# Estimating the economic value of water in Namibia



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# ESTIMATING THE ECONOMIC VALUE OF WATER IN NAMIBIA

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## Abstract

*The Stampriet Aquifer is the largest aquifer in Namibia covering an area of 65,000km$^2$. Presently there is a water-abstraction system approximating open-access operating among the commercial farming community drawing groundwater from this aquifer. Depletion is evidenced by a falling water-table level over time. Farmers currently pay the full financial cost of water abstraction, but although a system of groundwater permits exists, it is poorly enforced. A large-scale geo-physical study on the Stampriet Aquifer is underway, part of which included a hydrocensus of approximately 1500 farms, concentrating on physical and socio-economic variables. This hydrocensus is currently being completed with over 600 returns and includes more robust data on water and its use than exist for any other area or aquifer in Namibia. This paper aims to firstly create the baseline information to calculate the economic value of water in the Stampriet area. Using residual value analysis, the marginal value product is estimated for surveyed farms in the area. A typical farm is modelled using enterprise models and data from a face-to-face questionnaire. It is found that while water is a very important and integral resource, the economic efficiency of the farms is poor. A financial water 'value' of N$ 0.03 and an economic water 'value' of N$ 0.64 per cubic metre is calculated, and the policy implications of this discussed. The analysis is then supplemented by the initial, more robust hydrocensus data, used to conduct further examinations and to start to build an environmental economic model for all activities impacting on the Stampriet Aquifer. This study is being used as a pilot to test the ability of economics techniques to provide a realistic and accurate value for water in Namibia. The results of the study and techniques used are also of use to other future water valuation studies in Namibia and will also be used to inform the water sector policy in promoting economic development.*

## Section I – Introduction

Water is often cited as the single largest constraint to development in Namibia. Namibia is one of the world's most sparsely populated countries as well as one of the driest; roughly 80% of its 842,000 square kilometres consist of desert, arid, and semi-arid land (Brown, 1994). Rainfall is not only low, but also extremely variable over much of the country and droughts are common. Namibia's economy is largely resource-based – the four sectors that generate most of GDP, government revenues, and foreign exchange earnings are mining, agriculture (mainly livestock), fisheries, and wildlife-based tourism.

Each of these sectors is highly dependent on water and, consequently, water management policy is a critical component of Namibia's development strategy. Its current scarcity and the limited options for augmenting supply to meet the needs of a growing economy and population strongly suggest that water resource management should focus on efficient supply and efficient usage of existing resources.

Until recently, water management was based on the Water Act of 1956, an act that was designed to serve commercial farming, mining, and the major urban centres through increasing supply as a means to cope with water scarcity, and relatively few resources were directed toward Namibia's rural population. Pricing had little relationship to the cost of providing water[1]. In most instances water prices did not reflect the financial costs and certainly not the economic costs. This gave an incorrect signal to consumers concerning water scarcity, and encouraged the inefficient use of water. In many areas property rights have also been uncertain or unclear, and water was, in effect, an open-access resource (Groom, 1999; van der Merwe *et al*, 1998).

Namibia's water policy has been re-oriented since independence, first with the Water and Sanitation Policy (DWA, 1993) and now with a new Water Act (NWRMR, 2000). The new Water Policy White Paper emphasises the need to recognise the economic value of water and the use of economic instruments for efficient and equitable water management (NWRMR, 2000). Appropriate water pricing is a key component of the new policy, which calls for tariffs that reflect full financial costs, environmental impacts, and the opportunity costs of water (NWRMR, 2000). In addition, it calls for a tariff structure that will create incentives for water conservation.

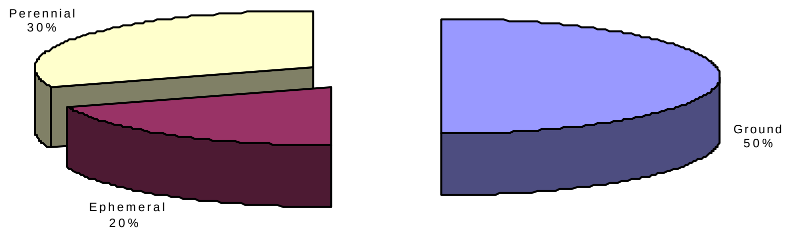



**Figure 1 – Water Use by Source in Namibia, 1996**

Appropriate price setting is a difficult task because much of the water used is not metered. There is some information about the financial costs of supplying water, but little information about the full economic value of water – neither its private marginal benefit, nor its opportunity cost and externalities. Externalities include saltwater intrusion, depletion of aquifers due to open access which increases water pumping costs, ecosystem damage due to excessive abstraction of groundwater, or ecosystem damage due to dams which prevent or limit the flow of seasonal rivers. Owing to the lack of information, the strategy of the new Water Act calls for a programme to value water resources (Section III.2.2).

Namibia's Natural Resource Accounting (NRA) Programme has constructed water accounts (Lange, 1997), which estimate the use of water by economic activity. An abbreviated version of the accounts is shown in Table 1. Namibia obtains its water from three main primary sources: the perennial border rivers, the internal ephemeral rivers, and groundwater. The proportions of water supplied from these sources in 1998 are shown in Figure 1. Indicators of the opportunity costs of water across high-use sectors have been calculated by measuring the sectoral value-added generated per cubic metre of water used (Table 2). The values have increased slightly from 1993, in response to government policy of gradually increasing water tariffs to achieve full-cost recovery (financial cost only), and provides an indication that economic instruments can be effective in managing this resource.

[1] Except in commercial faming areas where farmers paid the financial costs of abstracting water, although the construction of boreholes was subsidised.

**Table 1 – Water Use by Source and Economic Activity in Namibia, 1996**

| | | All Sources | Ground Water | Ephemeral Rivers | Perennial Rivers |
|---|---|---|---|---|---|
| **AGRICULTURE** | | **142.9** | **48.6** | **30.6** | **63.8** |
| **Livestock** | | 58.2 | 40.7 | - | 17.5 |
| | Communal | 32.2 | 14.7 | - | 17.5 |
| | Commercial | 26.0 | 26.0 | - | - |
| **Crops** | | 84.7 | 7.9 | 30.6 | 46.3 |
| | Communal | 17.8 | 1.6 | - | 16.2 |
| | Commercial | 66.9 | 6.3 | 30.6 | 30.1 |
| **MINING** | | **25.2** | **22.6** | **1.2** | **1.4** |
| **MANUFACTURING** | | **5.3** | **3.8** | **1.5** | **-** |
| **SERVICES** | | **5.6** | **3.9** | **1.4** | **0.3** |
| **GOVERNMENT** | | **2.4** | **1.7** | **0.8** | **-** |
| **HOUSEHOLDS** | | **73.8** | **47.1** | **14.8** | **11.8** |
| | Urban | 39.2 | 17.0 | 11.1 | 11.1 |
| | Rural, communal | 10.3 | 5.9 | 3.7 | 0.7 |
| | Rural, commercial | 24.3 | 24.3 | - | - |
| **TOTAL** | | **255.3** | **127.6** | **50.3** | **77.4** |

Note: The figure for 'Rural, commercial' households assumes substantial use of water for gardening.
*Source*: Based on unpublished data from the NRA Programme, MET.

**Table 2 – Value-Added per Cubic Meter of Water Input in 1993 and 1996**
(in constant 1990 prices)

| | | Value-added per cubic metre of water input | |
|---|---|---|---|
| | | **1993** | **1996** |
| **Agriculture** | | 2.6 | 4.0 |
| | Commercial | 2.7 | 3.8 |
| | Subsistence | 2.4 | 4.4 |
| **Mining** | | 56.9 | 60.4 |
| | Diamond mining | 56.0 | 69.1 |
| | Other mining | 58.3 | 50.2 |
| **Manufacturing** | | 173.6 | 165.2 |
| **Services** | | 266.6 | 283.0 |
| **$ of GDP per m3 of water input** | | **33.0** | **35.7** |

*Source*: Based on unpublished data from the NRA Programme, MET.

This value-added analysis, however, does not measure the economic value of water because value-added includes the value of non-water inputs. Furthermore, figures derived from national-level data can be misleading because of the tremendous variation among regions in terms of water availability and the opportunities for the use of water. The costs of transferring water from one region to another are very high. Consequently, the economic value of water must be measured in specific locations. The NRA Programme with colleagues in other ministries has begun the effort to value water as an input to water pricing discussions.

**This Study**

Agriculture, notably crop irrigation, is the major user of water (65% of total water use), so it was decided to begin valuation with a case study of one critical commercial farming area, Stampriet. This area has an added importance because it draws on an aquifer that is being depleted, evidenced by falling level of the water-table over time. Groundwater management is particularly important for Namibia, as it supplies roughly 50% of the country's water (see Figure 1). However, in much of Namibia, data concerning the extent of aquifer recharge and abstraction are absent and fossil groundwater constitutes a significant portion of groundwater resources. Depletion of groundwater is a serious concern, especially in the coastal region, which includes important urban and tourist centres, mining, and industry (Lange, 1997). Costly desalination is the only alternative in many of these regions.

This paper reports on the preliminary attempt at estimating a value of water for agricultural use in the Stampriet area and further provides preliminary results from a recent hydrocensus conducted for the area. Section 2 discusses the theory and the methodology adopted for this study. Section 3 provides a brief overview of current water use and agricultural practices at Stampriet, with some discussion of how representative our sample may be. The results are presented in Section 4 for the average farm as well as for farms of different sizes. The final section discusses the policy implications for water pricing, and future work.

## Section II – Theory

The value of water to a user is the maximum amount the user would be willing to pay for the use of the resource. However, Young (1996) conceded that water value assessment is not easy since markets for groundwater services either do not exist or are highly imperfect. Nevertheless, several methods have been devised to ascertain the value of water in private, commercial and environmental uses. In this regard, the residual imputation approach is one of the most prominent techniques employed to estimate the value of water as an intermediate good in agricultural production, and hence useful in the Stampriet area.

### 2.1 The Residual Imputation Method

Using the residual imputation method, accurate results are guaranteed only if the quantities and prices of other factors of production, excluding water, are estimated correctly at their marginal values. The technique requires that all non-water factor inputs be deducted from the total value of the product(s) produced by an agricultural activity. Using this method, the additional contribution of each input in the production process is determined.

Following Young (1996), the residual imputation value can be derived by using a production function with four factors of production: capital (K), labour (L), land (R) and water (W). Assuming that the value of the marginal product of a production factor equals its price, the residual value of water used in agriculture can be computed by using the following equation:

$$Pw^* = \{TVP - [(PK \times QK) + (PL \times QL) + (PR \times QR)]\}/Qw$$

Where: $Pw^*$ = the shadow price of water.

$TVP$ = the industry's total value product (value added)

$P$ and $Q$ = the prices and quantities of the non-water factor inputs.

$Qw$ = the quantity of water used.

However, there are two main drawbacks associated with this technique: problems relating to specification of the production function and to the market and policy environment.

### 2.1.1 Production Function Specification

When attempting to specify the production function for the residual imputation method, three main problems arise. First, listing of all relevant inputs and assigning productivities to them is performed. If one or more important inputs are excluded from the specification of the production function, the productivity of the omitted input(s) is incorrectly attributed to the residual claimant. This means that the value productivity of the residual would be inflated. The omission of variables generally occurs when a short-run modelling framework is used to represent a long-run situation. The second problem is correct forecasting of the levels of an output associated with given factor inputs. Over- or under-estimating the level of production will result in a corresponding over- or under-estimate of the residual value. The third problem is related to difficulties in empirical measurement. This problem is prevalent in situations in which water contributes a relatively minor portion of the total value of output. Therefore, the possibility of errors in assigning opportunity costs to non-water inputs may seriously alter the residual assigned to water. For instance, when applying the residual technique to valuing water used in industrial production, one must allocate opportunity costs to other inputs such as financial capital. A minor change in the assumed opportunity cost of stockholder financial capital or in the interest rate payable on debt can have a large impact on the residual obtained from water.

### 2.1.2 Assigning prices to inputs and outputs

If government intervention or market failures lead to prices for both inputs and outputs which differ from the competitive equilibrium prices, the imputed value of the residual will be correspondingly inaccurate. Under-priced inputs will yield over-estimates of the residual; if outputs are under-priced, the residual is under-estimated.

## Section III – Conceptual Framework and General Methodology

### 3.1 Motivation for this study

There is a common perception that commercial farmers are earning a “rent” on the water they use, which should be recovered by government. The ultimate aim is to ensure that water *in situ* and *ex situ* is utilised as efficiently as possible, and to the benefit of the economy and the welfare of the citizens of Namibia. Owing to generous subsidies and a lack of monitoring and enforcement mechanisms in the commercial farming sector, there is a good possibility of inefficient practices (both economically and environmentally) existing, and land uses being sub-optimal.

This study is a pilot which aims to generate primary data on the current situation in the Stampriet area on farming, land use, water use and the financial data. It aims to construct an enterprise model of a typical farm for the area, to look at sensitivity analysis on important inputs, and use this to design future research. Important questions that should be addressed are: how much water is really used by each farm? for what economic purposes is this water employed? what is the value-added by each unit of water in its current use ?

This paper relies heavily on economic and financial models constructed by Barnes in Botswana that was the basis for developing the Typical Farm model (see Section 4).

### 3.2 Methodology

Since limited data are available on farming from official sources, a questionnaire was designed and information was elicited in face-to-face interviews. This fieldwork and some initial analysis was carried out by Lindgren in June 1999. A copy of the questionnaire and complete description of its development is given in Lindgren (1999).

The survey instrument was derived from a farm production model based on work by Barnes (1994). A questionnaire asked about quantities and costs of inputs used in production (capital variable, and overhead), quantities and value of output, and the quantity of water consumed (farmers do not pay for water). Prices were elicited in current 1999 prices.

Time was spent developing and pre-testing the questionnaire. In total, 17 farmers were interviewed, from the total of 66, yielding 14 usable surveys. Because a sampling framework was not possible, the interviewers travelled in a specified direction interviewing every other farmer they meet. Survey data were then entered and analysed in a spreadsheet.

### 3.3 Assumptions and Adjustments

To ensure a rigorous analysis, inflation was excluded from cash flows, which necessitated the use of real discount rates. In this 10-year model, all capital expenditures were included and depreciation was accounted for in the residual value of assets in the final year of analysis.

Adjustments are made for distortions of prices from competitive equilibrium prices. We use shadow pricing to convert financial prices into economics prices. Shadow pricing aims to ensure that values applied to inputs and outputs reflect their real scarcity in society (ie: the cost to society of their being used or produced in the specific activities). Where there is unemployment and social pressure for higher wages, the market price for labour is generally higher than its scarcity value. Hence a general shadow price for unskilled and semi-skilled labour of 0.35 of the market price was applied to reflect general unemployment. This is the shadow price recommended by the central planning authorities (Barnes, 1994). The market price of skilled labour and management is considered to be equal to the economic price.

Whenever there is excess demand for goods or services (commonly resulting from exchange control restrictions or the artificial setting of exchange rates), economic analysis must include a premium for foreign exchange. The value of the Namibian dollar is pegged to that of the South African Rand, and although this is a free-floating currency, it is currently maintained at approximately 10% above a true market value owing to foreign exchange restrictions.

The effects of domestic taxes and subsidies on market prices were removed where necessary to acquire economic prices. There were no indirect sales taxes or duties.

## Section IV – Water in the Stampriet area

Presently there is a system approximating open-access operating in the Stampriet area for groundwater. Although a system of groundwater permits exists, it is poorly monitored, enforced and provides little incentive to a farmer to abide by the amount legally permitted. Currently, there are 66 permits for irrigation totalling 9,907,560$m^3$ per annum, but in the absence of monitoring, the viability of this figure being adhered to is unsure. The area receives an annual average rainfall of 200mm per annum, but the chief recharge for the aquifer is not known owing to a lack of information on the hydrological cycle in the area and 'upstream'.

On each farm there are a number of boreholes, some are 'legal' (that is, they are known about by the Ministry of Agriculture, Water and Rural Development), but a number are not known. Of the legal category, there exists little reliable information on pumping rates, extraction volumes or pumping time. Hence, our methodology relies on volumes elicited from farmers directly in the face-to-face interviews.

Farmers currently pay the full financial cost of water abstraction (the capital cost of siting, drilling and sealing the borehole plus pumping costs [capital cost of generator or windmill plus the variable cost of fuel plus ongoing maintenance and repair]). However, no economic cost, resource rent or opportunity cost of groundwater and the aquifer's depletion, has been estimated or captured.

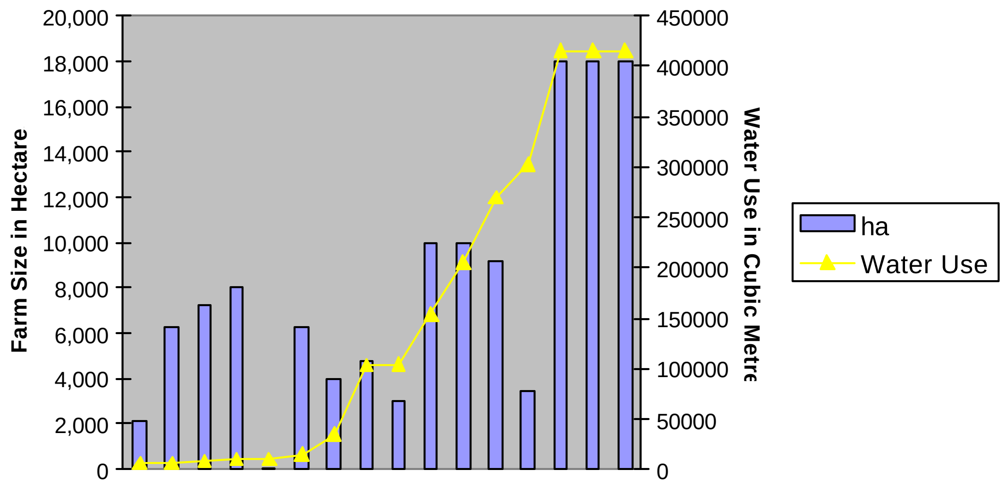
A large-scale geo-physical study on the Stampriet Aquifer is underway and will return results late-2000. These data should include more robust data on water [use for irrigation and stock; abstraction and leakages; availability *in situ*, recharge rates and the maximum sustainable yield per annum]. Our pilot study aims to create the baseline information which can in the near future complement this more robust data, to build an environmental-economic model for the whole area impacting on the Stampriet Aquifer [some 1500 farms in total].

As an average, each farm uses 19m$^3$ per hectare of land.

**Table 3 – Water Use by farms in ascending order**

| Farm Number | Hectares | Livestock Water Use (m$^3$) | Irrigation Water Use (m$^3$) | Total Water Use (m$^3$) |
|---|---|---|---|---|
| 7 | 2162 | 4681 | 1200 | 5881 |
| 1 | 6283 | 5376 | 728 | 6104 |
| 13 | 7200 | 7650 | 182 | 7832 |
| 14 | 8050 | 8286 | 1950 | 10236 |
| 8 | 35 | 0 | 10280 | 10280 |
| 2 | 6300 | 3919 | 10540 | 14459 |
| 12 | 4000 | 3732 | 30936 | 34668 |
| 3 | 4800 | 6679 | 96920 | 103599 |
| 10 | 3000 | 8130 | 96000 | 104130 |
| 5 | 10,000 | 12954 | 141260 | 154214 |
| 9 | 10,000 | 8933 | 196000 | 204933 |
| 6 | 9148 | 10025 | 260000 | 270025 |
| 11 | 3439 | 3039 | 300000 | 303039 |
| 4 | 18000 | 27330 | 388464 | 415794 |
| 15 | 18000 | 27330 | 388464 | 415794 |
| 16 | 18000 | 27330 | 388464 | 415794 |
| **TOTAL** | | **165392** | **2311389** | **2476781** |

**Figure 2 – Water Use and Farm Size, 1999**



## Section V – The Typical Farm

### 5.1 Summary of the Financial and Economic Model

Table 4 presents the financial statement of the typical farm constructed from the questionnaire results. It turns a small profit (N$ 4,977 per annum). The chief sources of income are sales of sheep and irrigated crops, but the overhead, capital and variable costs all but crowd-out the potential for greater gains from the land. Appendix 1 contains detailed information on the various costs, incomes, stock and depreciation values given in Table 4.

**Table 4 – Financial Statement for the Typical Farm**

| **ITEM** | **UNITS** | | **TOTAL** |
|---|---|---|---|
| Concession Extent | Hectares | | 8151 |
| Concession Stock | Large Stock Units (LSU) | | 319 |
| **ITEM** | **N$/LSU** | **N$/HECTARE** | **N$** |
| **(a) Financial Analysis** | | | |
| Total Financial Capital (TCI) | 9066 | 355 | 2889626 |
| Financial Gross Income | 1887 | 74 | 601543 |
| Variable Financial Costs | 681 | 27 | 217083 |
| Fixed Financial Costs | 1150 | 45 | 253003 |
| Cost of Financial Capital Depreciation | 412 | 16 | 144481 |
| Net Cash Income | 56 | 2 | 4977 |
| (b) **Economic Analysis** | | | |
| Economic Gross Income | | | 564671 |
| Economic Costs | | | 464994 |
| Net Economic Value Added | | | 99677 |
| Water Use (m3) | | | 154869 |
| Marginal Value Product of Water (N$/m3) | | | |
| (a) Financial Price | | | 0.03 |
| (b) Economic Price | | | 0.64 |

### 5.2 Calculating Marginal Value Product of Water

*(a) Financial Price*

The farm uses 154,869 $m^3$ of water each year to irrigate crops and 'water' stock (approx. 19$m^3$ per hectare). Modifying equation (1) from Section 2.1:

$$Pw_t^* = \{TVP_t – [(PK \times QK) + (PL \times QL) + (PR \times QR)]\}/Qw_t \qquad (2)$$

$$Pw_t^* = \{601543 – [596556]\}/ 154369 = 0.03$$

Using the residual imputation method, the financial marginal value product of water equates to N$ 0.03 per $m^3$.

(b) *Economic Price*

Using the above methodology for economic costs and benefits:

$$Pw_t^* = \{564671 – [464994]\}/154369 = 0.64$$

The economic marginal value product of water is N$ 0.64 per $m^3$.

### 5.3 How 'typical' is the Typical Farm?

Models were constructed in parallel with the Typical Farm model for actual farms in the Stampriet region that gave solid responses throughout their questionnaires. One was compiled from the 3 largest farms (see Table 6) and one of the smaller (see Table 5).

**Table 5 – Example of a small farm in the Stampriet area, Farm 11**

| **ITEM** | **UNITS** | | | **TOTAL** |
|---|---|---|---|---|
| Concession Extent | Hectares | | | **3439** |
| Concession Stock | Large Stock Units (LSU) | | | **99** |
| Annual Visitor Days (VD) | Number | | | **786** |
| **ITEM** | | **N$/LSU** | **N$/HECTARE** | **N$** |
| **(a) Financial Analysis** | | | | |
| Total Financial Capital (TCI) | | 25383.16 | 730.7161966 | **2512933** |
| Financial Gross Income | | 6958.737 | 200.3242222 | **688915** |
| Variable Financial Costs | | 3435.859 | 98.90956673 | **340150** |
| Fixed Financial Costs | | 4354.76 | 125.3623801 | **431121.2** |
| Net Cash Income | | -831.881 | -23.94772463 | **-82356** |
| **(b) Economic Analysis** | | | | |
| Economic Gross Income | | | | **645388** |
| Economic Costs | | | | **638921** |
| Net Economic Value Added | | | | **6467** |
| Water Use ($m^3$ per annum) | | | | **303039** |
| Marginal Value Product of | | | | |
| Water (a) Financial Price | | | | **–** |
| (b) Economic Price | | | | **0.02** |

This farm covers only 40% of the range of the Typical Farm, and has a less diverse land use, concentrating on irrigated crops (63.2% of gross income), with a stock composition of 700 sheep and 85 ostrich only. Financially, Farm 11 does not turn even normal profit, and without a residual amount, there is no opportunity for valuing water used. However, an economic price of N$ 0.02/$m^3$ is calculated.

**Table 6 – Example of a large farm in the Stampriet area, Farm 4**

| **ITEM** | **UNITS** | | | **TOTAL** |
|---|---|---|---|---|
| Concession Extent | Hectares | | | **18667** |
| Concession Stock | Large Stock Units (LSU) | | | **2555** |
| Sales at Full Production | Number | | | **10526** |
| **ITEM** | | **N$/LSU** | **N$/HECTARE** | **N$** |
| **(a) Financial Analysis** | | | | |
| Total Financial Capital (TCI) | | 3583.89 | 490.545 | **9156840** |
| Financial Gross Income | | 1297.66 | 177.61725 | **3315522** |
| Variable Financial Costs | | 331.0763 | 45.31607143 | **845900** |
| Fixed Financial Costs | | 505.8454 | 69.23758929 | **1292435** |
| Net Cash Income | | 460.7386 | 63.06358929 | **1177187** |
| **(b) Economic Analysis** | | | | |
| Economic Gross Income | | | | **3099027** |
| Economic Costs | | | | **1596164** |
| Net Economic Value Added | | | | **1502863** |
| Water Use (m3) | | | | **1247381** |
| Residual Water Value ($/m3) | | | | |
| (a) Financial Price | | | | **0.94** |
| (b) Economic Price | | | | **1.21** |

Farm 4 covers double the range of the Typical Farm, and sports a very diversified land use, only 6% of income coming from irrigated crops, and stock composition of 14,000 sheep, 750 goats, 800 cattle, and 850 ostrich. It returns a reasonable rate on investment of around 8% (Financial Rate of Return) and a financial residual water 'value' of N$ 0.94/$m^3$, and an economic price of N$ 1.21/ $m^3$.

The conclusions from this are that scale and complementary land use are important factors. The questionnaire did not elicit information on farmer's other income earning activities. For instance, if the owner of Farm 4 runs his farm in parallel with other business interests, this would paint a different picture – although the productivity of his unit water use would not vary.

## Section VI – Policy Implications and Further Research

In conclusion, it seems the application of the residual imputation methodology to the farms in the Stampriet area represents a successful way of approaching the problem of water over-abstraction in the short-term and given the information available.

### 6.1 Policy Implications

- this study points to the possibility of water pricing, but we need more physical data (particularly geo-physical information) and further studies elsewhere in Namibia
- some farms appear to not be economically efficient and hence, agricultural policy in Namibia may need to be re-drafted – but further studies are needed
- owing to the apparent falling level of groundwater in the Stampriet area, it seems that sub-optimal practices are mining the groundwater (the current geo-hydrological study on the Stampriet aquifer will probably further evidence this). With current use being ecologically unsustainable in the long-term, policy needs to reflect this cost to Namibia
- farms overuse water for irrigation through inefficient practices, and hence this exploitation of an open-access resource needs to be arrested by either policy or monitoring and enforcement to ascertain the breadth of the problem
- some subsidies increase the incentives on the farmers to over-abstract

### 6.2 Further Research

- target farms which gave useful responses to the questionnaires and try to analyse whether the information they gave is correct
- water-saving technologies for farmers (eg: crops which are less thirsty, more efficient irrigation techniques,
- efficient techniques for farmers (eg: labour, energy, water and time efficiencies to be investigated)
- investigate the use of imported 'virtual water' in goods produced in Stampriet area