Implications of the National Water Resource Strategy 2 on irrigation agriculture, its economic contribution and the long run sustainability

A pilot study report in the Elias Motsoaledi Local Municipality (Groblersdal)

A report by the Bureau for Food and Agricultural Policy (BFAP) & PULA Resource engineers, commissioned by the South African Irrigation Corporation (SABK)

April 2013

The Bureau for Food and Agricultural Policy (BFAP)

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

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Executive summary

On 11 November 2011 the National Development Plan 2030 of the National Planning Commission was released. The overall target is to reduce the number of households living below R448 per month per person from 39% to zero by 2030. Within the Plan agriculture is identified as a key driver of food security, job creation and the social upliftment of rural communities. Many of the potential winning industries that have been listed in the plan are dependent on water. In fact, water takes on a role as critical strategic resource within the National Development Plan. With an increasing demand for water in industries such as mining/electricity generation and the rapid growth in demand by domestic/urban growth, agriculture finds itself in a tight space within government's new National Water Resource Strategy 2 (NWRS-2) framework of water allocation, taxes and quotas. This puts forward the current debate between conflicting parties competing for water in South Africa and the need to fully evaluate the impact of water as a key component in the agro economic sector.

This study was commissioned by the South African Irrigation Corporation (SABK) and undertaken by the Bureau for Food and Agricultural Policy (BFAP) and PULA strategic resource management. A first attempt was made to highlight a selection of plausible implications of the NWRS-2 on irrigation agriculture, its economic contribution and sustainability by developing a range of scenarios that could unfold depending on the final outcome of the NWRS-2. For the purpose of this study, the Elias Motsoaledi Local Municipality was selected as the pilot area. In this area 25 000ha are irrigated and the gross value of the primary agricultural produce that is produced on this land amounts to R2.3 billion, which implies 1.9% of RSA total gross value of agriculture is produced on this small area. It is further estimated that 18 500 on-farm jobs are dependent on irrigation.

A range of scenarios were developed around two of the basic elements of the NWRS-2, namely the costs of water and the water quota that is allocated to agriculture. Modelling results illustrate that under a scenario of increased water costs and a reduced quota the loss in gross margin from primary agriculture in the area could amount to 75%, putting 30% of the area at risk of going out of intensive production and threatening 33% of the on-farm jobs.

This could be the "tipping-point" for an already stressed agricultural sector, with significant impact on the local economy, rural livelihood and food security. The study determined the sensitivity and vulnerability of agricultural food production in a potential water re-allocation scenario. It also highlights the broader social and economic implications on household food security in an area where about 885,000 people or 56% of households are classified as indigent.

The results of this study, therefore, clearly highlight the potential of the NWRS-2 standing in contrast to the targets set out by the national development plan. In addition to pure economic implications, the socio-economic considerations and the implications for food security are significant. Apart from the direct job losses and the implications for the dependent households, there is a significant volume of informal trade, mainly due to the large volumes of vegetable production in the area. Hence, a reduction in the level of vegetable production will also have an impact the informal economy of the district, thereby also influencing the level of food security.

The impact of a decline in production on food prices will differ for the various commodities. Since at least 25% of the countries cabbage is produced in this area, one can expect that cabbage prices on national markets will be influenced by a shift in production in this region. This is however not the case for maize or wheat where this area's share of the national maize crop is small. Yet, the point is that this is only one case study for a specific area and the NWRS-2 could affect all irrigation areas in the country and under that scenario, the impact of food prices and therefore food security will have to be considered.

To conclude based on findings of this pilot study and the severity of impacts, a national assessment of irrigation areas is recommended. In other words, the uniqueness of irrigation agriculture in South Africa provides the motive for evaluating each irrigation area separately. The financial viability is influenced by a number of economic factors, but even more so influenced by the geographic region in which cultivation takes place.

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1. Introduction and background

With an increasing demand for water in industries such as mining/electricity generation and the rapid growth in demand by domestic/urban growth, agriculture finds itself in a tight space within government's new National Water Resource Strategy 2 (NWRS-2) framework of water allocation, taxes and quotas. This puts forward the current debate between conflicting parties competing for water in South Africa and the need to fully evaluate the impact of water as a key component in the agro economic sector.

A series of workshops were held by Department of Water Affairs (DWA) with organised agriculture to explore the role of water in agriculture and identify areas requiring water allocation and management reform to meet the overall objectives of the NWRS2. This included, the use of water by irrigation schemes to produce food to boost the country's food security and to generate much needed economic and social development in rural areas of our country. It also included the need for agriculture to reduce its water quality impacts and demonstrate its efforts and successes in improving water use efficiency.

The National Development Plan (NDP) has set specific development targets for Agriculture, which depend on water as a primary resource and enabler as many of the high value and labour intensive commodities are dependent on water. It is therefore essential for the Department of Agriculture, Forestry, Fisheries (DAFF) and DWA to jointly evaluate the requirements necessary to achieve the NDP targets as part of the development and review of the NWRS2. This includes possible scenarios for:

1) Water availability and
2) the utilisation for food security,
3) job creation and socio-economic development

Subsequently the South African Irrigation Co-operation (SABK) commissioned this pilot study by BFAP and PULA strategic resource management to quantify the role of irrigation agriculture in a pilot area and to assess the potential impacts of water allocation reform on the sector and its roles of food security, job creation and socio-economic development.

Due to the diverse nature of natural production conditions and the economic and socio-economic environment for various production areas, it was agreed that irrigated water use and its contribution to economic growth, social development and job creation is area specific and ultimately needs to be assessed for each and every irrigation scheme in the country.

It was, therefore, decided that as an interim, a pilot study is selected for the SABK study by means of using a representative irrigation scheme as an example of potential impacts and opportunities. Such a

pilot should have all or most of, the elements of irrigated agriculture and must have readily access to actual water use and production information for a rapid but accurate assessment.

Due to the following characteristics, the Loskop irrigation scheme was selected as a pilot area of research:

- Located within a catchment with increasing water shortage and growing water demands across various sectors (e.g. natural, social, mining, agricultural and industrial water use).
- Comprises of a variety of irrigated crops to test the sensitivity and vulnerability of irrigated production across different cropping patterns.
- Plays a significant role in local, regional and national food security through its supply of basic food to neighbouring impoverished areas on the Nebo Plateau, its food supply to fresh produce markets in Limpopo, Mpumalanga and Gauteng, its supply into the national food chain of frozen vegetables and through fruit exports of citrus and table grapes.
- Is a measurable creator of jobs in the primary production of food and secondary processing of food.

First-order study findings are presented in the sections to follow and an attempt is made to extrapolate the impacts to the national context, albeit at provisional / indicator level only. Further investigation and modeling is required to firm up on the scenarios, especially on the national implications.

2. Irrigated Water Use and the NWRS2 - Contextual Overview

The draft NWRS-2 provides an overview of water's contribution to the South African economy (see chapter 4) and states that … " there is potentially sufficient water available for development" (see chapter 5) if water losses are reduced and water is used more diligently and productively. Chapter 6 emphasizes the need to "manage water use for optimum, long term environmentally sustainable social and economic benefit", which implies that water allocation must be seen holistically across social, economic and ecological benefits.

Agriculture and irrigated water use plays a strategic role in many aspects of the above mentioned fundamentals of the NWRS-2.

- While irrigation is the largest water user, as stated in chapter-4, it must be noted that national volumetric figures such as 60% (or 56% as stated in WRC research) can be misleading if it is not evaluated spatially against alternative water uses and if the level of assurance is not considered in such comparisons. As an example, irrigated water use is a minority user in Gauteng Province, while it dominates in the lower Orange river and many other remote / non-urban areas. It is also well known and accepted that agriculture, receives a much lower level of assurance than most other water users and that it has to manage the risks of water shortages through profits and losses over multi-year cycles. Volumetric comparisons must thus be clarified through a spatial footprint and must be at a common comparative assurance level;

- The economic value of irrigated water use must also be put into context of its value chain and cannot be classified as contributing only 3% to the GDP as stated in chapter-4. While the primary agriculture may be as low as 3%, it contributes up to 18% in secondary processing (total of 21% as per IPAP-2).

- The socio-economic value of irrigated water use is significant and responds directly to the basic human right to life, food and social security. It also plays a key role in the 3rd highest water allocation priority of the NWRS-2 (see chapter 6) to address poverty eradication through job creation and its key role in sustaining rural livelihoods. The National Development Plan (NDP) has set specific targets for job creation in agriculture and the role of water is key to achieve these.

The purpose of this pilot study is to test the relevance of irrigated water use in the above social and economic performance areas in order to inform the NWRS-2 in its difficult task to manage an ever increasing multi-faceted water demand within the constraints of South Africa's limited water resource.

Key aims of the study are therefore to quantify the economic and social contributions of irrigated water use in a selected irrigation scheme where water is a scarce commodity and where social needs and economic driving forces are prevalent. It cannot be a full reflection of irrigated water use in South Africa and must in future be validated and extended in other irrigated areas across the country.

3. The pilot study area – Elias Motsoaledi (Groblersdal)

Most of the Elias Motsoaledi irrigation area also referred to as the Groblersdal or pilot area is based in the Loskop irrigation scheme. According to the Loskop irrigation board (2013), the scheme has a water allocation of 16 117 hectares with a water quota of 7 700 m3 of water per hectare per year.

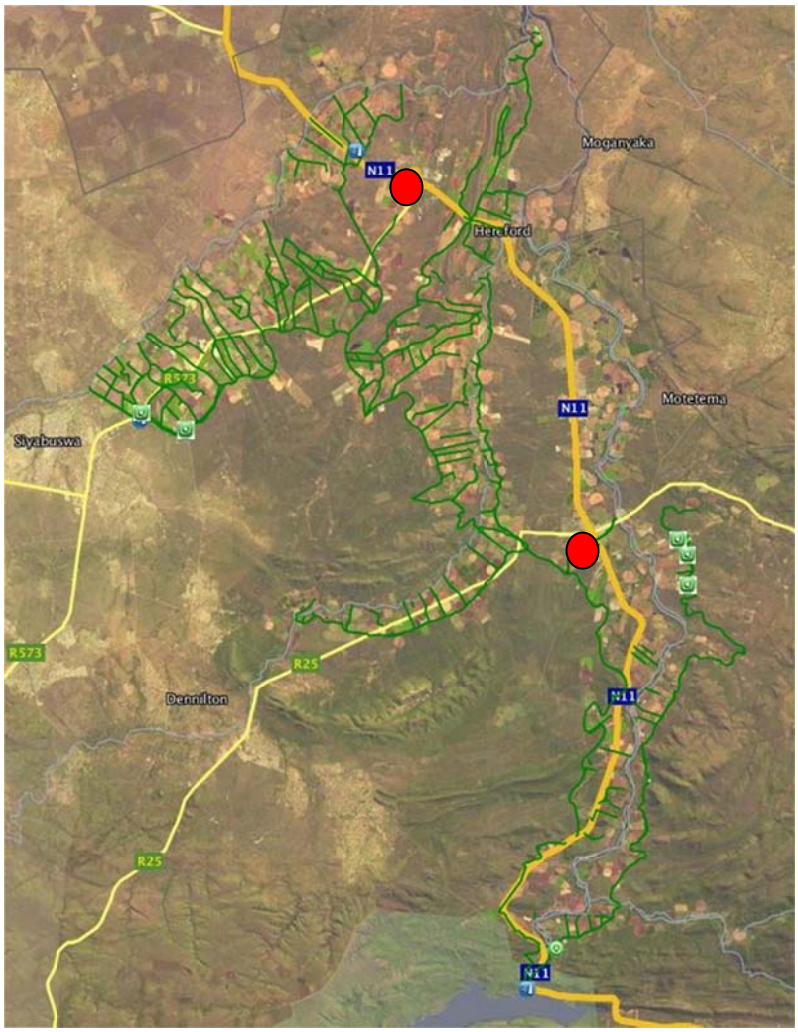
Recent surveys of cultivation in the scheme area (LDoA, 2012 and confirmation by Loskop Irrigation Board 2013) shows that up to 25 600 ha are currently being irrigated, which indicates that available water volumes have been stretched to enable more hectares of cultivation and more production with the same water. This could however also indicate that farmers are exposing themselves to a higher risk of failure especially considering that the water allocation is at a relatively low assurance level of 80%, or less if stretched.

Loskop dam was initially built to provide for the irrigation needs of primary producers (farmers) in the Olifants, Moses and Elands River valleys.

Outlet works were built on both sides of the dam wall to support the water released into a canal system of 676 km, providing water inter alia to irrigate an area of approximately 25 600 ha.

It was further noted that water from the Loskop dam supplies the Olifants River Irrigation Board, the Hereford Irrigation Board as well as the domestic water needs of Groblersdal, Marble Hall, Motetema, Tafelkop and other communities on the south-western side of the Nebo Plateau.

The irrigation scheme borders the Nebo plateau where water resources are scarce and up to 400,000 people are in need of basic water supply and household food security.

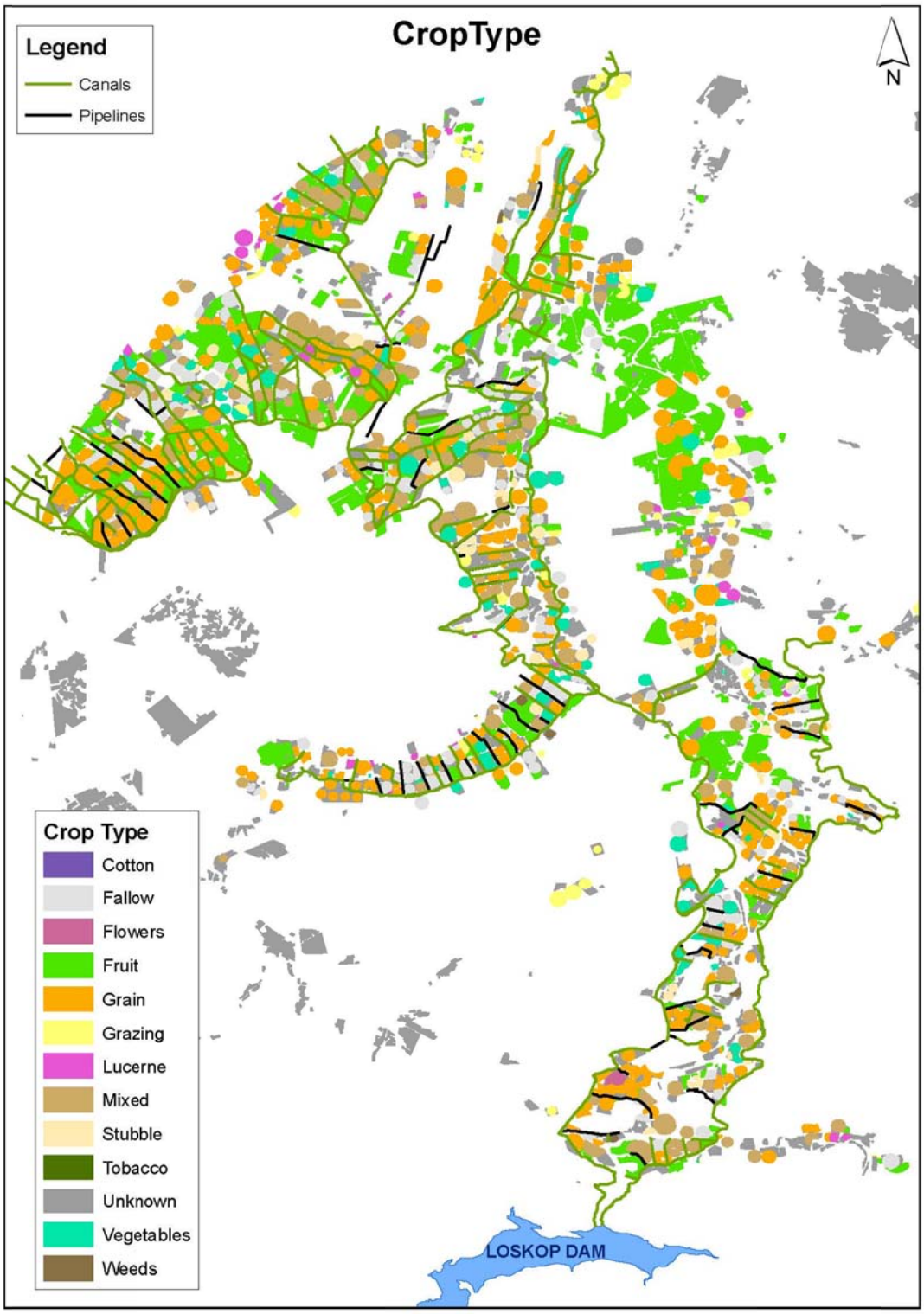


Regional mining developments in Mogalakwena and Greater Tubatse areas are also demanding water and there is mounting pressure on the existing water resources to be extended for these new water needs. The construction of the De Hoop dam will bring much needed relief to the water needs on the Nebo Plateau and Tubatse mining areas, while some water re-allocation may still be required to serve the future water needs of the Mogalakwena LM and north-western mining areas.

Similarly, irrigated agriculture produces much needed food and jobs for the social and mining development needs in the area. The pilot study looks into the social and economic role of irrigated agriculture to support sustainable development in this area.

3.1 Spatial overview of irrigation area

The area under irrigation and its cropping patterns were determined by a recent field survey undertaken by SIQ in 2012 for the Limpopo Department of Agriculture. (LDoA), with the project title named "The Mapping of Agricultural Commodity Production in Limpopo". The spatial data was further analysed and processed by BFAP, to limit the area to a 30km buffer pilot area, as displayed in map 1.



Map 1: Overview of irrigation in pilot area - 30km buffer zone

Source: *The Mapping of Agricultural Commodity Production in Limpopo (LDoA), compiled by PULA*

The actual hectares under irrigation was derived from the SIQ (2012) survey data and is summarized in Table-1 below:

Table 1: Overview of hectares planted in pilot area

Winter irrigated crops	**Ha**	**Summer irrigated crops**	**Ha**	**Annual irrigated crops**	**Ha**
Beetroot	**128**	Broccoli	**28**	Citrus	**8 506**
Broccoli	**54**	Butternut	**101**	Table Grapes	**1 422**
Butternut	**5**	Cabbage	**148**	Pecan Nuts	**87**
Cabbage	**328**	Carrots	**11**	Olive	**34**
Canola	**50**	Cauliflower	**53**	Peach	**33**
Carrots	**101**	Cotton	**434**	Macadamia Nuts	**20**
Cauliflower	**157**	Dry Beans	**385**	Plum	**18**
Lettuce	**2**	Lettuce	**1**		
Lucerne Medics	**550**	Lucerne Medics	**208**		
Maize	**37**	Maize	**10 155**		
Onions	**20**	Planted Pastures	**579**		
Peas	**952**	Potatoes	**102**		
Planted Pastures	**422**	Pumpkin	**110**		
Potatoes	**781**	Sorghum	**31**		
Pumpkin	**7**	Soybeans	**1 380**		
Spinach	**32**	Squash	**25**		
Sweet Potatoes	**26**	Sunflower	**5**		
Wheat	**10 539**	Sweet Potato	**7**		
		Tobacco	**1 221**		
		Tomato	**3**		
Total Winter Irrigation	**14 190**	**Total Summer Irrigation**	**14 987**	**Total Annual Irrigation**	**10 119**

Source: The Mapping of Agricultural Commodity Production in Limpopo (LDoA). Compiled by BFAP 2013.

Above table provides a comprehensive summary of the crops and areas under production. In total 25 106 ha is being irrigated taking into consideration double cropping of summer and winter crops.

A wide range of commodities are produced in this area ranging from field crops like maize and wheat to high value labour intensive crops like vegetables, citrus and table grapes. This makes the pilot study area a good example of the contribution and potential impacts across the various crops and food commodities.

The area under citrus alone amounts to 8 506 ha, which represents 14% of the total area under citrus production in South Africa. Similarly, the area is producing about 25% of the cabbage in South Africa, which together with maize, wheat and other vegetables is the main food supply to the local population and regional fresh produce markets.

The area is also one of the largest producers of frozen vegetables and supplies about 35% of the national demand for frozen vegetables.

3.2 Summary of crop areas

The following pie charts provide an overview of the products that are produced in the pilot area.

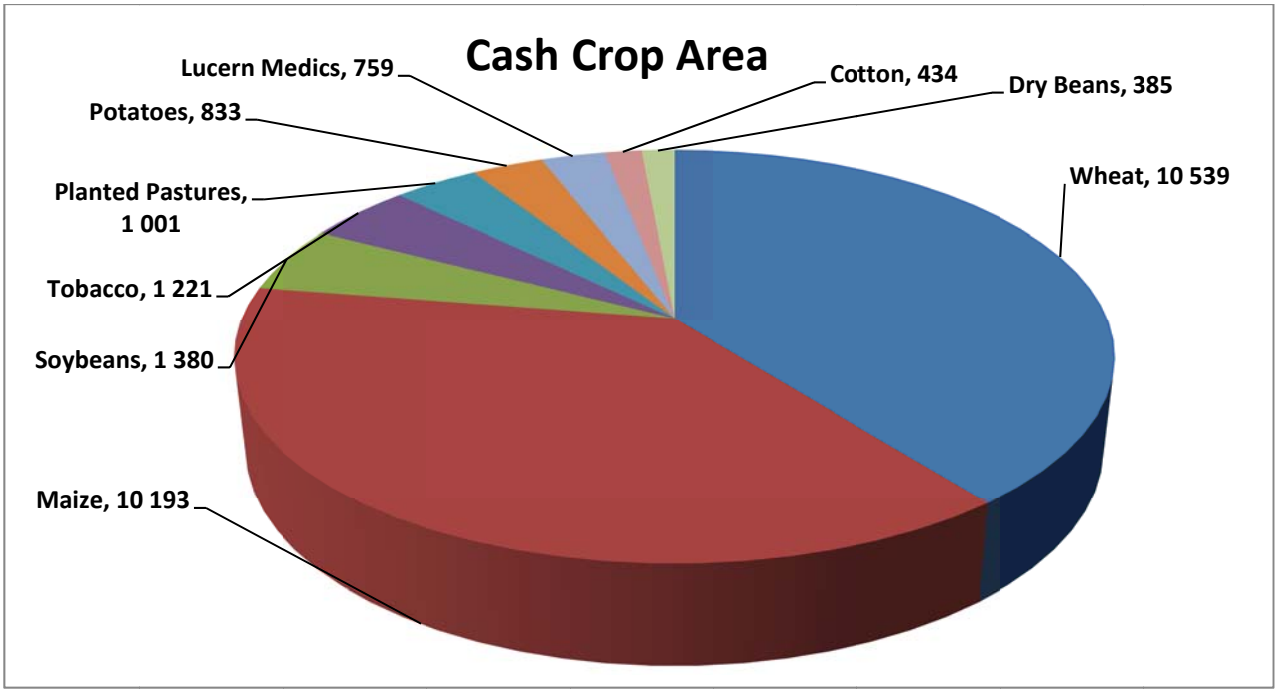


Chart 1: Summary of cash crops – Hectares per crop

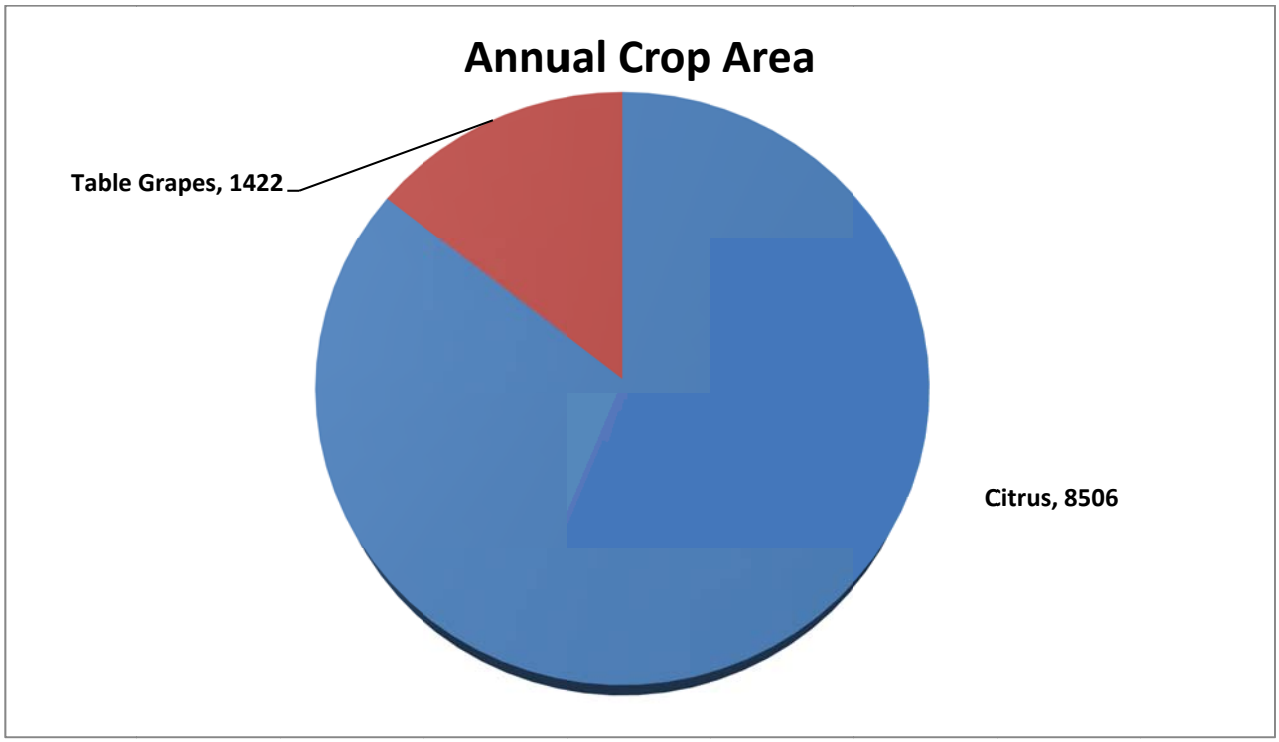


Chart 2: Summary of Annual crops – Hectares per crop

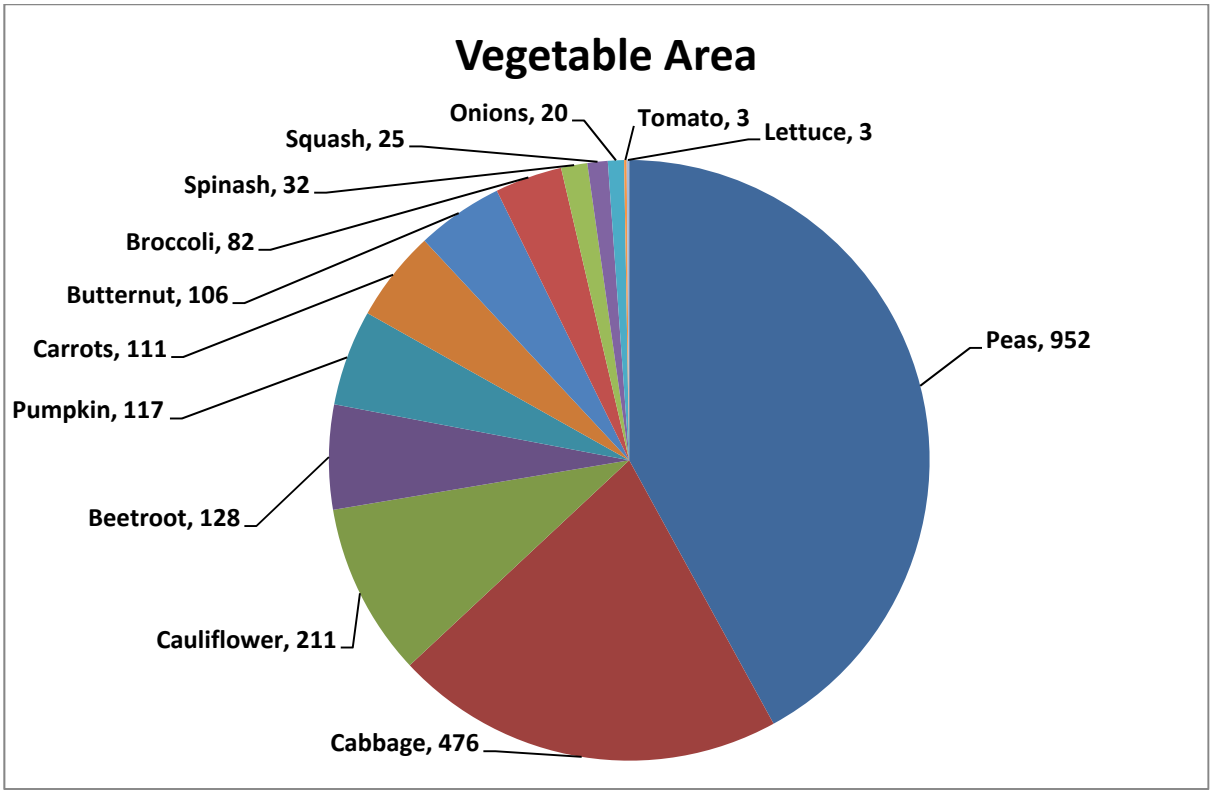


Chart 3: Summary of Vegetables - Hectares per crop

Cultivation areas and irrigation infrastructure are optimally utilised through double cropping and sustainable crop rotations to suit the climate, soil types, labour requirements and market demands.

Much of the local produce is also further processed within the local municipality area, creating much needed jobs for an area with over 50% unemployment. This includes fruit packaging and further processing of vegetables for the national frozen vegetable markets.

This involves huge capital investments on and off the farm to handle processing, packaging, cooling, freezing and transporting.

4. Gross margin evaluation for irrigated agriculture in the pilot area

In order to assess the impacts of various scenarios of water costs and quotas, the total turnover and production costs of the agricultural activities need to be calculated. For this exercise the detailed breakdown of the irrigated hectares that was presented in the previous section is merged with the relevant price, yield and cost data per commodity that was collected for the region.

A base case is developed for the 2012/13 cropping season and then the various scenarios are compared to the base case to evaluate the economic effects that water costs and quotas have on primary agriculture. Although some of the backward and forward linkages are taken into consideration when the impacts on job creation are discussed, the impact analyses do not include the economic impacts per se on the agro-industrial complex at large where agro-processing or input suppliers are also taken into consideration.

4.1 Crop scenarios

It is important to note that the results from the different scenarios are **Gross Margin** based. In other words, they only reflect revenue minus direct input costs. Fixed costs (which include **down payments of land, pack-houses, family living expenses** and **other fixed assets**) are therefore not taken into consideration.

For the purpose of this case study these costs are not provided at an average per hectare base as most farmers differ in scale of operation and a more detailed survey would be required to pin point these costs. Furthermore, the scenarios follow each other. In other words, they are "staggered" scenarios where it starts off with a base case and then with each scenario an additional element is added.

- **Base case 2013/2014**: The most likely input and output prices, as projected in the BFAP models, are taken into consideration in order to develop realistic enterprise budgets for the various commodities for the 2013/14 production season.

- **Scenario 1**: Scenario 1 assumes a corrective water tariff increase to full cost recovery, which is up to R4/mm/ha/year higher than the current tariff regulation, exceeding the maximum increase of 30% per annum and comprising the full cost of the following cost elements: 1) water resource management cost, 2) water research levy, 3) water infrastructure charge to repay capital and financing costs of the Loskop dam, canals and operating buildings, 4) operation and maintenance costs, which may include WUA administrative costs as well as annual refurbishment and betterment costs to maintain the assets.

- **Scenario 2**: Assumes a quota reduction of between 15-20% per hectare, of what the individual crop requires. Although water costs will decline due to the reduced volume of use, the net saving in costs is outweighed by the negative impact on yields.

- **Scenario 3**: Scenario 3 was introduced to illustrate the impact of typical market price volatility (in this case a 10% reduction in market prices) on the various industries that are already under pressure due to lower yields induced by the quota reductions under scenario 2 as well as higher water costs in scenario 1. In other words, this scenario illustrates the ability of the industry to handle further market shocks once the reduction in water quotas and the higher costs are introduced.

- **Scenario 4**: From scenario 3, it is evident that the gross margins for a number of industries will be so marginal and in some cases negative, that a consolidation in hectares and number of farming units can be expected. It will be a fine balancing act where farmers will have to reduce hectares under production in order to boost yields back to optimal levels given the allocated amount of water. However, a reduction in hectares will affect the economies of scale, especially for the more capital intensive industries. For the purpose of this case study, a high level view was taken for each of the affected industries to estimate to what extent the hectares under production will decline.

  To summarize, this scenario takes higher water costs and the reduced water quotas into consideration but uses the base case price levels and not the 10% shock that was introduced in scenario 3.

4.2 Total pilot area gross margin comparison – per crop

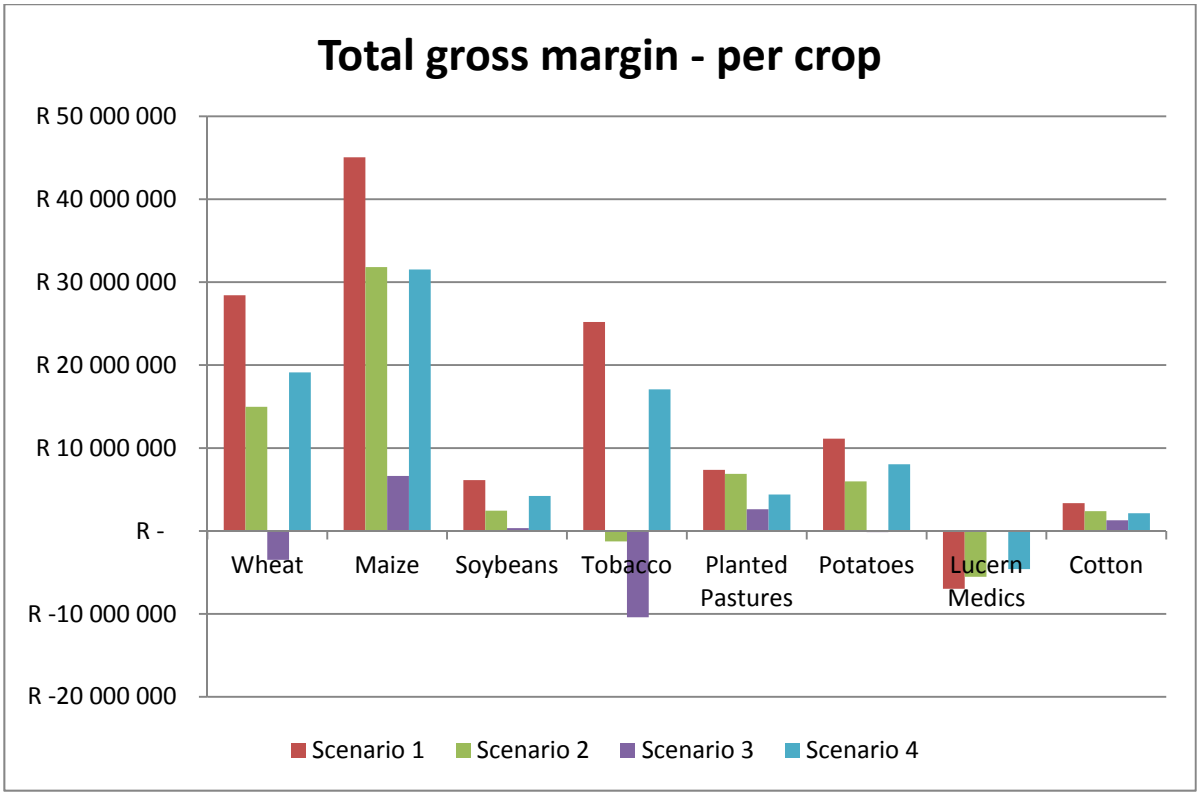


Figure 1: Gross margin scenarios for cash crops

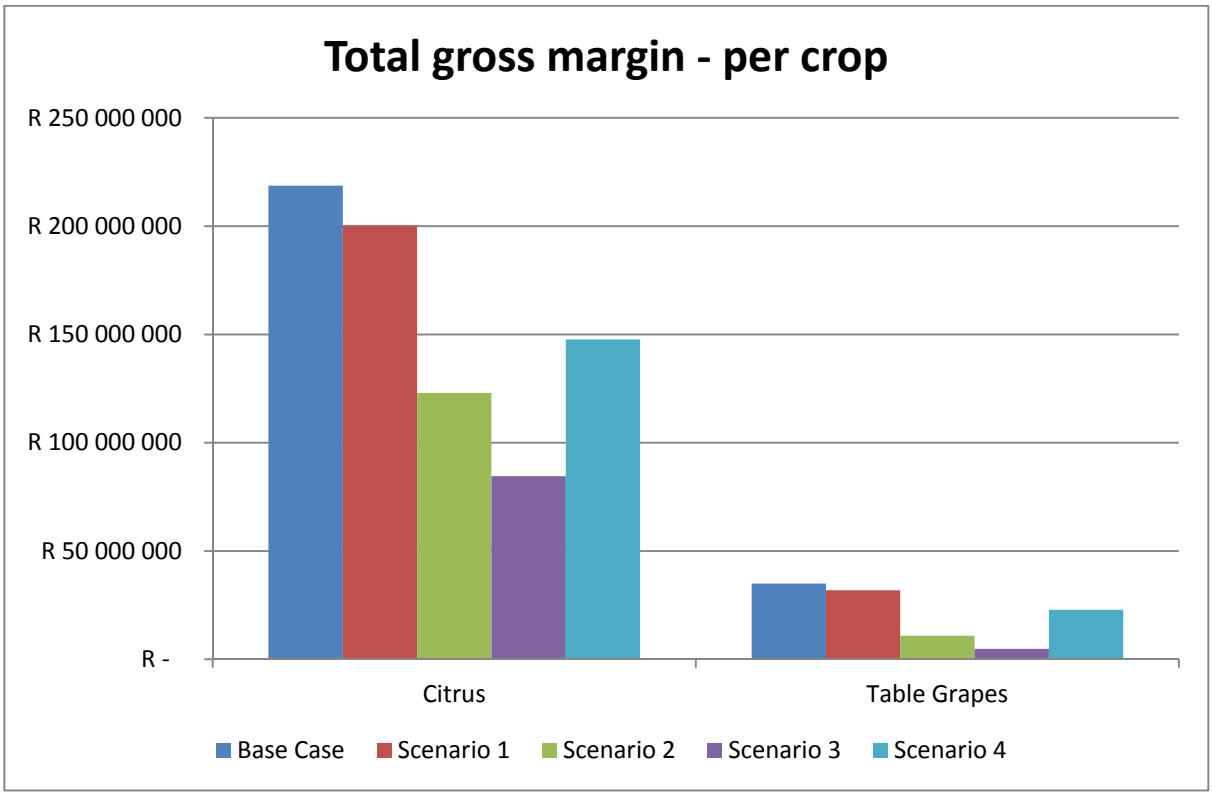


Figure 2: Gross margin scenarios for annual crops

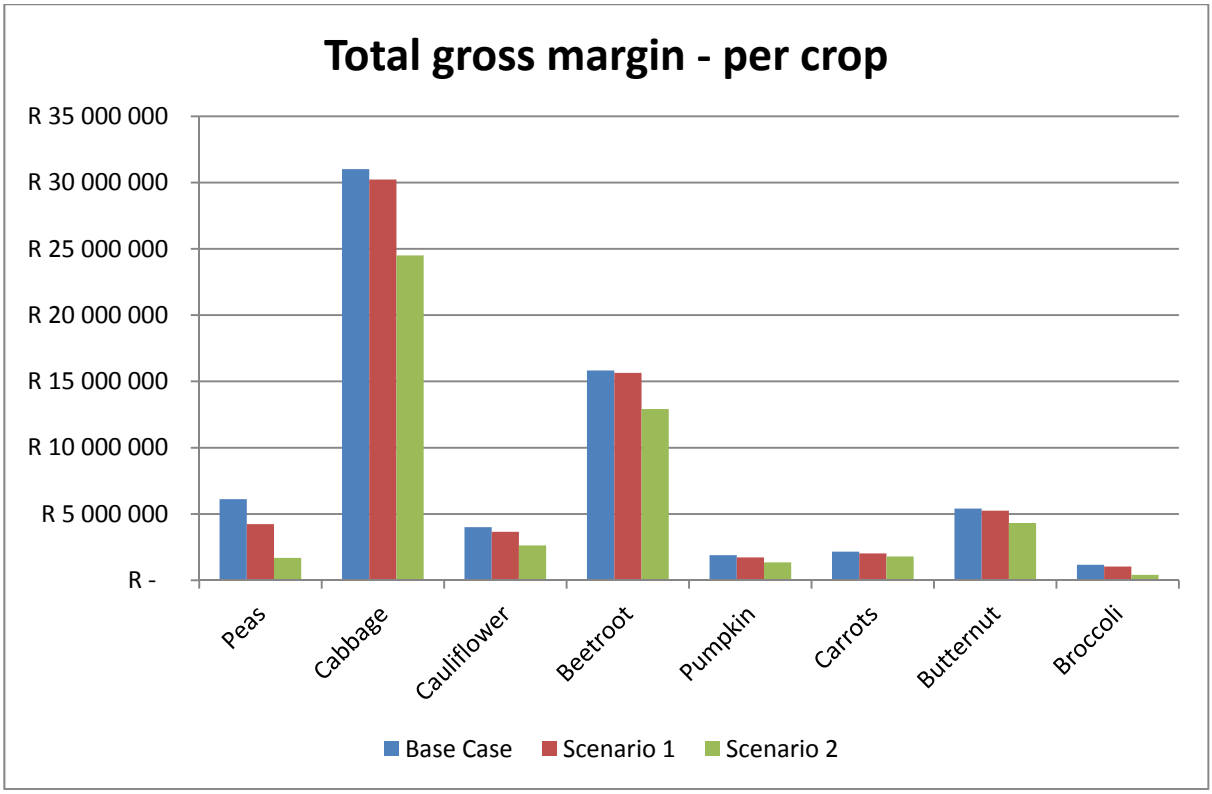


Figure 3: Gross margin scenarios for vegetables

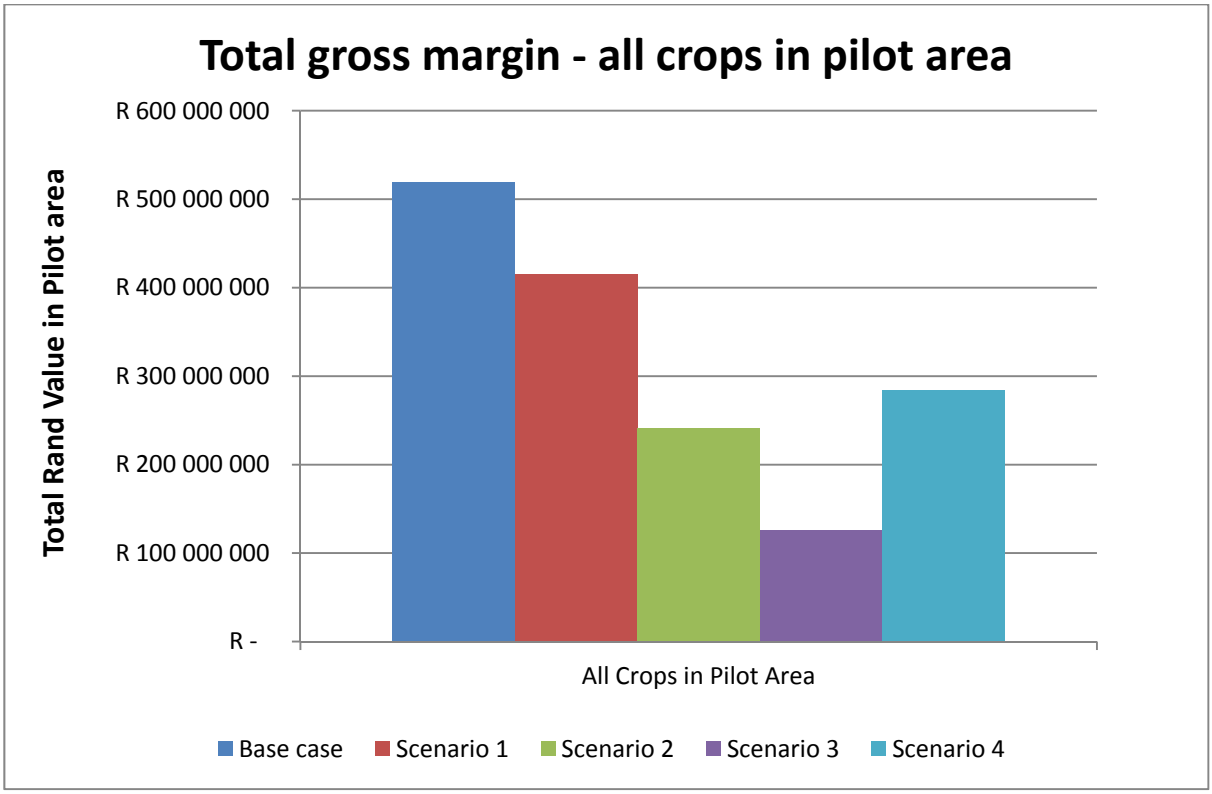


Figure 4: Total gross margin comparison for pilot area, under all four scenarios

The net results from the farm-gate gross margin scenario comparison are the following:

1. From the **base case to scenario 1** one finds a drop of more than **R 100 000 000** in gross revenue in the area. This result was due to a R4 increase in water cost (per mm/ha/annum/crop). The impact differs depending on the value of the crop.

2. **Scenario 2** shows a further drop of **R 280 000 000** from the **base case to scenario 2**. The result is based on the increase in water cost from scenario 1, plus a further quota reduction of approximately 15-20% per crop, per hectare. It is also assumed that further efficiency gains cannot be achieved over the short run and yields for the various industries will decline between 15-20%, depending on the degree of water dependence of a crop and whether it is a summer crop where rainfall is received or a winter crop.

3. **Scenario 3** has the most severe impact, resulting in a **R 390 000 000** drop from the base case to scenario 3. This illustrated a 10% decrease in market price of the crops produced in the pilot area. A 10% drop in market price is a very realistic scenario and if this is combined with increased irrigation costs and quota reductions, it will have detrimental effects on farming operations.

4. **Scenario 4** illustrates the effect of an area reduction would have on total gross revenue. The area reduction will occur if water quotas are cut, due to the need to maximise revenue per hectare, as input costs are ever increasing. The net result from **base case to scenario 4** amounts to a **R 235 000 000** reduction in gross revenue as almost 30% of the land is taken out of intensive agricultural production.

5. Infrastructure overview

Irrigation water is released from the Loskop dam into canals running on either side of the Olifants river to serve irrigation farmers in the Groblersdal and Marble Hall areas.

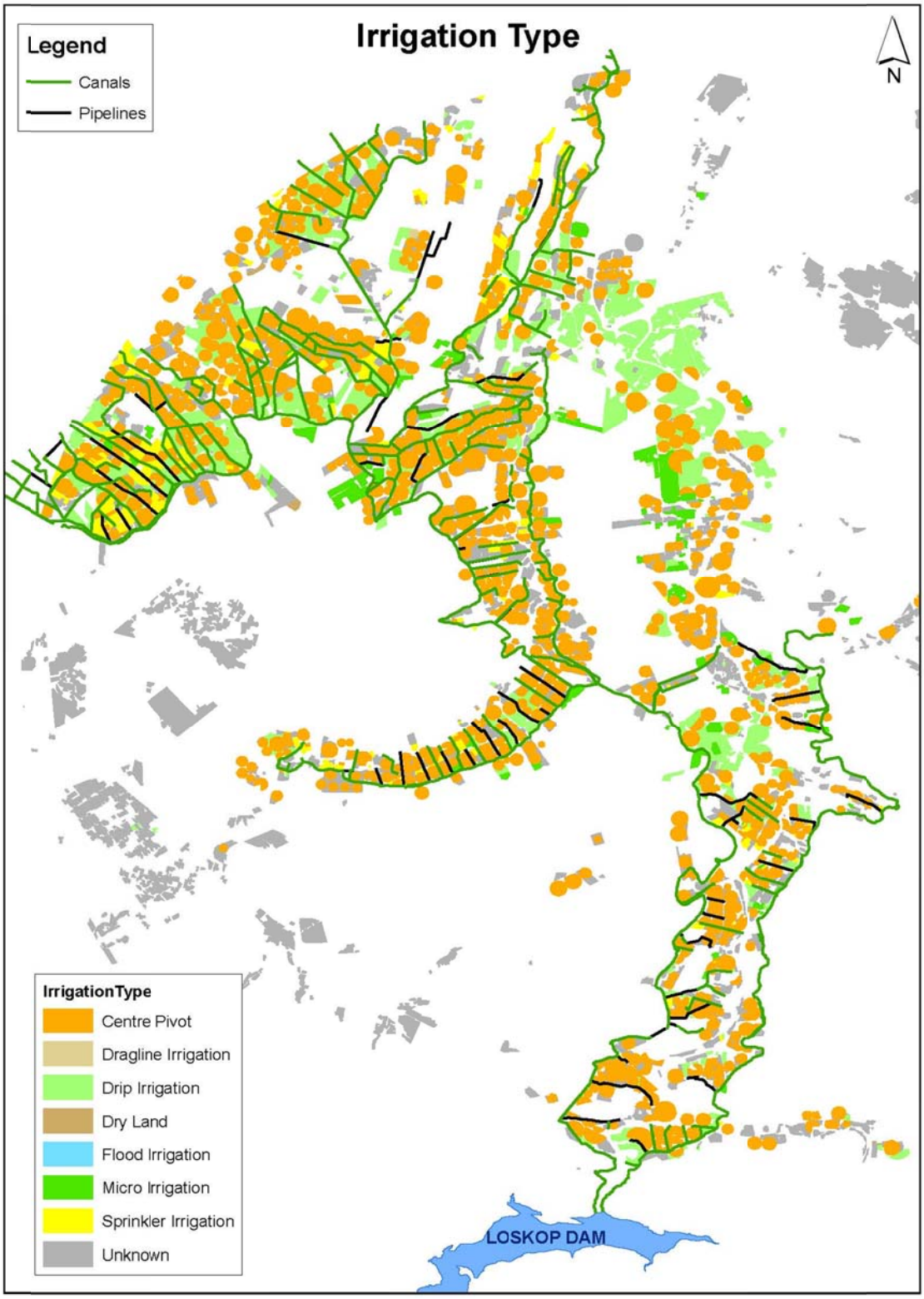
5.1 Off-farm infrastructure:

- The Loskop dam and canal distribution network is owned by DWA.
- The canal system is operated and maintained by the Loskop Irrigation Board / WUA
- In total there are about 676 km canals varying in size from 7m to less than 1m in width
- The average age of the canals is about 51 years and many of the canal linings have already required some sort of refurbishment to extend their useful life.
- The ageing canal linings need ongoing maintained (e.g. cleaning, replacement of seals, refurbishment of berms, removal of vegetation, scouring of siphons, etc) to prevent degradation and increased leakages from the canals.
- Some of the smaller canal sections, which were in poor condition, have been replaced with pipe sections in the past 10 years, totalling about 46km in length
- Overall, the canals are well operated and maintained and water losses are low at about 20%

5.2 On-farm infrastructure:

- The total area under irrigation comprises the following irrigation application systems:
    - 17 800 ha under centre pivots (70% of total irrigated area)
    - 6 670 ha under drip and micro irrigation (25% of total irrigated area)
    - 1 224 ha dragline sprinkler systems (3% to 6% of total irrigated area)

This is a huge change from previous dragline and flood irrigation systems and a significant improvement of water use efficiency of about 20% to 30%.
The following map shows the irrigated areas per application system type, confirming that the majority is under centre pivots, drip and micro irrigation, which achieve water application efficiencies of 75% to 90%. It is also noticeable that about 1300 ha are under shade netting which further reduces evapotranspiration and yields higher volume and quality produce.



Map 2: Overview of irrigation system types in pilot area

Source: *The Mapping of Agricultural Commodity Production in Limpopo (LDoA), compiled by PULA*

5.3 Water Losses / Water Use Efficiency

The Agricultural Research Council (ARC) conducted a WRC[1] funded project to investigate irrigation use efficiency across all major irrigation schemes in South Africa in the period from 2004 to 2010.

The ARC used the WRC's "Water Administration System (WAS)" to monitor the water use and water losses in the canal distribution system. The total water loss from the dam wall to the farm edge was calculated using a module in the WAS program which was developed specifically for this purpose. The raw data for the Left and Right bank main canals measuring stations at Loskop dam was imported from datasets supplied by the Hydro Directorate of DWA. The water orders are historical data which were captured on a weekly basis by the scheme to keep track of each farmer's water quota balance and to calculate dam releases. The water orders are audited externally by an accounting firm on a regular basis and confirm that the water delivered to the farm edge, through pressure regulating sluice, is equal to the water ordered.

Reference to the WRC study, the total water loss from the dam wall to the farm edge at Loskop is well within acceptable limits. The scheme is very well managed with excellent water distribution practices in place. The average water loss for the period from 2000 to 2005 is only 20% and lower than most other large irrigation schemes. It is also interesting to see that the highest water loss of 31.1% in 2003/2004 occurred when the scheme did not receive their full quota. This corresponds with the fact that lower flows in a canal leads to higher water losses.

On-farm irrigation efficiency is also good. This is primarily through the use of centre pivot and micro irrigation application systems and the use of soil moisture monitoring and active water application scheduling to minimise evaporation losses and optimise soil-water uptake in the plant root zone. The ARC study tested the application efficiencies of irrigation systems in the scheme area and found that most centre pivots have an application efficiency of 75% to 80%, while micro and drip irrigation systems showed efficiencies of 76% to 89%, both within the industry norms and standards.

With growing economic pressures, farmers have to increase production to cover overhead costs amidst lowering profit margins. Farmers area therefore planting larger areas with the same water allocation and thus have radically increased the water use efficiency (crop per drop) over the past 10 years to survive economically.

It can therefore be expected that any reduction in water allocations will have an immediate impact on the quantity of food produced as there is limited opportunity to further improve water use efficiency in this scheme area. Maintaining the status quo and further improving on margins, remains a high priority for this irrigation scheme amidst growing pressure on available water resources.

[1] Ref. K5/1482/4 "Standards and guidelines for improved efficiency of irrigation water use from dam wall release to root zone application"

6. Social impact evaluation

The social economic impact evaluation is key to the new NWRS2, as the aim of the NDP is to create new jobs, not shed them. The employment implications in the pilot study under scenario 4, is clearly illustrated in the figures below. This section speaks to the potential impact of the NWRS 2 on employment in agriculture, which is one of the key drivers of the National Development Plan.

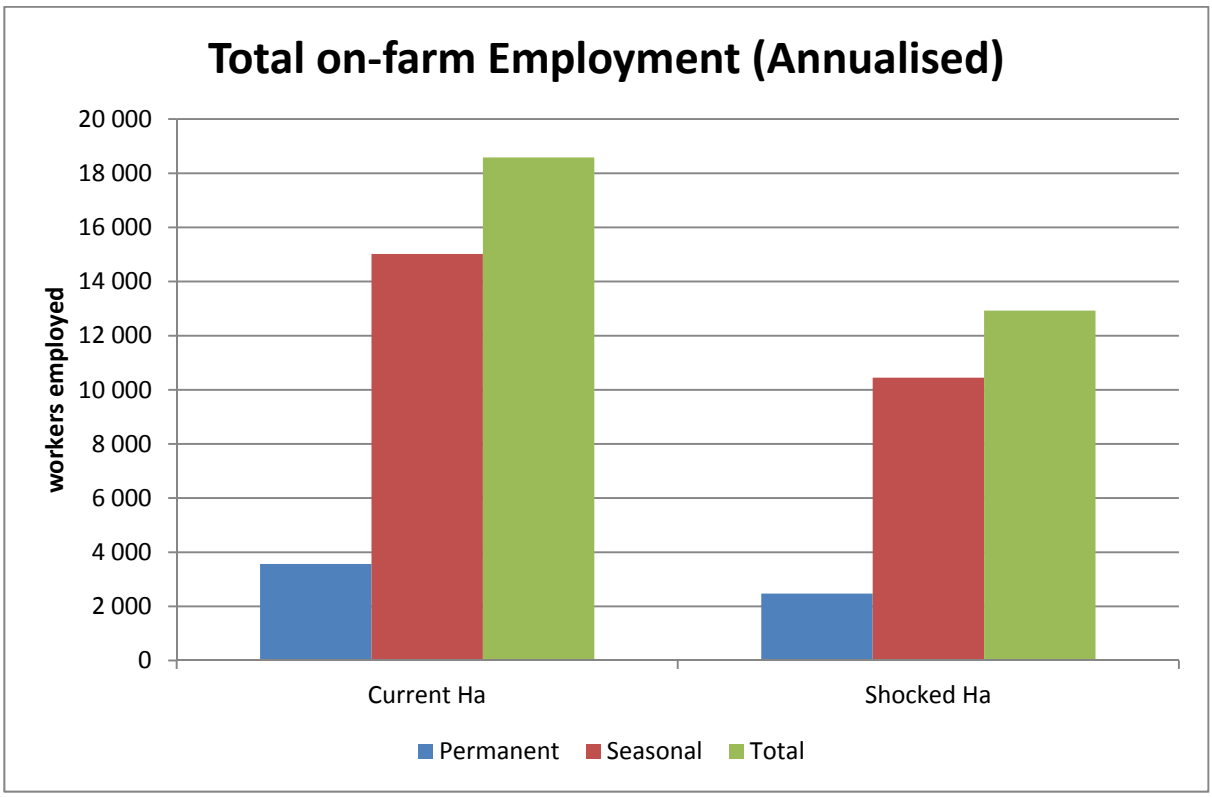


Figure 5: Total primary employment evaluation

Total primary, on-farm employment for permanent labourers in irrigation, amount to approximately **3 565** workers per annum, whereas the total amount of seasonal labourers amount to **15 015 (normalised/annualised to permanent workers)** workers per annum. This only accounts for the on-farm employment and the seasonal employment factor is further broken down to employment per hectare, per month, to fully quantify the seasonal factors per annum. A total amount of **5 656 workers** (seasonal & permanent) are under threat if the quota reduction should take place as shown in scenario 3 & 4.

***It should be noted that a large percentage of the employment in the area is solely dependent on seasonal irrigated agriculture and the seasonal workers will in some cases have to make a living based on **seasonal employment**. This could range from 1month employed to 7months employed. A scenario was therefore included in the figure below to illustrate the total "per head effect" in the pilot area. The seasonal factor is now expressed as a total figure for seasonal employment, or showing the "per head count" of individuals dependant on seasonal labour in the pilot area (Non-annualised). The total of **15 015** workers per annum, has now increased to **40 585** workers per annum in the seasonal split of workers. The job loss risk under this scenario amounts to **12 886 workers** in primary agriculture (seasonal & permanent workers).

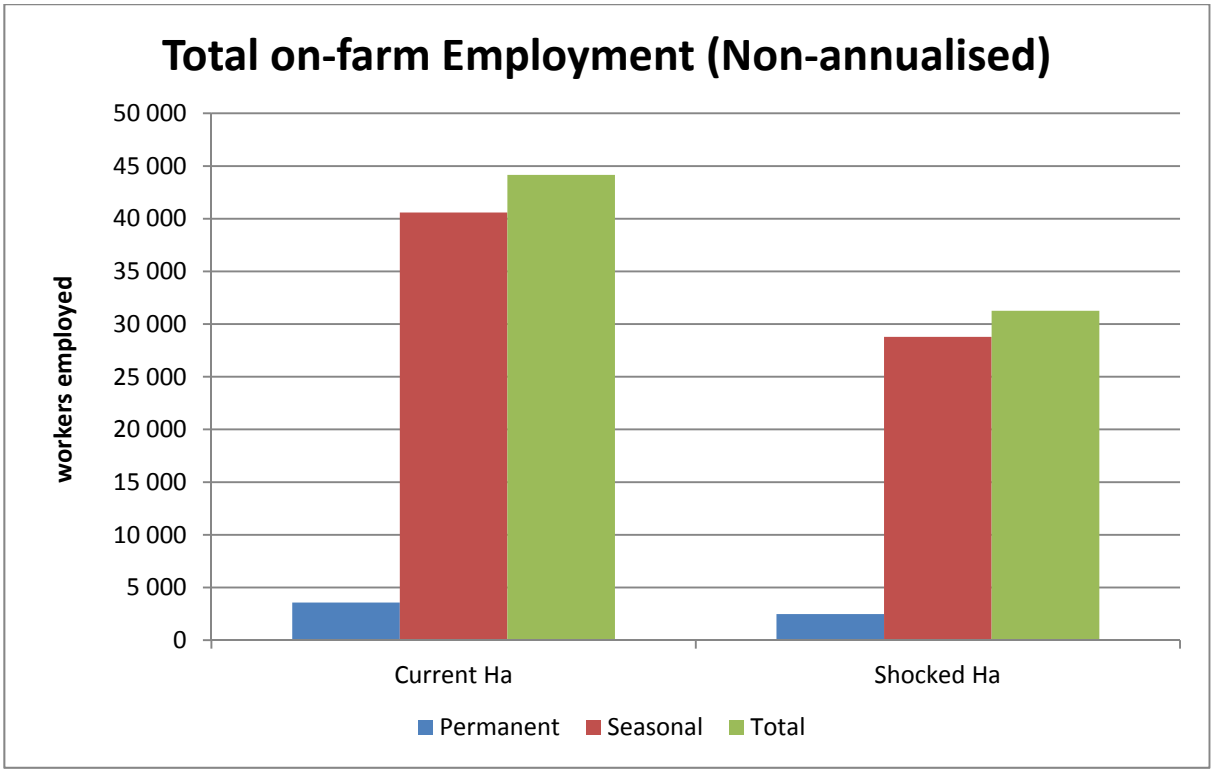


Figure 6: Total primary employment - "per head count"

Other than the primary employment, **secondary linked employment** was also calculated. This is based on research done in the area, and the results are shown below. The secondary employment includes workers in the cold chain of vegetables produced in the pilot area. The secondary chain will only include the processing up to bulk frozen storage. The factor could be even larger if calculated further downstream. Again if the production hectares are shocked, secondary employment could decrease by **3 425 workers.**

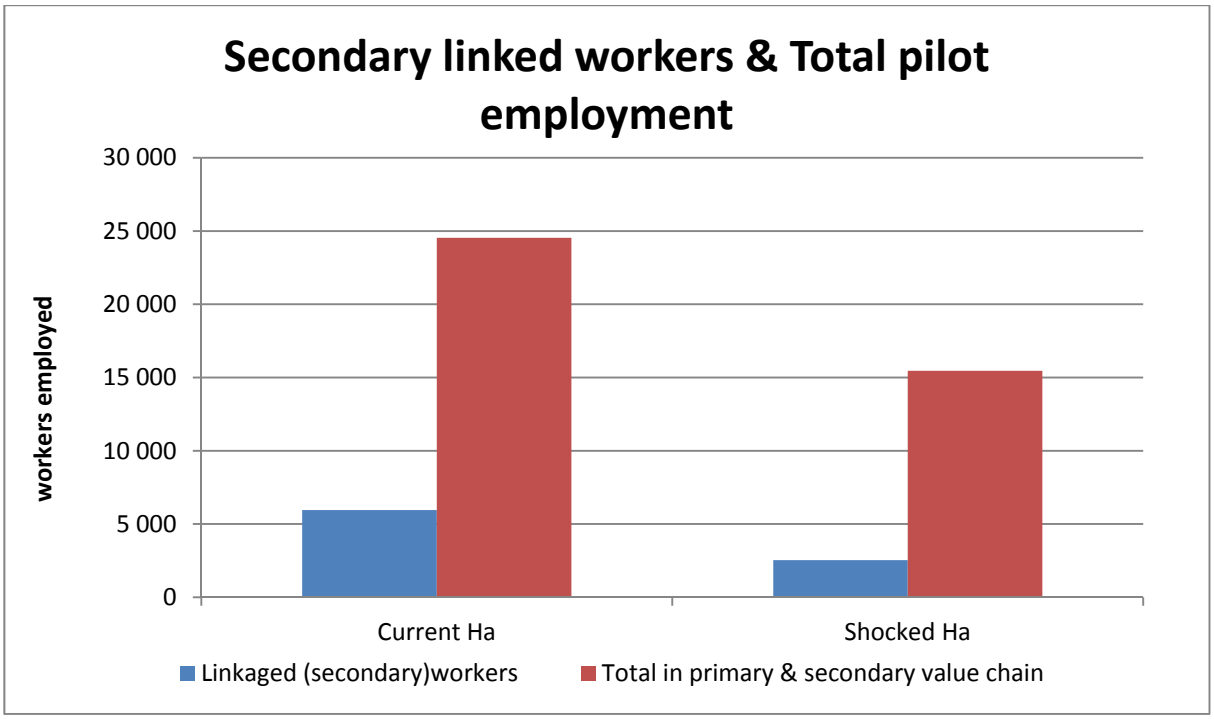


Figure 7: Total secondary employment evaluation

7. Summary of implications – Pilot area conclusions

In order to quantify the impact that irrigated agriculture has on this specific pilot area, we concluded on three critical drivers, namely: financial viability, job losses and food security implications.

7.1. Financial viability

The uniqueness of irrigated agriculture in South Africa provides the motive for evaluating each irrigation area separately. The financial viability is influenced by a number of economic factors, but even more so influenced by the geographic region in which cultivation takes place. Each geographic location is unique in its ability to generate profit, and this section aims to summarise the Groblersdal/Marbel Hall irrigation area:

Optimized production: Most farmers in the area had to adapt their production techniques to remain competitive. The reason for this comes back to the fact that most of the direct input costs remains to increase year on year, these include fuel, fertilizer, chemical sprays and the most severe one, electricity. It was therefore a case of survival for the producers to remain in the farming business and they adapted with the following practices:

- use probes for water scheduling (irrigation efficiency),
- apply variable fertilizer application,
- use of GPS grid patterns to evaluate most arable land and optimizing these pieces of land.
- Laser leveling of land to optimize natural rainfall infiltration
- gross margin measured per month/hectare, to optimize cash flow and meet down payments. Planting crops that provide quicker returns, with less water needed.

Even so, gross margins remain tight and the illustrations in the different scenarios provide context for this argument. The fact that fixed costs are not incurred in these scenarios makes it even more cumbersome, as we can already see margins running close to break-evens if costs are not well managed.

If quotas are reduced, we will most likely see smaller farmers not making ends meet, as fixed costs in irrigation are simply too high, and volatility in markets remain an inevitable threat component.

7.2. Job losses

Arguably one of the more serious concerns seems to be the job loss factor. With NDP aiming to create a million jobs in agriculture, irrigation remains the foundation of this strategy.

The job loss potential in this area amount to 5 656 workers at primary level of production and a further 3 425 workers at secondary level, which adds up to **9 081 workers** at risk if the production hectares were to decrease. The direct dependants of these workers are not included, which will increase the number of the effected drastically.

What further makes this a unique and irreplaceable irrigation scheme, is the entrepreneurial skills developed in the area. This creates even more downstream employment and creates sustainable self-employed individuals. Examples of these ventures would be “bakkie smouse”. Mostly women driving out to the farmers, picking the produce (cabbages, spinach, butternut, pumpkin etc.) and then selling it beside the road. This can be seen along all the major roads surrounding the pilot area. This adds to the third point of food security, as the people in these settlements would have been exposed to greater retail prices, if these entrepreneurial shops were void due to no/under production.

7.3 Food security implications

The Loskop irrigation scheme is an important producer of food for local, regional and national food security.

Local household food security

There are a total of 439 communities and over 1,3 million people living within a 50km radius around the scheme area. This includes the Makhudutamaga LM to the north where the majority of 274 358 people (Census 2011) are indigent and at risk of household food security. On the western side is the Dr JS Moroka and Thembisile LMs with a total population of over 540,000 people who also receive most of their basic food from the Loskop irrigation scheme area. Driving through the area, it is common to see farm produce being sold to the general public through street vendors. Local entrepreneurs collect bakkie loads from the farms to deliver them as far as 100km to the north, west and south.

The following tables show prices at local street vendors in the production area and peripheral to it (100km) as well as related fresh produce markets in Pretoria and Johannesburg. (Note that units are not always the same)

Table 2: Local vegetable prices (within production area)

NAME	**MABLE HALL** (street vendors near production farms)			
	SIZE			
	EACH	SMALL BAG	MEDIUM	LARGE (GRADE)
Butternut	R5.00	R25.00	R30.00	
Carrots	R5.00/ bunch			R85.00
Spinach	R10.00/ bunch			
Cabbage	R7.50			
Pumpkin	R20.00			R120.00
Potatoes		R10.00	R25.00	R40.00
Cauliflower				
Beetroot	R10 / bunch			R95.00
Tomatoes	R10.00	R 15.00	R25.00	R80.00
Green pepper	R2.00			
Green beans		R10		R65 / box
Onion	R10.00	R30.00	R40.00	R70.00

Table 3: Peripheral vegetable prices (street vendors 100km from production area)

VEGETABLE	**Tshatane / Malegale Village** in Makhuduthamaga LM (130km north)			
	SIZE			
	EACH	SMALL BAG	MEDIUM	LARGE (GRADE)
Butternut	R5.00- R9.00	R25.00	R35.00	
Carrots	R5.00/ bunch	R20.00		
Spinach	R7.00/ bunch			
Cabbage	R12.00			
Pumpkin	R20.00 – R30.00			
Potatoes		R10.00	R25.00	R40.00
Beetroot	R10.00 – R14.00			R95.00
Tomatoes		R 10.00	R25.00	R80.00
Green pepper	R3.00			
Onion		R10.00	R35.00	R65.00

Table 4: Fresh produce markets in Gauteng (200km from production area)

	Jo-Burg Market (2013/4/11)		Pretoria Market (2013/4/11)		Siyabuswa - retailer	
	R/Kg	Bought as:	R/Kg	Bought as:	R/Item	Bought as:
Cabbage	R 9.63	500G Pack Box	R 7.17	1kg	R 6.60	per head (1.3kg)
Beetroot	R 8.13	5kg Pocket Box	R 8.87	5kg	R 5.50	Bunch
Butternut	R 3.89	3kg Pocket Box	R 2.72	6kg		
Spinach	R 4.52	Bannana box bundle	R 4.34	1kg	R 4.50	Bunch
Cauliflower	R 13.08	500G Pack Box	R 14.00	5Kg		

Example:

- a cabbage of 1,8kg sells at R7-50 from street vendors within the production area (R4/kg)
- the same cabbage sells for R12-00 from street vendors some 120km north (R6-60/kg)
- at the Siyabuswa retailer it also costs R6-60 for 1,3kg (R5-08/kg)
- at Pretoria fresh produce market it costs R7-17/kg
- at Johannesburg fresh produce market it cost R9-63/kg

While, the above is just a sample of street vendors within the area, it is evident that costs of basic vegetables are substantially cheaper within the production area and that prices increase with km of transport by about 50% in 100km and up to 100% in 200km.

The prevalence of street markets and the volumes of vegetables sold within a 50km radius of the production area is evident of the desperate need for basic vegetables to sustain household food security and that affordability is essential for the extensive indigence in the area.

The definition of food security states that being food secure is not just the availability of food, but also the affordability of food. With the unemployment rate in the area at 50% to 80%, it is of utmost importance that nutritious foods such as vegetables are available and affordable. This area provides just that.

8. National perspective

This chapter summarises the findings of the Loskop production area and provides estimated comparisons to the national situation. This is in no means a extrapolation to the national situation as the various irrigation schemes have different characteristics and socio-economic circumstances. It primarily serves to put the Loskop pilot study in a national context

8.1 Irrigated area

- 1,3 mil ha total irrigation in RSA
- 16,000 ha irrigation allocating from Loskop dam. (1,2% of national)
- 25,000 ha actual irrigated cultivation in Loskop area (1.9% of national)

8.2 Water use

- National irrigation = 56% to 60% of 13b m3/a = 7.28b m3/a
- Loskop water allocation = 126m m3/a (1% of national water use;1.7% of national irrigation)

8.3 Loskop water use efficiency

- Up to 25000 ha irrigation with 16000 ha allocation (55% added production)
- Well managed canal distribution with average losses of 20% (ranging from 13% to 31%)
- On-farm application efficiency of 80% and above due to modern technology
- Soil moisture management using probes is increasingly used together with irrigation scheduling to optimize plant water uptake;

8.4 Main driving forces for water use efficiency

- increased electricity cost (pumped irrigation application systems)
- reduced margins of agricultural production (farmers must increase hectares / production to survive economically)

8.5 Comparative WRC study

Canal conveyance losses:

- Loskop = 20%
- Hartbeespoort =57%
- Vaalharts =28.5%
- Potential conveyance loss improvement of 5% from 20% to 15%

8.6 Food production

- Citrus
  - *national = 60,000 ha*
  - *Loskop = 8500 ha (14% of national)*
  - *Loskop production (R value) = 16% of National*
- Grapes
  - *National = 23,000 ha*
  - *Loskop = 1400 ha (6% of national)*

- Frozen vegetables
    - *Loskop = 35% of national*
- Fresh market vegetables
    - *Cauliflower = 20% of national*
    - *Cabbage = 25% of national*
    - *Beetroot = 15% of national*

8.7 Job creation

- *permanent + seasonal = total on-farm jobs*
    - *Loskop = 3565 + 40 585 = 43150 (or 18 580 with seasonal labor annualized)*
    - *With an estimated national formal employment of 660,000 jobs (Stats SA) in agriculture (irrigation specific employment not known), the Loskop scheme represents approximately 12% to 14% of irrigation related jobs in the country. (note: due to its nature, agriculture also caters for large number of jobs in the informal sector which cannot be accounted for in this pilot study)*
- primary + secondary = total sector jobs in scheme area
    - *Loskop = 18 580 + 5953 = 24 534 (very conservative figure as figures of the informal sector are not known)*
- potential job losses (primary agriculture) with a 15-20% cut in water allocation
    - *Loskop primary (on-farm) agriculture jobs at risk, if not annualized = 12 886 (30% of Loskop employment)*

9. Summary and recommendation

The results of this study clearly show the bigger social and economical impact of the Loskop irrigation scheme and proof that irrigated water use has a far reaching impact on rural livelihoods. It also shows the site specific benefits and implications, and calls for a national investigation of the socio-economic role of irrigated agriculture. The fact that the Loskop irrigation area falls within a water stressed river catchment, furthermore highlights the urgency of a comprehensive integrated socio-economic analysis of the irrigation and other water uses for long-term sustainable socio-economic development.

It is furthermore noticed that some of the NWRS-2 strategies may stand in contrast with the set targets of the National Development Plan and that urgent alignment must be sought to enable the role of water in the achievement of the NDP. In addition to pure economic implications, the socio-economic considerations and the implications for food security are significant if irrigated water allocation is reduced in certain areas of primary food production, such as the Loskop irrigation scheme. Apart from the direct job losses and the implications for the dependent households, there is a significant volume of informal trade, mainly due to the large volumes of vegetable production in the area. Hence, a reduction in the level of vegetable production will also have an impact on the informal economy of the district, which is already highly vulnerable and could have devastating effects on the level of household food security.

The impact of a decline in production on food prices will differ for the various irrigation schemes and their commodities. For the Loskop irrigation scheme, there are some serious implications since it produces large portions of the national production of cabbage (>25%), frozen vegetables (>35%) and citrus (>14%). One can therefore expect that cabbage prices and frozen vegetable prices will be

influenced on the national markets if a shift in production is enforced in the Loskop irrigation scheme area. This is however not the case for maize or wheat where this area's share of the national maize crop is small. Yet, the point is that this is only one case study for a specific area and the NWRS could affect all irrigation areas in the country and under that scenario, the impact of food prices and therefore food security will have to be considered.

To conclude, based on findings of this pilot study and the severity of impacts, a national assessment of irrigation areas is recommended. In other words, the uniqueness of irrigation agriculture in South Africa provides the motivation for an in-depth evaluation of all major irrigation schemes in the country. The financial viability of irrigation agriculture is influenced by a number of economic factors, but even more so influenced by the geographic region in which cultivation takes place.

10. References

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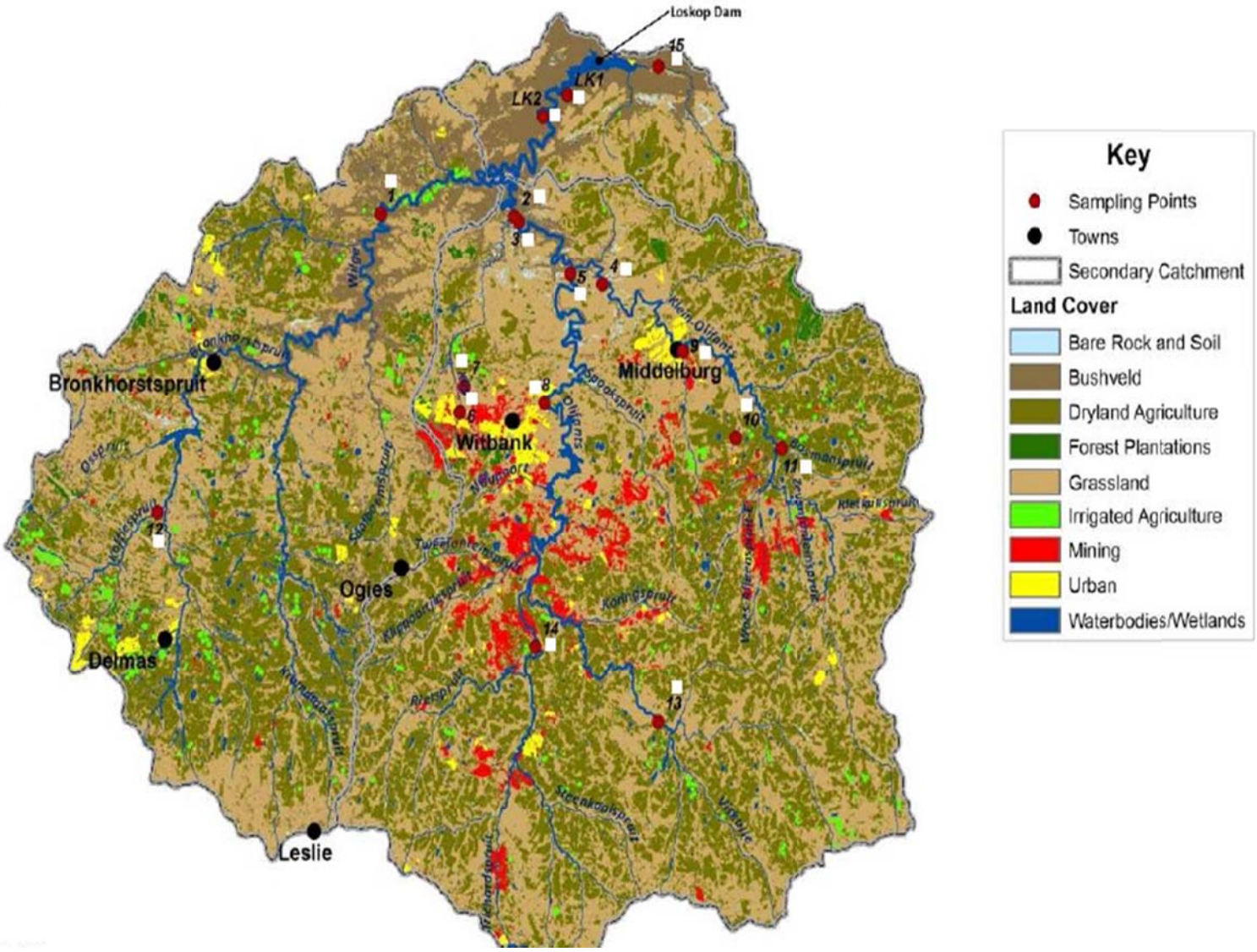
11. Appendix A

Concerns upstream – Olifants catchment (Pilot area water catchment)



Map 3: Upper Olifants testing stations – Seventeen sampling sites

Source: Oberholster *et al*. 2011 sourced from CSIR

According to the authors (Oberholster, Aneck-Hahn, Ashton, Botha, Brown**,** Dabrowskia, de Klerk, de Klerk, Genthe, Geyer, Hall, Hill, Hoffman, Kleynhans, Lai, le Roux, Luus-Powell, Masekoameng, McMillan, Myburgh, Schachtschneider, Somerset, Steyl, Surridge, Swanevelder, van Zijl, Williams and Woodborne, 2011), the following was observed in the Upper Olifants catchment, based on a study done in March 2011:

> ***Seventeen sampling sites****, representing sites impacted by all of the different impacts (mining, industry, agriculture and sewage input) were selected within the upper Olifants catchment. Two sites were selected in the Wilge River catchment, one further upstream in the Koffiespruit (site 12) and one downstream in the Wilge River (site 1), just before its confluence with the Olifants River.*

These sites are mainly impacted by agriculture, with low levels of mining and industrial activity upstream of these sites.Three sites were selected in the Klip River catchment (sites 2, 6 and 7), an area that is heavily impacted by mining and industrial activity. One site each was selected on the Steenkoolspruit (14), Klein-Olifants River (4) and Middelburg (9). Five sites were selected along the main stem of the Olifants River (sites LK2, 3, 5, 8 and 13), while two (sites 10 and 11) were located in the vicinity of intensive feedlot areas and were sampled only for microbial pathogens and EDC activity. Site LK1 is a pristine stream originating from a wilderness area in the Loskop nature reserve and site 15 (Kranspoortspruit) were selected as a reference site.

Land use Impacts on Water Quality

Sites 12 and 15 *in the upper reaches of the Wilge River and Kranspoortspruit, respectively, are the* ***least contaminated*** *sites in the study area and show low concentrations of water quality variables and low values for three key water quality indicators (sulphate to chloride ratio [SCR], corrosion potential [CPR] and sodium absorption ratio [SAR]). In contrast, the* ***entire Klip River catchment (comprising sites 2, 6 and 7)*** *is* ***acidic (pH < 6),*** *and recorded the* ***highest concentrations of heavy and trace metal ions in the study area; these include aluminium, iron, manganese, vanadium and zinc. The concentrations of metal ions at sites 2, 6 and 7 are well in excess of aquatic ecosystem guideline values and are likely to be toxic to aquatic life****. These metals are most likely to have originated from acid mine drainage from abandoned coal mines and industrial activity in the catchment as well as sewage inflow. The extent to which current mining activities contribute to heavy metal concentrations will need to be determined in further studies. Contamination of the main stem of the Olifants River (sites, 3, 5, 8 and 13) by trace metals is relatively low in comparison to the tributary rivers that feed into the Olifants River. The phosphate concentrations recorded during low flow conditions were however the highest for these sites in comparison to all other sites in the study area. High phosphate concentrations in association with low flow conditions indicates that sewage inputs from urban areas are the most likely sources of nutrient input in the catchment.*

Total area:

High SCR values across the study area indicate that the water quality in the system is already heavily affected by processes that could include mining, industry and wet or dry deposition of atmospheric emissions (e.g., from industry and power generation). This is further supported by the fact that sulphate is the dominant constituent of the high concentrations of total dissolved salts (TDS) in the catchment. The high CPR at many sites indicates that corrosion of metal pipes and pumps is likely to occur (or is already occurring). Insufficient maintenance of effluent and water pipes could therefore lead to additional water quality problems, now and in the future, as a result of leakages. The SAR levels indicate that the water in the main stems of the Olifants and Wilge Rivers is still suitable for irrigation purposes.

Loskop Dam:

Conditions in Loskop Dam during the current study (July – October 2010) indicated that the most important impacts affecting water quality were those arising from or linked to mining and nutrient enrichment. While the low pH values that are typically associated with acid mine drainage were not observed during the study, the impact of mining was evident in the elevated levels of sulphate in Loskop Dam compared to Kranspoort Dam. Evidence of eutrophication was observed in the elevated concentrations of total nitrogen and total

phosphate, as well as the presence of algal blooms of Ceratium hirundinella and Microcystissp. The transitional zone in Loskop Dam was most affected by algal growth and showed the greatest variation in water quality during the study. Natural mortalities of Mozambique Tilapia (Oreochromis mossambicus) were observed in the riverine and transitional zones during October 2010. When dissected, all these fish had symptoms associated with pansteatitis, including yellow-coloured fat, fat intrusions in the liver and areas of concentrated lipofuscin in fat throughout the body. These findings justify both current research assessing the general health of this species in Loskop Dam and ongoing research based on these results.

Knowing that the majority of the water used to irrigate in the pilot area comes from the Olifants catchment, creates room for major concern. As illustrated by the BFAP/PULA study, more than a quarter of the countries vegetables are produced with the water which was tested in the literature above. The effects that contaminated irrigation water could have on crops in the pilot area, again creates enormous concerns with regard to food security and the well-being of communities surrounding these areas who consume the produce.