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PROVINCE OF KWAZULU-NATAL

20 YEARS OF FREEDOM
South africa 1994 - 2014

ANNUAL RESEARCH TECHNOLOGY TRANSFER SYMPOSIUM

ENHANCING AGRICULTURE THROUGH SCIENCE

PROGRAMME & SUMMARIES

FEBRUARY 2015

TOGETHER WE HAVE MADE KZN A BETTER PROVINCE TO LIVE IN.

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PROVINCE OF KWAZULU-NATAL

Research Technology Transfer Symposium
Organising Committee
2015

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FOREWORD FROM THE MEC

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Mr V.C. Xaba

Message from the Honourable Mr V.C. Xaba
MEC: KwaZulu-Natal Department of Agriculture and Rural Development

The South African Government has identified Agriculture as a major driver of the economy of the country. The National and Provincial Departments of Agriculture have taken steps towards the radical transformation of the agricultural sector, especially in line with the National Development Plan mandates and new agricultural policies and innovations. The main objective of these mandates is to contribute to the creation of one million jobs in the agricultural sector by 2030. The KwaZulu-Natal Department of Agriculture and Rural Development has as its objectives to, *inter alia*, enhance activities towards the development of innovative market linkages and increase and refocus investment in research and technology development - giving greater attention to alternative energy, soil health, tillage and other forms of conservation farming. Agriculture is a business and a science and the KwaZulu-Natal Department of Agriculture and Rural Development also aims to ensure effective economic development and upliftment in all areas of the Province through enterprise development, agro-processing and a general agribusiness development approach.

Implementation will be a ‘people-driven process’ where everyone will be able to contribute. Two key aspects are improved food security and smallholder farmer development and support, both in terms of technical support and infrastructure. To achieve these objectives, research and technology development play a vital and strategic role.

Further, factors such as the predicted rise in the population and climate change will undoubtedly put natural resources of the Province under further pressure. It is clear that continuous investment in a needs-driven research and technology development programme is essential to provide solutions to problems and constraints and to offer new and innovative technologies that will ensure sustainable agricultural production in KwaZulu-Natal in future.

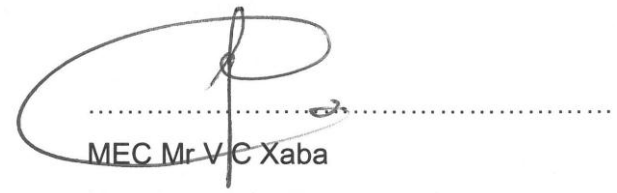
The annual Research Technology Transfer Symposium allows Departmental researchers to present their latest research findings and recommendations. The Symposium is therefore an important channel for the exchange of information between researchers and agricultural practitioners.

I am excited to be part of the Department's renewed focus on how technology can be employed to sustainably produce more food and energy using fewer resources. Our scientists need to be part of the global effort towards changing the way the world's rapidly growing population is being fed. The 2014/15 Research Technology Transfer Symposium proceedings booklet contains the summaries of invited papers from research projects conducted by Departmental staff, funded by the KwaZulu-Natal Department of Agriculture and Rural Development on an annual basis.

I wish to take this opportunity to thank institutions such as the Agricultural Research Council, Universities, Private Sector, NGO's and Commodity Organizations for the research work they do in the Province to contribute to a food-secure Province.

I wish you a fruitful and successful symposium.

Kind regards



MEC Mr V C Xaba

KwaZulu-Natal Department of Agriculture and Rural Development
18 February 2015

DIRECTORATE INFORMATION

The South African Government has identified Agriculture as a major driver of the economy of our country. The main issues covered under Outcome 7 of the Provincial Growth and Development Plan (PGDP) are:

(i) unleashing agricultural potential,
(ii) increasing land productivity and
(iii) enhancing sustainable household food security in KZN.

South Africa's population will reach close on 60 million by the year 2050. As a result, the country will have to provide for an additional 20% (by volume) in food requirements for its expanded population and diminished productive agricultural land. Climate change could further reduce the productivity of agricultural land.

Continuous and substantial investment into a needs-driven research and technology development programme is essential to provide solutions to problems, offset constraints and to offer new and innovative technologies which will ensure sustainable agricultural production in KwaZulu-Natal in the future. A Research Policy, developed by the Directorate, is presently being drafted for implementation by the Department.

The Directorate: Research and Technology Development with 429 staff members performs one of the line functions of the KwaZulu-Natal Department of Agriculture and Rural Development. Five Sub-directorates with respective divisions are involved in research and technology development:

1. Analytical Services (Laboratory Analytical Services, Bio-datametrics & Bioinformatics, Biochemistry, Soil Fertility Research),
2. Crop Production Research Services (Juncao Mushrooms, Agronomy, Horticulture, Crop Protection),
3. Livestock Production Research (Animal Science and Grass & Forage Science),
4. Farming Systems Research and
5. Agricultural Research Farms (3 Coastal and 3 Inland Farms = 6 Research Farms).

The five pillars of Research and Technology Development are as follows:

1. Agricultural research on-station and off-station,
2. Laboratory Services: soil, plant, plant health, water and animal feed,
3. Maintenance of research infrastructure,
4. Genetic conservation and characterization of indigenous livestock and
5. Transfer of technology developed.

As one of the key responsibility areas (five pillars), the Research Technology Transfer Symposium is an opportunity for researchers and their teams to share with colleagues and clients, information emanating from research. Following final and progress report feedback sessions conducted by the Sub-directorates during September 2014, those reports with a clear message or recommendation were identified to be included in the Symposium programme. A further addition to the Symposium is the presentation of information and knowledge by staff of the Directorate through demonstrations and practical talks on 17 February 2015. The value thereof is the opportunity to see technology being developed or practiced in the field.

For the 2015 Symposium, 15 talks will be presented. This provides a platform for discussion and debate around the subject while simultaneously creating an opportunity to identify further research needs.

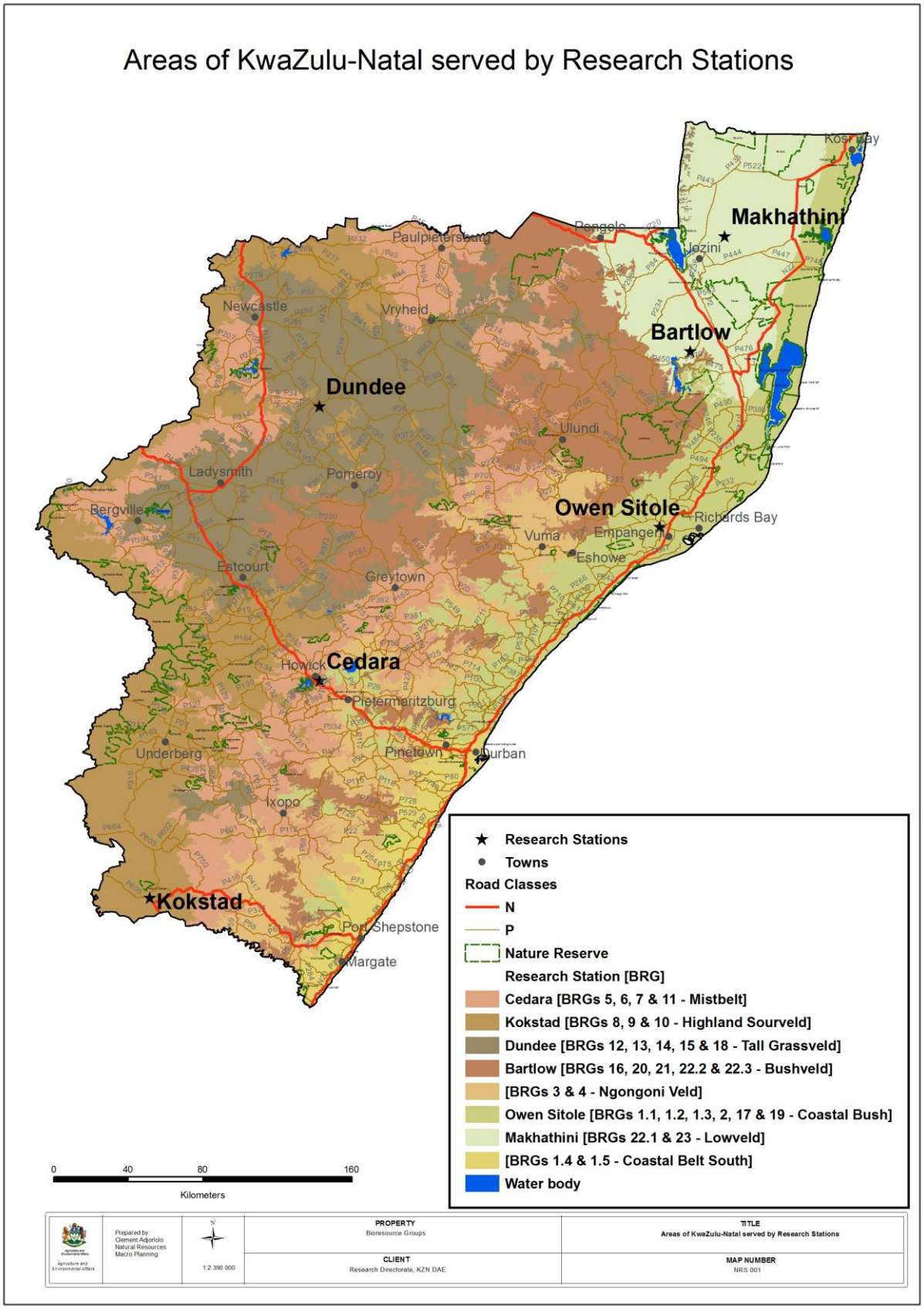
The Research Proceedings records summaries of the talks, a list of the current research projects, as well as the research projects approved during 2014. It also documents a list of staff currently involved in research and technology development.

Thanks are due to the Organizing Committee and to those presenters participating in the Symposium.

You are therefore encouraged to enjoy the Symposium and make full use of the opportunity to engage, to network and to communicate with fellow scientists and colleagues – all to the benefit of those within our Province.

Hannes de Villiers
(Senior Manager: Research & Technology Development)

MAP OF KZN INDICATING RESEARCH STATION LOCATION



MEMBERS OF THE RESEARCH PROJECT COMMITTEE

Dr Hannes de Villiers: Chairman
Ms Thembeka Mlambo: Secretary
Mrs Michelle Larsen: Administrative Support
Dr Trevor Dugmore: Acting Scientific Manager: Livestock Production Research
Mrs Les Thurtell: Scientific Manager: Analytical Services
Mr Thami Mpanza: Acting Scientific Manager: Farming Systems Research
Mr Ian Mcdonald: Scientific Manager: Juncao Mushroom Research
Ms Fikile Qwabe: Scientific Manager: Crop Production Research
Mr Bright Mashiyana: Liaison between R&TD and Extension and Projects
Mr Francois du Toit: Acting Deputy Manager: Farm Services
Dr Alan Manson: Professional Scientist (Soil Fertility Research)
Dr Suzette Bezuidenhout: Professional Scientist (Crop Protection)
Mrs Nomfuzo Mkhize: Senior Manager, Livestock Programme
Mr Rob Osborne: Professional Scientist (Horticulture)
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PROVINCE OF KWAZULU-NATAL

RESEARCH TECHNOLOGY TRANSFER SYMPOSIUM PROGRAMME

"Enhancing agriculture through science"

Cedara Centenary Complex, 18 February 2015

08h30 - 09h00	**REGISTRATION**	
SESSION ONE		*Chairperson: Dr Hannes de Villiers (Senior Manager: Research & Technology Development)*
09h00 - 09h10	Welcome	Ms Jabu Majola *(Acting HOD: KZN DARD)*
09h10 - 09h30	Opening address	Honourable MEC: Mr Cyril Xaba, *KZN DARD*
09h30 - 10h00	Guest speaker: Innovations in smallholder farming systems: a 'learning process' approach	Professor Benjamin Cousins *(University of the Western Cape, Institute for Poverty, Land and Agrarian Studies)*
10h00 - 10h25	**REFRESHMENTS**	
SESSION TWO		*Chairperson: Dr Suzette Bezuidenhout*
10h25 - 10h40	100 years of Cedara weather records - is climate change a reality?	Douglas Chapman *(Natural Resources, Cedara)*
10h40 - 11h00	Potholes in research	Victor Roberts *(Analytical Services, Cedara)*
11h00 - 11h30	Challenges facing aquaculture development and the way forward in KwaZulu-Natal	Mbongeni Khanyile *(Animal Science, Makhathini)*
11h30 - 11h50	Examining the potential of using grey water generated by rural households for irrigation of homestead vegetable gardens	Thami Mpanza *(Farming Systems Research, Cedara)*
11h50 - 12h10	Consumer acceptance of pro-vitamin A biofortified green maize	Fikile Qwabe *(Horticulture, Makhathini)*
12h10 - 12h30	Vegetable soyabean production	James Arathoon *(Agronomy, Cedara)*
12h30 - 12h50	The evaluation of mango cultivars at high density under irrigation and dry-land conditions	Comfort Dlamini *(Horticulture, Makhathini)*
12h50 - 13h10	The current state, future and the role of goat commercialisation in KwaZulu-Natal	Sibusiso Gumede *(Farming Systems Research, Cedara)*
13h10 - 13h50	**LUNCH**	

SESSION THREE		*Chairperson: Bright Mashiyana*
13h50 - 14h10	Mulch-effect on weed growth, soil moisture, yield and yield components of groundnuts under the conditions of KZN	Sibusiso Radebe *(Agronomy, Dundee)*
14h10 - 14h30	The effect of selected soil amendments on yield, quality and soil factors of a kikuyu pasture in the KwaZulu-Natal Midlands	Nicky Findlay *(Analytical Services: Soil Fertility, Cedara)*
14h30 - 14h50	Monitoring and evaluation of aphids on Cedara	Archana Nunkumar *(Crop Protection, Cedara*)
14h50 - 15h10	Evaluation of herbicides for weed control in chicory (*Cichorium intybus*) in KZN	Dr Suzette Bezuidenhout *(Crop Protection, Cedara*)
15h10 - 15h35	Ten years of essential oils research	Dr Maria de Figuiredo *(Analytical Services: Biochemistry, Cedara)*
15h35 - 15h55	**REFRESHMENTS**	
SESSION FOUR		*Chairperson: Sibongiseni Gcumisa*
15h55 - 16h15	Effects of soil acidity, and gypsum, lime or biochar soil-applied before the first planting, on potato foliar mineral levels, yield and late blight susceptibility over three seasons	Michael Relihan *(Analytical Services: Plant Health Diagnostics, Cedara)*
16h15 - 16h35	Wine grape cultivar evaluation at Cedara	Rob Osborne *(Horticulture, Cedara)*
16h35 - 16h55	Development of grey leaf spot disease resistant maize hybrids	Hlengiwe Gumede *(Crop Protection, Dundee)*
16h55 - 17h00	**CLOSURE**	Dr Hannes de Villiers *(Senior Manager: Research & Technology Development)*

ABSTRACTS

100 YEARS OF CEDARA WEATHER RECORDS - IS CLIMATE CHANGE A REALITY?

Douglas Chapman

Natural Resources, Cedara
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In July 2014, the Cedara weather station turned 110 years old. This fact has afforded a unique opportunity to investigate the possibility of climate change at this one location in KZN. The theory of climate change in KZN states:

- KZN is expected to become warmer
- Rainfall is expected to increase, however, the rainfall is expected to become more variable.

Three main elements; maximum temperature, minimum temperature and rainfall were analysed for significant trends. Tests of significance of the regressions were obtained for all data analyses. The analyses were further refined to include average temperature and Growing Degree Days (GDD). For rainfall, the record was analysed for increasing or decreasing trends in annual precipitation as well as variability. A separate analysis was conducted to compare seasonal totals to the El Niño and La Niña cycle.

For rainfall; it was concluded that El Niño plays a significant role on the rainfall record, however not all droughts were caused by El Niño. La Niña plays no role in the Cedara rainfall record. It was concluded that rainfall was becoming more variable.

For temperature; it was concluded that we are in a warming trend, however the increase in average temperature since mid-20th Century has been approximately 1°C.

POTHOLES IN RESEARCH

Victor Roberts

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When one endeavours to embark on a journey of research, one soon finds out that the road is full of potholes. Some humorous, some fatal, some fixable and some that are just despair-inducing incidents. The list is long and includes many un-thought-of challenges:
Airplanes, Baboons, Cattle, Drought, Erosion, Fire, Gerbils, Hail, Insects, Jackals, Kaput, Lime, Morning-glory, Neurosis, Omissions, Porcupines, Quelleas, Rats, Supply-chain, Thieves, Un-even depth, Viruses, Weedicides, Xanthium, Yields, and Zebra's.

This talk will take a look at some of these pitfalls and what it means to research when snags are encountered on the journey and the need for brave men and women who never-the-less plod on, with their faces set like flint to improve the production of food and protect the environment - so that at the end of the day they can say: "***This is significant***!"

CHALLENGES FACING AQUACULTURE DEVELOPMENT AND THE WAY FORWARD IN KWAZULU-NATAL

Mbongeni Khanyile[1], Kwazikwakhe Mkhize[1], Trevor Dugmore[2] & Hannes de Villiers[2]

[1]Animal Science, Makhathini; [2]Animal Science, Cedara

Aquaculture is the beneficial and sustainable use of water as a medium to farm organisms, for example finfish, shellfish and aquatic plants, (Qurban, 2004). The definition of aquaculture does not include fisheries, where surplus fish are harvested from populations in extensive water bodies. The potential for fresh water aquaculture in most parts of KwaZulu-Natal Province is significantly constrained by the natural environment. The first major constraint is the scarcity of water and second is the extreme seasonal temperature fluctuations over much of the interior (Britz and Hecht, 1990). For example, the winters over large areas of the interior are too cold for economically viable production of many warm-water aquaculture species, yet the summers in the same areas are too warm for cold-water fishes such as the salmonids. Greenhouse tunnel systems are needed to sustain warm-water aquaculture during winter. Water is often recirculated in such systems, which partly addresses the problem of water scarcity. More capital and skilled personnel are therefore required to overcome the temperature and water shortages for successful aquaculture enterprises. This poses a problem for the development of aquaculture in KwaZulu-Natal Province where skilled expertise and an efficient extension service for aquaculture are not in place. There is a need for aquaculture zoning in the Province where there is potential for aquaculture and the appointment of aquaculture advisory officers for sustainable aquaculture development. In rural areas, aquaculture should be integrated with fisheries to enhance food security, as fishing is a part of life in communities where there are open water bodies. With the limited water resources and limiting temperatures, combined with the drive to more environmentally acceptable methods of production, it is imperative that realistic guidelines for farming various species in the Province be drawn up.

EXAMINING THE POTENTIAL OF USING GREY WATER GENERATED BY RURAL HOUSEHOLDS FOR IRRIGATION OF HOMESTEAD VEGETABLE GARDENS

Thamsanqa Mpanza

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Introduction

Most households in remote rural areas do not have a reliable source of water; they rely on water collected from rivers, streams and springs. In some communities there are boreholes and taps are erected at different points in the community. The problem with these water sources is that they are normally a distance away from the homesteads and that means members of the households, which are usually women, have to collect water from these points. Collecting water for household uses is a compulsory activity for the rural households due to the fact that the household would not survive without water. Asking people in this situation to collect water for irrigation is like doubling the burden that they have to carry. The big question is how to supply these households with water for irrigation in a sustainable manner. This paper explores the opportunities and constraints of using grey-water as an alternative source of water for irrigating homestead gardens.

Methodology

A survey of 285 households was conducted in Indaka Municipal area. Indaka was selected because it is one of the less developed municipalities and it was ranked as one of the most poverty stricken municipalities in KwaZulu-Natal. A random sample of 19 villages was taken after Indaka was stratified according to wards, then villages. In each village a sample of 15 households was taken and a structured questionnaire was used to interview one household member that was available at home during the visit.

Results and Discussion

Profile of the respondents

More than eighty per cent (84%) of the respondents were female. This was appropriate because they are the people who are mostly responsible for water collection for the households in rural areas and they are also the ones responsible for homestead gardening. About 30% of the respondents have no formal education and none of the respondents had post matric qualifications. The majority (43%) of the respondents are earning between R1000 and R2000 per month. This also indicates why this area is one of the less developed municipalities. The respondents are active in agriculture, all of them keep livestock and more than 80% of the respondents are involved in crop production.

Challenges

Sixty per cent of the respondents collect their water from dams, springs, rivers, boreholes and some are supplied by municipal trucks. About 25% of the respondents indicated that these sources of water are more than 500m away from their homes. Some respondents collect water more than five times a day, this increases the distance being travelled. The attitudes of the respondents towards using grey water is also a challenge. Most (77.8%) indicated that they do not use grey water to irrigate their homestead gardens as they believe that it must not be used to irrigate food crops as it will make them sick because it is dirty. This is why more than 50% of the respondents throw their grey water away.

Opportunities

More than 50% of the respondents collect more than 100L of water per day. This indicates that more than 50L of grey water would be available in a day. Respondents were already using grey water in some way and about 20% were using it to irrigate their homestead gardens, although a small percentage compared to those throwing it away.

Conclusions

On-going research by the eThekwini Municipality indicates potential benefits of using grey water and health concerns. Some studies did not find any adverse effects on the soil even after prolonged use of grey water. Currently there is not enough research-based evidence to support or ban the use of grey water in general. Besides research, the key to unlocking the potential of using grey water lies with the mind-set of the people.

CONSUMER ACCEPTANCE OF PRO-VITAMIN A BIOFORTIFIED GREEN MAIZE

Fikile Qwabe[1], John Derera[2], Unathi Kolanisi[2], Natalia Palacios-Rojas[3] & Muthulisi Siwela[2]

[1]Horticulture, Makhathini, [2]School of Agricultural, Earth & Environmental Sciences, Pietermaritzburg; [3]CIMMYT, Mexico DF, Mexico
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Introduction

In most African countries maize is commonly eaten fresh as 'green' maize (on the cob boiled, steamed or roasted). When dry it is processed, prepared and consumed in various food forms and dishes. Maize is a chief source of energy and is an integral part of all African household meals, but it is low in nutrients, such as Vitamin A. Vitamin A deficiency (VAD) is a major health concern in most African countries. In South Africa, different strategies (food fortification, supplementation and promotion of dietary diversification) have been developed to address VAD. For several reasons, these strategies have not been effective in reducing VAD in South Africa and the incidence has increased by 31% from 1994 to 2005. Biofortification of maize with pro-vitamin A has been identified as a cost effective strategy to alleviate VAD. However, the presence of pro-vitamin A carotenoids in maize changes the grain colour, organoleptic properties and introduces an unfamiliar flavour and aroma resulting in low consumer acceptance. Studies conducted on food (phuthu, samp and thin porridge) made from dry pro-vitamin A maize grain in rural areas of KwaZulu-Natal showed low consumer acceptance. However, consumer acceptance of pro-vitamin A biofortified maize in its fresh (green) form has not previously been investigated in KwaZulu-Natal. The aim of the study was to determine the consumer acceptance of roasted or boiled pro-vitamin A green maize.

Materials and Methods

A mixed research methodology approach was applied in this study to determine consumer acceptance. Both sensory (aroma and taste) evaluation tests were used and focus groups evaluated consumer perceptions towards the consumption and acceptance of fresh pro-vitamin A biofortified roasted and boiled yellow and white kernelled maize genotypes.

Maize grain varieties

Two maize varieties, one yellow and PVA synthetic population (HP326-2) and one white (control) (SC 701) - were grown at Makhathini Research Station, The two varieties were planted in the first week of March 2013. Each hybrid had 20 x 5 m row length with 0.9 m inter and 0.3 m intra spacing under irrigation. Fertilizers, both basal and top dressing, were

applied according to Fertrec recommendations for optimum yield. Standard cultural practices were followed. This included hand weeding and herbicide application.

Sensory evaluation test

A total of 64 panellists were selected on the basis that they were maize farmers and consumers. Samples of 128 fresh roasted yellow/cooked yellow maize and 128 roasted white/boiled white maize were blind-labelled with three-digit codes obtained from a Table of Random Numbers, and were served to the panellists in random order which was determined using a Table of Permutations of Nine. Four coded pro-vitamin A biofortified roasted and boiled maize samples and a reference white maize sample were randomly presented to each panellist. Each sample was rated for acceptability on a 5-point pictorial Hedonic scale (1-5) rating taste, aroma and colour.

Focus group discussion

A trained facilitator conducted the discussion in isiZulu local language exploring issues around experiences, perceptions and concerns that the farmers might have about the fresh pro-vitamin A biofortified maize. A set of 5 guiding questions was used; however the group was allowed to raise other issues or questions during the focus group discussion.

Statistical analysis

Statistical Package for Social Science (SPSS) version 15.0 (SPSS, Chicago, III, USA) was used to analyse the sensory evaluation data. Using content analysis the data was transcribed; themes and concepts were identified to illustrate the consumer perceptions and acceptability of pro-vitamin biofortified maize.

Results and Discussion

The yellow fresh maize boiled and roasted was accepted by consumers. The sensory attributes which were strong for both boiled and roasted fresh maize were taste and aroma. The male group preferred fresh maize roasted, while their female counterparts preferred boiled fresh maize. Youth and adults preferred yellow fresh maize products while elders, age 61-75, preferred white fresh maize products. For the youth group, fresh pro-vitamin A yellow maize consumption was a new experience. The adults and elderly groups were more familiar with yellow maize consumption but perceive it as "*drought food*" since it was used in KwaZulu-Natal during the drought period in 1983.

Conclusion

It is recommended that for females yellow fresh maize products should be boiled and for male yellow fresh maize products should be roasted. This study indicated serious implications for marketing, profitability, research and development of PVA maize varieties. It also reveals an opportunity for the acceptability of pro-vitamin A since the younger generation *(future consumers)* does not hold any negative attitude nor misperceptions about yellow maize. Therefore, pro-vitamin A maize could be the food for the future.

VEGETABLE SOYABEAN PRODUCTION

James Arathoon

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Introduction

Vegetable soyabeans (*Glycine max* (L.)) are speciality cultivars that have been bred for human consumption as a green bean. The pods are harvested when still green and the beans have filled 80 – 90% of the pod. The pods are boiled for a few minutes, shelled and only the bean is eaten, usually as a snack or included in salads and stews. The beans are larger, sweeter, more tender and have a nuttier flavour than grain soyabeans. They are regularly eaten in Eastern Asia where they are called edamame ("beans on branches") in Japan and mao dou ("hairy bean") in China. In South Africa this high protein crop has the potential to fill a niche market and ensure food security in rural communities. Research on the crop is currently being conducted at Cedara and Dundee Research Stations.

Materials and Methods

Current research work is focused on cultivar evaluation, seeding rate, phosphorus and potassium requirements and fungicide and inoculant seed-treatments.

- Twenty one cultivars were evaluated in three seasons from 2010/11 to 2012/13 at a seeding rate of 266 666 seeds/ha in rows spaced 0.75 m apart.
- Cultivars with various growing-season lengths were planted in the 2012/13 and 2013/14 seasons at seeding rates ranging from 50 000 to 250 000 seeds/ha to determine their optimum seeding rate.
- The effect of various application rates of phosphorus (0, 30 and 60 kg/ha) and potassium (0, 40, 80, 120 and 160 kg/ha) on the production of two cultivars was evaluated in the 2012/13 and 2013/14 seasons.
- The effects of four fungicide seed treatments on plant population and four *Bradyrhizobia* inoculant seed treatments on nodulation and yield were evaluated on four cultivars in the 2012/13 and 2013/14 seasons.

Results and Discussion

1. The cultivars, which were evaluated under dry-land conditions, have a range of growing-season lengths and displayed good adaptability to the conditions at Cedara. However, individual performance varied over the seasons primarily as a result of the prevailing climatic conditions.

2. No significant differences in yield were measured among the medium- and long-season cultivars at seeding rates from 50 000 to 250 000 seeds/ha, but the short-season cultivar, AGS 292, produced significantly higher yields at seeding rates from 150 000 seeds/ha to 250 000 seeds/ha. AGS 292 did not canopy at the inter-row spacing of 0.75 m. This resulted in weeds growing between the rows and consequently the yields may have been reduced.
3. Mean pod and bean yields/ha for the 2012/13 and 2013/14 seasons were significantly higher at the phosphorus application rate of 60 kg/ha than at the applications of 0 and 30 kg/ha. At the potassium application rate of 0 kg/ha the yields were significantly lower than those obtained at application rates from 40 to 160 kg/ha, among which there were no significant differences.
4. Thiram and Captan, applied as fungicide seed dressings, improved plant population but did not significantly increase seed yield. At Cedara, the inoculants, Soycap and Eco-soy, recorded significantly more nodules/plant than the control treatment (no inoculant) in the 2012/13 season only, but produced significantly higher mean seed yields than the control treatment. In the inoculant trial conducted on a sandy Avalon soil at Dundee no significant differences in the number of nodules/plant and seed yield were measured among the inoculants.

Conclusions

It is recommended to plant inoculated seed of a range of cultivars with varying growing-season lengths at various planting dates to provide continuous production for as long as possible. Furthermore, plant medium- and long-season cultivars at a seeding rate of 100 000 seeds/ha and the short-season cultivars at 150 000 seeds/ha into a well fertilized soil. The application of fungicides as a seed dressing is unnecessary provided good quality seed is used.

THE EVALUATION OF MANGO CULTIVARS AT HIGH DENSITY UNDER IRRIGATION AND DRY-LAND CONDITIONS

Comfort Dlamini, Fikile Qwabe & Ntokozo Nxumalo

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Introduction

Mangos (*Mangifera indica L*) are widely grown in tropical and subtropical regions of the world, and is reported to be one of the top five fruit crops. Mango yields are generally poor, ranging from 4-9 tons per ha. This is partly due to wide tree spacing, population and orchard management. Currently, mango farmers at Makhathini area grow mangos at a spacing of 10 m x 10 m (100 trees per ha) with low yield and return per ha. There is little information on high density mango production under irrigation and dry-land available for small scale farmers. This study aimed to investigate high density mango production under both irrigation and dry-land conditions and to identify the best cultivars suitable for irrigation and drought in the Makhathini area.

Materials and Methods

The mango trial was planted at Makhathini research station in 1997. The trial was laid in a factorial randomized complete block design consisting of 11 cultivars with three replications. Trees were planted at a spacing of 6 m x 3 m (555 trees/ha) under irrigation and dry-land conditions. The following parameters were measured: field weight, fruit size per tree, number of marketable fruits, and number of spoiled fruits and total yield per cultivar.

Results and Discussion

The study showed high yields under irrigation compared to dry-land planted mangos. The cultivars Neldica, Kensington and Tommy Atkins produce comparative yields at high density spacing (6 m x 3 m) under both conditions, (irrigation and dry-land).

Conclusion

The cultivar Neldica was recommended for commercial planting, while Tommy Atkins was recommended for small-scale farmers due to its tolerance to anthracnose and mango weevil. Kensington was not recommended for either commercial or small-scale use, due to high perishability of the fruits.

THE CURRENT STATE, FUTURE AND THE ROLE OF GOAT COMMERCIALISATION IN KWAZULU-NATAL

Sibusiso Gumede, Sibongiseni Gcumisa & Francis Khubone

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Introduction

Goats in developing countries are still considered one of the most important farm animals, especially for small-scale farmers. Goats provide rural people with meat, milk, skins, and manure (Peacock *et al*., 2005). Goats play an important role in KwaZulu-Natal (KZN) (National Department of Agriculture, 2004), and are used by the Zulu people in KZN for different ceremonies and communicating with ancestral spirits (ARC-ANPI, 1999). Goat commercialisation in KZN was initiated through the collaboration between the Department of Agriculture and the Department of Economic Development. This emanated from noticing the high numbers of goats entering the province weekly and being sold by speculators. This study was carried out to look at the Government funded projects with regards to their current state, the problems faced by the participants and more.

Methodology

This study was conducted in 2014. Meetings with farmers were organised with the assistance from Extension Officers (EO) based at the different District offices. Before the different projects were visited and participants interviewed, Extension officers were briefed on the study. The questionnaire was completed during the visits to the project sites and during face-to-face interviews. The interviews were aimed at obtaining information from the farmers that will give a clear understanding of the current status of the Government funded goat projects in KZN. Survey data was captured on a Microsoft Excel spreadsheet. Data was then analysed using descriptive statistics such as percentages, means and frequency tables.

Results and Discussion

From the results it was noted that the goat commercialization projects are not doing as well as expected. The respondents are involved in multiple projects which limits the time that is spent per project. This trend was also observed in Government funded broiler projects of Sisonke (Gcumisa *et al.,* 2011). A total of 27 farmers were interviewed in five districts (eThekwini, uThukela, Mkhanyakude, Ugu and Zululand). The number of people that were available for the interviews was very low, as most did not attend the interviews for a number

of reasons. Membership withdrawal was quoted as one of the reasons why people did not avail themselves for the interviews.

Very few youths were present as part of the study, with at least 76% of the respondents being over 46 years of age. A high number of respondents (52%) were in their fifties or already on pension. Different sources of income were found that provide different amounts of money monthly for the different households. Respondents were asked to provide information on the sources of income as well as amounts received. Most families of the participants were found to be surviving mainly through Government grants, mainly child grants. The two most mentioned reasons for keeping goats or becoming part of the project were income (37%) and income together with traditional ceremonies (30%). Different marketing channels are utilized, with the local market being more popular, which is selling within the community.

Problems noted were those of internal conflicts, diseases, poor winter nutrition, poor availability of water, theft, mortalities and less enthusiasm from some members over the work as was it discovered that some had no interest in goats and were merely there to make quick cash, or were just put on the list without their consent.

Conclusions

From the study and answers received, it was evident that in most projects only one or two members fully understood what was happening within the project. This therefore raises questions on the functioning of Government funded projects and the procedure utilized in selecting members.

MULCH-EFFECT ON WEED GROWTH, SOIL MOISTURE, YIELD AND YIELD COMPONENTS OF GROUNDNUTS UNDER THE CONDITIONS OF KZN PROVINCE

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Introduction

Groundnuts are one of the most important oilseed crops in the world. They contain 48 - 50% oil, 26 - 28% protein and are a rich source of dietary fibre, minerals and vitamins. Groundnut growers at Matiwane are situated in a fairly normal rainfall area of about 600 - 779 mm per annum, with drought incidences occurring normally in the Uthukela District. Dundee Research Station has sandy soils with limited soil moisture retention, especially during hot months. In areas where drought stress is common, soil moisture levels can become too low to obtain optimum yields. The aim of this project was to determine the effect of different mulching treatments on soil moisture, groundnut yield, and yield components and weed growth.

Materials and Methods

A field experiment was planted on 20 December 2013 at Matiwane farm (29^{o} 52' 38. 752 E) and on Dundee Research Station. Treatments were arranged in a randomized block design with six replicates. The mulching treatments included maize residue, grasses, plastic, no-weeding, lucerne residues and hand-weeding. Treatments were applied one week after planting. The cultivar "Kwarts" was planted at 222 000 plants per ha in plots of 3.0 x 6.0 m, with an intra-row spacing of 7.5 cm and inter-row spacing of 60 cm. Soil moisture was measured at 30 days after sowing (DAS) and at harvest at a depth of 5 cm to 20 cm by gravimetric method. Soil samples from different depths were weighed and air-dried. The occurrence, extent and weed types were investigated at 30 DAS in a 900 m quadrat at four random locations per plot. The experiment was harvested at 150 days and plants were dug out and left to air-dry. Shoots were taken for dry matter analysis. Data were collected from sowing until harvest and analyzed by Genstat. Fisher's protected least significant difference (LSD) test was used to test the significance of the differences of the mean.

Results and Discussions

Soil moisture: White plastic, grasses and maize residue retained significantly ($P \leq 0.018$) higher levels of soil moisture compared to hand-weeding and no-weeding treatments. The soil moisture content increased with depth. At a depth of 10 cm, higher levels of moisture

content were measured compared to the control. No significant differences in soil moisture levels were measured at harvesting.

Weed infestation: The numbers of weed species were not significant at 30 DAS. However, the hand-weeding and mulching treatments had the lowest number of weed species compared to no-weeding.

Yield and yield components: Treatments influenced yield and soil moisture levels. Hand-weeding, maize residue and white plastic mulch treatments increased the plant population significantly compared to no-weeding. All the mulching materials used produced comparable yields. Lucerne residues increased yield significantly by 56% compared to no-weeding. Soil moisture levels correlated with yields produced under lucerne, plastic, maize residue and grasses. Shelling percentage among the treatments did not differ except for the no-weeding treatment which had the highest percentage. Results indicate that plots with mulches increased plant shoot weight compared to no-weeding plots. In general, mulch plots had more vigorous and better developed plants compared to no-weeding plots. According to the Bioresource Unit data, the optimum groundnut yield under dry land conditions, ranges from 1 to 2 t/ha. However, maize residue and grasses increased yields up to 3.3 t/ha.

Conclusion

Results indicate that mulching materials significantly increase retained soil moisture in the drier areas of groundnut production. In this study, locally available mulching materials were used, which is an advantage for the farmers in the area. In dry areas where soil moisture is limited, the information is beneficial. In the future soil temperature, the thickness of the mulching material and the type of mulching material should be investigated.

THE EFFECT OF SELECTED SOIL AMENDMENTS ON YIELD, QUALITY AND SOIL FACTORS OF A KIKUYU PASTURE IN THE KWAZULU-NATAL MIDLANDS

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Introduction

Much of the nitrogen (N) in the soil exists in an immobilised form that is unavailable to plants. Nitrogen is released into the soil during mineralisation by microbial decomposition, but at a rate that is too slow to meet the N needs of an intensive pasture system. In order to maintain pasture yield, quality and persistence it is necessary for the pasture's N requirements to be met through regular applications of fertiliser. There are currently many products on the market that claim to reduce the fertiliser N requirement of pastures and crops, mostly by increasing microbial activity and hence the rate of N mineralisation. The efficacy of the majority of these products is untested in the scientific arena. The concept, however, of increasing the availability of natural N in the soil for use by pastures and crops is one that requires exploring, as fertiliser N is one of the most costly inputs when farming with pastures. This project aimed to examine the effects of selected soil amendments on the yield and quality of an established kikuyu pasture in order to determine whether or not their use can be recommended as an alternative to inorganic fertilisers.

Materials and Methods

The trial was set up in a randomised block design with three replications. It consisted of four treatments (manganese dioxide (MnO_2) + lime, molasses, lime and vermileachate) and a control, each at four levels of applied N (0, 20, 40 and 60 kg N per ha).

Plots were cut monthly during the growing season. The cut material was weighed to determine yield and grab samples taken for herbage analysis. Soil samples were taken annually from each plot to determine soil moisture, pH, acid saturation and mineral elements.

Results and Discussion

Nitrogen application significantly increased kikuyu yield while application of the soil amendments did not have a significant effect on yield.

Dry matter percentage (% DM) of herbage decreased significantly with both N and amendment application. Applied N increased herbage N, S, Ca, Na, Cu, Mg and Zn and decreased herbage P and Mn. Lime significantly increased kikuyu Ca content, but decreased

Zn, Mn and Cu levels in herbage. Mn application significantly increased herbage Mn levels, despite the inclusion of lime in the treatment. The other soil amendments did not have an effect on kikuyu nutrient content.

Nitrogen application decreased soil pH, K, Mg and total cations and increased exchangeable acidity and acid saturation. Application of treatments containing lime significantly decreased soil P, exchangeable acidity and acid saturation and increased pH, total cations and soil Ca, Mg and available Mn. There was a decrease in soil Mn in the Mn-treated plots over the duration of the trial. As a similar decrease was noted in the limed plots, the decrease is probably due to the change in Mn species, and thus Mn availability, that occurs as soil pH becomes more alkaline.

Conclusions

This study has shown that the application of certain soil amendments does not affect yield of an established kikuyu pasture in the KZN Midlands. The application of treatments containing lime had a limited effect on herbage nutrient concentration but not to the extent that it affects the nutritive value of the pasture as a whole. Nitrogen application negatively affects certain soil parameters, but these effects can be ameliorated through the use of lime.

MONITORING AND EVALUATION OF APHIDS ON CEDARA

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Introduction

Pathogens such as Potato Virus Y (PVY) and Potato Leaf Roll Virus (PLRV) threaten the quality of seed potatoes in South Africa. In order to efficiently manage the disease in the field, farmers and researchers require a thorough knowledge of the insects responsible for transmitting the virus. Aphid species are widely known to be responsible for transmitting viruses onto plants. Different aphid species can transmit PVY and PLRV with varying success. Potato Virus Y and PLRV are responsible for tuber quality and yield losses which may be as high as 80%. In South Africa, 21 aphid species are known to transmit PVY. Some aphids, such as the peach potato aphid (*Myzus persicae*) are exceptionally efficient in transmitting the virus. However, in contrast, other aphid species are not able to transmit PVY. Potato Virus Y management involves spraying pesticide or preventative measures such as making use of aphid monitoring and the determination of vector pressure to aid timing of desiccant sprays. The aim of this project is to provide seed potato growers with aphid abundance data to assess virus risk and also to serve as an early warning system to assist growers in making management decisions regarding location and timing of aphid control measures.

Materials and Methods

Potato South Africa assisted with the erection of an aphid trap on Cedara Research Station. The aphid trap consists of a four metre high metal chamber housing the suction pump, the control and a funnel for directing the trapped insects into a glass Ball-jar containing water, 5 ml of liquid soap and a pinch of benzoic acid. A 12 metre high plastic tube sucks in flying insects. The bottle is replaced daily. The trapped insects are sieved out and placed in 96% ethanol. Aphids are identified, counted and placed into vials containing glycerol. These vials are posted weekly to the University of Pretoria for aphid identification.

Results and Discussion

Results indicate that a total of 2651 aphids were caught in the suction trap during September 2013-June 2014. Aphid species were most abundant between September and November 2013. *Rhopalosiphum padi*, *Aphis spp* and *Brevicoryne brassicae* are aphid species which are known vectors of PVY and PLRV and were present on Cedara. The aphid specie *Pemhigus spp* was the most abundant aphid species during September 2013-June 2014

while pine aphid species were most abundant during July to October 2014. However, these aphid species are not vectors of PVY or PLRV. Potato Virus Y and PLRV vector pressure were low during July to October 2014.

Conclusion

The results give an indication of the different types of aphid species present on Cedara and when they are most active. This information can be used to determine flight patterns of the aphid vectors which gives an indication of when to apply insecticide to control them.

EVALUATION OF HERBICIDES FOR WEED CONTROL IN CHICORY (*CICHORIUM INTYBUS*) IN KZN

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Introduction

Chicory (*Cichorium intybus* L.) is a deep-rooted perennial herb, selected for various purposes. Chicory roots are harvested, dried, roasted and ground for use as a coffee substitute or supplement. Nestlé has identified and invested in KZN as a potential chicory production area for both commercial and developing farmers. One of the biggest challenges related to chicory production in KZN is weed control. The lack of full season weed control leads to substantial reductions in root yield, impacting both root mass and number, and KZN chicory growers struggle to reach economically viable yields. Hand-weeding, currently the main method of weed control is considered labour intensive and time consuming. An effective weed control strategy must therefore be devised to facilitate profitable chicory production.

Materials and Methods

A field experiment was carried out from 2011 to 2012 at the Cedara Research Station. Six pre-emergent herbicides were evaluated in combination with two post-emergent herbicides. The four pre-emergence grass and two broadleaf herbicides consisted of:
S-metolachlor (Dual S Gold EC 915 g a.i./L)
Flumetsulam/S-metolachlor (Bateleur EC 20/630 g a.i./L)
Benfluralin (Balan EC 180 g a.i./L)
EPTC (Eptam EC 720 g a.i./L)
Flumetsulam (Broadstrike WG 800 g a.i./kg)
Imazethapyr (Hammer SL 100 g a.i./L)
The post-emergence grass and broadleaf herbicides were:
Haloxyfop-R-methyl ester (Gallant Super EC 108 g a.i./L)
Imazamox (Cycure SL 40 g a.i./L)

Herbicides were applied at the recommended application rates with a knapsack sprayer with a 1.2 m mini-boom and four flat fan nozzles. Chicory, variety Orchies, was planted with a hand-planter directly into the seedbed. Weed coverage was estimated visually after emergence and chicory root mass and yield were determined.

Results

Weed control varied considerably between the different herbicide treatments and the performance of the Balan herbicide combinations overall were less effective in both seasons. Significant differences were evident between the Balan treatments compared to the Bateleur, Dual S Gold and Eptam treatments, when considering the single effect of the PRE grass herbicides and weed cover was consistently highest in the Balan treatments. Balan is the only herbicide registered for use on chicory, instilling concern that effective herbicide intervention is not available to growers. *C. esculentus* is one of the most problematic weeds for developing farmers. Balan does not control the weed although satisfactory control was achieved with the use of Eptam, Dual Gold and Bateleur.

The lack of full season weed control (untreated control) resulted in an 84% and 99% reduction in chicory root yield compared to the hand-weeded control in 2011 and 2012 respectively. Herbicide combinations, applied pre- and post-emergent, targeting both grasses and broadleaf weeds, resulted in yield increases ranging between 70 - 78% compared to the untreated control.

Conclusions

Herbicide combinations, applied pre- and post-emergent, targeting both grasses and broadleaf weeds, resulted in yields ranging between 21 tons/ha and 30 tons/ha. Considering the single effect of the PRE grass herbicides, the yield performance for Bateleur and Dual Gold was significantly higher, despite the observed reduction in chicory stand when compared to the other treatments. The break-even yield for chicory production is 30 tons/ha and the target yield for developing farmers is 40 tons/ha. A maximum yield of 46 tons/ha was only achieved in the hand weeded plots. Although a weed control strategy combining the selected PRE and POST grass and broadleaf herbicides shows some promise, further research is necessary to improve weed control and enhance root yield.

TEN YEARS OF ESSENTIAL OILS RESEARCH

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The essential oil industry supplies the raw material for various high lucrative industries such as the food & flavour, cosmetic, perfumery, aromatherapy, veterinary and pharmaceutical industries. The essential oil industry can be divided into three components. The first component deals with the growing of the essential oil producing plants. There are over 400 different species of essential oil producing plants with different soil, fertilization, water, weather conditions and management requirements. The second component involves the distillation of these oils, which might require different extraction procedures and conditions, and the third component which deals with the marketing of the oil. Essential oil prices can vary from R 200.00/kg to over R 100.000.00/kg depending on the oil quality, difficulty of production and distillation and the supply/demand principle. Research has been undertaken by the Biochemistry unit on some aspects of these three different components of the essential oil industry.

Field trials to study the influence of season (weather conditions) and fertilization were established according to the appropriate statistical design in and outside Cedara over a 3 to 5 year period and data collected monthly or seasonally depending on the type of crop under evaluation. Tea tree, lemon grass, both *citrarus* sp. and *flexuosus sp.*, different chemotypes of artemisia, rosemary and rose-geranium were evaluated on the effect of season on the quality and quantity of the extracted oil. The effect of macro and micro fertilization was also evaluated for rose-geranium grown at Tongaat. Furthermore, the profitability of growing rose-geranium in tunnels was evaluated based on results from the study of the quality and quantity of the geranium oil obtained under these conditions.

The collected plant material from the various studies was brought to the laboratory and the oil was extracted by steam distillation, measured and analysed for quality by gas chromatography/mass spectroscopy (GC/MS).

In addition to the research trials, a demonstration trial has been established to give new growers the opportunity to be introduced to various essential oil plants and receive information on how to grow them successfully.

The seasonal effect on the quality and quantity of the essential producing crops studied was determined and differed between and within the season for the various essential oil crops evaluated. The optimal amount of NPK fertilization was established for the optimal production of rose-geranium growing at Tongaat (North coast), without negative influence on the oil quality. Three different chemotypes of *Artemisia afra* were identified.

Rose-geranium oil extracted by hydrodistillation was found to have a higher linalool content than that extracted by steam distillation.

In addition to the GC calibrations developed to enable the quantification and qualification of the different compounds present in the oils studied, further calibrations were developed for the quantification and qualification of components present in thyme, buchu, *Leptospermum petersonii*, lavender, spearmint and peppermint essential oils.

The results of our research have been conveyed to emerging and commercial farmers by emails, telephone, reports, farm visits and in-office consultations. The acquired information will enable essential oils producing farmers to produce economically high quality essential oils and compete in the lucrative essential oil industry. Publications and presentations of results from our oil research have taken place nationally and internationally by means of scientific papers, posters and talks at symposia, congresses, workshops and various other meetings.

EFFECTS OF SOIL ACIDITY, AND GYPSUM, LIME OR BIOCHAR SOIL-APPLIED BEFORE THE FIRST PLANTING, ON POTATO FOLIAR MINERAL LEVELS, YIELD AND LATE BLIGHT SUSCEPTIBILITY OVER THREE SEASONS

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Introduction

Prior potato trials on Cedara had shown that regularly-applied foliar-calcium sprays did not reduce levels of Late Blight or improve yields, but that elevated foliar aluminium, calcium, manganese, zinc and iron were correlated with higher Late Blight levels. Diverse soil acidity was hypothesized to impact potato foliar mineral levels, so a three-season trial was implemented on Cedara to determine the effect that diversely-acidic soil sites have on foliar mineral levels, yield and susceptibility to Late Blight (due to *Phytophthora infestans*). Since soil applications of gypsum, lime and biochar are known to impact soil acidity or mineral availability, these treatments were selected to be superimposed at each site.

Materials and Methods

Seven separated locations with diversely-acidic soils were identified on Cedara, spanning an acid-saturation range of 2 to 23%. A block of six treatment plots was demarcated at each site. After standard land preparation of each block, pre-plant treatment applications of gypsum (2 Mg/ha), lime (4 Mg/ha) and biochar (code: BS, 'wattle charcoal' 5 Mg/ha) were spread over the surface of three plots per site and rotovated in. After ridging of all plots (0.9m spacing) an additional biochar treatment (code: BB, 5 Mg/ha) was applied to the furrow of one plot. The remaining two plots of each block served as control treatments. All plots per block received the same applications of N, P and K fertilizer according to soil analysis recommendations. The potato variety Frodo was selected for the first season (February 2012) on the basis of having moderate resistance to Late Blight, since no fungicide treatments were to be applied. Due to the discontinuation of Frodo variety, Sifra variety was used for the next two summer season's plantings, except for use as border rows in the second season. One site was abandoned for the second and third seasons and planting of the remaining plots was done in a way that plot locations coincided. Late Blight was monitored regularly through the growing period using a rating scale. Leaf samples were taken from every plot for foliar mineral analysis every season whereas soil samples were taken from every plot in the first and third seasons. Tubers were lifted for yield determination and size grading at the end of each season. After widespread rootknot damage on tubers in

the second season, a Sorghum-Sudan grass cover crop was planted (50 kg/ha sowing rate) before the last season planting. Yield and area under disease progress curve (AUDPC) data were analyzed by analysis of variance, and together with soil and foliar mineral analysis data by multiple linear regression using Genstat.

Results and Discussion

Late Blight was a major factor limiting yields along with limited irrigation or dryland production at some sites. Yield data for a remotely-located block was lost for the first two seasons due to theft. Yields of a few plots were excluded from further analysis due to cutworm damage or flood-damage. Early flood damage to two sites, combined with *Fusarium* wilt, low rainfall and severe Late Blight, reduced the final season's overall yields. Yields for the three seasons were 24, 27 and 19 Mg/ha and most treatment comparisons were not-significant. Yields and disease levels on the more acid sites (~20% acid saturation) were typically as good, or better than, those of the more neutral sites, except that the lime treatment had the best yield with Sifra variety in 2013, and the lowest disease (disease on a par with the BS treatment). Both biochar treatments resulted in higher end yields in the first two seasons. In 2012 the biochar BB treatment had significantly lower disease than other treatments. No treatments produced better yields or disease levels than the control in the 2014 season. Foliar mineral levels associated with optimal production in this trial were identified. Root knot damage was absent in the last season, implying effective control by the sorghum-sudan grass cover crop.

Conclusions

Trial results do not implicate acid saturation up to 23% as a production-limiting factor. Neither gypsum, lime or biochar applications produced economically-justifiable benefits to potato production on these (~50% clay) Cedara soils. Models indicated that varying yield and disease levels were most associated with varying foliar levels of carbon, potassium, sulphur, phosphorus, aluminium, zinc, copper and manganese.

WINE GRAPE CULTIVAR EVALUATION AT CEDARA

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Introduction

The South African wine industry on a global scale is relatively small, accounting for around four percent of the world's total wine production. In South Africa there are more than 3323 wine producers with a total area of 99 680 hectares under vines. The wine industry employs over 275 000 people and contributes almost R 28 billion to the GDP. Over 1097 million litres of wine are produced annually from 564 registered cellars. Exports of South African wine have risen by almost 20% in the last ten years with 57% of the total production in 2013 going to export. The United Kingdom has the biggest market, comprising 91 million litres in 2013, but there are significant inroads being made into African markets with 7.5 million litres exported to Kenya and Nigeria in 2013. The South African industry has historically been centered in the Western Cape which accounts for more than 80% of the total area under vines. There is considerable interest in exploring new production areas and in 2005, KwaZulu-Natal as a geographical area was demarcated as a Wine of Origin Unit with the South African Wine Information Services (SAWIS). A total of 40 hectares of commercial vineyards have been established in the province, and three vineyards have produced certified wine. In 2005, the Department of Agriculture and Environmental Affairs established a large cultivar trial at its research station at Cedara where a total of 19 cultivars are under evaluation. The results from the cultivar trial have identified cultivars which are suited to the climatic conditions in the Midlands area of KZN.

Materials and Methods

Two cultivar trials were planted at Cedara in 2005. A red wine trial with total of 12 cultivars and a white wine trial with seven cultivars are under evaluation. Each trial was planted as a randomised blocks design with three replications and 10 vines per plot. The spacing is 3 m by 1.5 m, and the vines are trained according to the "Perold" cordon system. There are two outside border rows.

Results

Yield data from the last five seasons were analysed using GenStat 14.2. The two-way analysis of variance showed that there were highly significant differences between cultivars, seasons as well as the interaction between cultivar and season. The seasonal results are presented in Tables 1 and 2.

Table 1 Seasonal red wine cultivar grape yields in ton.ha^{-1} (LSD at 5% level = 1.58)

Cultivar	Year harvested					5 year Mean
	2010	2011	2012	2013	2014	
Pinotage	3.93	3.99	4.05	8.08	4.400	**4.89**
Cabernet savignon	2.47	4.00	3.87	3.17	2.45	**3.19**
Petit verdot	2.61	1.31	4.07	2.17	2.26	**2.48**
Shiraz	4.20	0.00	4.93	0.00	2.47	**2.32**
Merlot	1.24	2.72	2.14	3.12	2.29	**2.30**
Cabernet franc	1.09	1.44	1.52	4.81	1.88	**2.15**
Mourvedre	0.59	1.57	3.50	1.53	2.59	**1.96**
Cinsault noir	2.00	1.70	3.79	0.00	0.94	**1.69**
Tannat	0.37	1.74	1.49	1.67	2.76	**1.61**
Pinot noir	0.05	0.00	0.91	1.18	4.35	**1.30**
Malbec	0.19	1.09	1.12	0.83	0.53	**0.75**
Roobernet	1.14	0.000	0.00	0.00	2.41	**0.71**
Annual Mean	**1.66**	**1.63**	**2.62**	**2.21**	**2.44**	

Table 2 Seasonal white wine cultivar grape yields in ton.ha^{-1} (LSD at 5% level = 2.39)

Cultivar	Year harvested					Mean Yield
	2010	2011	2012	2013	2014	
Colombar	1.74	4.50	6.42	4.44	5.12	**4.44**
Nouvelle	0.88	3.54	2.43	3.17	3.31	**2.67**
Chardonnay	0.30	1.23	2.00	2.31	4.90	**2.15**
Chenin blanc	2.71	0.00	0.00	3.89	2.22	**1.77**
Sauvignon blanc	1.10	1.04	2.09	2.15	1.85	**1.65**
Weisser Riesling	1.92	0.00	0.00	3.30	2.47	**1.54**
Viognier	0.10	0.36	0.00	0.35	0.95	**0.35**
Annual Mean	**1.25**	**1.52**	**1.85**	**2.80**	**2.97**	

Discussion and Conclusions

This project has conclusively demonstrated the feasibility of commercial wine production in select areas of the KwaZulu-Natal Midlands. The Cedara trials show that there are significant interactions between wine grape yields and season. The following red grape cultivars show potential in terms of quality and yield, Pinotage, Cabernet savignon, Cabernet franc and Petit verdot. The white cultivars have not performed as well as the red cultivars at Cedara; however, of these Chardonnay has shown the most potential.

DEVELOPMENT OF GREY LEAF SPOT DISEASE RESISTANT MAIZE HYBRIDS

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Introduction

Maize is the staple cash crop of South Africa. Maize accounts for 30-50% of low-income household expenditures in Eastern and Southern Africa. One of the major biotic constraints in maize production is grey leaf spot (GLS). Grey leaf spot is a foliar yield-limiting disease on maize caused by fungal pathogen *Cercospora zeina* (Crous & U Braun nov sp). Planting resistant varieties is the most effective and cost efficient way to reduce yield losses from maize GLS. Conventional breeding complemented by molecular assisted breeding (MAB) could be used to improve maize GLS resistance. In MAS, molecular markers are used to identify the specific genes present for a trait of interest. Thus, the selection is based on genotype rather than phenotype in breeding programmes. In this study, recombinant inbred lines (RILs) having different levels of GLS resistance were crossed with other lines of different background. Levels of GLS resistance of RILs were in terms of expression quantitative loci (eQTLs) dosages, ranging from three to eight. Resultant hybrids were tested for performance under field combinations.

Materials and Methods

Twenty one RILs, namely 11NS01 to 11NS21 used in this study were from ACCI eQTL project. Control GLS susceptible lines, were obtained from ACCI breeding programme and from CYMMIT Zimbabwe, namely 11NSH22 - 11NSH26 and CMT01 - CMT08, respectively. The crosses were generated at Makhathini Research Station in winter 2011 using Northern Carolina mating design II: 21RILs x 12 controls, generating 252 hybrids. Due to lack of synchronisation only 95 hybrids of 252 had enough seeds for planting three replicates in three sites. Sites used were Cedara Research Station, Baynesfield Estates and Ukulinga in summer 2011/12. Control varieties were commercially grown maize hybrids PAN53, PAN67, PAN6724B, PAN6777 and PAN6227. Data collected were field weight, grain weight and moisture content, GLS score of severity and yield (calculated). Data were analysed using Genstat 14th edition.

Results and Discussion

Average area under disease progress curve (AUDPC) values ranged from zero to 1100. The mean for AUDPC was 600. Cedara had more disease prevalence than Ukulinga with 67%

and 41%, respectively, of hybrids scoring more than the trial mean of 600. The results showed that the frequency distribution pattern of AUDPC across two sites varied, indicating genotype by environment effects. Average yield across two sites ranged from two to eight ton/ha. The mean yield was 3.9 ton/ha. There was no significant difference in yield between the two sites. Most of the hybrids at both Ukulinga (68%) and Cedara (73%) yielded more than 3.9 ton/ha. Yield was not affected by disease incidence as Ukulinga site had no GLS. This indicated that other factors such as drought had more or less effect on the yield. Correlation between eQTL dosage and AUDPC was significant ($P<0.05$) and negative. This implied that hybrids with high eQTL dosage developed less disease. Correlation between eQTL dosage and yield was positive and highly significant ($P<0.001$). So resistant hybrids produced higher yield compared to those with low eQTL dosage. Correlation between AUDPC and eQTL dosage was negative and significant ($P<0.01$) showing that as eQTL dosage increased less disease developed.

Conclusion

Grey leaf spot is a yield-limiting disease. Therefore, it can be expected that if a hybrid is resistant to the disease the yield will be high. The association between eQTL dosage and yield was significant and positive. However, the environmental effect played a role in expression of the trait as there was a highly significant difference between sites in the performance of hybrids. For breeding purposes, it is important to assess hybrids under different environments and also to check their heritability.

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RESEARCH PROJECTS APPROVED IN 2014

Researcher	Title	Location	Period
Arathoon AJ	Effect of seeding rate on maize production	Cedara, Kokstad & Dundee	2014-2017
Dlamini C	The effect of intra-row spacing, row spacing and planting date on green maize ear size	Makhathini	2015-2018
Gcabashe VAD	Effect of potassium on days to spoilage of Beauregard sweet potato (*Ipomea batatas*) tubers	Makhathini & OSCA	2015-2016
Mashiyana BK	Comparison of phosphorus analysis in South African soil laboratories	Cedara	2015-2017
Mpanza TP	Effects of row intercropping orange fleshed sweet potatoes (OFSP) & maize on soil moisture, land use efficiency and the yield under different row spacing	Ndwedwe Training Centre	2014-2014
Mtum-Tum N	Integration of soyabeans (*Glycine max (L) Merrill*) into small-holder maize production system in KwaZulu-Natal	Cedara	2014-2017
Nash D	A survey on the energy status of newly calved cows at Cedara Dairy	Cedara	2015-2017
Nunkumar A	Evaluation of soyabeans, dry bean and sunflower cultivars for tolerance to different strains of *Sclerotinia sclertiorum*	Cedara	2014-2016
Radebe SB	The effect of gypsum and lime application on soil properties and groundnut yields	Dundee & Bergville	2015-2018
Van Rij N	Identification and management of factors affecting oyster mushroom spawn production	Cedara	2014-2017
Van Rij N	On farm trials to research an alternative pasteurization technique to prepare substrates for oyster mushroom production	Dlondlobala Co-op, Inchanga & Dukuduku	2015-2017

RESEARCH AND DEMONSTRATIONS PROJECTS IN 2014

Researcher	Title	Location	Period
Ammann SB	Evaluation of *Festuca arundinacea* (Tall Fescue) varieties, herbage quality and grazing management to determine suitability as a lower input pasture for dairy systems	Cedara & Kokstad	2014-2019
Ammann SB	Evaluation of the effect of Glyphosate, soil temperature and soil moisture on the establishment of ryegrass oversown into kikuyu	Cedara	2014-2017
Arathoon AJ	Influence of different phosphorus and potassium rates on the production of three vegetable soyabean cultivars	Cedara	2012-2015
Arathoon AJ	National soyabean cultivar trial	Cedara & Kokstad	- 2020
Arathoon AJ	Open-pollinated maize cultivar trial	Cedara& Kokstad	2005-2009
Arathoon AJ	The evaluation of vegetable soyabean cultivars for adaptability and yield	Cedara, OSCA, Kokstad & Dundee	2009-2013
Arathoon AJ	Vegetable soyabean cultivar versus seeding rate trial	Cedara	2012-2014
Bezuidenhout SR	Characterization of the biology of *Cyperus esclentus* (yellow nutsedge) growth	Cedara	2012-2014
Bezuidenhout SR	Influence of cover crops and crop rotations on weed density and *Zea mays* (maize) competitiveness	Dundee	2013-2023
Bezuidenhout SR	The influence of different ryegrass (*Lolium multiflorum*) varieties on the growth of pasture species	Cedara	2010-2011
Bezuidenhout SR	The influence of different weed types on the growth and development of maize and sunflower	Cedara & Kokstad	2008-2014
Bezuidenhout SR	The management of cover crop residues to reduce weed growth in maize	Cedara	2011-2015
Buthelezi M	National soyabean cultivar evaluation Phase 1	Dundee	ongoing
De Figueiredo M	Establishment and maintenance of an essential oil trial for demonstration purposes	Cedara	2007-2020
De Figueiredo M	Evaluation of the quality and quantity of the essential oil extracted from different cultivars of *Artemisia* grown at Eston	Eston	2009- 2013
De Figueiredo M	The effect of fertilization on the plant yield, oil yield and chemical composition of rose geranium growing at Tongaat	Tongaat	2009- 2013

Researcher	Title	Location	Period
De Figueiredo M	The production of rose geranium in tunnels at Cedara	Cedara	2009- 2013
De Figueiredo M	The study of factors affecting the oil quality and quantity of rose geranium in a growth room environment	Cedara	2009- 2013
Dladla ND	Mushroom - Investigation into the use of pulp waste for production of shiitake mushroom	Cedara	2013-2014
Dlamini C	Mango cultivar & mango grafting and pruning demo	Makhathini	1997-2020
Findlay NJ	Catalysis of phosphodieterase by manganese dioxide	Cedara, Danesfort Farm, Kambert	2013-2014
Findlay NJ	Improving N-use efficiency in pastures	Rosetta	2010-2012
Gcumisa ST	The untold story of the pig farming sector of rural KwaZulu-Natal: A case study of Uthukela District	Ladysmith area	2009-2013
Gumede NSH	Development of grey leaf disease resistant hybrids	Dundee	2010 -
Gumede SA	The current state, role and the future of goat commercilaization in communal areas of KwaZulu-Natal	KZN	2012-2016
Household SD	Control of *Senecio* species in the Dry Highland Sourveld of KwaZulu-Natal	Kokstad	2013-2025
Household SD	Lucerne cultivar evaluation at Kokstad Research Station	Cedara & Kokstad	2014-2018
Household SD	The effect of a two-camp "blaze and graze" system on sheep performance, veld condition and soil loss	Kokstad	1992-2014
Household SD	The effect of cattle to sheep ratio and stocking rate on veld condition (Simulation Trial) on Kokstad Research Station	Kokstad	1989-2014
Khanyile M	Feed intake and metabolic response of Large White pigs fed on incremental levels of *Acacia tortilis* leaf meal	UKZN	2012-2013
Khanyile M	Indigenous knowledge on fish harvesting and utilization in the Umhlabuyalingana District Municipality (KZN)	Umhlabuya-lingana	2014-2015

Researcher	Title	Location	Period
Khubone FZ	An overview of cucurbits production in Umnambhighi and Indaka local municipalities	Umnambithi & Indaka	2014-2015
Khubone FZ	Dry bean production in the Ilembe District	Ilembe	2008-2013
Luthuli CF	Manure as alternative fertilizer for pastures	OSCA	2010-2015
Mann J	Biological control of the blue tick using entomopathogenic fungi in cattle on Cedara	Cedara	2010-2012
Mann J	DEMO: The grazing of beef breeding cows on kikuyu for 12 months of the year	Cedara	1989-ongoing
Manson AD	Cover crops for maize silage system production	Cedara & KZN	2011-2020
Manson AD	Nitrogen Use Efficiency for Vegetables	Cedara	2013-2023
Manson AD	Soil fertility for truffles	Underberg (D Little farm)	2010-2020
Mchunu CN	Analytical Services - Effect of tillage on carbon dynamics in KZN's small-scale farming systems	KZN	2009-2011
Mchunu CN	Effect of tillage on carbon dynamics in KZN's small-scale farming	Bergville & Potshini	2009-2013
Mkhathini KM	Postharvest handling and value adding to peach fruit	Cedara, Impendle & UKZN	2013-2019
Moodley S	Use of essential oils on the control of agricultural pathogens	Cedara & UKZN	2009-2015
Mpanza TP	Examining the potential of using grey water generated by the rural households for irrigation of the homestead vegetable gardens	Ladysmith	2011-2015
Msomi MF	Napier fodder cultivar evaluation	OSCA	2012-2017
Msomi MF	Plant introductions	OSCA	ongoing
Msomi MF	Plant introductions	OSCA	2013-2017
Mtumtum N	Long season maize cultivar trial	Kokstad, Loskop & Dundee	- 2020
Mtumtum N	Maize silage cultivar evaluation trial	Kokstad	2009-2013
Mtumtum N	Short-season maize cultivar trial	Kokstad, Cedara & Dundee	- 2020
Naidoo M	Commercial potato cultivar trial	Cedara & Kokstad	- 2020
Naidoo M	Elite potato cultivar trial	Cedara & Kokstad	- 2020
Naidoo M	Mulched potato trial		2008-2012
Naidoo M	Potato production demonstrations	Umthentweni, Harding & Ixopo	2009-2015

Researcher	Title	Location	Period
Naidoo M	Small-scale farmer potato cultivar trials at different Bio-resource Units in KZN	Highflats & Bulwer	- 2020
Nash D	Raising and managing Friesland dairy heifers for optimum milk production	Cedara	2014-2019
Ngcamu S	The effect of different management / breeding strategies has on Nguni performance	Bartlow Combine	2012-2022
Ntombela TE & Sikhakhane MP	National dry bean cultivar trial.	Cedara, Kokstad & Loskop	- 2020
Nunkumar A	Controlling aphid and viruses in potatoes	Cedara	2006-2020
Nunkumar A	Epidemiological research into grey leaf spot and northern corn leaf blight in KZN	Cedara	2011-2018
Nunkumar A	Epidemiology and control of *Phaeosphaeria* leaf spot in maize	Cedara & UKZN	2009-2016
Oosthuizen PA	An investigation into the effect of different breeding strategies on an Nguni herd's performance	Dundee	2008-2020
Oosthuizen PA	Small scale dairying in an integrated farming system	Dundee	2003-2020
Osborne R	Horticulture - The effect of sulphur & copper treatment on macadamia production	Stanger	2012-2014
Osborne R	Sweet potato cultivar evaluation	Cedara & OSCA	2009-2020
Osborne R	Viticulture/Wine grapes	Cedara	2005-2010
Qwabe FNP	Consumer acceptability of pro-vitamin A bio-fortified green maize	Makhathini, Ndumo & Tugela Ferry	2013-2015
Qwabe FNP	Development of fresh maize hybrid model	Dundee	2010-2015
Qwabe FNP	Improving productivity and quality of green maize: green maize potential of orange pro-vitamin A and yellow quality protein maize	Makhathini, Ukulinga, Tugela Ferry, Dundee & Vryheid	2012-2015
Qwabe FNP & Gcabashe VAD	Sweet potato demonstration in support of the emerging farmer	Makhathini	Ongoing
Qwabe FNP & Dlamini C	Evaluation of mango cultivars under irrigation conditions at high density planting	Makhathini	1997-2014
Qwabe FNP & Dlamini C	High density litchi cultivar evaluation	Makhathini	1997-2014
Qwabe FNP & Dlamini C	Sweet potato demo	Makhathini	2004-2018

Researcher	Title	Location	Period
Qwabe FNP & Gcabashe VAD	Citrus cultivar demo	OSCA	1997-2015
Qwabe FNP & Gcabashe VAD	Horticulture - National sweet potato cultivar evaluation	OSCA	ongoing
Qwabe FNP & Gcabashe VAD	Mango cultivar demo	Makhathini	Ongoing
Radebe SB	Mulch effect on weed growth, soil moisture, yield and yield components of groundnuts under conditions of KZN Province	Matiwane	2010-2014
Relihan M	Cedara Plant Disease (Plant Health) Clinic	Cedara	1998-2030
Relihan M	Effects of diversely acidic soil sites on mineral levels of potato foliage and on Late Blight susceptibility, as modified by pre-plant soil application of gypsum lime or biochar	Cedara	2011-2014
Relihan M	In depth research on diseases associated with infection by *Lagena* species on pepper & other crops	UKZN	2009-2015
Roberts VG	Phosphorus fertilizers for resource-poor farmers on acid soils	Mbabazane	2013-2018
Roberts VG	Soil P requirements of vegetables	Dundee	2011-2016
Roberts VG	The improvement of FERTREC nitrogen recommendations	Cedara & KZN	1999-2019
Tembe NJ & van Rij NC	Optimizing substrate requirement in production of oyster mushroom	Cedara	2012-2013
Thibaud GR	Soil acidity interactions with no-till	Karkloof	2001-2015
Thibaud GR	Tillage effect on N requirements	Loskop	2005-2015
Vacant	Development of pest reference database to enhance Entomological Services at Cedara	Cedara	2011-2030
Vacant	Establish the effect of having an unrestricted breeding season on animal fertility and productivity in a system with no fencing versus a restricted breeding season	Kokstad	2008-2015
Vacant	Monthly planting of maize, potatoes and dry beans at Umzumbe	Umzumbe	
Vacant	Small-scale farmer maize cultivar trial in different Bio-resource Units	Cedara & Kokstad	on going

Researcher	Title	Location	Period
Vacant	The effect of night time kraaling on cow productivity and fertility.	Kokstad	2008-2011
Van Rij NC	Effectiveness of six different fungal storage procedures in maintaining the viability of mushroom cultures	Cedara	2013-2014
Van Rij NC	Evaluation of cheaper and more easily accessible agricultural waste for substrate in oyster mushroom production (*Pleurotus ostreatus*)	Cedara	2013-2015
Van Rij NC	Using spent mushroom substrates (SMS) of Oyster mushroom (*Plueurotus ostreatus*) to produce vegetables	Cedara	2013-2014
Van Zyl E	Genetic conservation and characterization of indigenous sheep	KZN	2007-2020
Van Zyl E	Investigation of the potential of *Sericea lespedeza* as summer grazing for sheep and establishment of production norms for north west KZN	Dundee	2010-2015
Van Zyl E	Investigation into different breeding seasons on beef cow performance	Dundee	2007-2012

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