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THE CLASSIFICATION OF SIGNIFICANT WATER RESOURCES IN THE OLIFANTS-DOORN WATER MANAGEMENT AREA (WMA 17)

SOCIO-ECONOMIC IMPACT OF PROPOSED CLASS CONFIGURATIONS ON IRRIGATION FARMING

APRIL 2012

This report should be read in conjunction with the final project report:

Department of Water Affairs, South Africa, April 2012. Final project report for the Classification of significant water resources in the Olifants-Doorn WMA. Belcher A and Grobler D, April 2012. Report number: RDM/WMA17/00/CON/CLA/0111.

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Abbreviations used in this report

Annuity	Net income stream over 25 years, expressed as equal annual amounts, taking the effect of interest into account
IRR	Internal Rate of Return
NPV	Net Present Value
WMA	Water Management Area, in reference to the Olifants Doorn WMA

1. INTRODUCTION

Water use in the Olifants Doorn Water Management Area (WMA) is dominated by agricultural use. Approximately 95% of the water used in the area is applied in the agriculatural sector. The diversity of agricutural activities in the WMA can be subdivided into four predominant crop production areas. This includes the following production areas:

- Decidous fruit in the Koue Bokkeveld,
- Citrus fruit in the Upper Olifants,
- Wine grapes in the Lower Olifants, and
- Potatos in the Sandveld area.

The determination of the availability of water is informed by the classification scenarios that were generated during the classification process. In general it can be stated that water is available in a limited number of selected areas in the catchment and the need for possible reduction of groundwater in use in the Sandveld might be required. The need to reduce or at least limit further increases in the low flow season abstractions is also a general principle that should be applied, especially in the Upper Olifants Area.

The agricultural-economic component of the Olifants-Doorn River Classification process describes the financial-economic and employment impacts of a possible reduction or increase in water allocated to agricultural use after taking into account the requirements of the ecological Reserve, current use and the particular scenario proposed to support a particular class configuration. The impact is determined by means of representative, typical farm units and models developed for each of the production areas in the water management area covered by the study.

2. METHODOLOGY: TYPICAL FARM MODELING

A change in the quantity and/or assurance of supply of water available for irrigation affects the area under irrigation and/or the crop choice and causes changes in land, labour and capital use, which in turn determines production and the farm profit. Both income and costs change with either an increase or reduction in water availability. In order to capture the interrelationships among the various components of a complex farming system to calculate the net financial-economic and employment effects, a typical farm model is used. A typical farm model simulates a farm which is typical of farms in a production area in terms of physical extent, size and nature of the farming operation of the farms. The use of average industry cost and income values is avoided as it distorts those relationships. See a description of typical farm modeling in Annexure 1.

The typical farm model provides the net financial-economic and employment outcome of a typical farm in a particular production area within the WMA. It allows a before-and-after comparison of the input-output situation when it changes due to a change in water availability. It takes the form of a multiperiod budget that captures the costs and income involved in the establishment and production of an orchard or vineyard or potato-grain rotation system. When dealing with a perennial crop or even annual crops integrated in a crop rotation system, profitability cannot be expressed simply in terms of an annual gross margin as the time value of money has to be incorporated. A multiperiod budget captures the time value of money and therefore measures the financial result of the farming operation in terms of the net present value (NPV)of a discounted income-cost stream over 25 years. The internal rate of return (IRR) measures the return on the funds invested in the farming operation in the form of fixed and operational costs. The annuity is the net income stream over 25 years, expressed as equal annual amounts, taking the effect of interest into account. The change in permanent and seasonal labour required by the existing and the expanded or smaller farming operation is also given by the typical farm model.

The financial and employment impacts are given as totals for the typical farm, as well as per irrigated hectare, per $1000m^3$ irrigation water applied and the totals per production area. The before-and-after comparisons in terms of these parameters show the financial and employment impact of a change in water allocated to irrigation on farm level and on regional level. The expression of the financial and employment impacts per hectare and per $1000m^3$ irrigation water allows interregional comparison. It also shows the opportunity cost or profit and employment opportunities forgone in a particular production area if water is re-allocated to another production area or even WMA or to an alternative, non-agricultural use, like the ecological Reserve.

An increase in available irrigation water allowing an increase in irrigated area causes a disproportional increase in profit as expressed in the increase in NPV or the annuity of the typical farm provided that suitable land is availble for expansion . This relatively higher profit is due to the increase in scale of production. The total variable cost increases more or less in the same ratio as the increase in income, while the total fixed cost increases to a far lesser extent. The fixed cost per unit product drops, implying that the existing physical infrastructure and managerial capacity of the farm are utilised more economically. Likewise, a decrease in the amount of available irrigation water causes a relatively greater drop in profit and employment capacity.

The four production areas were further subdivided to include more refined results for the four key production areas:

- Decidous fruit in the Koue Bokkeveld,
- Citrus fruit in the Upper Olifants,
- Wine grapes in the Lower Olifants,
    - Lower Olifants (Wine grapes, Clanwilliam dam to Klawer – abstraction from the river)

    - Lower Olifants (Wine grapes, vegetables from the Clanwilliam Dam irrigation channel)

- Potatos in the Sandveld area
    - 15% increase
    - 10% decrease

3. SUMMARY OF RESULTS

See Table 1 with a summary of the financial-economic impacts and Table 2 showing the employment impacts of an increase or decrease in irrigation water availability on farm level and per production area.

TABLE 1: SUMMARY OF FINANCIAL -ECONOMIC IMPACTS OF CHANGES IN WATER ALLOCATION

Water Management Area (WMA)	Total farm size (ha)	Irrig. land (ha)	Water use m3/ha/ year	Total water p.a. on farm (1000m3)	IRR (%)	NPV (R)	NPV/ irrigated ha (R/ha)	Annuity (R)	Annuity/ irrigated ha (R)	Annuity/ 1000m3 irrig. water used p.a. (R/1000m3)	Total irrigated area in WMA: (ha)	Total annuity for irrigated area in WMA (R)
Tributeries of Leeuwrivier (Deciduous fruit)												
Status quo	1 500	200	8 000	1 600	9.6%	43 833 009	219 165	2 296 826	11 484	1 436	8 600	98 763 502
15% water increase	1 500	230	8 000	1 840	11.4%	59 762 852	259 838	3 131 541	13 615	1 702	9 890	134 656 250
Upper Olifants (Citrus)												
Status quo*	150	75	10 800	915	11.1%	42 780 770	570 410	2 241 689	29 889	2 768	7 000	209 224 297
13.3% water increase**	150	85	10 800	1 037	13.5%	54 134 162	636 872	2 836 600	33 372	3 090	7 933	264 738 250
Olifants: Clanwilliam dam to Klawer (Table grapes)												
Status quo (3000 -1 673 = pump water)***	50	43	7 600	327	9.7%	8 589 399	199 753	450 080	10 467	1 377	1 673	17 511 244
9.3% water increase****	50	47	7 600	357	12.1%	12 601 023	268 107	660 287	14 049	1 849	1 829	25 694 986
Lower Olifants (Wine grapes, vegetables)												
Status quo*****	50	47	6 400	301	4.3%	3 830 777	81 506	200 731	4 271	667	10 000	42 708 644
Increase irrig. security and irrig. area 6.4%******	50	50	8 200	435	5.7%	7 374 531	147 491	386 421	7 728	942	10 638	82 215 016
Sandveld (Potatoes) Area I: Potential increase												
Status quo: Potatoes and winter grain(#)	1 300	360			6.1%	7 702 015		403 581				
Status quo: Potatoes only (irrigated)		60	6 200	372			128 367		6 726	1 085	1 750	11 771 123
15% water increase: Potatoes and winter grain(#)	1 300	414			11.1%	16 478 354		863 457				
15% water increase: Potatoes only (irrigated)		69	6 200	428			238 817		12 514	2 018	2 013	25 190 411
Sandveld (Potatoes) Area II: Potential decrease												
Status quo: Potatoes and winter grain(#)	1 300	360			6.1%	7 702 015		403 581				
Status quo: Potatoes only (irrigated)		60	6 200	372			128 367		6 726	1 085	1 750	11 771 123
10% water decrease: Potatoes and winter grain(#)	1 300	324			3.2%	1 851 123		96 998				
10% water decrease: Potatoes only (irrigated)		54	6 200	335			34 280		1 796	290	1 575	2 829 103
Sandveld (Potatoes) Area III: No change												
Status quo: Potatoes and winter grain(#)	1 300	360			6.1%	7 702 015		403 581				
Status quo: Potatoes only (irrigated)		60	6 200	372			128 367		6 726	1 085	3 500	23 542 247

Notes: * = Registered for 12 200m3/ha for 75 ha, but get and use only 10 800m3/ha for 75 ha	** = Registered for 12 200m3/ha for 75 ha, get 12 200m3/ha for 75 ha and use 10 800m3/ha for 85 ha
*** = Registered for 8 200m3/ha for 43 ha, but get and use only 7 600m3/ha for 43 ha	**** = Registered for 8 200m3/ha for 43 ha, get and use 7 600m3/ha for 47 ha
***** = Registered for 12 200m3/ha for 47 ha, but get and use only 6 400m3/ha for 47 ha	****** = Registered for 12 200m3/ha for 47 ha, get 8 200m3/ha and use 8 200m3/ha for 50 ha
(#) = Potatoes (irrigated) and winter grain (not irrigated)	

TABLE 2: SUMMARY OF EMPLOYMENT IMPACTS OF CHANGES IN WATER ALLOCATION											
Water Management Area (WMA)	Irrig. land (ha)	Water use m3/ha/ year	Seasonal labour (man days)	Seasonal labour/ irrig. ha (man days)	Seasonal labour/1000m3 irrig. Water (man days/ 1000m3)	Total irrig. area in WMA: (ha)	Seasonal labour for irrig. area in WMA (man days)	Permanent labour on farm (number)	Permanent labour/ irrig. ha (number)	Permanent labour/1000m3 irrig. Water (number/ 1000m3)	Permanent labour for irrig. area in WMA (number)
Tributeries of Leeuwrivier (Deciduous fruit)											
Status quo	200	8 000	18 837	94	12	8 600	810 009	100	0.50	0.062	4 286
15% water increase	230	8 000	21 354	93	12	9 890	918 209	113	0.49	0.062	4 877
Upper Olifants (Citrus)											
Status quo*	75	10 800	4 062	54	5	7 000	379 102	57	0.76	0.070	5 289
13.3% water increase**	85	10 800	4 482	53	5	7 933	418 284	64	0.75	0.070	5 973
Olifants: Clanwilliam dam to Klawer (Table grapes)											
Status quo (3000 -1 673 = pump water)***	43	7 600	19 759	460	60	1 673	768 744	24	0.56	0.074	937
9.3% water increase****	47	7 600	21 597	460	60	1 829	840 426	27	0.57	0.076	1 051
Lower Olifants (Wine grapes, vegetables)											
Status quo*****	47	6 400	1 289	27	4	10 000	274 226	8	0.17	0.027	1 702
Increase irrig. security and irrig. area 6.4%******	50	8 200	520	10	1	10 638	110 635	8	0.16	0.020	1 702
Sandveld (Potatoes) Area I: Potential increase											
Status quo: Potatoes and winter grain(#)	360		2 400								
Status quo: Potatoes only (irrigated)	60	6 200		40	6	1 750	70 000	6	0.10	0.016	175
15% water increase: Potatoes and winter grain(#)	414		2 850								
15% water increase: Potatoes only (irrigated)	69	6 200		41	7	2 013	83 146	7	0.10	0.016	204
Sandveld (Potatoes) Area II: Potential decrease											
Status quo: Potatoes and winter grain(#)	360		2 400					6			
Status quo: Potatoes only (irrigated)	60	6 200		40	6	1 750	70 000		0.10	0.016	175
10% water decrease: Potatoes and winter grain(#)	324		2 205					6			
10% water decrease: Potatoes only (irrigated)	54	6 200		41	7	1 575	64 313		0.11	0.018	175
Sandveld (Potatoes) Area III: No change											
Status quo: Potatoes and winter grain(#)	360										
Status quo: Potatoes only (irrigated)	60	6 200	2 400	40	6	3 500	140 000	6	0.10	0.016	350

Notes: * = Registered for 12 200m3/ha for 75 ha, but get and use only 10 800m3/ha for 75 ha		** = Registered for 12 200m3/ha for 75 ha, get 12 200m3/ha for 75 ha and use 10 800m3/ha for 85 ha
*** = Registered for 8 200m3/ha for 43 ha, but get and use only 7 600m3/ha for 43 ha		**** = Registered for 8 200m3/ha for 43 ha, get and use 7 600m3/ha for 47 ha
***** = Registered for 12 200m3/ha for 47 ha, but get and use only 6 400m3/ha for 47 ha		****** = Registered for 12 200m3/ha for 47 ha, get 8 200m3/ha and use 8 200m3/ha for 50 ha
(#) = Potatoes (irrigated) and winter grain (not irrigated)		

4. IMPACT OF A CHANGE IN WATER ALLOCATION ON FARMING IN THE KOUE BOKKEVELD WMA

4.1 Area

The total Koue Bokkevled area currently irrigated is 8 600 ha. The Koue Bokkeveld includes the rivers in both the upper Doring and parts of the upper Olifants.

4.2 Typical farming pattern

The Koue Bokkeveld is well known for its deciduous fruit production, mainly apples and pears, mainly for the export market. Deciduous fruit production is complemented by vegetable production. This combination allows an assured availability of irrigation water for the perennial crops and surplus water with less certainty of availability for annual crops.

The climate allows high yields, making this area one of the most productive agricultural areas in South Africa. Water for irrigation is extracted from rivers like the Leeu River which feeds the Doring River. The Koue Bokkeveld is not a Government Control Area. Water is mostly stored in dams on farms constructed with private capital. Water is often gravity fed from the dams located at higher altitudes to orchards, saving on pumping cost.

4.3 Current water allocation

The current water use per hectare per annum is 8 000 m^3 and the typical farm in this WMA has some 200 hectares of irrigated land. Total farm size is around 1 500 hectares with ample suitable land to expand irrigated crop production if more water can be allocated for irrigation. Winter water is currently stored in dams on the farms in the area to be used during the summer growing season.

4.4 Projected change in water allocation

An increase of 15% in water availability was projected. This increase can be attained if producers will be allowed to store more winter water in dams that will have to be constructed on their farms at their own cost. The additional water will allow a producer on a typical Koue Bokkeveld farm to expand the irrigated land from 200 hectares to 230 hectares. The amount of water irrigated per hectare will remain at 8 000 m^3. The irrigated area for the Koue Bokkeveld as a whole is 8 600 but cannot be increase with 15% in all areas. The Houdenbeks is fully developed and some smaller areas in the Leeu river can be expanded.

4.5 Financial-economic impacts of projected changed water allocation

The impacts of a projected increase of 15% in water available for irrigation was determined by means of a typical deciduous fruit farm model for the Koue Bokkeveld WMA. Additional water can only be obtained by storing winter water. The dam and mother pipeline construction costs to allow storage of additional water was spread over the lifespan of such infrastructure and were included in the farm model. The dam construction cost is R33 000/ha and the pump station and mother pipeline cost is R23 000/ha of the new land brought under irrigation.

The 15% projected increase in water will cause the NPV and the annuity to increase by 36%, despite the fact that the typical farm will have to carry the water storage and distribution cost. The annuity for the Koue Bokkeveld production area will increase from R98 763 502 to R134 656 250, if a 15% increase could be applied in the entire area. The increase will proportionally benefit the indvidual farming unit on which an increase in use can be allowed given the class scenarios. Clearly a major increase in welfare creation for the area (see Table 1 and 3).

4.6 Employment impacts of projected changed water allocation

The increase in seasonal and permanent employment is 13.4 % and 13 % respectively, more or less in correspondence with the 15% increase in water availability (see Table 2). The total seasonal labour requirement for the Koue Bokkeveld WMA will increase from 810 009 to 918 209 man days (8 200 additional), while the total number of permanent labourers will increase from 4 286 to 4 877 (591 permanent jobs created).

5. IMPACT OF A CHANGE IN WATER ALLOCATION ON FARMING IN THE UPPER OLIFANTS RIVER BASIN

5.1 Area

The total area currently irrigated in the Upper Olifants is 7 000 ha.

5.2 Typical farming pattern

The Upper Olifants area is well known for its citrus production, traditional as well as soft citrus varieties, mainly for the export market. The climate and well drained soils allow high yields, making this area one of the most productive agricultural areas in South Africa. Water for irrigation is extracted from the Olifants River. Winter water is stored in dams on farms. The current restriction is 6 000 cubic meter of water can be stored for each hectare under irrigation. The water stored is primarily the result of winter water abstraction but supplemented during the low flow season.

5.3 Current water allocation

Producers are currently registered for 12 200 m^3/ha for 75 hectares on a typical farm, but they get and use only 10 800 m^3 /ha.

5.4 Projected change in water allocation

If producers are allowed to store additional winter water (and reduce the summer low flow season abstraction) in order to extract their full quota of 12 200 m^3 per hectare, a producer on a typical farm will get 12 200m^3/ha for 75 ha, but will only apply 10 800m^3/ha and will expand the area under irrigation to 85ha, an increase of 13.3%. The irrigated area for the Upper Olifants area as a whole could theoretically be increase from 7 000 hectares to 7 933 hectares.

Additional water can only be obtained by storing the additional winter water. The existing dams will have to be increased and new dam(s) will have to be constructed on farms at the producers' own cost. The dam and mother pipeline construction costs was spread over the lifespan of such infrastructure. The dam construction cost is R40 000/ha and the pump station and mother pipeline cost is R23 000/ha.

5.5 Financial-economic impacts of projected changed water allocation

Additional water that may become available will have to be stored in dams on farms that will have to be constructed with private capital. The dams will have to be constructed outside the river, implying that winter water will have to be pumped from the river to the dam and from there to the orchards. More water and greater assurance of water availability will allow an expansion of the irrigated area, and the planting of more profitable citrus cultivars.

The impacts of a projected increase of 13.3% in water available for irrigation was determined by means of a typical deciduous fruit farm model for the Upper Olifants river WMA. Additional water can only be obtained by storing winter water. The 13.3% projected increase in water will cause the NPV and the annuity to increase by 36%. The annuity for the Upper Olifants production area could increase from R209 224 297 to R264 738 250, if a 13.3% increase could be applied in the entire area. The increase will proportionally benefit the indvidual farming units on which an increase in use can be allowed given the class scenarios. Clearly a major increase in welfare creation for the area (see Table 1 and 3).

5.6 Employment impacts of projected changed water allocation

The increase in seasonal and permanent employment is 10 and 12.3 % respectively, slightly lower than the 13.3% increase in water availability (see Table 2). The total seasonal labour requirement for the Upper Olifants River production area will increase from 379 102 to 418 284 man days (39 182 increase). The total number of permanent labourers will increase from 5 289 to 5 973 (684 permanenet jobs created).

6. IMPACT OF A CHANGE IN WATER ALLOCATION ON FARMING IN THE OLIFANTS RIVER BASIN BETWEEN CLANWILLIAM DAM AND KLAWER

6.1 Area

The total area currently irrigated is 3 000 ha. The Clanwillian canal supplies water to 1 673 hectares, while the rest of the area (1 327 ha) requires pumping from the Olifants River. The analysis focuses only on the area supplied by the Clanwillian canal. (This should not be confused with the LORWUA distribution canal).

6.2 Typical farming pattern

The area is well known for its table grape production.

6.3 Current water allocation

A producer on a typical farm of 50 ha currently receives 7 600 m^3/ha for 43 hectares.

6.4 Projected change in water allocation

The projected increase of 9.3% in water allocation will allow a producer on a typical farm to expand the area under irrigation from 43 to 47 hectares at the same intensity of 7 600 m^3/ha. The irrigated area in the Olifants River basin between Clanwilliam dam and Klawer production area served by the Clanwillian canal will increase from 1 673 hectares to 1 829 hectares.

6.5 Financial-economic impacts of projected changed water allocation

The impacts of a projected increase of 9.3% in water available for irrigation was determined by means of a typical table grape farm model for the Olifants River basin between Clanwilliam dam and Klawer production area(see Table 1). The 9.3% projected increase in water will cause the NPV and the annuity to increase by 47%. The annuity for the Olifants River basin between Clanwilliam dam and Klawer production area will increase from R17 511 244 to R25 694 986, a major increase in welfare creation for the area.

6.6 Employment impacts of projected changed water allocation

The increase in seasonal and permanent employment is 9.3 and 9.4 % respectively, the same magnitude as the 9.3% increase in water availability (see Table 2). The total seasonal labour requirement for the Olifants River basin between Clanwilliam dam and Klawer production area will increase from 768 744 to 840 426 man days (71 682 increase), reflecting the labour intensive harvesting of table grapes, while the total number of permanent labourers will increase from 937 to 1 051 (114 permanenet jobs created).

7. IMPACT OF A CHANGE IN WATER ALLOCATION ON FARMING IN THE LOWER OLIFANTS RIVER BASIN

7.1 Area

The total area currently irrigated is 10 000 ha.

7.2 Typical farming pattern

TheLower Olifants River basin is well known for wine grape production. Due to the uncertainty of sufficient water during the summer assurance of supply, producers do not plant their whole irrigable areas with wine grapes, but use some 14% of the area for vegetable production. During a very dry winter the water stored in the Clanwilliam dam is inadequate for irrigation during the summer for the whole irrigable area. Producers can then decide not to plant vegetables as annual crops in order to use the available water for the wine grapes as a perennial crop.

7.3 Current water allocation

Producers are registered for 12 200m^3/ha, but the canal from the Clanwilliam dam allows a maximum of only 325m^3/ha per week (or 8 400 cubic meter oper hectare). Given the limitation provided by the distribution canal and the uncertainty of delivery of water from the dam due to limited storage capacity to bridge dry years, producers receive on average only 6 400m^3/ha per annum.

7.4 Projected change in water allocation

An increase in the height of the wall of the Clanwilliam dam will improve the assurance of delivery by bridging dry winters and will bring about a fuller utilisation of the exiting capacity of the Clanwilliam canal. A typical farm will then receive and use 8 200m^3/ha. The increased amount of water per hectare will be combined with a limited expansion of the irrigated area from 47 to 50 hectares. Due to the increased assurance of delivery, 94% of the total irrigated area will be used for wine grape production and 6% for vegetable production. This scenario has not taken the possible increase in the distribution canal into consideration.

A suggestion to utilise some of the irrigated area with subtropical fruit was not accommodated in the typical farm model as it is the opinion of horticulturalists of SUBTROP and the Horticulture Departement of the University of Stellenbosch that frost and/or strong winds in September will allow only marginal production. Experimental plantings of suitable varieties will be needed to confirm the profitable production of subtropical crops in this WMA.

The irrigated area in the Lower Olifants River basin production area will increase marginally from 10 000 hectares to 10 638 hectares.

7.5 Financial-economic impacts of projected changed water allocation

The impacts of a projected increase of 6.4% in the area under irrigation, the increase in the quantity of water per hectare of 28%, as well as the assurance of delivery was determined by means of a typical wine grape and vegetables farm model for the Lower Olifants River basin production area. These changes will cause the NPV and the annuity to increase by 93%. The annuity for the Lower Olifants River basin production area will increase from R42 708 644 to R82 215 016, a major increase in welfare creation for the area (see Table 1).

7.6 Employment impacts of projected changed water allocation

The seasonal employment will drop by 60% due to the termination of vegetable production which relies heavily on seasonal labour. Permanent employment will remain the same (see Table 2). The total seasonal labour requirement for the Upper Olifants River basin production area will decrease from 274 226 to110 635 man days (decrease of 163 591), while the total number of permanent labourers will stay constant at 1 702.

The drop in seasonal employment capacity must be seen as a sacrifice to allow a financially more viable farming pattern. A typical farm currently shows an IRR of only 4.3% which is lower than the real bank interest rate. This implies that a producer can do better by selling his/her farm and invest the money in the bank. Stated differently, a farmer will not be able to service his/her loan if he/she borrows money from a bank to buy land and farming equipment.

8. IMPACT OF A CHANGE IN WATER ALLOCATION ON FARMING IN THE SANDVELD

8.1 Area

Three sub-areas are distinguished.

Area 1: Total irrigated area is 1 750 ha and an increase of 15% water extraction is projected,

Area 2: Total irrigated area is 1 750 ha and a decrease of 10% water extraction is projected, and

Area 3: Total irrigated area is 3 500 ha and no change in water extraction is projected.

8.2 Typical farming pattern

Potato production on circular fields with sandy soils under centre pivot irrigation systems fed by groundwater is the common intensive farming practice in the Sandveld. A rotation system of one season potatoes on an irrigated circle, followed by five years winter grain on the same circle to combat soil pathogens that would have spoiled a potato crop directly following a previous potato crop. The total area under circles will thus consist of one sixth of the number of circles under irrigation and five sixths of the number of circles without irrigation. The Sandveld typical farm model incorporates the contributions from the winter grain.

8.3 Current water allocation

Groundwater is extracted to provide 6 200m^3/ha on an irrigated circle in all three areas.

8.4 Projected change in water allocation

Area 1: An increase of 15% water extraction is projected. This will increase the irrigated area on a typical farm from 60 to 69 ha and the total area under circles (irrigated and non-irrigated) from 360 to 414 ha.

Area 2: A decrease of 10% water extraction is projected, reducing the irrigated area from 60 to 54 ha and the total area under circles (irrigated and non-irrigated) from 360 to 324 ha.

Area 3: Total irrigated area is 3 500 ha and no change in water extraction is projected.

8.5 Financial-economic impacts of projected changed water allocation

The impacts of a projected increase or decrease in the area under irrigation was determined by means of a typical potato farm model for the Sandveld production area (see Table 1). The total IRR, NPV and annuity of the typical farm include the contribution of the winter grain as it forms an integral part of the total farming system. The NPV per irrigated hectare and per 1 000m^3 focus on the profitability of the whole farm per irrigation unit to allow comparison with the other WMA's.

Area 1: The 15 % increase in water availability and likewise in irrigated area causes the NPV and the annuity to increase by 114%. The annuity for Area 1 of the Sandveld will increase from R11 771 123 to R25 190 411, a major increase in welfare creation for the area (see Table 1). The reason for the relatively great increase of the annuity in the Sandveld compared to that of the other production areas in the WMA's is the limited increase in capital expenditure needed to expand the area under pivot irrigation, as the Sandveld producer does not have to store water (construct storage facilities) and does not have a high crop establishment cost and interest on capital while waiting for the crop to reach its breakeven year, as in the case of perennial crops. Variable cost contributes the dominant part of the total cost structure of potato farming.

Area 2: The 10 % reduction in water availability and likewise in irrigated area causes the NPV and the annuity to decrease by 307%. The profitability of potato farming is clearly very sensitive for a reduction in scale of production. The annuity for Area 2 of the Sandveld will decrease from R11 771 123 to R2 829 103, a major setback in welfare creation for the area (see Table 1).

Area 3: No change in profitability will take place. The annuity for the whole area will be R23 542 247.

8.6 Employment impacts of projected changed water allocation

Area 1: The 15 % increase in water availability and likewise in irrigated area causes the seasonal and permanent employment to increase by 19% and 17 % respectively (see Table 2). The total seasonal labour requirement for Area 1 of the Sandveld production area will increase from 70 000 to 83 146 man days, while the total number of permanent labourers will increase from 175 to 204 (29 permanenet jobs created).

Area 2: The 10 % reduction in water availability and likewise in irrigated area causes the seasonal employment to decrease by 8% and permanent employment to remain constant (see Table 2). The total seasonal labour requirement for Area 2 of the Sandveld production area will drop from 2 400 to 2 205 man days (195 increase), while the total number of permanent labourers will remain constant at 175.

Area 3: No change in employment will take place. The total seasonal labour requirement for Area 3 of the Sandveld WMA will stay at 2 400 man days, while the total number of permanent labourers will remain constant at 350.

Table 3: Summary of the financial and economic changes due to changes in water allocation

Production area	Current	After increase	Change	Percentage change
Koue Bokkevled (15% increase in water)				
IRR (%)	9.60%	11.40%	1.80%	18.75%
NPV in Rand	R 219,165	R 259,838	R 40,673	18.56%
Annuity per irrigated ha	R 11,484	R 13,615	R 2,131	18.56%
Citrusdal (13.3% increase)				
IRR (%)	11.10%	13.50%	2.40%	21.62%
NPV in Rand	R 570,410	R 636,872	R 66,462	11.65%
Annuity per irrigated ha	R 29,889	R 33,372	R 3,483	11.65%
Olifants Clanwilliam to Klawer (9.3 % increase) Table grapes				
IRR (%)	9.70%	12.10%	2.40%	24.74%
NPV in Rand	R 199,753	R 268,107	R 68,354	34.22%
Annuity per irrigated ha	R 10,467	R 14,049	R 3,582	34.22%
Olifants (Wine grapes and vegetables) 6.4 % increase and assurance of supply increase				
IRR (%)	4.30%	5.70%	1.40%	32.56%
NPV in Rand	R 81,506	R 147,491	R 65,985	80.96%
Annuity per irrigated ha	R 4,271	R 7,728	R 3,457	80.94%
Sandveld (15% increase)				
IRR (%)	6.10%	11.10%	5.00%	81.97%
NPV in Rand	R 128,367	R 238,817	R 110,450	86.04%
Annuity per irrigated ha	R 6,726	R 12,514	R 5,788	86.05%
Sandveld (10% decrease)				
IRR (%)	6.10%	3.20%	-2.90%	-47.54%
NPV in Rand	R 128,367	R 34,280	-R 94,087	-73.30%
Annuity per irrigated ha	R 6,726	R 1,796	-R 4,930	-73.30%

Refer to the assumptiosn made and listed in table 1 and 2.

9. CONCLUSIONS

9.1 **Impact on profitability**:

The projections show that all the production areas in the Olifants Doorn WMA's, on farm level, will experience a significant increase in profit generation if water availability can be increased according to the projected levels. In the case of the Lower Olifants River production areas, such a change is desparately required by farms with a size similar to that of the typical farm model.

On a WMA regional level the increased availability of water will result in significantly greater welfare creation. This will in turn generate more upstream (input side of the farm) and downstream (marketing of the farm produce) benefits.

The financial impact of the increased water availability in the case of the Koue Bokkeveld and Upper Olifants River basin as expressed in terms of an annuity per 1 000m^3 irrigation water used per annum (R/1 000m^3) (see Table 1) exceed that of all the other WMA's. If one takes into account that the values of this parameter for these two areas are negatively influenced by the dam storage and water distribution cost incorporated in their farm cost structures, while the storage cost in the case of the Lower Olifants river basin should be lower due to scale benefits of large irrigation schemes, and none of the other WMA's farms have water storage costs, the former areas (Koue Bokkeveld) do actually even better.

The reduction in water availability as in the case of Area 2 of the Sandveld has a similar magnitude, but negative financial impact. The low IRR of 3.2% warns that such a reduction in water availability will mean the termination of most farms in the particular area. In order to minimise the economic impact of a reduction in the use it would be recommneded that the reduction in use that is required should not be applied proportionally to all existing lawful users in a partulciar area but the unlawful use be identified and used as a starting point to reduce current use.

9.2 **Impact on employment**

All the areas show an increase in employment numbers in response to an increase in water availability, except for seasonal labour in the Lower Olifants River production area (LORWUA), due to the termination of labour intensive vegetable production that will be associated with an increase in assurance of supply and some increase in water avialability. More water and greater assurance of delivery are essential for the longer term viability of the typical farm and the protection of the employment capacity of wine grape production.

ANNEXURE 1

Farm Modelling for Interactive Multidisciplinary Planning of Small Grain Production Systems in South Africa

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Extract from PhD Dissertation, University of Stellenbosch, 2010

Budgeting models

Budgeting is perhaps the most widely used method of financial planning. Budgeting, as a non-optimising method evaluates plans in physical and financial terms. The popularity of budgets stems from their simplicity of use and the fact that they aid in the heuristic approach to decision-making, rather than imposing an analytical framework on the decision maker. Budgets are often used as comparable quantitative techniques and play an important role in benchmarking. The development of computer technology introduced a dimension to budgeting methods that allowed budgets to be used as dynamic planning and decision-making tools. In this sense, budgets can now also be classified as simulation models that are based on accounting principles and methods, rather than purely on mathematics.

Whole-farm budget models are in essence simulation models, normally developed using spreadsheet programmes. Within spreadsheet programs complex and sophisticated calculations and relationships can be expressed in a relatively simple way. The sophistication of budget models lies in their ability to allow for detail, adaptability and user-friendliness.

Whole-farm budgets are drawn up to show the anticipated consequences, in terms of selected criteria, proposed farm plans, parameters and policy options. Whole-farm budgets incorporate physical as well as financial parameters and usually produce profitability criteria such as net farm income or cash flow. Whole-farm budgeting quantifies and subtracts overhead and fixed costs to return a net farm income value. Net farm income is commonly used for a financial comparison of farming units. With some adaptation, whole-farm models may also be extended over time to calculate returns on capital invested and to calculate profitability indicators such as the Internal Rate of Return on capital investment (IRR) or Net Present Value (NPV).

The purpose of developing the budget model for each homogeneous area was twofold. Firstly, the models were used to determine the current financial position of the typical farm for each homogeneous area. Secondly the models were used to measure the impact of proposals by expert groups in terms of established financial criteria.

To establish the current financial position of each farm, the complexity of the farm needed to be captured. The factors and interrelationships that influence and determine profitability were incorporated in such a way that these factors could be manipulated and could instantly show the financial impact on the entire farm. Whole-farm, multi-period budget models were developed for each area. Budgets allow for the incorporation of large numbers of variables, which allow for accurate reflection of the factors and interrelationships that influence the financial performance of the total farm. The models consist of various sets of data and calculations that are interconnected and are based on standard accounting principles and methods.

The components of the calculation model are shown in Figure 1. It illustrates the input component, calculation component and output component of the budget model. Each component consists of various parts.

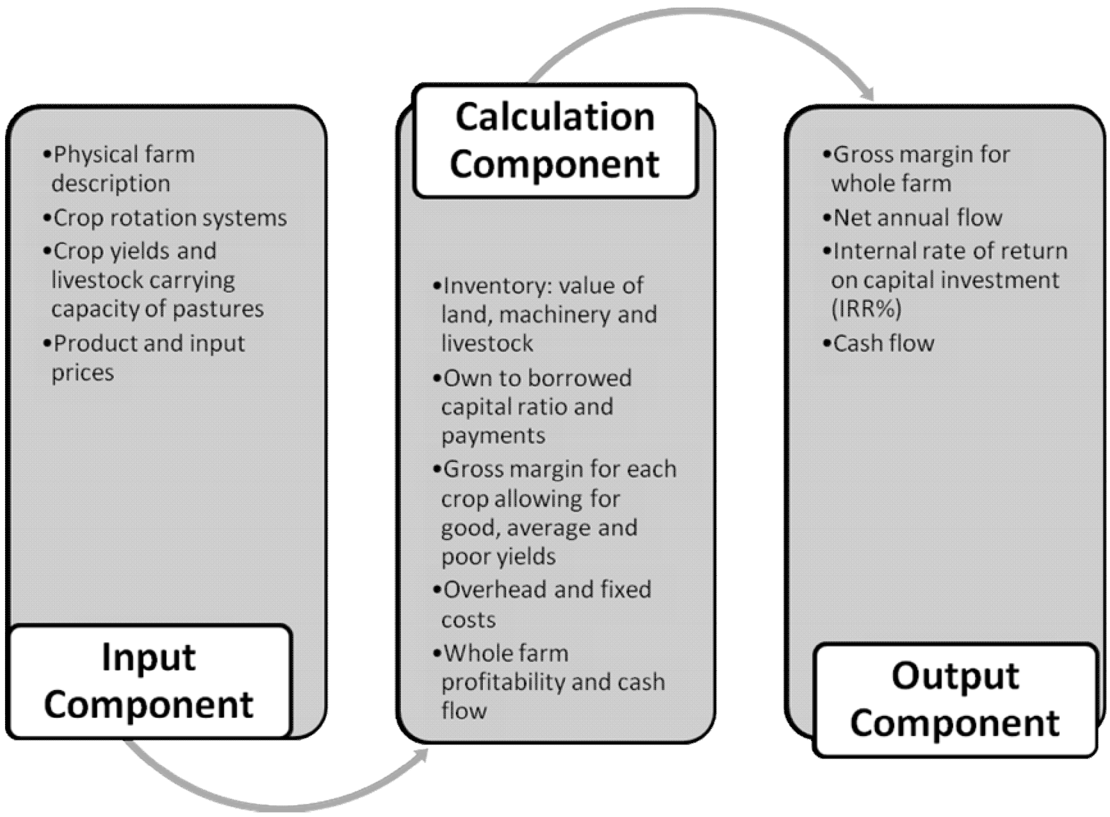

Figure 1: A graphic representation of the components of the whole-farm, multi-period budget model

The input component

The input component consists of the description of the physical farm description, land use patterns, crop rotation systems, yield assumptions, input prices and output prices. All of these factors can be adapted, which will immediate impact on the output component.

- Physical description of the typical farm

The aim of using a typical farm is to represent a farm with physical parameters to which producers in a particular area can relate. The physical and financial extent of the typical farm for each area has to be established. From study-group information, the mode for each of the aforementioned aspects was established. The mode is the point around which data is most heavily concentrated and that is closest to the definition for a typical farm. This method was used to establish the physical extent of the typical farm described in terms of farm size, land ownership, land use pattern, mechanisation infrastructure, and overhead and fixed costs.

- Farm description

The first important assumption in the typical farm model for each area was the size of the total farm. Within the model, farm size forms the basis that determines numerous other factors. Factors that depend on and change with a change in farm size include cultivated area, land utilisation, mechanisation requirements, investment in fixed improvements, investment in land, number of permanent labourers required, as well as the other fixed costs.

Other physical parameters that influence the financial performance of the typical farm include land ownership, land usability and land utilisation. Total land consists of rented land and own land. Rented land influences the factor cost component of the model. Own land and the assumed own-to-borrowed capital ratio determine the payment required, which impacts on the expected cash flow. All farms include an uncultivated part.

- Financial description of the farm

The farm's financial description expresses the physical extent of the farm in financial terms. It is presented in the form of an inventory or asset register. It calculates the sum of the investment requirement for all assets. It contains values for all items. Items in the inventory include land, fixed improvements, machinery, equipment and livestock. All these factors are connected and dependent on the farm size, and are automatically adjusted if farm size is altered. The assumptions regarding the relationships between land and moveable items were based on the field capacities of machines and the livestock carrying capacity of pasture. All the assumptions were validated during the group discussions. All the assumptions and parameters in the model can also be adjusted.

- Data on input and output prices

Lists of prices for all production factors, including machinery and directly allocated inputs like seed, fertilisers, chemicals and fuel, were accommodated in the model. These lists are in the form of data tables, from which items can easily be selected by various spreadsheet functions.

The calculation component

The calculation component consists of the various calculations and interconnections that relate and connect the various input parts to generate valid outputs in the form of profitability criteria. Standard and established accounting principles are applied to ensure the validity of the model.

The total investment in mechanisation depends on the number, size and age of machines and equipment. The mechanisation requirement can be calculated. Factors included in the calculation are the area that needs to be cultivated, the time available for the activity, and the capacity of the machine and implement set.

- Inventory

The role of the inventory is to calculate the expected capital requirement for the whole farm. The capital requirement is in essence a financial quantification of the sum of all assets required to farm sustainably. Capital items include land, fixed improvements, machinery, equipment and livestock. The investment in land, determined by farm size and the price of land, is the biggest contributor to capital requirements for all areas. Fixed improvements were included with the land price.

- Gross production value and gross margin

For each homogeneous area, a separate enterprise budget was compiled for every crop included in the crop rotation system. The price data included in the enterprise budgets were selected from the aforementioned data tables.

- Overhead and fixed costs

Overhead and fixed costs were determined by the information provided by the producer study groups. The overhead and fixed costs for each area were verified during group discussions. The owner’s remuneration is included as a fixed cost in the models. Fixed and overhead costs typically include permanent labour, licences, insurance, water scheme levies, fuel and maintenance on general farm vehicles, maintenance on fixed improvements, banking costs, accountant’s fees, electricity, communication costs, administration costs and provision for diverse costs.

The output component

The output of the models includes a calculation of whole-farm profitability expressed as an IRR (internal rate of return on capital investment) and a NPV (net present value). The cash flow measures the affordability of the borrowed capital amount in terms of cash flow.

- Profitability

The budget models were based on a 25-year calculation period. The main reason for the long period was to capture the development from establishment to replacement of perennial crops and to capture the nature of the potato crop rotation systems, which run over a 6-year period. Another important reason was to allow for the replacement of machinery and equipment. The 25-year calculation period reflects only a random period in the life of a farm to allow for comparable evaluation.

The annual fixed and overhead costs remain the same over the calculation period. These costs are typical for each homogeneous area, and were determined with the help of study-group data and verified during the workshops. Capital expenditure is calculated on the information in the inventory or asset register, which is determined by the farm's physical description. Replacement of machinery and equipment is based on the life and age at the beginning of the calculation period and the life of the machines. The salvage value of an item of machinery and equipment is subtracted from the price of the new item.

The capital-flow budget calculates the net flow of funds, which is gross margin, minus overhead and fixed costs, minus capital expenditure. The annual net flow of funds over the 25-year period is used to calculate profitability. The profitability for each typical farm was measured in terms of Net Present Value (NPV) and Internal Rate of Return on capital investment (IRR). The NPV and IRR are closely related. By definition, the IRR is the rate that when used as an interest rate would return a zero NPV. The NPV measures the present value of future cash flow. The IRR measures the growth that the cash flow generates, as a return on the initial investment. The NPV and IRR are ideal criteria if different projects or options, which start at different times, run over different periods, or have different capital investments, need to be compared to one another. In this instance, the financial implications of various changes to the parameters and assumptions can be established. The impact of different strategies on whole-farm profitability can be measured by the IRR while the size of the initial investment affects the NPV result.