Community Engagement, Research and Teaching: The Comparative Farming Systems Research Trials, 2014 – 2024 as part of the NRF Centre of Excellence for Food Security & the African Organic Farming Systems Research Project (NRF-RTF).

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The National Research Foundation (NRF) and the Department of Agriculture Forestry and Fisheries (DAFF) through its Research & Technology Fund (RTF) are funding three research projects at NMMU's George Campus in the Western Cape.

Food security means health to Eve Stoffels, Kos en Fynbos

Eve Stoffels organised a garden competition with the help of NMMU Agro-ecology programme; 56 gardeners participated in 2014 (Photo: Christine Ridge-Schnaufer)

Food gardens are one thing, commercial research into large-scale climate smart farming requires a rather different scale, but agro-ecology applies to both. This is the point of departure of the initiatives at the Nelson Mandela Metropolitan University in George.

The new long term farming systems research trials examine productivity, water use efficiency, biodiversity, carbon sequestration, yield components, gross margin analysis, changes in soil fertility and food quality. Post-graduate students have received bursaries from Hygrotech and AgriSETA (biological control) and from the Africa Earth Observatory Network in Port Elizabeth (Agronomy), as well as from the NRF & Centre of Excellence in Food Security (CoE FS). The initiative is part of the new CoE FS, funded by the Foundation for Research and Development.

In 2014, long-term comparative farming systems research trials were set up to examine the effects of farming system on soil fertility, water use efficiency, yield components and food quality in organic and conventional farming systems. These trials were developed after examining long-term research in Switzerland (the DOK trials, see Annexure 1 and http://www.fibl.org/en/switzerland.html and the earlier article in Science in 2002: http://orgprints.org/5514/1/Maeder%2D2002%2DScience%2DDOC%2DTrial.pdf) and also the US trials at the Rodale Institute, US (see: http://rodaleinstitute.org/our-work/farming-systems-trial/farming-systems-trial-30-year-report/). Both of these trials (DOK and Rodale) have been running for three decades, and there are extensive publications on the comparisons between organic and conventional farming systems, not only using these trials, but also several other research trial sites in various countries (http://www.isofar.org/publications/scientific-01.html; www.orgprints.org); several review studies have been done on food quality (www.qlif.org; http://www.agronomy-journal.org/articles/agro/abs/2010/01/a8202/a8202.html - see Annexure 2).

In general, these international trials have shown five similar characteristics: first, organic systems often take a few years (two to four years, depending on the skills of the practitioners) to develop soil biology to a level where yields stabilise at a high level. Second, organic yields are then often still slightly lower than conventional yields, though the input costs are also lower; if there is a price premium, profits tend to be higher. Third, the quality of the crops produced is usually higher on several nutritional parameters. Fourth, soil biology is more diverse and soil organic matter is higher (often carbon sequestration is double that of conventional sytems). Finally, under drought conditions, the organic systems usually outyield the conventional systems.

Given the realities of climate change, African food production needs to become more water efficient; thousands of researchers world-wide are monitoring the changes in climate, co-ordinated by the Inter-Government Panel on Climate Change (IPCC). Carbon needs to be sequestered in the soil rather than Carbon dioxide increasing the global greenhouse effect. Systems of food production such as organic farming deal with these issues using socially participative approaches tosustainable development. Comment on the implications of the latest report of the IPCC is given in Annexure 3; the impacts on the world food system, and in particular on food security in sub-Saharan Africa, are likely to be dramatic; steps to adapt to, and to mitigate, climate change are essential. They should be based on applied research into systems which can work.

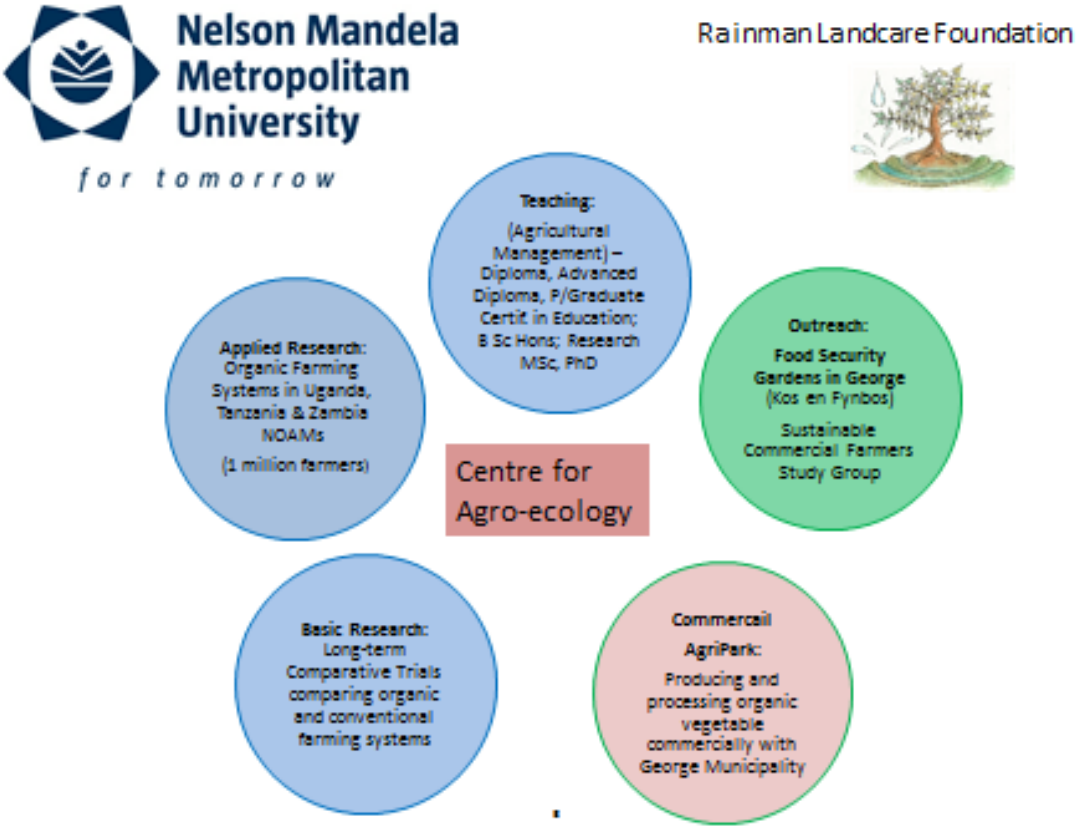

Figure 1: Concept for the Collaborative Centre for Agro-ecology

The CoE FS contributes to food security at household level and improves access to food nationally and regionally, using a trans-disciplinary approach to food production research. The work on the NMMU George Campus is integrated with Public Health and Value Chain projects at UCT, with nutrition and health projects, and with consumer choice projects. Partnerships are at the heart of this research programme. The proposed Collaborative Centre for Agro-ecology (see Figure 1) is a vehicle or building such trans-disciplinary work, both at NMMU and with other institutions.

Elements of a Collaborative Centre for Agro-ecology

For our work to be transfomative, work such as the existing "Kos en fynbos" initiative, undertaken jointly by NMMU, Rainman Landcare Foundation, George Clinic (Dr Zilla North), WESSA George Branch (Ms Chris Godfrey), and members of the Blanco Community (community gardener, Eve Stoffels and traditional leader and biodiversity campaigner, Neil Carelse) are vital (see Annexure 4). The proposed George Urban Agri-Park (a joint initiative of Prof Auerbach (NMMU) and the George (Ms Carli Bunding-Venter) & Eden (Ms Natalie Raubenheimer) Municipalities will allow commercial and food–processing perspectives to inform our work in the Food Production theme.

Design of the food production research trials

Given the vulnerability of small scale African farmers to drought, scarce input supplies, lack of infrastructure, poor information systems and fickle markets, systems which reduce external inputs, hold water and nutrients in the soil colloids, sequester carbon,

and produce high-quality produce even under drought conditions seem highly desirable. Research from the United Nations (UNCTAD 2013 – Wake up before its too late - http://unctad.org/en/Pages/DITC/TradeTandTEnvironmentTReviewTSeries.aspx; Auerbach et al., 2013 - http://www.fao.org/docrep/018/i3294e/i3294e.pdf; Scialabba, 2009 - ftp://ftp.fao.org/docrep/fao/meeting/012/ah952e.pdf; and UNCTAD/ UNEP 2007 - http://www.unep.ch/etb/publications/UNCTAD_DITC_TED_2007_3.pdf) shows that organic farming projects are promoting food security and outperforming conventional projects in many African countries. The research shows that yields are at least trebled using organic management, water and energy efficiency improves, carbon sequestration doubles and food quality improves.

Our trials were therefore designed to build on what is already known in Europe, the United States and other African countries, so that South Africa can develop evidence-based policies for sustainable agricultural development.

The research site is located near Ystermartiens at the south-eastern corner of the campus next to Patula Residence. A 2.4 m high diamond-mesh fence has been erected around an area of about one hectare, electrified with six strands of wire, energised by a solar panel working through a heavy duty deep cycle battery; a randomised block split-plot design with four replications was laid out, consisting of forty gross plots, each 6m x 5m, which includes an organic and conventional rotation, as well as non-fertilised control plots.

The research site represents an area where basic farming systems research will take place. It is closely linked to three post-graduate research projects in Uganda and Zambia, where three doctoral candidates are looking at applied research into training, support, marketing and governance of agro-ecology in southern and eastern Africa.

Figure 2: The baboon-proof Permaculture Garden (PG) on the George Campus of NMMU

This site and the adjacent permaculture garden (PG – see Figure 2) are intrinsic parts of the Green Campus initiative, and serve seven functions for the NMMU:

1 The PG serves as a teaching garden where agriculture and conservation students can prepare soil, plant seeds, observe ecological pest control approaches and learn about teaching gardens and agro-ecology.

2 The PG is a resource for all NMMU staff and students, where the importance of healthy lifestyles can be shown practically through demonstrations, film clips and interaction with nutritionists.

3 The PG and the research trials provide teaching and research infrastructure to students in the School of Natural Resource Management, and will stimulate an interest in sustainability research on campus.

4 The research trials will establish a long-term research facility for Africa, where the effects of chemical fertilisers, compost, crop poisons and production systems will be evaluated in terms of soils, water use efficiency, carbon sequestration, crop yields, economics of production and crop quality; this will provide the opportunity for many post-graduate studies over the next twenty years, where crops and AIPs can be evaluated for food and health.

5 The research trials are part of a Centre of Excellence in Food Security which includes the Universities of the Western Cape and Cape Town (School of Public Health) Stellenbosch, Fort Hare and Pretoria, as well as agricultural researchers at the Agricultural Research Council.

6 The trials are part of the Sustainable Organic Agriculture Action Network (SOAAN), and are working with partner Rainman Landcare Foundation and a number of international research centres to develop a system for evaluating the sustainability of agricultural practices.

7 The trials are the first attempt in southern Africa to study the inter-relationship of climate change, food security, environmental degradation and health. Measuring the effects of farming systems on soil fertility, water use efficiency, yield and food quality of organic and conventional farming systems will inform policy makers and agricultural advisers on the relative efficiency of investments in various approaches to rural development.

<u>Other Elements</u>:

In addition to the Basic and Applied research elements described above, there will be teaching, farmer outreach and market diversification elements to the centre, which are closely linked to community engagement processes through *Kos en fynbos* gardening projects and the proposed George Urban AgriPark.

Long-term comparative agro-ecology trials, Saasveld

What is the purpose of the trials?

Organic and conventional farming systems will be compared to measure how each system afects soil fertility, soil carbon sequestration, water use efficiency, yield components and food quality parameters. The economics of production will be evaluated to assess whether organic farming systems are cost-effective. There will likely be trade-offs between production and quality, and the research will help to evaluate eco-system services from both systems, and to estimate the relative contributoons to sustainability.

Overview of the fenced site (see Figure 3, Location, and Figure 4, Trial Site)

It is planned that open land to the south of George around the Outeniqua Sewage Treatment Works will be used for our proposed George Urban AgriPark, and the Blanco area to the north-west of George is where the main *Kos en Fynbos* household food security gardens started off; gardens have now spread to Pacaltsdorp, Touwsranten and Thembalethu, and a School Garden research project has started at Mount Frere in the eastern Cape (Livhuwani Malaba).

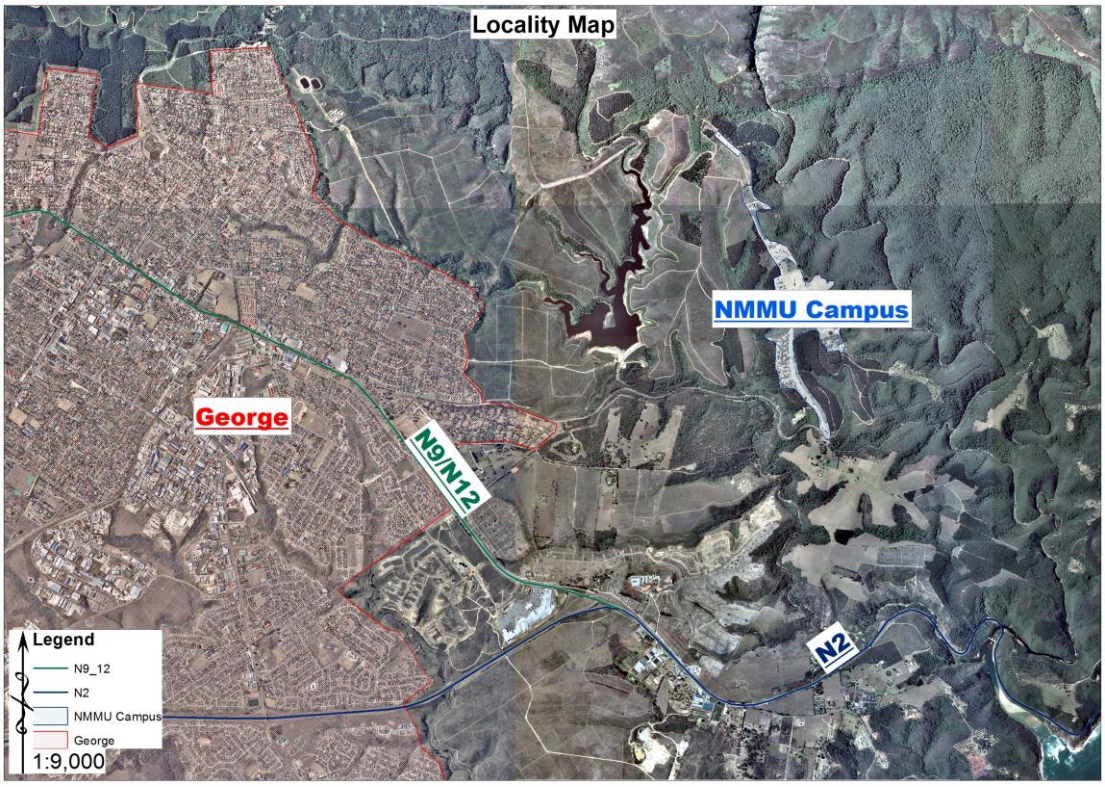

Figure 3: Location of the NMMU Saasveld Campus, where the Research trial is based

The research trial site (see Figure 4) and the George Urban AgriPark project will be developed over the next three years. The worm-farm unit is located in the shed behind

the shade-cloth nursery unit, where Mr du Toit and the fourth year Plant Production students are also developing their Aquaponics Legacy Project; the actual long-term organic farming systems research trials (students N'wa-JamaMashele - agronomy and Catherine Eckert – water use efficiency, as well as Mr du Toit's soil organic matter research) are located in the bottom part of the red rectangle. Braam van Niekerk is working on biological pest and disease control on this site and on another site in Phillipi where he is sponsored by his employers (Hygrotech Seeds) as well as AgriSETA, BASG and Agro-organics. SSK Agri Garden Route assisted with fencing material, and our industry partner for the RTF-NRF African Organic Farming Systems project is S Haddad Agricultural Services. We thank all our sponsors, in particular Sandor Haddad; without Sandy's dedicated support and faith in our work, we would not have leveraged several million Rand worth of research funding.

Figure 4: Land Use within the security-fenced research area (about 0.5 ha) on the NMMU George Campus at Saasveld; the new Permaculture Centre is between the site and the circle at the top right part of the short open strip of grass, adjacent to the forest on the right.

The Permaculture Garden and the comparative research trial site are located to the south-east of the campus, and these are already funded for the next five years, with several post-graduate students working on various aspects of soil, water, energy, productivity and food quality, and good collaboration with the NRF Centre of Excellence in Food Security, as well as several overseas universities.

The area fenced in will be used for several research projects in addition to the comparative trials (located in the south-eastern part), there is already a rehabilitation trial under design from our Conservation Programme in the northern section, and adjacent to this is an area reserved for African Indigenous Plant research.

Figure 5: Masters student N'wa-Jama Mashele with a cowpea crop.
Jama's research compares organic & conventional farming systems.

Inside the Permaculture Centre: students plan their gardens, quietly supported by technician Marius Strydom

Students planting the gardens which they planned, using crop rotation and permaculture principles; Respect for the Environment is an NMMU value which we uphold

Students explore the stories of their various journeys to university, and their arrival at NMMU George; this is their first Agricultural Management practical in First Year, and Respects Diversity, one of the NMMU values

Members of the Eden PGS visit the organic farm of Terence & Anne-Marie Atterbury; (PGS = Participatory Guarantee System, where consumers and farmers engage in peer-review rather than costly certification)

NMMU students visit local commercial orchards to learn about Integrated Pest Management

Award-winning Biodynamic wine farmer Johan Reyneke photographs an instance of biological pest control as he shows NMMU students his biodiverse cover crops which help him to produce top organic wines on his farm

Annexure 1: Sustainability of organic and integrated farming (DOK trial)

Paul Mäder and Andreas Fliessbach, Research Institute of Organic Agriculture (FiBL, Frick), e-mail: paul.maeder@fibl.ch

The land area of organic agriculture in Europe and in many other countries of the world has increased considerably in the last years and organic agriculture is investigated intensively in many fields of research (Macilwain, 2004). Earlier the organic farming movement was created by pioneers, whose ideas and innovations formed an alternative to the so-called „green revolution" that came along with pesticide use and synthetic fertilizers. In recent time, environmental problems caused by agriculture became more evident.

In 1978 the DOK long-term field experiment was installed at Therwil close to Basel, comparing the farming systems „bio-Dynamic", „Organic" and „(K)conventional". In the first years of the trial, crop yield and feasibility of organic farming were investigated. Soils were analysed with respect to long-term effects on fertility and were rated in the view of farming effects on the environment. Today the quality of organic products and the analyses of nutrient fluxes (C, N, P) as related to microbial activities are the main research interests in the DOK trial.

Long-term trials such as the DOK-trial offer unique opportunities for this kind of research (Drinkwater et al., 1998, Reganold et al., 1987, Mäder et al., 2002).

The DOK-trial compares the three systems mentioned above on the basis of the same intensity of organic fertilization (i.e. the same number of animals per area), the same crop rotation and the same soil tillage.

Fertilization and plant protection are different and performed according to the respective farming system. An exclusively minerally fertilized conventional treatment is mimicking stockless farming and unfertilized plots serve as controls (Mäder et al., 2002).

Crop yields of the organic systems averaged over 21 experimental years at 80 % of the conventional ones. The fertilizer input, however, was 34–51 % lower, indicating an efficient production. The organic farming systems used 20–56 % less energy to produce a crop unit and per land area this difference was 36–53 %. In spite of the considerably lower pesticide input the quality of organic products was hardly discernible from conventional analytically and even came off better in food preference trials and picture creating methods.

Maintenance of soil fertility is important for a sustainable land use. In our DOK field plots the organically treated soils were biologically more active than conventional, whereas chemical and physical soil parameters differed less significantly.

In: ECOSYSTEM SERVICES AS A TOOL FOR PRODUCTION IMPROVEMENT IN ORGANIC FARMING – the role and impact of biodiversity
Birgitta Rämert, Lennart Salomonsson, Paul Mäder (editors)
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SLU (Swedish Agricultural University)

Annexure 2: Food Quality – AFFSA study abstract

Agron. Sustain. Dev. 30 (2010) 33–41

Review article

Nutritional quality and safety of organic food. A review

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Abstract

Food security, nutritional quality and safety vary widely around the world. Reaching these three goals is one of the major challenges for the near future. Up to now, industrialized production methods have clearly shown severe limitations such as a worldwide contamination of the food chain and water by persistent pesticide residues, and reduced nutrient and flavor contents through low-cost intensive food production and/or processing. In line with several published literature reviews, the French Agency for Food Safety (AFSSA) performed under my coordination an up-to-date exhaustive and critical evaluation of the nutritional and sanitary quality of organic food. This review is based on the AFSSA report issued and recently published studies. The major points are: 1/ organic plant products contain more dry matter and minerals (Fe, Mg); and contain more anti-oxidant micronutrients such as phenols and salicylic acid, 2/ organic animal products contain more polyunsaturated fatty acids, 3/ data on carbohydrate, protein and vitamin levels are insufficiently documented, 4/ 94–100% of organic food does not contain any pesticide residues, 5/ organic vegetables contain far less nitrates, about 50% less; and 6/ organic cereals contain overall similar levels of mycotoxins as conventional ones. Thus, organic agricultural systems have already proved able to produce food with high quality standards. I propose also improvements of organic production to achieve sustainable food production for humans in the near future.

Key words: sustainable agriculture / organic agriculture / human food / nutrition / food safety / contaminants / health

Annexure 3: Gaia Foundation Press Release UN Climate experts: Green Revolution leaves food systems vulnerable to climate change

Agro-ecological practices needed for adaptation

The United Nations' experts from the Intergovernmental Panel on Climate Change (IPCC) have stated that the so-called "green revolution" is leaving agriculture vulnerable to climate change, and that new approaches are urgently needed to enable food systems to adapt.

Speaking during the release of the IPCC's Fifth Assessment Report (AR5) in Yokohama yesterday, a panel of the world's most eminent climate scientists presented their review of climate studies from around the world. Their conclusions were alarming, highlighting the devastating impacts of climate change on the world's food systems, and the urgent need for governments to begin the work of adaptation in earnest.

When asked about projected food yields, the panellists indicated that the "green revolution" model of agriculture, which uses chemical fertilisers, pesticides and corporate-owned seeds and requires large amounts of water, is likely to fail in the face of temperature extremes and changing rainfall patterns.

"It's now becoming evident that the so-called 'green revolution' has probably reached a plateau," said Rajenda Pachauri, the IPCC chair. Pachauri went on to explain how the green revolution is unlikely to benefit the hundreds of millions of farmers dependent on rain-fed agriculture in India, Africa and Latin America.

As a result of the green revolution "Global food production may have increased," added Michel Jarraud of the World Meteorological Organisation and one of the report's lead authors "but this has come at the expense of vulnerability."

"All the ingredients are there for a new food crisis," Jarraud concluded.

Chemical fertilisers and pesticides have been shown to weaken soil health and reduce its ability to store water in the face of droughts or floods.

In the decades since the green revolution was introduced in the 1960s, global seed diversity has rapidly disappeared, as corporations have transformed farmers from savers and breeders of seed, to customers of just a few hybrid varieties bred to require high levels of fertiliser, pesticides and water.

"The green revolution is a recipe for disaster in the face of climate change. With farming systems facing unpredictable rainfall patterns and extremes of

temperature, farmers need to enhance their seed diversity more than ever, to increase the chances of producing food in these unstable conditions. It is these small farmers who still provide 70% of the food we eat using 30 % of the land. And it is these diversity-based farming systems which build up soil and maximize food production to feed people, not commodity markets" said Liz Hosken, director of The Gaia Foundation.

"But the green revolution entices farmers to abandon their locally adapted and diverse seed varieties, and to become dependent on corporations based thousands of miles away. Pachauri and his IPCC colleagues are essentially acknowledging that we rely on the agribusiness sector at our peril as climate extremes become the norm."

"This is a clear signal that the green revolution is a dead-end, and that tried and tested agro-ecological approaches to farming must be prioritised," adds Teresa Anderson, The Gaia Foundation's international advocacy co-ordinator. "It is urgent that we rebuild soil health and increase seed diversity for effective adaptation in an increasingly unstable climate."

NOTES TO EDITORS:

1) The Press Conference of the IPCC Report can be viewed here: http://www.ipcc.ch/news_and_events/press_information.shtml

2) The report has been produced by the IPCC's Working Group 2, and covers the issues of impacts, adaptation and vulnerability. The report by WG1 covering the physical science of climate change was released in September 2013. The report by WG3 will cover issues of mitigation and will come out later this year,

3) View summary of the IPCC's predicted impacts of climate change on food here: http://climatejusticecampaign.org/images/ipcc/DCJ_Food_and_Climate_Change.pdf

4) The Gaia Foundation's report "Seeds for Life: scaling up agrobiodiversity" explains the importance of seed diversity to adaptation and farming, and the negative impacts of the green revolution in greater detail: http://www.gaiafoundation.org/sites/default/files/seedsforlifereport.pdf

Annexure 4: *Kos en Fynbos* – Southern Cape Food Security Movement gathers momentum!

(Above) Prizewinners, and (Below) Deputy Mayor of George, Eve Stoffels, Dr Zilla North (Dept Health, Blanco), Anthonie du Toit and Prof Raymond Auerbach (NMMU) and Chris Godfrey (WESSA) at the *Kos en Fynbos* prize-giving in 2014.