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**Session: Alternative crops and production practices, including
dealing with extremes.**

**Alternative crops and ideas for the entire
Western Cape**

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Alternative crops and ideas for the entire Western Cape

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A. Introduction - Climate Change basics

Globally climate change is accelerating (IPCC AR4¹) and African countries are being urged to start adapting now.

Africa has been warned in various international documents and studies that its agriculture is highly at risk from changes to the climate. South Africa's agriculture sector is also at risk, especially in the western areas (soil moisture map).

The agricultural sector is already characterized by high exposure to risk. Risks in agriculture are grouped into two main groups: Price risks (trade issue) and production risks (climatic conditions, pests and diseases) and also other risks (eg. Changes in the markets, opportunities for organic produce, major switches in consumer demand like the margarine versus butter issue, etc).

Now there is climate change added, which looks to create long term threats and opportunities for the agricultural sector.

As well as commercial agriculture and its contribution to the provincial GDP, subsistence agriculture is also at risk, and needs attention in terms of an Adaptation Plan for farming in the Western Cape.

Farming and the Weather

The weather is a major production factor in farming and is a major cause of uncertainty in agriculture, manifesting itself in crop yields, pests, or crop failures, and influences the type of crop or livestock that can be grown in a given area.

Farmers try and minimize this risk through measures like insurance, or try to minimize their losses by using information to manage their risk eg. planting a number of different crops, not planting, and also regional mapping climate risk (as in the EU) eg. Soil types, rainfall, temperature so that both farmers and insurance companies know what they're dealing with.

¹ Intergovernmental Panel on Climate Change Fourth Assessment Report, www.ipcc.ch

While the weather may be generally variable from years with risks of floods, winds, droughts, within these kinds of risks, will also be bigger trends towards major permanent changes in climate, which for the W’Cape include hotter and dryer trends by 2050, but already manifesting themselves (Already not cold enough for fruit growers).

B. Agricultural statistics for the Western Cape

Agriculture in the Western Cape is distinguished in several ways from that in the rest of South Africa, largely because of the physical geographic differences. The winter rainfall region of the Cape winelands area around Stellenbosch and the year-round rainfall of the Southern Cape provide agricultural conditions that make the crop mix and productive potential unique. One of the primary features of the region’s agriculture is production stability, based on stable and relatively adequate winter rainfall, supported by well-developed infrastructure for both input supply and output processing.²

Agriculture is one of the primary pillars of the Western Cape economy. Although the province contributes some 14% to the country’s Gross Domestic Product, it generates almost 23% of the total value added by the agricultural sector in South Africa, Agriculture accounted for 5,2% of the Western Cape’s Gross Regional Product of R185,4 billion in 2004. This is declining though, according to the Growth and Development Strategy for the Western Cape (2007 – 2014).

The Western Cape has a diverse production capacity with 11 commodities contributing significantly to agricultural production. These include fruit, poultry and eggs, winter grains like barley, wheat and hops, viticulture and vegetables together contribute more than 75% of the total output. Potato growing is a big industry, as is the rooibos tea industry. Consequently, the diversity of the agricultural enterprises also contributes to the sector’s general stability.

This growth trend has been consistent since the political transformation of 1994. The main industries in the sector include fruit contributing R2,4 billion, winter grain contributing R1,8 billion, white meat valued at R1,6 billion, viticulture worth R1,6 billion and vegetables worth R1,4 billion.

The Western Cape a proud heritage of farming, linked to sophisticated education, training and research facilities which help to promote the sector locally and internationally.

Some areas of focus and development include:

- Agri-tourism
- Exotic meat and leather
- Natural products including cut flowers
- Organic farming practices
- Essential oils
- On-going expansion in the wine industry

² <http://www.elsenburg.com/economics/statistics/start.htm>

The agricultural activity of the Western Cape covers an area of 11,5 million hectares (ha). Although this is only approximately 12,4% of the total agricultural land available in South Africa, the Western Cape produces between 55% and 60% of South Africa's agricultural exports, which is valued at more than R7 billion per year. The Western Cape also contributes approximately 20% towards South Africa's total agricultural production.

The nearly 9 700 farms in the province, averaging approximately 1 000 ha in size, have a combined capital asset base of more than R680 million. Although the Western Cape produces a variety of produce and agricultural related commodities, the key export products currently include wine, wool, ostrich related products and fruit. The products are high in quality and competitively priced, resulting in good value for money in a number of international markets.

C. Climate change predictions for the Western Cape.

The scaled down climate change predictions have been generated for South Africa, and show how temperatures will change by 2050. Rainfall patterns are more variable, more difficult to model and predict.

But for the Western Cape, a general trend will be hotter and drier, with the degree of change differing in the regions of the Western Cape (see the maps).

- Increase in annual average temp of at least 1 deg C by 2050, but perhaps by 3 – 5 deg C by 2100.
- More winds, dry vegetation conditions and therefore fire hazards
- The winter rainfall pattern will break down, with more rain in the summer months
- Also, more intense rainfall and storm events, which is a problem for agriculture.
- Decreased water resources
- Reduction of soil moisture (increase in Temp, decreased precipitation).
- Temperature impacts on crops (crop burn, drought, pests, microbes, yield reductions and loss of rural livelihoods).

These are not forecasts, but indicate the direction that change will be moving over time.

D. Climate Change and Western Cape Farmers

Key questions from Western Cape province and farmers

- What could be grown in the W'Cape if can't grow wheat?
- Do we have other local alternative crops that could be grown instead?

- What are the other ‘international’ crops that could be considered?
- What will we be able to grow if the climate changes?
- What are the new/future market opportunities – need to match these with what will grow.
- Carbon miles threat – need to consider growing items that are durable, can be processed into a durable form eg. Dried products that can be shipped.
- What will get rid of rural poverty in the W’Cape and SA?
- Commercial, semi-commercial, subsistence farmers – what are their needs? Now and under climate change impacts?
- What new pests and diseases, weeds, alien woody vegetation is on the way?

Discussion of these and other farming issues:-

There are fears that many of the existing crops (Wheat, deciduous fruit) will not be able to grow if the region warms and gets drier. Farmers in the Western Cape are already looking for other crops to plant other than wheat, for example.

Some of the bigger wine estates are looking at pomegranates (Backsburg Wines) or olives.

There are also suggestions that rooibos tea farmers will want to plant higher up in the mountains in the Cedarberg region, and this will bring them into conflict with the biodiversity conservation sector.

Many of the farmers already looking for new opportunities, but these are tending to be the well-resourced farmers who are able to respond, put in new planting stock, investigate markets etc.

Adaptation measures for farming that are possible - includes existing crops and agricultural practices and permutations

- Actions like changing row spacing, minimum tillage, restoration of degraded land – could also buy farmers time while using existing field crops.
- Plant breeding and knowledge of genetics, and methods like Marker Assisted Breeding, could stretch the range of conditions that maize, wheat and other crops could tolerate.
- Bring in non-GMO drought resistant cultivars or breeding lines from elsewhere, if available.
- Genetic engineering – could also add new drought and heat tolerance traits to existing crops.

- Switch to entirely different crops like Mediterranean crops, “novel crops”.
- Switch to a bio-based economy that goes beyond conventional food crops into production of novel compounds for health, functional foods, industrial uses and fuels.

E. New Crops, novel crops and bio-products - definitions

There are global trends to develop new crops based on novel and indigenous biodiversity and food species that have been used by indigenous people around the world. Also, novel products and chemicals are now produced agriculturally through the development of another set of crops which supply pulp, fibres, polysaccharides, flavours, oils and health products like antioxidants.

New Crop - A new crop has been defined as a crop which has not been previously successfully commercialized in a specific geographical area.

This might be useful in the W’Cape if a match can be found between crop, climate and markets.

Novel Crops – non-mainstream crops, usually farmed on a small scale, can eventually become mainstream. In 1500’s would have been potatoes, tomatoes, tobacco and sugar cane. Now, mostly medicinal plants, indigenous people’s food to supply affluent markets, but also novel fibres, plants that produce antibodies, plants that produce antioxidants, anti-cancer drugs etc.

Orphan Crops – similar to above, no research funding spent on them, usually used by indigenous peoples as emergency foods, or by small specialist growers or enthusiasts.

Lost Crops – similar to orphan crops, crops that attract no R&D investment because they are not considered part of mainstream agriculture eg. Many African grains, fruits and vegetables. All mostly unimproved.

Bio-products - Bio-products are a new grouping of products which are made from or by living systems, mostly plants or microorganisms. Many new substances have been found which have applications in industry, food preparation, health care, textiles which need to be prepared from plants, using new chemical and biotechnological processes.

The production of bio-products in the so-called ‘bio-based economy’ is a global trend and the list of bio-products seems to grow by the day.

As human society has moved from the steam age to the information age, the next “age” is predicted to be the age of the ‘bio-based economy’ producing and using bio-products. A big part of the bio-based economy is intellectual property (patents).

A quick search of the internet reveals that this arena is very big globally, and that some time would be needed to fully investigate all of the opportunities that are contained here (CPL book lists). In South Africa, the development of a bio-based

economy, which produces these kinds of products, is part of a national Ten Year Innovation Plan (DST, 2007).

F. Replacing and augmenting Western Cape agriculture in preparation for climate change.

There is a hierarchy of agricultural adaptation approaches, starting with simple measures and leading to, perhaps, a complete replacement of existing crops with entirely different crops produced for a range of purposes (non-food, food crops).

Agriculture is a major component of the Western Cape province, where crops are grown on a commercial scale, and a large supporting industry. Agriculture makes a major contribution to the economy of the Western Cape through jobs, linked or supporting industries etc. Typically like the wine industry with vineyard growers, the wine producers, suppliers of equipment and also agri-tourism and hospitality spinoffs.

What could replace these crops if they could not be grown here? What could replace these industries?

New or novel crops could become more substantial, if there are markets and if they can be grown in enough quantity to supply demand. Considerable investment would be needed over time to develop novel crops to the same level of sophistication as existing crops and their associated industries in the Western Cape.

Also, important issues like offer new choices to consumer, diversify rural livelihoods, perhaps create new spinoff industries, improving farming sustainability by diversifying risk, as well as offering new options for export (depending on what the new crop is).

There does seem to be a fair amount of new/novel crop activity around the world, if the Australian New Crops conference (2004) can be believed.

New crops can include :-

1. Field crops (fibres, cereals, pseudocereals (millets and other minor cereals), oilseeds, legumes, forage crops).
2. Horticultural crops fruits and nuts, also vegetables and cactus.
3. Herbs, spices, medicinal and native food crops.
4. Biofuels feedstocks
5. Carbon sequestration crops
6. Crops that link to the 'bio-based' economy, basically producing new compounds for food, health and industry.

Important issues in new crop development include:-

Conventional aspects of the farming sector that would need to be established for new crops.

- Markets and marketing, Supply chain management, intellectual property protection and access, food standards, pesticide regulation and allowable residues, best farming practices for those crops to ensure maximum production.
- Plant Breeders Rights
- Phytosanitary issues, field trials etc. for imported varieties.
- Also, the provision of extension to farmers with new or novel crops.
- A database of information on new/novel crops would be necessary to stimulate this sector. Also, government support for exporting these crops/products.
- Similarly, with new crops, there is a higher level of risk to the tried and tested mainstream crops.
- Some prioritizing of 'priority' novel crops and avoid support for hopeless crops.

Funding for research including plant breeding of new and novel crops.

- Other issues would be Research and Development and funding of this, who pays/who benefits? The nature of rural innovation, the sociology and anthropology of new crops (as was a big issue in *Hoodia* development in South Africa).
- Government funding for smaller, more novel crops.
- Intellectual Property in new and novel crops and industries - Plant Breeders rights, brands, logos, copyright etc
- Much of this involves commercializing innovation (rural innovation).

Networks and collaboration

- Issues like networking, collaboration in marketing, sharing information are important.
- In USA they have groups like the California Rare Fruits Society
- There are moves to become less academic and encourage farmer-driven research (this must help when formal research is so expensive).

Pest and disease management

- Pest and disease management for new crops.

Standards, health claims

- Also standards, health claims made for products. Food safety issues for new crops.

- Australia (Rural Industries Research and Development Corporation) have annual New Crops conference and seem to take new crops very seriously. Western Cape/South Africa would need a new crops policy, networking in new crop industries, the role of cooperatives, strategic planning, the regulation of agricultural chemicals in this sector, and the requirement of new food standards for new, functional and novel foods.
- We should think of something like this.

G. Climate Change Response Strategy for Western Cape.

The planning time period for the Climate Change Response Strategy is the 2030 – 2045 period. 2030 is apparently the earliest year that predictions can be localized based on global climate models, which look at 2045 and beyond. 2030 is also thought to be a reasonable time horizon within which policy, economic and business decisions can realistically be made (Adaptation).

In terms of mitigation planning, DEAT has said that by 2020, the Peak and Decline model must kick in (mitigation).

H. Climate Change Strategy and Action Plan for the Western Cape (2007)

A very thorough document³ has been put together with many suggestions made for agriculture.

Development of the Climate Change Strategy for the Western Cape included extensive workshops with stakeholders.

The agricultural stakeholders consulted included farmers engaged in the following industries :-

- Fruit and vegetables
- Citrus
- Wine
- Cereals (wheat, hops)
- Lifestock
- Fynbos
- Potatoes and rooibos

A set of comments from Western Cape Stakeholders was obtained as is included in the Strategy and Action Plan document for the W’Cape – In terms of agricultural suggestions, I’ve sorted the comments into categories:-

Novel crops, new crops

³ Climate Change Strategy and Action Plan for the Western Cape 2007 www.wc-climatechange-response.org.za

- Develop suitable genotypes for drought, heat and pest resistance through local breeding.
- Change the crops to something more suited for new conditions including indigenous plants and Mediterranean type plants (olives)

Markets and research

- Maintain and develop local research capacity, especially linked to indigenous knowledge.
- Improve trade equity, market access, benefit from new opportunities in global context.

Agricultural practices

- Practices to reduce soil loss and increase water retention
- Other crop practices which create resilience in agricultural activities (conservation agric, minimum tillage, water harvesting etc).
- Irrigation efficiency and other Practices linked to irrigation
- Secure reliable supply of fresh water for irrigation
- Reduce pollution and salinisation of ground water
- Technology transfer of modern farming methods.
- Better land use planning and economic development that takes account of climate change and other scenarios

Alien species

The spread of alien species is one of the major concerns of climate change, as the range of problematic organisms spreads.

- Remove and control alien species that reduce stream flow
- Surveillance for new pests, integrated pest management, including sterile insect release programmes (fruit fly).

Early warning systems

- Extension of weather station network, regular forecasts to farmers, early warning systems.
- Information transfer systems (extension) and other ways of regular, accurate info to farmers.

Options from the literature (and discussed in the stakeholder meetings)

- **Different varieties**
 - **Crops to livestock**
 - **Crops that use less water**
 - Different planting dates, changes to growing seasons.
 - Change quantity of land under cultivation
 - Increased use of water conservation techniques in farming
 - Tree planting
- } **Novel and new crops**

- Shading, sheltering
- Investment in irrigation technology
- Insurance and risk sharing
- Desalination
- Indigenous knowledge and coping strategies.
- Re-use of water (grey water)
- Cease farming activities
- Processing technologies to deal with CC
- Research, extension officers, land reform
- Minimum tillage to conserve soil water and carbon
- Diversification of production and processing
- Organic farming
- Different ploughing practices
- Soil moisture conservation practices

Final priority options for agriculture chosen for inclusion in the W’Cape Response Strategy from a matrix of options (none of which included novel crops).

Priority 1 (top of entire list of priorities)

Secure reliable supply of fresh water for irrigation

Priorities 4, 5 ,6 and 7 were Fisheries concerns

Priority 7

Dealt with vulnerable communities (many of which would be rural and require a diversification of rural livelihoods).

Priority 12

Research efficiency of water use by the agricultural sector

Priority 21

Identify, monitor and control pests and diseases using integrated pest management (fruit fly)

Priority 22

Extend weather station network

My comments on the Agricultural priorities for the Western Cape :-

1. *None of the selected priorities for the W’Cape Strategy recommend novel/new crops.*
2. I would suggest that these (Western Cape CC Response Strategy) priority needs are short horizon needs, for problems that are already evident. And also reflects a strong commitment to existing crops.

3. None of the suggested stakeholder final priorities for agriculture were anything to do with novel crops, new crops or new farming methods, new irrigation methods. This does not seem to be a priority from the farming sector.
4. The farming sector is very adaptable in this way. Yet farming is also very risky, adaptive, except in cases where huge infrastructure investments are needed eg planting orchards, vineyards, putting up processing facilities (drying, roasting, fermenting etc).
5. What is likely to happen is over time is that farmers themselves will adapt, as they have been doing, seeking new crops, following trends, and eventually leaving farming if they can no longer make a go of things. But this is not a strategic approach is the W’Cape wants to continue to have an ongoing agricultural sector.
6. However, the W’Cape may want to research and identify a new “sector” that can be established, to pool resources, work collaboratively. Suggest investigate “bio-based economy” activities (Like India and Ireland selecting IT industry).
7. Gauteng had the “Blue I Q” economic development idea to create hubs, some were manufacturing eg. Roslyn Motor manufacturing hub (but all a bit ‘old style’ actually). W’Cape to consider a Bioproduct Hub.

I. Climate Change and South African National and regional issues, policies, strategies – and suggestions for agriculture.

- The DST’s “Climate Change Technology Needs Assessment” 2007 identified the agricultural sector as ‘vulnerable’ along with biodiversity and the water sector.
- DST Identifies the need for new crops, novel crops and new farming approaches (irrigation, tunnels ...?) to create resilience in South African agriculture.
 - New crop species and cultivars
 - Information technology (decision support and early warning)
 - Pest management
 - Vulnerability research
- The SA National Country study (UNFCCC 2000) also states that adaptive measures could be applied at the field level.
 - *Eg. Change planting dates, row spacing, planting density and cultivar choice.*
 - *Also plant drought resistant crops such as sorghum, millet, or shifting from crops to livestock.*

- *Also promoting practices such as conservation tillage, furrow dyking, terracing, and planting windbreaks.*

Other measures could include:

- *Address other major yield limiting factors*
 - *Develop capacity for drought early warning*
- Other studies of Africa show that agriculture is vulnerable, so this is a more wide spread issue that just W’Cape (soil moisture map). Other places where there will be no agriculture, or enhanced agriculture may be where the opportunities are in time.
 - South Africa also has a biotechnology strategy and aims to create a “bio-based economy”. Biotech hubs etc. and about 70 biotech start up companies (green and red). Biotechnology must produce products for sale.
 - Perhaps SA needs to investigate Australian and New Zealand biotech for horticulture particularly (benefication of floral diversity, for example).
 - SA would need to focus on the commercialization of new products
 - Need market research
 - Market development and a process for developing new products and adding value.
 - Perhaps need a specific arid areas agriculture programme (national) to investigate what will grow in regions that will get hotter and drier.
 - Need to look at crops that will grow (eg. Olives) and what products can be made from them, to add value.
 - Use of agriculture cellulosic residues to create biofuels (ethanol) feedstock – Stellenbosch University, biofuels chair (SANERI). – Attempt to produce both food and biofuels from the same land, at the same time. Need appropriate biotechnology to do this. Either algae or oil/starch crops.
 - Algal lipids – could also use biotechnology/genetic modification to get maximum lipid content from cultured algae.

Common sense issues

1. We need to know what the (local and international) markets want and see and then what can be grown in the Western Cape over time.
2. Issues like market segmentation, product lifecycles, keeping up with trends are also important when growing novel and new crops.
3. Many of these markets are volatile, and quickly the price falls as too many people get on the bandwagon.
4. Many of these markets are highly specialized eg essential oils and perfumes, and not easy to get ‘in’.
5. New crops, novel crops – need to watch out for any existing rights eg Plant Breeders rights or other intellectual property (eg. Linked to ABS).

6. Processing and product development – some thought needs to be given to this, to maximize returns. Big concern is the loss of existing industries in food processing eg. Dried deciduous fruits, juice production, in the W’Cape.
7. There are websites that indicate demand for novel plant compounds, commodities, specialty natural chemicals etc.

J. New trends agricultural linked to climate change

Trend item	Snags and difficulties
Carbon farming and the CDM (spekboom)	Need 10 000 ha to get CDM interest. Legally byzantine.
Biofuels and energy feed stocks	Policy issues Feed in tariffs in SA (this is now available) Resistance to Renewable Energy.
Keeping natural vegetation intact for CDM	Need to check new CDM categories and “programmatic CDM” Legally byzantine.
Tree Planting for CDM	Must not conflict with biodiversity spatial issues. Usually rehabilitation of degraded native forests is only ethical choice, SA doesn’t have enough natural forests.
Threat of “carbon miles” accounting for long distance products	EU and UK destinations (flowers and wines, strawberries) might diminish under the impact of implementing an embargo on goods that accrue ‘carbon miles’ or even have a high carbon footprint for their production.

K. Commercial farmers in the Western Cape

Province doesn’t interfere with commercial farming sector, but this sector is getting less profitable which has impacts on the provincial economy.

There are already CC threats eg. Fruit and flowers – **carbon miles**.

Wheat farmers are looking for a new crop to replace wheat in the W’Cape. Eastern Free State also grows wheat.

- New developments in wheat breeding - there is now a GMO wheat available. What characteristics will this give us?
- Small Grains Institute – also producing new cultivars of wheat for south African conditions.

What farmers really need is good seasonal forecasts (need now, to plan what to plant now) and then for climate change, longer term planning.

Also, the seed companies need to be ready with climate change adapted seed material that the farmers can use.

Seed companies

Seed companies need to start meeting the needs of changing climatic conditions with new cultivars.

Also, the seed companies need to be ready with climate change adapted seed material that the farmers can use.

Genetic engineering of conventional crops

What is interesting is Monsanto/BASF's plan to buy up all the drought R genes and gene sequences that are known, to create a library (which they own) from which they can produce GMO crop plants to respond to climate change. Climate change and agricultural adaptation is seen by them as a big new frontier and commercial opportunity!

They plan to work with the "big five" crops, maize, wheat, sorghum, sunflower, rice – selected presumably because such a lot is already known about the genetics and plant breeding of these plants, and gene banks already store thousands of acquisitions, wild relatives etc. used for plant breeding of these crops.

It would be very difficult to get to the same level of understanding for novel, orphan and lost and new crops – this prevents the further development of, and investment in, 'lost crops'.

However, Australia is investigating some of Africa's 'lost crops' in terms of pearl millets.

Subsistence farmers in the Western Cape

Subsistence farmers – what about them? They already end up in marginal areas and drought prone areas? Their farming activities usually do not account for 100 % of their income, they have to engage in other activities too (jobs in the formal sector).

The need to diversify rural livelihoods – perhaps new development from the new Rural Development

There are also food security issues that need to be balanced with economic activity issues eg. cash crops, luxury items (herbs grown for Woolworths), export items, biofuel crops etc. , job creation.

Regional and local food security

Food security an issue – but perhaps other ‘eastern’ provinces and SADC countries need to become better at growing and processing food for the region (SA expertise, investment and play a strong role, capacity building, partnerships etc), and that agriculture is planned on a regional basis as the climate changes. Then Western Cape and drier regions could focus on specialized processing or non-food agriculture activities where possible (eg. Linked to a bio-based economy, carbon trading etc).

South Arica and the Western Cape could look at supporting South African entrepreneurs to go into other African countries to set up food production, need to give these South African farmers training in dealing with complex situations (political and economic instability etc), but then supply raw materials to production centres in the Western Cape.

Market research would be needed to find markets for novel products and chemicals.

Market research would be needed to see what African consumers require in terms of novel or bulk agricultural produce.

N. Sources of new or novel crops



1. Existing crops grown in new areas, extending their planting range.
2. Bringing in crops grown in other parts of the world (Mediterranean crops).
3. New crops from old – plant breeding
4. New crops from old – genetically modified crops.
5. Entirely new crops - investigation of indigenous species of plants (never been domesticated or used), investigation of traditionally used plants (medicinal plants, food plants), investigation of “lost crops” where some cultivation or management done.
6. Entirely new uses for old or new crops and plants – the bio-based economy, novel molecules.
7. Ways to generate new crops and farming/manufacturing opportunities.
8. Issues with new agricultural products, organics, and new markets

Sources of new or novel crops

1. Existing crops grown in new areas, extending their planting range.

- Growing the big five crops, fruit crops etc. in different areas. Eg. Grow more maize in the Cape where wheat used to be grown.
- Grow more olives in areas where frost no longer occurs.

2. Bringing in new crops

Easy choice - Mediterranean crops

These plants are very well researched, hundreds of cultivars/varieties available, processing mostly known. Also the crops are well known so now marketing needs to be done to get consumers to buy them (olives, figs, dates, pomegranates) although marketing is needed to penetrate new markets.

The new challenge would be to find new uses for these plants (new products in food and health sectors) and new markets.

Table showing typical Mediterranean crops that are available, and some are already being cultivated in South Africa.

Crop	Market	Local/international
Olives	Oil, table olives, sophisticated antioxidant chemicals	Local, into Africa, also international. Need to expand range of cultivation, more players. Need to develop more products based on olives and respond to market segmentation (health markets).
Pomegranates	Antioxidants, anti-aging, nutraceuticals, natural foods and drinks	Small local market, bigger international market with sophisticated requirements for antioxidants (but carbon miles).
Carob	Grows well, already a municipal tree grown in many parks, streets.	Health market, chocolate substitute
Persimmon	Novelty fresh fruit	
Dates	Size of market would need investigation	Would need investigation
Pistachios	Already being researched as a crop in SA	Well established crop, markets
Figs	Demand exists locally for more figs, most imported.	Well established crop, markets

In South Africa, it seems these crops are planted by well-resourced farmers or maverick farmers who want to “go it alone” and there is no coordinate industry that extracts levies from farmers to pay for R&D, importing new varieties, handling training of new entrants into the sector, and joint marketing.

3. New crops from old – plant breeding

- Wheat breeding is coming up with new wheat cultivars (Small Grains research institute).
- Seed companies need to start matching their new breeding programmes with climate change challenges (different growth lengths, reduced water needs etc).

4. New crops from old – genetically modified crops.

- Monsanto/BASF big thrust is to develop drought tolerant varieties of the ‘big five’ world crops.
- The snag here is that South African farmers may not be able to pay for expensive GMO varieties, unless these can be subsidized by government.
- Similarly, imported GMO crop varieties may not suit local conditions.
- Also, to produce local crop varieties with the same genes from the multinationals could work, but expensive unless some special Kyoto Protocol “adaptation fund” need is identified.
- Funding for R&D is a big challenge.
- Need better technology transfer via university Technology Transfer Offices (TTOs).
- Also, need to investigate global technology transfer promises in terms of the Kyoto Protocol and the Adaptation Fund.

Convention on Desertification – also mentions that GMO crops may have value in areas of land that has been damaged and desertified.

5. Entirely new crops

At its simplest, includes new food, vegetable and grains crops, spices, flavourings looking at native biodiversity as a source.

Table showing sources of new crops, with some comments on markets and international trends.

Crop	Market	Local/international
<p>“Lost crops of Africa” including vegetable, fruit and grain species in South Africa.</p> <p>2000 species listed http://www.nap.edu Lost Crops of Africa Vol I – III (1996). National Academies Press, USA</p>	<p>Local nutritional needs, replacement ‘big five’ crops (maize, wheat, sorghum, rice, barley), crops for marginal areas, arid areas, specialty new proteins, carbohydrates.</p>	<p>Basic foods, food security issues.</p> <p>Domestication of these could be arduous, take years, unless they can be cultivated extensively as is.</p> <p>Also, the R&D for processing.</p>
<p>Indigenous fruit and vegetable from other parts of the world</p>		<p>Novel products, catering for diaspora markets and customers. Or for more affluent customers wanting variety.</p>
<p>ARC doing work on indigenous fruits</p>	<p>Medlars, plums, marula, indigenous leafy vegetables</p>	<p>Taste not optimal (eg. CSIR recipe book).</p>

Crop	Market	Local/international
	(<i>Chenopodium</i> , <i>Amaranthus</i> etc). Bambara beans	'Xenophobia' of unfamiliar plants for food.

Table showing examples of familiar new crops in the last 20 years (global)

New Crop (foods)
Kiwi fruit
Horticultural releases, varieties (floral varieties, cut flower, pot plants)
Star fruit
Yellow maize
Essential oils (indigenous)
Hoodia
Pepperdew
Okra and other Asian vegetables now seen more widely (custard apples).

6. Entirely new uses for old or new crops and native plants – the bio-based economy, novel molecules.

There is a growing global trend to look to novel plants to create new products and new industries (food, health care, pharmaceutical and industrial chemicals).

This is the new 'bio-based economy' that is predicted to be the next wave of industrial development. As well as making much more use of biodiversity, these industries must also aim to be sustainable and have a low carbon footprint.

6.1 Examples of the types of 'bio-based' activities underway locally and internationally

Table showing examples of bio-based activities, with comments on local and international issues.

Crop	Issues, Markets	Issues, Local/international
Indigenous medicinal plants	South Africa (DST's Ten Year Innovation Plan) looks at creating a Farmer to Pharma chain of value, specifically in SA indigenous plants and knowledge. To build up a local pharmaceutical	International partners and markets. Sophisticated, high value market, very competitive, huge barriers to entry (eg. FDA approval).

Crop	Issues, Markets	Issues, Local/international
	industry based on local medicinal plants	
Industrial crops – biofuels, ‘energy’ crops	Local 4.5 % of fuel mix. Growers need to lobby government for a great % of the fuel mix. Sale to local users, communities to produce their own energy requirements, self-sufficiency in energy.	Local, African and international markets. Africa would want to become an ‘OPEC’ grouping producing biofuels. Sustainable agriculture an issue. Food security an issue.
Natural technical fibres	Seem to be a complete new industry on its own.	
Commercialisation of native wildflowers. Cape Floral diversity and horticulture products	Proteas, fynbos plants, bulbs, Namaqualand, succulents. Wild harvesting (eg. Valley Trust) or cultivation and cultivar development (proteas).	Investigate what New Zealand is doing here. Capelands in vitro already exploring this for cut flower industry (mass propagation to supply on to growers).
Products from algae, and even genetically modified algae.	Biofuels, carotenoids, algal polysaccharides,	Local, African and international markets.
Biotechnology process feedstocks	Industrial fine chemicals, proteins, polysaccharides etc.	Local, African and international markets.
Microbially produced molecules, proteins, enzymes, fine chemicals etc.	Enzymes, novel molecules, DNA gene products for medicine, cloned proteins eg. Insulin.	International markets, very competitive. Global venture capital non-existent at the moment (recession).

6.2 Some issues on markets, opportunities and difficulties of ‘bio-based sector’ crops, especially for a developing country like South Africa.

Table showing some issues relating to the bio-based and biotechnology sector, with comments.

Crop	Market	Local/international issues	Difficulties
Imported GMO versions of conventional crops, to give pest, disease or drought resistance.	Local, SADC.		Monsanto/BASF have bought up just about every drought tolerance gene in existence.

Crop	Market	Local/international issues	Difficulties
Locally developed GMO crops of locally used varieties of crops	Local, SADC	Consider Adaptation Fund approach to fund technology exchanges.	Expensive, long term, technical difficulty huge. Need to develop the genes for this. Or pay royalties.
GMO crops for biofuels processing	Local, SADC biofuels markets	Eg. Syngenta ethanol maize.	Technological challenges, skills needed, start up arena difficult. Limited to big multinational players.
Bio-based economy	This is part of DST's 10 year Innovation Plan.	New global thrust, predicted to take over from IT revolution. Includes elements of a Knowledge based economy.	<p>Venture capital has dried up for technology innovation (global recession), even for very good ideas.</p> <p>Research funding has also become difficult.</p> <p>Start ups are very tough, unique set of business challenges.</p> <p>Serious business and technology skills needed to make a go of biotech startups.</p> <p>Market research is the single most important aspect of any start up and is mostly badly done.</p>
GMO crops and algae producing novel compounds	Eg. Producing vaccine components, novel proteins.		As above
Industrial crops – biofuels (sugar, sugar beet,	SA Biofuels Strategy - Local 4.5 % of fuel	Local, African and international markets.	Fairly low tech, needs agric and infrastructure

Crop	Market	Local/international issues	Difficulties
maize and cellulose residues).	mix.		development and investment.
Biotechnology process feedstocks	Eg. Wood or cellulose material that is easily digestible for yeast fermentations – Biofuels. Novel materials.	Local, African and international markets.	Start up arena very tough.
Bacterial and fungal processes	Genetically modified microorganisms (bacteria and fungi) yielding new enzymes, novel molecules, DNA gene products for medicine, cloned proteins eg. Insulin, vaccines.	International markets, very competitive. Global venture capital non-existent at the moment (recession).	Start up arena very tough.

6.3 Snags and major obstacles to the hi-tech route and route to development of bio-based industries.

Table showing some of the difficulties in establishing bio-based activities.

Crop	Snags	Local/international
GMO versions of conventional crops, to give pest, disease or drought resistance.	R&D needed, very expensive. Private or public research issues. Levy's from big agric sectors. Need to develop the genes for this. Or pay royalties.	Monsanto/BASF have bought up just about every drought tolerance gene in existence.
“Lost crops” of Africa	Funding of research. Access and Benefit Sharing, Patenting, plant breeder's rights.	Snag with people resisting eating new crops eg. Even yellow maize was met with resistance.

Crop	Snags	Local/international
	<p>Partnerships. “Alien species” issues and testing to ensure that new plants brought in are not going to be invasive eg. Jatropha issue.</p> <p>Long time horizons to domesticate new crops (15 – 20 years).</p> <p>Would be very difficult to get R&D funding for lost crops, unless it was an emergency eg. Perhaps Climate Change is that emergency!</p>	<p>Long preparation process for cooking, difficult to cook, no-one knows how to cook the material. Taste not optimal (eg. CSIR recipe book).</p> <p>‘Xenophobia’ of unfamiliar plants for food.</p>
<p>Indigenous plants eg. Medicinal plants</p>	<p>R&D needed, very expensive. Private or public research issues. Protection of IP, complexities of start ups, patents, royalties. Also, Access and Benefit sharing issues. Eg. Hoodia</p>	<p>South Africa intends to become a key player in the global pharmaceutical industry, through development of local plant species (Ten year innovation plan, DST).</p>
<p>Indigenous plants – fruits, grains, leafy vegetables.</p>	<p>Research is under-funded. Orphan crops. Community issues eg. Marula. Access and benefit sharing.</p>	<p>Taste not optimal (eg. CSIR recipe book).</p> <p>‘Xenophobia’ of unfamiliar plants for food.</p>
<p>Health markets</p>	<p>Teas, herbs, Hoodia, organic products.</p>	<p>Seems very big globally, need sound market research studies.</p>
<p>Industrial crops - biofuels</p>	<p>Local 4.5 % of fuel mix. This is said to be not enough to stimulate investment in the biofuels sector in South Africa.</p> <p>Environmental issues (eg. Further destruction of valuable biomes for</p>	<p>Local, African and international markets.</p>

Crop	Snags	Local/international
	agriculture). Social issues – food security, maize for biofuels rather than food.	
Industrial crops	Fibres, novel compounds (antioxidants, polysaccharides etc).	Novel fibres are apparently always in demand. Need market research

6.4 Other issues with management of innovation linked to novel crops and novel bio-based ventures, start ups.

Table showing issues that need to be addressed early in the development of novel crops, biotechnology enterprises and those connected to developing bio-based industries and products.

Commercialisation of a new idea	Market research	IP and Patents
Patents and innovation Commercial advantage has to be created, to add value, or else the patent is useless. Need to find the market opportunities, to add value.	For any new product, venture, crop – do adequate market research. You need to truly understand the market for the technology (new crop, new chemical, material, agricultural product).	Patents are essential to keep competitors at bay, but there is a cost to registering and protecting a patent. Also, having a patent does not mean anything until the patent is developed into a product that sells and generates profits. Patents are useless without the resources to take the idea through to commercialization.
University TTOs and scientists do not fully understand the gap between research and commercialization, and the costs and time that it takes to successfully commercialise a high tech process.	Market research is the single most important aspect of any start up and is mostly badly done.	There is a whole issue around “publically funded research” that is then taken forward by private research agencies.
Understand the time and cost it takes to get something new into the	Just because something is the latest and greatest, doesn't mean that people	

Commercialisation of a new idea	Market research	IP and Patents
market place	will buy it.	
Partnerships essential, to be able to meet a wide range of complex technical, market and IP issues.	High tech Entrepreneurs under-estimate the importance of a market survey – and the cost.	

7. Ways to generate new crops and farming/manufacturing opportunities.

Rural innovation, screening of local biodiversity for interesting chemicals/medicinal – being done in SA, especially medicinal plants and indigenous knowledge.

Market research (give an example of those international market surveys) and then growing the plants needed for these commodities.

Snags – any plant breeders rights, any patents, any further R&D

Investigate African, regional or South African biodiversity.

Some research done on fruit ...

Hoodia

Rooibos tea,

Essential oils (buchu, Lipia javonica and others).

Lost crops material – try then out in SA.

Medicinal plant screening (CSIR, MRC and academic consortium)

Biodiversity of interest elsewhere in the world – bring in new material and try out.

A whole lot of procedures, Access and Benefit Sharing, phytosanitary issues.

No wonder everyone keeps to conventional crops (even Monsanto/BASF's big investment in genetically engineered conventional crops).

Novel crops from other parts of the world – that are domesticated already. There are many such crops being explored in other parts of the world, they would need to be brought into SA for field trials.

8. Issues with new agricultural products, organics, and new markets

- Global trends - Natural products markets and pharmaceuticals, nutraceuticals
- Indigenous vegetables
- Organic vegetables and standards, marketing
- Marketing information, better markets
- Actual cultivation and horticultural issues.
- New pests and diseases, phytosanitary issues
- Research into agronomy, cultivation, breeding
- Quality management and certification
- Packaging and processing

- How to build in ‘sustainability’ and resilience into agriculture at all levels?
- Need market research (how volatile are the markets, are they existing markets, or do they need to be created). Branding issues, geographical indicators, trademarks etc.

9. What will be needed to establish an agricultural industry that has elements of novel crops or a bio-based economic approach:-

- Partnerships with other countries doing same kind of work to identify and develop novel crops.
- Groups of local farmers or co-ops, or local agricultural business associations, or government research agencies (ARC) to purchase or “order” a big market survey to find out what products/crops, compounds and opportunities are needed globally and continually keep an eye on this, to pick up new opportunities.
- A system for funding novel crop research and to be able to move quickly to take up opportunities.
- A way to “match” novel crops with future climatic landscapes in the future.
- A levy system in “novel crop” sectors eg. Olives to fund research and development, assist new entrants and do joint marketing.
- Plant breeding skills for novel crops
- Capacity building for farmers to be able to grow new and novel crops, to be able to process new and novel agricultural products,
- Significant commercial partners (who would these be?)
- Better research alignment for startups – universities, research and business start ups.
- Investigate horticulture biotech in Australia and New Zealand, and try to find partnerships or products are.
- We might have to fund the setting up of novel agriculture/horticulture and biotechnology “industries” rather than just novel crops.
- Processing facilities including those involving biotechnology eg. Growing feedstock material for fermentations (ethanol).
- Dealing with novel waste produced by novel crops.

10 Case studies on the difficulties of domesticating and commercializing native species

A paper I did last year⁴ illustrated different difficulties in developing and commercializing novel crops from indigenous material. Hoodia, Rooibos Tea and Marula were investigated to compare how they had been commercialized.

The key finding was that the domestication and commercialization of new wild species is not a straightforward undertaking. For novel crop development, it might be easier and cheaper to import crops that have been developed elsewhere, like the suite of Mediterranean crops (olives, pomegranates etc) before considering indigenous species.

Table: Summary of issues linked to the domestication and commercialization of three South African indigenous plants.

Plant name	Issues	Opportunity
<i>Hoodia gordonii</i>	<p>Patent, royalty and ABS issues, cultivation issues, product development, safety and efficacy.</p> <p>Patent 1994, various serious complications with licensing and the patent.</p> <p>CITES issues, overharvesting.</p> <p>Rachel Wynberg just written a book on all of these issues. (2009).</p>	<p>Huge global market for obesity and dieting products.</p> <p>New compound on the scene, but already many hundreds of informal products (capsules, drinks, food products).</p> <p>Plant can be grown anywhere with limited rainfall, even in cold, frosted areas.</p> <p>Cultivation methodology worked out.</p> <p>No plant breeders rights registered.</p> <p>South Africa needs to grab hold of this situation and make a big industry of this plant.</p> <p>Need to sort out the safety and efficacy problem (Unilever withdrawal, 2008).</p>
Rooibos tea <i>Aspalanthus linearis</i>	<p>Since the 1940's farmer cheap tea. Moved through to a bigger industry, following health trends, caffeine-free beverage,</p>	<p>Good research, marketing approach, to track sophisticated new markets (healthcare, anti-aging etc).</p>

⁴ "Making the most of what we've got: The commercial beneficiation of indigenous plant species in arid areas" (2008). Sue Taylor. Centre for Development Support. University of the Free State. Bloemfontein.

Plant name	Issues	Opportunity
	<p>now antioxidants.</p> <p>Any ABS issues have been ducked. There are community growers and harvesters, as well a big commercial growers. Central drying and packaging.</p>	<p>SA Rooibos tea Ltd control the supply of authentic rooibos tea to global markets.</p> <p>Lucky that this plant can't be grown elsewhere.</p>
<p>Marula <i>Sclerocarya birria</i>.</p>	<p>Still no formal cultivars protected by PBR, accessions to Israel and no ABS. No formal orchards yet. Much of the research has focuses on the role of this plant/fruit in the community and the dynamics and contrib. to livelihoods. About 20 years of research.</p>	<p>Needs work to become a recognized fruit cultivar, with selections for best quality fruit. Need associated processing to make this fruit into a big range of products. Need to brand this fruit and its products. Need to protect IPR, global indicators, trademarks, plant breeders' rights etc.</p>

M. POSSIBLE APPROACHES TO ADDRESS THE UPTAKE OF NOVEL CROPS

1. **Suggest that Elsenburg set up a task team to look into Bio-products and the bio-based economy, source some of the material – and host a conference/workshop on this subject. Need a strategy to get this going in the W’Cape. Need to work with the DST, although suggest Elsenberg would be able to do this for themselves.**
2. W’Cape and South Africa needs a “Novel Crops association” to foster the development of these crops.
3. As in other countries, need to foster smaller novel sector agricultural groups eg. An indigenous fruits group, Hoodia Growers Association (existing). There are already essential oils group etc.
4. Needs funding to get a networking forum going, with an annual conference, and perhaps workshops, website, information portal and other support.
5. Need a Novel Crops policy for the province – phytosanitary, patent issues, intellectual property, sustainable agriculture etc. norms and standards to be spelled out.
6. Support to farmers who would be prepared to try out novel crops.

7. Market research – who to pay? Perhaps the ARC would pay for a market research report on new market trends (novel chemicals, novel fibres, organic markets, juice bars and other “shopping mall” markets etc).
8. Research and development for these crops – who to pay?
9. Need links to other groups eg. Australian Rural Industries Research and Development Corporation (www.newcrops.uq.edu.au) and groups in USA and Canada.
10. Some government funded research to ‘match’ likely new crops with climatic and soil conditions in the Western Cape, and then begin a field trial programme to see how these crops do locally.
11. Government R&D focus on a portfolio of novel crops (some food, some industrial, pharmaceutical) along the lines of the medicinal plants consortium (CSIR, MRC and others).

N. Conclusion

While there are many simple and affordable methods that farmers can use to adapt their farming practices to a harsher climate (including changing to different agricultural practices like minimum tillage, drip irrigation and so on), there is a hierarchy of approaches that can and need to be put into place as the climate slowly changes to another state, predicted to be in place by 2050.

The adaptation hierarchy will include the use of drought tolerant cultivars of existing crops, GMO versions of existing crops, novel crops and plants from arid areas (eg. Mediterranean crops, crops like sisal and poppy). A final state may be linked to the bio-based economy where more and more products are produced in tanks. Input materials are needed, but they could be produced elsewhere in the SADC region, for instance.

With the bio-based economy, intellectual property, innovation management, industrial processes, setting of standards and other similar issues become important.

The main challenges, in addition to the above, include sourcing funding for research and start ups, and also how to include the less skilled person or farmer into this challenging sector.

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