 2013.

Dr Lizel Mostert received the 'Applied Plant Pathology' award at the 48th Congress of the Southern African Society for Plant Pathology in January 2013 for phytosanitary work done for the deciduous fruit industry.

Field trip to research facilities near Kisumu, in Kenya, where research on different Striga control methods was demonstrated

Research

The following research focus areas are addressed by the Department of Plant Pathology: pathogen identification and detection of plant pathogens; integrated disease management, which includes the optimisation of fungicide application and evaluation of sanitation strategies; postharvest pathology of fruit crops; management of mycotoxins in grains and cereals; and plant-microbe interactions.

Research programmes in the Department include:

Fusarium diseases of agricultural crops

Plant pathogens belonging to the fungal species *Fusarium* are of serious importance to continued food production in the world. They are well known to cause disease in important staple food crops such as maize, wheat, sorghum, rice and bananas, and in some instances produce mycotoxins that can be fatal to humans and animals. Many diseases caused by *Fusarium* spp. and their toxins cannot be treated, and have to be prevented. The programme on the *Fusarium* diseases of agricultural crops therefore focuses on the characterisation and management of *Fusarium* spp. associated with Fusarium wilt and mycotoxin production in staple food crops, specifically relating to the identification and characterisation of *Fusarium* spp. through using conventional and molecular techniques; quantitative detection of *Fusarium* spp. and their mycotoxins; the epidemiology and aetiology of *Fusarium* spp.; field management of *Fusarium* diseases and the mycotoxins they produce; biological control of pathogenic *Fusarium* isolates; and understanding the interaction of plants with *Fusarium* spp.

The most effective means to prevent damage caused to agricultural crops by *Fusarium* spp. is by planting resistant material. Such resistance depends on the ability of the fungus to enter, colonise and damage the plant, and the ability of the plant to prevent or resist damage caused by the fungus. A proper knowledge of *Fusarium*, and of its genetics, pathogenicity and toxicity under different environmental conditions, is required to exploit plant resistance as a means of disease management. In this programme, the interaction between agricultural crops and *Fusarium* spp. is investigated by means of comparative and functional genetics of the *Fusarium*-plant interactions; the isolation and

MSc student Gugulethu Makatini prepares to inoculate sucker wounds made on Cabernet Sauvignon vines to test the susceptibility of sucker wounds to trunk disease pathogens

identification of defence-related genes in agricultural crops; the identification of virulence genes in *Fusarium*; studies on the evolutionary biology and phylogenetics of *Fusarium*; and the unconventional improvement of plants for resistance to *Fusarium* spp.

Fruit and postharvest pathology

Fruit production plays an important part in the economy of South Africa, both internationally and locally. Unfortunately, plant disease and decay impact on the profitability of deciduous fruit production, and negatively influence consumer confidence in these products. There is an increasing demand from consumers and, consequently, retailers and marketers for fruit with little or no pesticide/fungicide residues. Producing quality fruit under such constraints is a major challenge for the deciduous fruit industry, which currently relies heavily on pre- and postharvest chemicals for the control of disease and decay. The main objective of the Fruit and Postharvest Pathology Research Programme within the Department of Plant Pathology is to improve disease and decay control in deciduous fruit products through the design of appropriate integrated disease management strategies with reduced reliance on fungicides.

Dr Lizel Mostert received the 'Applied Plant Pathology' award at the 48th Congress of the Southern African Society for Plant Pathology in January 2013 for phytosanitary work done for the deciduous fruit industry

Projects within this programme are: aetiology, epidemiology and management of postharvest decay pathogens of apples and pears, including *Botrytis, Penicillium* and *Neofabraea* species; the efficacy of sanitation practices in reducing apple scab; the occurrence and importance of overwintering of apple scab conidia in the Western Cape; fungicide sensitivity of South African populations of *Botrytis cinerea, Venturia inaequalis* and *Neofabraea alba*; characterisation of physiological races in the South African apple scab population; and the potential use of essential oils and garlic extracts in the management of postharvest diseases of apples.

Phytomycology and grapevine trunk diseases

The field of phytomycology entails the study of fungal systematics and the taxonomy of fungal plant pathogens. This knowledge enables the correct identification of causal agents of diseases. The aetiology of plant diseases is very important as the first step in understanding the disease and aiding in working towards a control strategy. Plant diseases are often complex, being caused by a variety of fungal taxa. The identification and relevance of these taxa are very important. A focus area of research concerns the aetiology and epidemiology of trunk diseases of grapevine, pome and stone fruit trees.

Phytomycology also entails the development and use of up-to-date molecular identification tools for fungal pathogens to be used to ensure clean planting material, and for early disease warning. Compiling reliable information regarding the status of fungal pathogens in South Africa is very important. This, together with expertise in phytomycology, is of the utmost importance in order to ensure market access within the agricultural sector, as well as food security in South Africa. Phytosanitary support is provided on an ongoing basis to the deciduous fruit industry (Hortgro Science).

Grapevine trunk diseases have an impact on wine and table grape production by reducing the number of productive years of vines.

The research on grapevine trunk diseases focuses on describing the causal fungal pathogens, understanding their disease cycle and finding effective ways to manage these diseases. Describing new species and understanding the epidemiology of the fungal groups occurring on grapevines form a vital part of the research. Fungal groups that are studied include the Botryosphaeriaceae, Diatrypaceae, Diaporthales, Calosphaeriales and Hyemnochaetales. Improving the management of the trunk diseases starts with the detection of pathogens in soils and in nursery plants, and by improving pruning wound protection through the application of *Trichoderma* products on pruning wounds. Two isolates occurring naturally in grapevines have been tested *in vitro* and *in vivo* and we are in the process of developing a product that can be used as a pruning wound protectant.

The Robigalia festival is held for undergraduate students every year in April and is used as an opportunity to recruit postgraduate students. The festival is inspired by festivals held in Ancient times to protect crops against rust diseases, which were believed to be caused by the god of rust, Robigalia.

Citrus pathology – fungicide application technology

In plant disease control, the use of very effective aqueous remedies (i.e. fungicides, biocontrol agents, GRAS chemicals, etc.) sometimes yields disappointing results through which growers suffer economic losses. In these cases, failure to control disease is often attributed to insufficient application of the remedy. In this research programme, various conventional and novel application technologies are evaluated and optimised in citrus orchards and pack-houses in order to ensure biologically effective residue loading onto susceptible plant parts, without exceeding allowable maximum residue levels. Concomitant aims involve addressing the cost- and time-efficiency aspects of application methods by which production and environmental costs are influenced directly. The methodology employed involves a proprietary deposition assessment protocol using fluorometry, digital photography and image analyses, as well as residue analysis and biological efficacy tests.

Citrus pathology – epidemiology of citrus black spot

Citrus black spot (CBS) is a cosmetic disease of citrus fruit. However, its causal organism, *Guignardia citricarpa*, is regarded as a quarantine organism in certain countries. The South African citrus industry is the second largest exporter of fresh citrus fruit in the world, and CBS therefore is an economically important disease, given the implications for market access. In this research programme at USPP (University of Stellenbosch Plant Pathology), the epidemiology of the disease is studied to understand and predict its behaviour under climatically diverse conditions. It is expected that this will allow improved

control programmes, but also assist in ongoing deliberations concerned with market access. In addition, the population genetics of *G. citricarpa* will be studied on a global scale in order to ascertain the global movement of this organism and the relative importance of sexual and asexual reproduction under diverse climatic conditions.

Community service

The Plant Disease Clinic is a service laboratory situated in the Department of Plant Pathology at Stellenbosch University. The Clinic started its activities in October 2000, and specialists in the field of plant pathology diagnose problems on the samples received. All types of fungal or bacterial diseases on various crops, including trees, shrubs, vegetables, fruit, ornamentals, etc., are diagnosed. In 2013, a total of 790 sick plant samples were received and analysed diagnostically, and reports were sent to the clients.

During a meeting that involved all the important role players it was decided that the Disease Clinic would also receive insect samples from January 2014. These insects and insect problems will be analysed by the Department of Conservation Ecology and Entomology. Furthermore, the Department of Plant Pathology is involved in the transfer of knowledge concerning plant health issues to the agricultural and forestry industries on a continuous basis through discussions with the industry, participation in technical training and presentations at farmers' days.

During 2013, the Department of Plant Pathology had to deal with two fungal plant pathogens with significant international impact. A new race of the banana Fusarium wilt fungus, *Fusarium oxysporum* f. sp. *cubense,* was discovered in northern Mozambique. This race, called FOC TR4, was previously limited to Asia. The discovery initiated a continental response, in which the Department played a leading role.

In addition, citrus black spot became a considerable problem

Citrus black spot, caused by Guignardia citricarpa, *is the reason why exports of citrus from South Africa to the European Union have been blocked*

Plant samples reach the Disease Clinic in many ways!

The Disease Clinic team: (from left to right) Tammy Jensen, Sonja Coertze and Brenda de Wee

due to European Union regulations that blocked further exports from South Africa. The studies of the epidemiology and population genetics of the black spot fungus are an important component of the Department's postgraduate training.

Internal Fusarium wilt symptoms of banana caused by a new race of the pathogen, Fusarium oxysporum *f. sp.* cubense. *The photos show different symptoms of the disease.*

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Dr A McLeod (Molecular Plant Pathology)
Dr L Mostert (Phytomycology)
L Rose (Disease Resistance in Grain Crops)
Prof A Viljoen (Chairperson; Plant-microbe Interaction, Fusarium Pathology)

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Department of

ANIMAL SCIENCE

"Our task is to prepare our students for a lifetime of learning."

-Whiteman, 1964

Overview

The Department of Animal Sciences was established in 1921 with the appointment of its first lecturer, Prof JHW Th Reimers, who was head of the Department from 1921 to 1952. The Department is one of the oldest of its kind in Africa, and celebrated its 92nd birthday in 2013.

The mission of the Department of Animal Sciences is to train animal scientists of excellence in order to fulfil the research, extension and development needs of South Africa in order to improve the quality of life of all its inhabitants.

The Department offers various undergraduate and postgraduate training programmes in the disciplines of monogastric and ruminant nutrition, development physiology and meat science, animal breeding, livestock management, reproduction physiology and aquaculture. The respective programmes focus on production systems and management of a variety of domesticated animal species, including sheep and goats, dairy cattle, beef cattle, poultry, pigs, ostriches and various aquaculture species.

Community interaction

The various subdivisions within the Department are closely involved with the respective animal industries throughout the country, and technology/ information transfer normally takes the form of farmers' days and industry information days. The Department is currently developing short courses that range from basic information on various subjects pertaining to animal production to more specialised courses for individuals who want to enrol for a postgraduate qualification.

Activities and achievements

Staff and postgraduate students of the Department of Animal Sciences attended several national symposia, as well as national and international conferences, during 2013. A total number of 49 scientific articles were published in ISI-rated scientific journals. Four PhD (Agric), four MScAgric and two BScAgricHons degrees, as well as one Postgraduate Diploma in Animal Science, were awarded in 2013. The Prof AI Perold Medal was awarded to Martie Knoetze in 2013 in recognition of being the top student in AgriSciences. The Department also maintains a number of cooperative agreements on a national and international level.

The majority of the academic staff members serve on University and/ or scientific committees. **Prof K Dzama** is a panel member of the SADC Drought Monitoring Centre (Livestock Committee), convenor of the Animal Breeding and Genetics Forum, and serves on the South African Society of Animal Science Awards Committee. He also serves on the committee of the South African Red Meat Research and Development Trust Project, as well as the Professional Accreditation Committee of SACNASP. He further serves on the NAMC Red Meat project steering committee and is convenor of the Cape Town Urban Agriculture Forum. He also serves on the University's Employment Equity Forum. **Prof LC Hoffman** serves on the University's Research Committee. He is the chairperson of the Southern African Wildlife Management Association (member for life), an Associate Editor of the *Journal of the Science of Food and Agriculture*, and serves on the Editorial Board of *Meat Science*. **Prof CW Cruywagen** is a member of the Faculty of AgriScience's Faculty Committee and of the Academic Programme Committee, and also serves on the SU Research Ethics Committee. He serves on the Editorial Committee of the *South African Journal of Animal Science* and is a member of various international committees. He is the current Vice-Chair and incoming Chair of the Agricultural Microscopy Division of the American Oil Chemists' Society,

and serves on the International Relations Committee and the International Awards Committee of the American Dairy Science Association. He is also registered with the American Registry of Professional Animal Scientists. **Dr H Lambrechts** is the secretary of the South African Reproductive Research Group and secretary of the Western Cape branch of the South African Society for Animal Science. **Dr E Pieterse** serves as Chairperson of the Western Cape branch of the South African Society for Animal Science and on the Faculty of AgriScience's Timetable Committee. **Ms A Davids** serves on the Faculty of AgriScience's Marketing Committee.

The SARChI Chair in Meat Science was awarded to Professor Louwrens Hoffman, and the research chair is co-hosted by Professor Voster Muchenje from the University of Fort Hare (UFH). In the past year the Chair hosted 38 postgraduate students and two postdoctoral students; four of these students were from the UFH, of which Prof Hoffman is a co-supervisor. The Meat Science team had a very successful year in 2013 and published 26 peer-reviewed papers, while two PhD students and 12 MSc students graduated. Prof Hoffman's research on game meat and its contribution to international knowledge was recognised internationally when the American Meat Science Association awarded him the AMSA International Lectureship Award. He is the first South African to receive this award. A highlight for the team was the publication of an article indicating the adulteration of processed meat products (amongst others with donkey) by one of the postdoctoral research fellows, Dr Donna Cawthorn.

The University's dairy on the Welgevallen Experimental Farm has been commercialised and houses a brand new milking machine that offers state-of-the-art technology for research. Value is added on the premises in that the milk is pasteurised, skimmed, homogenised and packaged in sachets as full cream or low fat milk and made available to retail stores as Maties Milk.

Research

The research undertaken by the Department of Animal Sciences focuses on the nutrition, breeding and physiology of animals, as well as on animal products such as meat. The respective focus areas are as follows:

With regard to ruminant nutrition, the research is aimed primarily at the optimal utilisation of available raw materials to increase the production efficiency of cattle, sheep and goats. There is a strong focus on rumen metabolism and roughage fermentation rates. Aspects such as the effect of rumen pH and particle size on ruminal fibre digestion are being investigated, as well as combinations of different forage and energy sources to increase microbial efficiency. The use of exogenous fibrolytic enzymes to increase the digestibility of roughage has been a focus of research for the past six years.

Regarding small stock, the focus is on the efficient production of lambs and sheep in intensive and extensive production systems. For the intensive systems, the research focus is directed to both the pre-weaning (creep diets) and post-weaning (finishing diets) stages, and focuses on optimising diets for amino acid, non-structural carbohydrate, fibre and mineral content. Attention is also given to alternative feedstuffs, such as silage as a component of feedlot diets or medics grazing as a basis for the fattening of lambs for the market. Where possible, meat quality aspects are assessed, as this is of importance to consumer demands for healthy meat that has been produced in an environmentally friendly manner.

Research on monogastric animals focuses on different aspects of poultry nutrition and management that will ensure the development and health of the gastrointestinal tract that will have a long-term

influence on production efficiency. With regard to management aspects, research focuses on the manipulation of the environment to improve the health and production of poultry.

Animal breeding research focuses on improving the accuracy of selection in the national commercial livestock herds, e.g. dairy cattle, beef cattle and sheep, by developing relevant genetic parameters and using them to develop new selection indices or improve existing ones. Another focus area is the evaluation of farm animal genetics using functional genomics. This involves the use of traditional quantitative genetics tools and molecular-based techniques to uncover the livestock genetic code. The main species being evaluated are pigs, chickens, ostriches and cattle. The research aims to characterise the genetic diversity (using molecular biology techniques) and population dynamics of these species in Southern Africa, leading to phenotypic characterisation.

The second stage aims to look for quantitative trait loci (QTLs) that are of economic importance to the respective industries. This research is being conducted in collaboration with the Agricultural Research Council (ARC), the Western Cape Department of Agriculture and the University of the Western Cape.

The meat science research team has focused on increasing output related to the University's Food Security Initiative as part of the HOPE Project. They follow a holistic research approach by researching intrinsic and extrinsic factors that influence the meat quality and composition of various animal species, using a 'gate-to-plate' focus. This has resulted in strong inter-departmental links being formed with the animal nutrition research colleagues in the Department, as well as those situated at the Elsenburg Animal Production Institute. The meat types that have been researched include red meat, poultry and fish, with a strong focus on the traditional farmed species. The research team is also renowned internationally for their research on exotic meats (game and ostrich).

Physiological research focuses on the influence of management on the physiology of both reproduction and digestive systems, with both aspects that have a significant impact on the profitability of small-scale and commercial systems. Research focuses on the interaction between nutrition and reproduction, and the role of assisted reproduction techniques that can be used to increase and optimise the cost-efficiency of commercial systems, as well as make these techniques more accessible to emerging and commercial producers. The use of *in vitro*-produced embryos to genetically improve and thus optimise the cost-efficiency of dairy production systems, and to minimise the potential environmental effect of such systems, is one of the primary focus areas, and is already being applied in the broader industry.

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A Davids (Poultry Production)
Prof K Dzama (Chairperson; Animal Breeding)
Prof LC Hoffman (Meat Science)
Dr H Lambrechts (Animal Physiology)
Dr C Mapiye (Meat Science)
Dr E Pieterse (Monogastric Nutrition)
K Salie (Aquaculture)
Dr WFJ van de Vyver (Ruminant Nutrition)

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Department of

FOOD SCIENCE

Overview

The mission of the Department of Food Science is to be a nationally and internationally competitive centre of excellence in Food Science and to supply, through visionary education and innovative research, the South African food industry with cutting-edge technology, knowledge and environmentally friendly products and practices, as well as well-trained role players. The Department of Food Science has a strong research culture based on the application of fundamental scientific principles, and focuses on expanding our understanding of foods and biomaterials. The research initiatives cover a range of topics, including chemical, processing, sensory, microbiological and safety aspects.

The Department prides itself on fostering strong student-staff interactions and thereby creating a stimulating research environment. We attract significant research funding annually – a sign of both the high quality of research we undertake and the relevance of our postgraduate qualifications (MSc Food Sc, PhD (Food Sc) and DSc (Food Sc)) to the needs of today's global food industry.

Although the Department procures research funding and postgraduate bursaries, it still faces many challenges. The Department is still small in terms of human capacity, with only six academic staff, and we can still expand in terms of research equipment. However, the Department's success rate in terms of number of postgraduate students and research outputs clearly demonstrates the quality of the research and the commitment of the staff.

Activities and achievements

The Department's research activities are structured in such a way that they cover a broad spectrum of areas within food science and technology, resulting in many interdisciplinary projects. Collaboration on research projects is interdepartmental – on the Stellenbosch University campus, with other national and international tertiary institutions and with science councils. The Department has bilateral research agreements with Sweden (Swedish University of Agricultural Sciences) and the Norwegian Research Institute (Nofima Mat). The food industry and government departments are strongly involved in the research activities, and partners include Distell, Büchi Labortechnik AG, the Winter Cereal Trust, Winelands UV Technology, South African Breweries Maltings (SABM), Caledon, Sasko Research and Development, Sensako, the Medical Research Council (MRC), Enviro Services, the National Departments of Agriculture, Forestry and Fisheries (DAFF) and Water Affairs (DWA), the South Africa Rooibos Council, as well as the Department of Agriculture, Land Reform and Rural Development, Northern Cape Province. A considerable amount of research support emanates from the National Research Foundation (NRF), THRIP, the Water Research Commission (WRC) and Winetech.

The success of the Department's research activities is influenced greatly by the quality and dedication of its postgraduate students. In 2013 a total of 33 MSc students and 19 PhD students were registered in the Department. Two postdoctoral fellows were also part of the research projects. The postgraduate students and postdoctoral fellows came from Namibia, Zambia, Mozambique, Zimbabwe, Nigeria and Romania. A total of 11 MSc degrees and two PhD degrees were awarded in 2013, and 30 scientific articles were published in international journals. The Department's research was also presented at conferences, with 13 international and ten national presentations. Academic staff undertook visits to the following countries for research-related purposes: Australia, Belgium, France, Italy, Spain and the USA.

Dr Gunnar Sigge was invited by the Institute of Food Technologists (IFT) to take part in their Strategic

Retreat in Huntington Beach, California, USA from 2 to 5 December 2013.

Research

Food microbiology theme

The ***food microbiology theme*** focuses on the detection and identification of a diversity of microbial populations present in food products, including fruits, fruit juices, vegetables, cheese and other dairy products, cereals, meat and fermented foods. Traditional microbiological isolation and identification methods, as well as molecular techniques, are used to identify these microbes. Research is focused on spoilage microbes, food-borne pathogenic microbes and the microbes present during food fermentation (with a specific focus on milk fermentation), often using a non-culturing approach to ensure the detection of all viable, although often not culturable, microbes.

Research has also been done on the safety of traditionally fermented milk products using milk contaminated with *Mycobacterium bovis*. The specific objective was to determine whether different fermented milks inactivate sufficient numbers of *M. bovis* to prevent the transmission of the zoonosis through contaminated dairy products.

Stellenbosch University's 4th-year Food Science (Packaging) students performed very well in the IPSA Goldpack Student awards. In the photo Dr Gunnar Sigge is handing over the trophy to Claire Kirkby, the 2013 winner.

Members of the newly elected Executive Committee of ICNIRS. From left to right: Pierre Dardenne (Immediate Past Chair), Ana Garido-Varo (Chair), Mui Saranwong (Secretary), Marena Manley (Chair Elect) and Peter Flinn (previous Immediate Past-Chair). Steve Holroyd (Treasurer) was not present.

Environmental theme

The ***environmental theme*** focuses on the impact of food processing operations on water usage, wastewater characteristics and treatment options. The application of anaerobic digestion technology and the use of ozone and other pre-treatment techniques to improve the efficiency of wastewater treatment systems are also researched.

Water wastage – either the excessive use of water or the unnecessary disposal of large volumes of polluted wastewater – has been a research focus for many years because South Africa is increasingly becoming water scarce, while its population is steadily increasing. Sustainable food production to ensure food security means that more food needs to be produced and preserved, despite ever-dwindling water resources. Therefore research on water minimisation in food processing, wastewater treatment and recycling, and energy recovery from waste and wastewater is becoming increasingly important. Sustainable food and beverage processing, especially in the Western Cape, is crucial for job security, as this sector is a major economic contributor in terms of foreign exchange and job creation.

The research done in the Department focuses on minimising the water used in food-processing environments, although much research is also done on treating various food-processing wastewaters due to the fact that food processing cannot really be done without generating some wastewater. Anaerobic digestion technology, which utilises bacterial consortiums to degrade the organic pollution in the wastewater to carbon dioxide and methane, is a focus of study. The methane generated in this way can be recovered and is a valuable energy source that can offset some energy expenditure. Ozone and other advanced oxidation processes, like UV, can be used as a pre-treatment to anaerobic digestion. A benefit of ozone use is that it leaves no chemical residue in the water.

Food safety

The ***food safety theme*** researches the occurrence, identity, survival and control of spoilage and potential pathogens in the pre- and postharvest processing environment of a variety of foods. Emphasis is placed on the impact of water quality on the safety of agricultural products.

A research programme on the safety of agricultural produce was a national multidisciplinary effort led by Prof Trevor Britz of our Department. Other team members were from Food Science and Medical Virology at the University of Pretoria, Environmental Sciences at the University of Venda, and Microbiology at the University of KwaZulu-Natal.

The research focused on investigating the links between irrigation water quality and food safety in commercial and subsistence agriculture. There is growing concern about the safety

The South African Dairy Association (SAMPRO) awards bursaries to undergraduate, senior undergraduate and postgraduate students at selected tertiary institutions with the aim to broaden knowledge and skills (which have been identified as scarce skills) in Food Science and Technology, with specific reference to Dairy Science and Technology. Letitia Schoeman, a first-year MSc student in Food Science, is the current holder of the SAMPRO bursary.

MSc student Stephanie Bosman received the SAAFOST Academic Prestige Award in 2013 based on her final-year marks. The recipient of this award must already have a degree in Food Science.

of agricultural produce that is consumed raw or after minimal processing. If irrigated products are contaminated by microbes they will affect the health of the consumer and have a negative impact on the country's national and international trading status. A better understanding of the presence, survival and decay rates of contaminating microbes is essential for the development of an efficient strategy that will assure the delivery of safe agricultural products to the local and export markets.

Our research over the last six years has shown clear evidence of poor-quality irrigation water and the risk of pathogens being carried over to agricultural produce. The health risks emanating from the use of such water are setbacks South Africa can ill afford in the present economic climate. The social consequences of the increased risk of disease are equally devastating, especially to the substantial proportion of the population living in poverty.

The success of the abovementioned national study has given rise to further funding from the Water Research Commission to do a scoping study on different on-farm treatment options to reduce the high microbial contaminant loads of irrigation water in order to reduce the related food safety risk. This project commenced in 2012 and will continue until 2016.

Vibrational spectroscopy

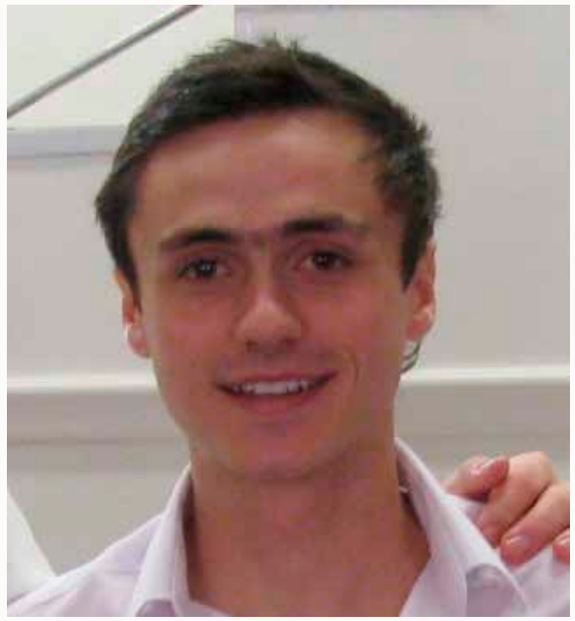
The ***vibrational spectroscopy theme*** focuses on the evaluation of bulk near infrared (NIR) spectroscopy and NIR hyperspectral imaging in conjunction with chemometric techniques for quantitative, qualitative and authentication studies of food and food products. NIR hyperspectral imaging research is possible at the Department due to researcher exchanges being funded by a South Africa-Sweden bilateral agreement. The work is done in collaboration with Prof Paul Geladi of the Swedish University of Agricultural Sciences (SLU).

NIR hyperspectral imaging is similar to taking a picture with a digital camera, which shows pixels and colours. In the case of hyperspectral imaging, however, each pixel is also linked to the sample's chemical composition, which provides a chemical map of the sample. This makes it possible to identify plant material that is visually similar but chemically different. Ongoing studies include the evaluation of the potential of NIR hyperspectral imaging to distinguish between different maize kernel hardness categories, as well as the detection of fungi on whole maize kernels before they are visible visually. This work has been extended to also include X-ray micro-tomography, which is performed in collaboration with Dr Anton du Plessis (CT Scanner, Central Analytical Facility).

Cereal quality

Between 25 and 33% of the total gross value of agricultural production in SA is from grain. The quality of grain determines profitability, hence

Magriet Muller, a 2013 final-year student, received the Aubrey Parsons scholarship. This scholarship is awarded to an individual with an exceptional study record and with an average percentage of at least 70% over the past four academic years.



Francois Olivier was the recipient of the SAMPRO (student) merit award

economic growth requires the improvement of cereal cultivars. The improvement of quality monitoring is achieved through the optimisation of existing methods and the implementation of new techniques.

In the ***cereal quality theme*** we aim 1) to develop greater understanding of the underlying factors determining cereal quality parameters, and 2) to develop rapid methods for the early identification of superior breeding lines. Cereal quality research projects are funded by the Winter Cereal Trust. The trust also supports students by providing grants for those working on cereal-related topics.

Sensometrics theme

Within the ***sensometrics theme***, which entails mathematical and statistical methods of analysis, research projects are usually multidisciplinary: chemical, sensory and physical attributes of food products are correlated.

In experimental sensometric studies, three pieces of information need to be linked to each other: information about the samples tested (sensory or extrinsic product attributes), consumer liking of the same samples (liking, choice or ranking), and additional information about the consumers (demographics, attitudes and habits). In this regard, fruitful research collaboration was established in 2013 between SU and Prof Tormod Næs, principal statistician at Nofima, an international food research institute in Norway. This collaboration resulted in novel research in which residual analysis was performed on preference data, resulting in new insights into the analysis of consumer preference data, as well the establishment of a new research project focusing on the development of rapid sensory-profiling methodologies.

Community interaction

Staff of the Department are involved in several community service actions. Several staff members acted as judges in the food science and technology category of the regional Expo for Young Scientists. Prof Britz was involved in an advisory capacity to the agricultural sector on the food safety risks associated with contaminated irrigation water being used for fresh produce. Staff of the Department were also involved in advisory capacities and for external moderation at other tertiary institutions offering food science and technology courses, and serve in professional industry-related associations. Dr Gunnar Sigge is currently the Immediate Past-President and Cape Branch Chair of the South African Association for Food Science and Technology (SAAFoST) and also serves on the Joint Advisory Committee of the Food Technology Department and the Agri-Food Technology Station of the Cape Peninsula University of Technology (CPUT). Prof Marena Manley chaired, on invitation, the meetings of the respective wheat breeders with the baking and milling industry, as well as a subsequent meeting of the Committee for the Evaluation of Wheat Breeding Lines. Prof Manley is also Chair-elect of the Executive Committee of the International Council of Near Infrared Spectroscopy (ICNIRS) and Chair of the Executive Committee of Cereal Science Technology – South Africa (CST-SA). In addition, she serves on the Editorial Board of *Acta Alimentaria* and is an Associate Editor of the *Journal of the Science of Food and Agriculture* and the *Journal of Plant and Soil*.

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Prof TJ Britz (Food Fermentation, Water Microbiology)
Prof M Manley (Near Infrared Spectroscopy, Grain Quality)
N Muller (Sensory Science, Sensometrics)
CC Ng'andwe (Cereal Science, Food Chemistry)
Dr G Sigge (Chairperson; Environmental Management, Food Processing)
Dr W Verachia (Food Security)

LECTURERS EXTRAORDINARY

Prof L Anelich (Food Industry: Anelich Consulting)
Prof G Fox (University of Queensland, Australia)
Prof P Geladi (Swedish University of Agricultural Sciences)
Prof L Joubert (ARC Infruitec-Nietvoorbij)
R Maguire (Food Industry: InEssence)
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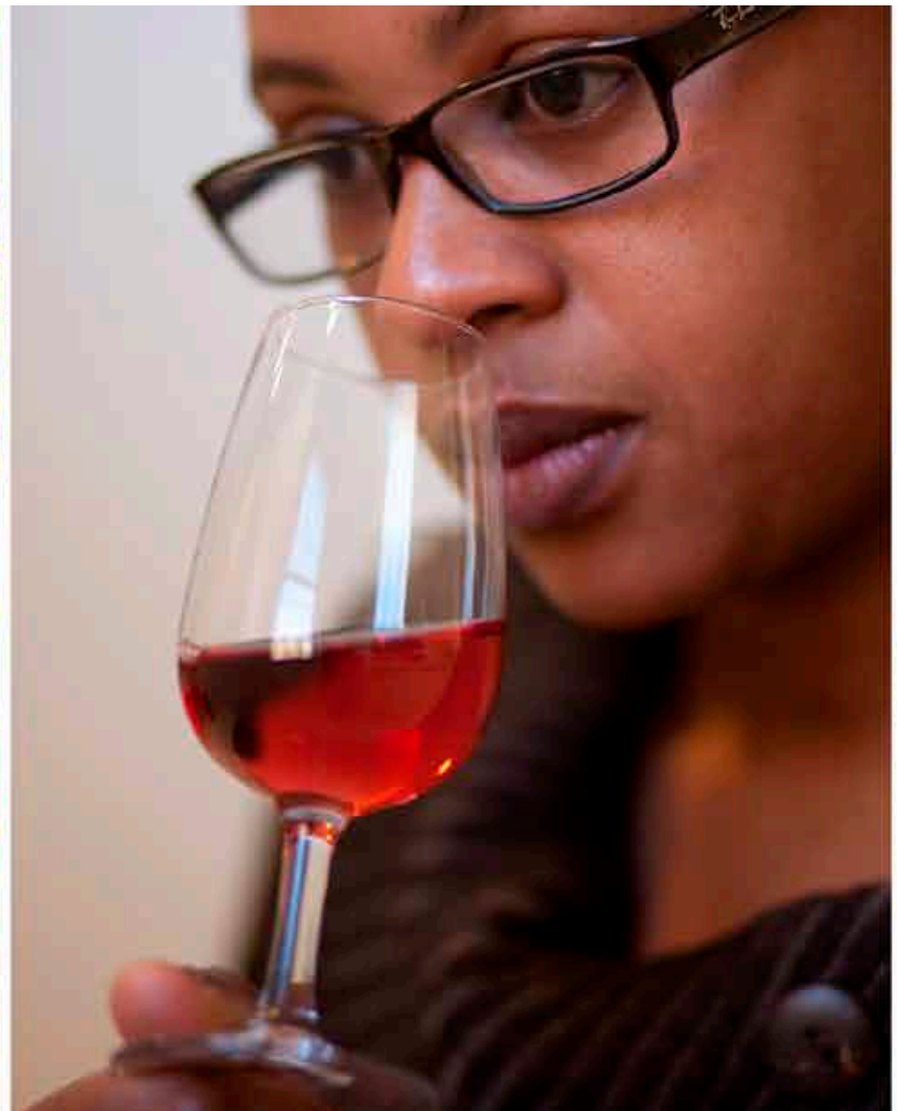

Introduction

The mission of the Department of Viticulture and Oenology (DVO) and the Institute for Wine Biotechnology (IWBT) is to be a centre of excellence in wine science that focuses on training and innovative research. We provide the South African wine and grapevine industries with well-qualified human resources, cutting-edge technology and the latest scientific knowledge. As the only wine science environment at a South African university, a major focus is on producing well-trained professional graduates and postgraduates who are empowered to make major contributions to the wine industry and/or to the agricultural sector in general. Research is multidisciplinary, and integrates traditional viticulture and oenology with disciplines such as physiology, biochemistry, molecular biology and biotechnology of grapevine, yeast and lactic acid bacteria, wine chemistry and sensorial sciences, and computational biology. Specific projects investigate the influence of viticultural and oenological practices on berry and wine composition (wine quality), wine microbiology, biopreservation, wine ageing and aroma, wood and phenolics, oxidation, and chemical and other taints in wine. Research in viticulture includes grapevine ecophysiology, molecular biology and biotechnology, ecophysiology of berry ripening, influence of abiotic factors on vine physiology and berry composition, harvest potentiality and site, table grape cultivation and nutrition. Funding for research and experimentation is generated through contributions from various sources, including the South African Table Grape Industry, the National Research Foundation, THRIP, Winetech and the Pinotage Association, as well as private companies such as Anchor Yeast/Oenobrands, Lallemand, Chr Hansen, Laffort and IOC. The National Research Foundation (NRF) also supports the South African Research Chair in Integrated Wine Science that was awarded to Prof FF Bauer in 2013. Furthermore, the newly established Institute for Viticulture and Oenology (IVO) provided additional support through donations by SANLAM, VINPRO and Dr Johann Rupert.

Overview of activities and achievements

Achievements by staff and students

The South African Research Chair in Integrated Wine Science was awarded to **Prof Florian Bauer** in 2013. The Chair, which is fully funded by the NRF, aims at strengthening the interactive and multidisciplinary nature of the research undertaken in the DVO-IWBT, and at supporting the integration of cutting-edge methodologies into the wine sciences. A particular focus of the Chair will be directed towards opening the world of wine to students from a wide diversity of cultural backgrounds.

Carien Coetzee, a PhD (Agric) student in Oenology under the supervision of Dr Wessel du Toit, has won a TATA Africa Scholarship for Women in Science, Engineering and Technology as part of the Department of Science and Technology's Women in Science Awards. This award aims at

Prof Florian Bauer

Carien Coetzee

profiling women scientists and researchers as role models for younger scientists and researchers.

From 2012 to 2013, 25 BSc (Agric) students in Viticulture and Oenology graduated, while the postgraduate graduates of the DVO were as follows: 10 MScAgric students (six in Oenology and four in Viticulture) and one PhDAgric student in Oenology (Dr Hanneli van der Merwe). At the IWBT, five Honours, eight MSc and two PhD students (Drs Dan Jacobson and Anita Smit) graduated.

Training activities

The 2012/2013 **Internship for Viticulture and Oenology** saw 31 final-year students introduced to the industry through six to eight months of industry-based training. The farms hosting the students included Rust en Vrede, Ernie Els, De Toren and Neethingshof. The students had to complete two research projects on the farms – one in viticulture and one in oenology. These ranged from looking at the effect of canopy manipulation on the levels of methoxypyrazines in grape must, to the impact of different yeasts on wine aroma. The internship was a great success and our students are benefiting enormously from the increased exposure to the industry.

Larissa van der Vyver in the vineyard at De Toren busy with her internship training

Students involved in panel training in and research on the sensory evaluation of wine

The Viticulture and Oenology internship student group in 2013

Alexandra Phillips in the laboratory at Mulderbosch during her internship

Barend Mouton (Chief Manager: Hoekstra Fruit Farms) demonstrates practical aspects of table grape cultivation to undergraduate students in Viticulture and Oenology

Postgraduate students are trained in all wine-relevant molecular biology and chemical analysis techniques

Conference contributions

The DVO-IWBT environment made more than 60 contributions to national and international conferences during 2013.

The environment contributed significantly to the 34th Conference of the South African Society of Viticulture and Oenology in Somerset West, with more than 20 presentations covering areas as diverse as terroir selection and GIS modelling, microbial diversity and rapid sensory methodology. Significant contributions were also made to the 8th Biennial Conference of the South African Society of Microbiology in Bela-Bela, where IWBT members presented new findings in metagenomics, microbial interactions during spontaneous fermentation, biochemistry and molecular biology. Malolactic fermentation, yeast and oxidation aspects of winemaking were addressed by members of the DVO at the 15th Australian Wine Industry Technical Conference in Sydney, Australia, and the environment was also represented at the 13th Scandinavian Symposium on Chemometrics in Stockholm, Sweden. Five papers and posters by IWBT researchers were presented at the International Botrytis Symposium in Bari, Italy. Prof Melané Vivier delivered the keynote address at the International Symposium on Grapevine Physiology and Biotechnology IX International in La Serena, Chile, while Prof Florian Bauer gave an overview of innovations in wine science at the AAWE Wine Economics Seventh Annual Conference at Spier in Stellenbosch. Viticultural aspects ranging from cell wall polymers in grapevine leaves to anti-fungal peptides were addressed by IWBT members at the 13th International Cell Wall Meeting in Nantes, France. International collaboration has been an important aspect of the success of our contributions to conferences, and our collaborators include colleagues in Germany, Sweden and France.

Research symposia

The **3rd DVO-IWBT Wine Sciences Research Day** was held in June 2013. As in previous years, the aim was to stimulate interaction between postgraduate students and academic staff engaged in various levels of wine research. The event was a huge success. Proceedings included an opening address by Dr Nelius Boshoff of the Centre for Research on Evaluation, Science and Technology (CREST), who shared valuable insight on how knowledge generated from wine sciences research is disseminated, and how South African winemakers utilise the information. The day was also filled with exciting oral presentations by postgraduate students and researchers from the DVO-IWBT and, for the first time, also researchers from the ARC-Nietvoorbij. The event was sponsored by five commercial companies by way of exhibitions and financial support.

Dr Nelius Boshoff of CREST

Information transfer to the South African wine industry gained new momentum through the very successful China-SA wine trade symposium, which was hosted by the IVO at Stellenbosch University (SU) in 2013. The theme was Bridging Barriers of BRICs and presentations focused on how wine trade between China and SA can be expanded, and the related problems and opportunities. More than 100 people from the business sector, wine industry and academia attended the symposium, which was held in the JH Neethling Building. Speakers included Hein Koegelenberg, CEO of La Motte and Leopard's Leap wine cellars, who emphasised the importance of building cultural bridges for successful business relationships with China. Carl van der Merwe of De Morgenzon cellar in Stellenbosch shared his personal experiences of being a winemaker in China with the audience.

Welgevallen Cellar

The Welgevallen Cellar produced excellent wines in 2013, some of which won awards in South African wine competitions. The Cellar's own wine range, called Die Laan, is becoming more popular and wine sales are increasing. The floors, roof and some equipment in the cellar were renovated by the University in 2013. The cellar also served as a training venue for undergraduate students in the year under review.

Research

Department of Viticulture and Oenology

Viticulture. The generation of new, innovative and applicable knowledge on the grapevine and its cultivation is the focus of the viticultural research undertaken by the DVO. The focus of the research and experimentation in the field of vine sciences (wine and table grapes) is on the effect of abiotic factors (light, temperature, wind and water) on the ecophysiology of vine functioning, berry growth and composition. Vineyard locations and cultivars are chosen according to scientific and practical questions that need to be addressed. Studies focus on the plant, organ and cell levels, so greenhouse and *in vitro* culture facilities have also been implemented. Remote sensing and the development of new technologies are also

Back, from left to right: Dr Hélène Nieuwoudt (Organiser, IWBT), Prof George Xie (Co-director, Confucius Institute, SU), Prof Maret du Toit (Chairperson, DVO-IWBT), Dr Steyn Heckroodt (Senior Lecturer, USB), Dr Hongbin Cheng and colleague (NTCC, SA). Front, from left to right: Pieter van Niekerk (Vinpro) and Jan Booysen (Winetech).

Die Laan wine produced by the Welgevallen Cellar

used intensively in research and experimentation in viticulture. Most of the studies are done in conjunction with oenology to better understand the effect of the abiotic factors and of cultural practices, including canopy manipulation (training system) and irrigation, on the composition and style of wine.

Oenology. The oenological research focuses on the influence of the vinification process (such as oxygen additions), microorganisms (yeasts and bacteria), additives (such as enzymes and CMC) and maturation on wine composition, style and quality, as well as the effects of various factors on wine ageing. Researchers work closely with industry partners and help to resolve issues facing winemakers at both a fundamental and practical level.

Antonio Ferreira's research focuses on the flavour chemistry of alcoholic beverages, and in particular on the correlation of sensory and chemical data in the perception of quality. His research projects have resulted in the development of new methodologies that allow for the quantification of flavour-relevant substances in wines that are perceived as off-flavours or positive flavours. The application of hybrid techniques and a holistic approach are used with sensory quality questions concerning aroma, mouthfeel sensations, etc. The research workflow includes integrating the most advanced chemical/sensory techniques and then using the set of information to design a prediction model. Non-invasive detection represents a great opportunity to integrate all these variables when mathematical models are provided and then applied to the development of on(in)line devices during wine production. The ultimate goal would be to provide tools to industry that enable highly accurate control of the desirable characteristic(s) from the vineyard to the consumer. In this context, Prof Ferreira's work follows an "omics approach" in order to create models that are applicable to complex issues such as understanding wine ageing chemistry, wine oxidation and the definition of grape quality.

Albert Strever's research focuses on understanding grapevine variability through non-destructive techniques, including field spectroscopy, thermal imaging and multispectral remote sensing. His PhD study also incorporated growth modelling and leaf age determination techniques within a study in which the interaction of plant water status and canopy manipulation was investigated. Other projects include studying the balance between grapevine yield components and growth (**Anneli Bosman**), and using remote sensing in climate studies (also incorporating thermal satellite imagery) (**Tara Southey**).

Anneli Bosman specialises in grapevine architecture and alternative trellis systems. Her research is focused on the use of alternative trellis systems in order to optimise productivity in vineyards while preserving or improving grape quality, relative to a specific production goal and price point. This involves observing the vine's compensation mechanism in reaction to the modification of its balances. Sustainable practices include the alteration of grapevine architecture, amongst others to be more environmentally friendly and cost effective, while ways to

Winemaking in the experimental cellar in the JH Neethling Building

Chris de Vries, an MSc-Agric student in Oenology, busy racking wine. He is doing research on the sources of volatile phenols that contaminate South African wines.

improve product marketability are also investigated.

Erna Blancquaert's research addresses the environmental factors that have a significant impact on wine grape composition and wine quality and style. Research is currently being conducted on the influence of abiotic factors (light, temperature) on tannin and phenolic development in the berry and the mouthfeel characteristics of the wines.

Marianne McKay is involved in ongoing research on the so-called 'burnt rubber (BR)' taint. Members of the BR team have conducted many tastings and have isolated some of the factors that may contribute to this off-flavour. Various analytical methods help identify the compounds that could be responsible, and students, including **Anne Alessandri** and **Chris de Vries**, have investigated factors in the vineyard that may enhance the aroma. Marianne is also involved in research on teaching and training in the wine industry, with a focus on looking at methods that enhance professionalism and graduate attributes.

Tara Southey's research focuses on modelling cultivar suitability in the context of climate change, using open source tools like GIS and remote sensing. This involves the monitoring of the grapevine's reaction to its direct environment in the form of vegetative and reproductive growth characteristics. This information is being used to model the grapevine's reaction to other environments in the context of climate change. Her master's degree focused on the effects of climate and soil water status on Cabernet Sauvignon grapevines in the Swartland region, with special reference to sugar loading and anthocyanin biosynthesis.

Wessel du Toit's research team (in collaboration with Auckland University in New Zealand) was involved in investigating the effect of different oxygen additions on the chemistry and sensorial quality of Sauvignon blanc wine. Part of this study entails characterising South African Sauvignon blanc wines in terms of their chemical and sensory composition. The effect of different winemaking practices on glutathione in wine was also investigated. Other research projects examined the tannin and anthocyanin concentrations in red grapes and how these are reflected in the corresponding wines. Advanced analytical techniques, such as GCMS, HPLC and infrared spectroscopy, have been developed and are being used in these studies.

Viticulture research at the Welgevallen Experimental Farm

Pinotage grapes from the Welgevallen vineyards

PhD student Mukani Moyo measuring chlorophyll fluorescence in greenhouse-grown transgenic grapevine populations

Cryo-stored grapevine berry samples being processed for downstream transcriptomic and metabolomic analyses

Astrid Buica's research is focused on the development of new analytical methods for compounds of interest in grapes and grape-related matrices. Target compounds vary from berry and yeast metabolites to contaminants in wine. The techniques used range from high-performance liquid chromatography (HPLC) to ultrahigh pressure liquid chromatography coupled with tandem mass spectrometry (UPLC-MS/MS) and are carried out in collaboration with Dr M Stander of the Central Analytical Facility (CAF). Another important aspect of the work is the development of highly sensitive and specific sample preparation methods.

Institute for Wine Biotechnology

The Grapevine Molecular and Biotechnology Programme. **Prof Melané Vivier, Dr Philip Young and Dr John Moore** are involved in fundamental and applied studies of grapevine in interaction with pathogens and the environment, supported by a grapevine transformation and regeneration platform. The ability to genetically transform grapevine enables in-depth studies of grapevine through overexpression and silencing approaches, as well as a range of other tissue culture applications. The research is progressively being integrated into viticultural field studies to "profile" grapevines growing under different conditions so that the plant's response to these factors can be understood on a plant biological level. Transcriptomic, proteomic, metabolite as well as hormone profiling are used to provide layers of data that are then overlaid with viticultural and oenological data to obtain a holistic view of the grape-growing process and its impact on the vine as a system.

The Microbiology Programme. This programme is driven by **Prof Florian Bauer, Prof Maret du Toit, Dr Evodia Setati and Dr Benoit Divol** and involves fundamental and applied studies of all wine microorganisms, with a specific emphasis on those responsible for alcoholic and malolactic fermentations. Prof Bauer was awarded a SA Research Chair in Integrated Wine Science in 2013, further strengthening this extensive research programme. Specific attention is paid to topics ranging from the microbial ecology of grape berries and grape juice, to survival strategies of spoilage microorganisms and the impact of non-*Saccharomyces* yeasts on wine composition. Interactions between all microorganisms are also studied. The different research projects make use of all standard microbiological and molecular biology techniques, as well as genomics-, metagenomics-, transcriptomics-, proteomics- and metabolomics-based approaches. The outcomes of these studies are also used to isolate, select and/or generate yeast and bacteria with enhanced oenological properties.

The Computational Biology Programme. This programme is driven by **Dan Jacobson** and involves the development/ application of mathematical,

statistical and computational methods to biological data sets in order to yield new insights and thus transform data into knowledge. Areas of mathematics of interest in this programme include the use of network theory, network-based topological clustering, and Markov clustering, wavelet theory and machine learning. Areas of statistics of particular interest to this programme are the use of both frequentist (parametric and non-parametric) and machine-learning methods, as well as the development of new methods in multivariate statistics (chemometrics). These methods are applied to various data sets to better understand the transcriptional, translational and chemical (kinetic) regulatory networks in the organisms and chemical systems involved in wine. This programme is actively involved with postgraduate students from the Biomathematics programme in the Department of Mathematical Sciences and the African Institute for Mathematical Sciences (AIMS) and, together with colleagues in Engineering and Information Technology, oversees the High Performance Computing (HPC) facility on campus.

Dr Hélène Nieuwoudt is involved in two research areas; one involves the development of rapid analytical techniques based on near- and mid-infrared spectroscopy and chemometric data analysis tools for qualitative and quantitative applications in wine biotechnology. The other area involves sensory and consumer perception profiling of South African wines. For the spectroscopy-based projects, multivariate quantification and classification are done based on the infrared spectra of grapes, fermenting must and wine. Wine sensory and consumer studies focus on the effect of vinification techniques on the sensory profile of Chenin blanc wine. The work also includes the development and validation of rapid consumer-based sensory methods.

Investigating the microbial biodiversity of vineyards and cellars: Thousands of species share these environments, and many remain unknown

Dr Hélène Nieuwoudt, Hugh Jumat and Alet de Wet busy with infrared spectroscopy analysis of wine in the Chemical Analytical Laboratory of the DVO-IWBT

Community interaction

The DVO makes wine on a small scale for the KWV (usually to test different clones) and other role players in the industry. The DVO is involved in various projects to transfer technology to the community. Staff members are invited on an ongoing basis to serve on evaluation panels for the wine industry's VinPro Vineyard Block Competition. Workshops are held regularly under the auspices of the South African Society for Enology and Viticulture (SASEV) for table grape growers in the Northern Cape and Paarl, while the Department also participates in numerous other workshops and forums for SASEV. The STIAS/Perold vineyard project is an ongoing concern that involves a number of role players in the wine industry, including the Pinotage Association, and also provides training in young vine development for trainee viticultural workers from underprivileged communities. During 2013, Dr Wessel du Toit presented two garagiste short courses. There also is regular involvement in the Wine Evaluation Committee of the Wine and Spirits Board at Nietvoorbij. Marianne McKay was seconded to the Advisory Board for the Pinotage Youth Development Academy (PYDA), and has been engaged in curriculum development and support for the programme. The

DVO was proud to be able to host the PYDA for three days of sensory training in November 2013. The students underwent training in wine components, basic sensory methods and legislation. They designed their own bottle labels and, due to their enthusiasm and commitment, were nominated for further training in wine evaluation (http://www.pyda.co.za/home/).

Students assess their wine labels

The Pinotage Youth Development Academy student group

Blind tastings in the Paul van der Bijl laboratory were an important part of the training

STAFF

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E Avenant* (Table Grapes); Prof FF Bauer (SA Research Chair in Integrated Wine Science, Yeast Molecular and Cellular Biology); EH Blanquaert (Viticulture); A Bosman* (Viticulture); Dr AS Buica (Oenology, Analytical Chemistry); Prof AC da Silva Ferreira (Flavour Chemistry); Dr BT Divol (Wine Microbiology); Prof M du Toit (Wine Microbiology and Biopreservation); Dr WJ du Toit (Wine Chemistry); D Jacobson* (Computational Biology); MA McKay (Wine Chemistry, Wine Aroma, Sensory Evaluation); TO Southey (Viticulture); Dr JP Moore (Grapevine Biochemistry, Metabolomics); Dr HH Nieuwoudt* (Spectroscopy); Prof BA Prior* (Microbiology); Dr ME Setati (Wine Microbiology); Dr AE Strever (Grapevine Cultivation and Remote Sensing); Dr AJG Tredoux*+ (Analytical Wine Chemistry); Prof MA Vivier (Grapevine Molecular and Cellular Biology); Prof MB von Wechmar* (Microbe Biodiversity); Dr PR Young* (Grapevine molecular physiology, Biotechnology)

ACADEMICS EXTRAORDINARY

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STANDARD BANK CENTRE FOR AGRIBUSINESS LEADERSHIP AND MENTORSHIP DEVELOPMENT

Introduction

The Standard Bank Centre for Agribusiness Development and Leadership, funded by Standard Bank of South Africa, started its operations as one of the initiatives under Stellenbosch University's HOPE Project in April 2010. The focus of the Centre is on the facilitation and support of strategic leadership and transformation in agribusiness. The Centre gained prominence in the wider agricultural environment and agribusiness community through its research activities, short courses and top-level agri-leadership laboratories, and is viewed as a well-established entity in the Faculty of AgriSciences. The Standard Bank of South Africa recently extended its support for the Centre until 2016 with a contribution of R5.13 million.

A number of significant international networks are being developed, leading inter alia to the involvement of the Centre in a number of African activities and also the direct involvement of the Centre in the forthcoming International Food and Agribusiness Management Association World Forum meetings in South Africa in June 2014, focusing on "African Agribusiness and Talent to Feed the World".

VISION: To foster agricultural development, growth and transformation through knowledge generation and transfer, with outreach activities directed at agribusiness leadership, extension and mentorship.

MISSION: To be the knowledge partner in successful agricultural transformation and land reform initiatives by providing academic training and research, leadership and advisory support and mentorship development.

Overview

1. The Academic and Research Programme

The Centre participates in postgraduate teaching in agri-management and development in the Department of Agricultural Economics at the PhD and master's level. Since 2010, twenty-one South African students have been supported through bursaries/scholarships from AgriSeta and SantamAgri, the Western Cape Department of Agriculture and the African Fellows Trust, and these students reflect a sound demographic, racial and gender balance.

The research programme focuses on studies at the master's level, some of which are expected to be completed in 2014, case studies in agricultural transformation, competitiveness and food security management, and the linking of new farmers/smallholders to commercial agri-food value chains. To date, 41 cases have been developed and are used for teaching purposes.

A number of research reports were compiled. These included the AgBiz/SantamAgri-funded Agribusiness Management, Aptitudes and Skills Survey (AGRIMASS); the Limpopo and KwaZulu-Natal Rural Household Food Security Analysis, funded by the National Agricultural Marketing Council (NAMC) and Standard Bank; and the study funded by the PMA Foundation on Human Capital Requirements for the Fresh Fruit Industry. The Director served on a panel to oversee a government investigation into the "Impact of the Mafisa funding scheme on

Prof Johan van Rooyen (Director of the Standard Bank Centre), Prof Mohammad Karaan (Dean) and Mr Willie du Plessis (Standard Bank)

Wine Economics students on the Porseleinberg Wine case study trip

small-scale farming". Research inputs were also made to the "Imbizo One Pagers" (see section on the Agri-Leadership Laboratory below).

2. Outreach Activities

Outreach activities were focused on transformational issues in the South African agribusiness environment.

The short course programme – Agri-leadership, management and mentorship development: This programme, presented in collaboration with PwC, is directed at middle management and offers training for agri-mentors and managers/leaders operating in the agricultural transformation and land reform environment. To date, short courses have been conducted in collaboration with the mentorship programme of a number of agricultural organisations, such as Grain South Africa. These courses are intended to support capacity development in the land reform programme. In collaboration with Standard Bank and PwC, the extension of programmes that focus on business development support is planned for the future.

The Agri-Leadership Laboratory: This programme focuses on leadership development in the agricultural sector through the staging of "Agri-Leadership Imbizos". Prominent agri-leaders and opinion makers are invited to discuss "hot topics" in agricultural transformation in a "laboratory setting" to stimulate "out-of-the-box" debate and discussion in an attempt to develop new solutions. Only consensus statements ("one-pagers") are formally published on the Centre's website and are communicated to institutions such as the National Planning Council, various representative groups in agriculture, government agencies and other relevant public bodies. Inputs were also made to, and accommodated in, the National Development Plan.

To date, twelve Imbizos have been held, covering topics such as:

- Land reform and agricultural development;
- Job creation in agriculture;
- Unity and cooperation in SA agriculture;
- Where to with black commercial farmers? and
- Water and agriculture.

Four "Young Leaders' Laboratories" were presented in collaboration with Standard Bank, GrainSA and Santam Agri.

The African Agricultural Leadership Programme: This initiative is aimed at prominent young professionals and leaders in the African agricultural environment and provides academic and operational experience in the agribusiness environment. The programme was implemented over a three-year period as a partnership between the Standard Bank Centre for Agribusiness

"Black Commercial Farmers" Imbizo, Bienne Donne

Young Leaders' Laboratory, Standard Bank Global Leadership Centre

Development and Leadership and the Royal Agricultural College (RAC) in the UK, and is funded by the African Fellowship Trust (AFT). The programme involves a master's-level component, plus networking and internship placements with South African agribusiness groups.

To date, 18 selected young professionals from Africa have visited South Africa. After an orientation period at Stellenbosch University, they spent six weeks at selected agribusinesses on an industrial internship basis. Participating institutions were KaapAgri in Malmesbury, TSB in Malelane, the National Agricultural Marketing Council (NAMC) and Nerpo in Pretoria, Haygrove Tunnels in Grabouw, AgriMega in Bredasdorp, ZZ2 in Moketsi, Standard Bank in Johannesburg, the Western Free State Seed Potato Company in Christiana, Stellenbosch Municipality and Pioneer Foods in Paarl.

African Agricultural Leadership Group 2013

"Water in Agriculture" Imbizo, Standard Bank Global Leadership Centre, Johannesburg

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SCIENTIFIC PUBLICATIONS

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