the eastern cape
historical legacies & new challenges
conference: 27 - 30 August 2003

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INCREASED AGRICULTURAL CAPACITY AS A NON-WATER BENEFIT OF THE WORKING FOR WATER PROGRAMME IN THE EASTERN CAPE

By

Lozelle du Plessis
Department of Economics and Economic History, University of Port Elizabeth

Abstract

The Working for Water programme (WfW) is a public works programme designed to clear South Africa of high water consuming invasive alien plant species. The main argument in favour of such a programme is its positive impact on water resources. For this reason research thus far has primarily focused on water gains as a primary benefit of the WfW programme. However, various non-water benefits of the programme have been identified, but not yet quantified. It has become imperative to branch out from the original narrow perspective of the WFW, whereby only water runoff gains are included in Cost Benefit Analysis studies, to include non-water benefits.

This article attempts to partially fill this gap by investigating the increase in agricultural capacity (a non-water benefit) as more land is cleared through WfW activities. Six representative WfW sites in the Eastern and Southern Cape, namely PE Driftsands, Albany, Pot River, Kat River, Kouga and Tsitsikamma were selected for this purpose. The agricultural potential, deemed to be predominant agricultural practices already existing, or those suitable for each area, were considered and valued. Six factors were used in the calculation of this benefit. These were: hectares available for land use, livestock categories, carrying capacity, level of alien infestation, hectares cleared and margin above cost. Although income can be generated through increased agricultural practices, these activities require water and this had to be taken into account when the agricultural benefit was estimated. For this reason the additional water use of each potentially productive land activity was subtracted and a revised non-water benefit generated.

Fort Hare Institute of Social and Economic Research **Working Paper No.6**

ISBN: 1-86810-074-X
Contact: Anne King at **aking@ufhel.ac.za/**

Introduction

The Working for Water programme (WfW) is a public works programme designed to clear South Africa of water-consuming invasive alien tree and plants, and to replace it with low water-consuming indigenous species (DWAF, 1998). The economic viability of the programme has been established in the Western Cape and Kwazulu-Natal (van Wilgen, Little, Chapman, Görgens, Willems and Marais, 1997; Gilham and Haynes, 2001), but questioned in the Eastern and Southern Cape (Hosking, du Preez, Campbell, Wooldridge and du Plessis, 2002). Hosking et al. (2002) investigated the economic case for the programme by performing a Cost Benefit Analysis (CBA), based on increased water yield and livestock potential[1]. This was done on six selected sites in the Eastern and Southern Cape, viz. Albany, Kat River, Pot River, Tsitsikamma, Kouga and Port Elizabeth Driftsands.

In the construction of a complete CBA, all the benefits and costs of the WfW need to be included, resulting in the need for quantification of the non-water benefits arising from WfW activities. Various non-water benefits have been identified. These are reduced fire protection costs and reduced damage to infrastructure as a result of wildfires, conservation of biodiversity and ecosystem resilience, gain in potentially productive land (grazing potential, livestock production and other agricultural practices), value added industries, increase in water quality, improved river system services, social development and poverty alleviation, job creation, economic empowerment and training, flood control and the containment of erosion and a decrease in the siltation of dams (Marais, Eckert and Green, 2000).

This paper describes the valuation procedure followed in the estimation of probably the most obvious non-water benefit, that of the gain in potentially productive land at the six selected WfW sites[2].

Methodological approach

The gain in potentially productive land of the WfW programme at the six project sites was estimated by subtracting the agricultural potential with infestation from the agricultural potential without infestation. All current farming practices, as well as other suitable land uses and their contribution to the area's overall productive capacity were traced. The agricultural practices included were categorised as livestock, horticulture and agronomy (including citrus). Alternative land practices such as wildflower and honey bush harvesting, together with commercial afforestation, were also considered. The contribution of each activity was expressed in terms of a percentage of total productive activity in the area. The potential

[1] This research was funded by the Water Research Council (WRC).
[2] This paper stems from a WfW programme report which assessed the value of three non-water benefits of the programme. The other benefits valued were the reduction in direct fire-fighting costs due to the removal of alien trees and the satisfaction of people's taste for indigenous vegetation, often referred to as the biodiversity and ecosystem resilience benefit. Funding from the WfW programme is greatly appreciated, as well as the assistance of Prof. S.G. Hosking (Head of Department, University of Port Elizabeth).

productive capacity for each site was calculated, using the methods set out below. The net benefit of these activities was then summed.

Increased agricultural activity at cleared areas implies increased water use, which would impact on the water benefit calculated by Hosking et al. (2002). This introduces a complication to the analysis: although income can be generated through increased agricultural practices, these activities require water, giving rise to a trade off between increased agricultural production (together with increased income) and increased water run off. This had to be taken into account when the agricultural benefit was estimated. For this reason the additional water use of each potentially productive land activity was subtracted and a revised water benefit profile generated.

Determination of the net livestock benefit

Six factors were used to develop a model in the determination of the net agricultural livestock benefit. These included:

(i) Hectares available for land use
(ii) Livestock categories
(iii) Carrying capacity
(iv) Level of alien infestation
(v) Hectares cleared
(vi) Margin above cost

(i) Hectares available for land use

The ownership of land is an important determinant of the present and future land use of cleared areas. In most cases, cleared government owned land is earmarked for conservation and there is no foreseeable alternative agricultural use for these areas[3], while privately owned land could be used for agricultural purposes. The possibility of productive use of state owned land in the future exists, where such land is accessible and suitable. This could alter the productive capacity of land benefit when land reform policies are ratified and executed in future. This paper focused attention on current land ownership in the calculation of the productive capacity of land benefit.

On privately owned land the productive capacity was calculated using the predominant land uses identified by farmers, the Department of Agriculture and agricultural extension officers in the areas (taking into account factors such as climate, topography and terrain: as most of the WfW activities take place in mountainous areas, this productive capacity is substantially lower than that on normal, flat terrain). Productive capacity was estimated as a percentage of total productive land use and the number of

[3] At the Kat River site, however, land ownership is still being negotiated between the government and the town of Balfour (Buckle, pers. comm., 2002).

hectares for every land use was determined from these percentages. If 60% of clearing was done on privately owned land, it was assumed that 60% of the total number of hectares cleared would be used for farming.

(ii) Livestock categories

Cattle, sheep, and goat farming are the main livestock activities prevalent at the six sites, although game farming is becoming increasingly important at many of them (Buckle, pers. comm., 2002). Goat farming – particularly Angora goat farming - traditionally has made up a substantial part of livestock activity in the Eastern Cape, but has been declining due to the increase in small stock theft (Zeeman and Buckle, pers. comm., 2001).

The 1995 Veterinarian livestock census (Döhne Agricultural Institute, 1996:10) was used to determine the composition of cattle, goat and sheep farming as percentages of total livestock activity. Agricultural extension officers' estimates were used when Census figures were lacking. The livestock census provided data by magisterial district. The Eastern Cape Province map of regions, subregions, agricultural and veterinary offices (Hall, Döhne Agricultural Institute) was used to determine the representative magisterial district of the WfW sites. The Low and Rebelo (1996) map of veld types of South Africa also provided information on natural grazing areas.

(iii) Carrying capacity

Determining the gain in potentially productive land for livestock production for the project sites entailed the establishment of the average carrying capacity in the area. The term carrying capacity gives an indication of the number of animals that could be sustained in an area, given the amount of foliage (worked out per ton per annum) available (Weitz, pers. comm., 2002). Carrying capacities are expressed in terms of hectares per Large Stock Unit (ha/ LSU) and hectares per Small Stock Unit (ha/SSU).

A LSU is defined as a three-year-old cow (dry), weighing 400kg (Departement van Landbou, 1982:2). This unit would typically be a cow belonging to a small frame meat cattle herd, such as Aberdeen or Herefords, or a medium frame milk cow such as an Ayershire[4].

SSU's can be converted into LSU's by using Meissner conversion tables, where all ratios are expressed in terms of LSU’s[5]. Meissner conversion tables enable people to calculate the carrying capacity of almost any animal (game and farm animals) on a piece of land. As a rough estimate, in sweetveld one LSU is equal to six SSU's (Maphuma & Scheltema, pers. comm, 2000). In the case of SSU's, the ha/LSU unit ratio is divided by six, in order to calculate the carrying capacity per SSU (Maphuma & Scheltema, pers.

[4] The assumption is made that only dry milk cows are put on grazing land. Pastures are usually planted for dairy farms, due to the intense nature of such farming practice (Departement van Landbou, 1982:2-4). Planted pastures will yield a higher carrying capacity than dry land (areas not under irrigation, with natural grass).

[5] Sometimes also known as Animal Units (AU).

comm., 2001). If 5.5 hectares were needed to sustain one LSU, only 0.92 hectares would be needed to sustain one SSU.

No exact carrying capacity figures are available, as capacities vary substantially within the same area, due to factors such as changing slopes, soil types and soil depths (Maphuma, pers. comm., 2000). Moreover, some animals eat bush even though they are grazers by preference - suggesting an overlap in grazing areas and carrying capacity (Zeeman, pers. comm., 2001). For this reason the Döhne Agricultural Institute in Stutterheim and the agricultural extension officer in the area were consulted with respect to each site in order to determine carrying capacities in terms of SSU and LSU. The average of these carrying capacities provided by them were used. These carrying capacities were for natural veld in good condition with no heavy encroachment of bush.

Ideally, the carrying capacities of indigenous and infested areas should be calculated and compared with each other in order to determine the net agricultural livestock benefit of clearing, but no data were available on the carrying capacity of areas with and without infestation. For this reason calculations were done under the assumption that the carrying capacity remained constant regardless of the level of infestation, but the area available for livestock farming increased as more alien infestation was cleared.

The use of carrying capacities as yardstick for grazing potential was criticised by some natural resource managers because it did not provide for natural cycles - such as droughts and wet years, or mixed grazing patterns (Marais, pers. comm., 2003). These figures were used because of the relative ease in which they could be incorporated into a quantitative study.

The rental income per hectare of grazing land was used as a cross reference for the livestock benefit. Farms in the vicinity of the WfW sites included in this estimation are rented out at between R25 and R30 per LSU (beef cattle) per month. This rate increases as the intensity of farming activity increases. The going rate for dairy farms, which are intensive in nature, was about R50 per LSU per month in the year 2001 (Jones-Phillips and Weitz, pers. comm., 2002). These rates vary according to the prices received for the agricultural products being farmed[6].

(iv) Level of alien infestation

The level of alien infestation for the sites under consideration was obtained from the WfW offices in the relevant areas. Average infestation levels were used.

(v) Hectares cleared

[6] Other ways to derive the rental income per farm per hectare exist. As a rule of thumb farms in general (eg. growing crops) can be rented out at a quarter of the income generated by it per year (van der Merwe, pers. comm., 2002), while livestock farms are rented out at approximately 13% of the value of the livestock per year (Weitz, pers. comm., 2002). However, the rental income per hectare was only used as a cross reference in the estimation of the livestock benefit.

Initial and follow-up clearing operations were undertaken on the WfW sites. Initial clearing was done in the upper parts of mountain catchment areas, as infestation was usually the highest in these areas, and the increased water yield benefit was realised through this action (Hosking et al., 2002).

The average level of alien infestation at each site was multiplied by the number of hectares cleared, in order to condense the area cleared to an equivalent of a 100% alien infestation.

(vi) Margin above cost

The difference between the agricultural profit before clearing (smaller area) and after clearing (larger area) is the net agricultural livestock benefit of the WfW clearing programme.

Enterprise budgets from the Dissemination of Information section's (2002) margin above cost figures per LSU or SSU was used, where cost included only variable costs. These variable costs, also known as directly allocable costs, comprise of medicine, lick and feed, transportation, shearing (in the case of sheep) and marketing costs (see Dissemination of Information section, 2002, Department of Agriculture for further details). These costs pertain to 2001 prices.

The margin above cost was determined using the formula:

Margin above cost / LSU or SSU = Total Gross income - directly allocable costs

No fixed costs (indirectly allocable costs or overheads) or capital costs, such as fencing, were included in the Department of Agriculture's estimation of the margin above cost (Dissemination of Information section, 2002:3,4)[7].

The assumption was made that areas cleared by the WfW and used for livestock purposes would be run by existing farmers (as opposed to new farmers), resulting in no additional fixed costs[8].

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7 Overheads include items such as fuel consumption of tractors and other vehicles, depreciation on vehicles, telephone, electricity, maintenance of implements, insurance and accounting costs (van Rensburg, pers. comm., 2002; Sub-Directorate of Agricultural Economics and Financing, 1998). The most important fixed costs are fences, water (pipes and tanks) and dip facilities (Els, pers. comm., 2002).

Personal visits to farms need to be made in order to assess these types of expenses, because they vary significantly between areas (due to the topography of the veld). The calculation of overhead costs requires a full analysis of a farm business. Such full farm business analyses were previously done in the South African wheat and maize industries, when the government was still responsible for the setting of prices of these goods. Surveys on other branches of farming, such as citrus, livestock and sugar were done in the 1970's (Antrobus, pers. comm., 2002). No more recent information is available (Antrobus, pers. comm., 2002; Sub-Directorate of Agricultural Economics and Financing, 1998; Els, pers. comm., 2002). The Department of Agriculture in the Eastern Cape does not have figures available on fixed and indirectly allocable costs. It restricts its contribution to consultation by in-house experts in order to assess the viability of farms (Nyokana, pers. comm., 2002).

8 This assumption was substantiated by the fact that overheads did not vary directly with production, and were usually shared between a number of enterprises. The size of the operation determined the average overhead cost, and not the size of the enterprise (Nyokana, pers. comm., 2002). A map of over/ understocking (stock numbers relating to carrying capacity) of the Eastern Cape, constructed by the Döhne Agricultural Institute (Raath, 1999), revealed that the sites situated in the eastern parts of the Eastern Cape fell within a balanced to overstocked area - strengthening the assumption that additional stock purchases, hence an increase in capital costs - would not be a crucial consideration. For instance, the adjacent area to the east of the Albany site was judged to be severely overstocked, suggesting that increased land for grazing could be used for a better distribution of livestock.

Determination of a net horticultural[9] benefit

Information from the Dissemination of Information section (2002), in conjunction with agricultural extension officers, the Department of Agriculture and the Döhne Agricultural Institute was used to identify crops suited for the cleared areas. The number of hectares available for horticulture was adjusted for the share of that crop in total horticultural activity and the share of horticulture in total farming activity. The assumption was made that crops prevalent at the site areas would be appropriate for cleared areas.

The difference in cost faced by farmers to clear indigenous vegetation and alien infested areas in the preparation of crop cultivation was estimated. The difference in these costs was multiplied by the number of hectares cleared, and this was deemed to constitute the net horticultural benefit. The agricultural extension officers in the region, as well as individual contractors involved in land clearing operations, provided figures for these costs.

It was assumed that farmers would only clear land with low infestation levels (up to 10%), where the cost would amount to labour wages (chopping down trees and digging out stumps) and the use of tractors for the removal of stumps (Weitz and van der Merwe, pers. comm., 2003). It would be unprofitable for farmers to clear dense stands of aliens for farming activities, as substantial costs (approximately R6000 per hectare) would be incurred using bulldozers or crawling tractors (van der Merwe, pers. comm., 2003). It was assumed that farmers would have previously cleared infested areas at their own initiative if it were perceived as being fertile. For this reason the only difference between a with and without alien infestation scenario would be the cost faced by farmers of clearing indigenous vegetation and vegetation with scattered infestation levels of up to 10%[10].

The cost of soil preparation, once clearing has been done for crop planting, was not included in the estimation of a horticultural benefit, as these costs (such as phosphate enrichment) would be incurred with or without the presence of alien trees (van der Merwe, pers. comm., 2002). The horticultural benefit captures only the difference in clearing pristine indigenous vegetation as opposed to the clearing of land with infestation levels of 10% of lower.

Determination of an afforestation benefit

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[9] The terms "agronomy" or "crop cultivation" can be used instead of horticulture, as is the case in the Enterprise budget. We used the term horticulture in order to standardise the terms used at all the sites.

[10] The decision to clear alien infested land depends on each farmer's individual situation. In some areas in the Kouga (along rivers in the Langkloof and Patensie) farmers would spend substantial amounts of money on bulldozers for the clearing of fertile land. In general, however, land on which fynbos grows is not very fertile (Buckle and van der Merwe, pers. comm., 2003).

In the estimation of the value of potentially productive land, all potential land uses need to be taken into account. Commercial afforestation with alien trees makes up a substantial part of the economic land use[11] in areas close to three of the six study sites, namely those of Tsitsikamma, Pot River and Kat River (Morgan, pers. comm., 2002; Buckle, pers. comm., 2002). This type of land use was not included in the determination of a net agricultural benefit, as WfW policy attempts to steer away from clearing land for commercial afforestation purposes (Buckle, pers. comm., 2002), because it would be counterproductive to clear a crop of land in order to establish the same crop again.

Most clearing at the WfW project sites takes place in mountain catchment areas with steep slopes that are difficult to access (Buckle, pers. comm., 2002). This access problem most often rules commercial afforestation out as a viable option. In addition, some mountain catchment areas do not satisfy legal water table requirements. Government laws state that plantations may only be established in areas where the water table is more than 1 metre deep (Buckle, pers. comm., 2002). In the Tsitsikamma, the financial viability of increased commercial afforestation is also threatened by the regular occurrence of fires (Marais, pers. comm., 2003).

Revised total benefit profile

Increased agricultural activity on cleared land would alter the water use in cleared areas, impacting on the water benefit calculated by Hosking et al. (2002). The increase in water required by these activities was included in a revised water benefit profile with the aim of constructing the optimal benefit profile for each site.

The water requirements for various crops grown under similar environmental circumstances differ widely due to genetic factors, population density and planting configuration (Green, 1985:1). For these reasons various environmental, water, management, weather, soil and economic aspects need to be included in the estimation of water requirements and irrigation needs. Two methods have been devised to estimate the water requirements of crops in South Africa. The Department of Agriculture and Water Supply's Estimated Irrigation Requirements of Crops in South Africa provides water requirements for various crops based on pan evaporation. This method implies that over a given time period, evapotranspiration (the daily rate of water loss) occurs in direct proportion to evaporation from a pan (Green, 1985:6).

The second method applies the computer programme Sapwat in order to obtain water requirements of crops, with evapotranspiration dependent on evaporation from a grasscover, instead of a pan (Kruger, pers. comm., 2002). Three steps are essentially followed in the estimation of the water requirement of a crop. During the first step, the amount of water needed by the crop is calculated, then the rainfall efficiency is established, and lastly the difference between these steps – constituting the irrigation

[11] In the Eastern Cape, plantations of predominantly *Pinus spp.* are found.

requirement – is then determined (Kruger, pers. comm., 2002). Both these methods have been subject to criticism, but are widely used in irrigation decisions, as no alternative is available. Results from both methods were used in the determination of water requirements of potential crops at the WfW sites. A normal growing season, as opposed to a very favourable or unfavourable one was assumed, with a 100% evapotranspiration.

Calculations

Calculations done at the Kat River site are used to describe the increased agricultural capacity through WfW activities. The results of similar calculations at the other sites are shown in Table 6.

Kat River

Approximately 30% of the Kat River WfW site is privately owned (six existing farms). The other 70% is on government property (van der Merwe, pers. comm., 2002). For this reason only 30% of the total area cleared could be used for agricultural purposes. Farming in the Kat River area includes citrus, crop growing and livestock farming. Tobacco used to be grown, but the amounts grown have steadily declined. An estimated 75% of farming is centred on crop growing and horticulture, and 25% on livestock. Citrus makes up 70% of all horticulture, 10% of crops consist of cabbage and the remaining 20% is left idle for rotation purposes (Morgan, pers. comm., 2002).

1.3.1.1 Livestock benefit

Beef cattle, sheep and goat farming are the predominant livestock activities in the area. Beef cattle farming makes up 10% of all livestock activity, goat farming 26% and sheep farming 64% (Veterinary livestock census, 1995). It follows that the amount of land made available for beef cattle, sheep and goat farming through the WfW project would be expected to be a mere 2.74 hectares.

Enterprise budgets[12] (Dissemination of Information section, 2002:3, 4) containing budgets for beef cattle in the Queenstown area was used to estimate the benefit values, as no budgets were available for the Kat River area. Similar budgets could be expected for this site (Zeeman, pers. comm., 2002). Two budgets were used: one for weaned calves and excess heifers sold at 7 or 30 months respectively, and one for cattle sold at 7 or 12 months, or mated at 15 months. The net cattle benefit was calculated for both these budgets. The average of these two calculations was taken to be the overall agricultural livestock benefit for beef cattle. The calculation of the beef cattle benefit is shown in Table 1.

[12] Enterprise Budgets are often condemned for underestimating the true economic potential of land according to scientists, and underestimating it according to landowners. It is, however, published every year and contains information which would otherwise be hard to come by, as the calculation of such budgets is a tedious process. For this reason it is used regularly and deemed as fairly reliable by the experts (Els and Nyokana, pers. comm., 2002).

Step	Description	Beef cattle (Queenstown, sell at 7, 12 or 30 months)
1	Hectares (total) under WfW clearance	1196
2	Hectares with equivalent 100% infestation	36.5
3	Hectares used for livestock farming	2.74
4	% of beef in all livestock activity	10
5	Hectares available for beef activity	0.27
6	Hectares / LSU	4.6
7	Number of LSU on land (ha) available for beef activities	0.06
8	Average margin above cost/LSU (R)	690.73
9	Average beef cattle benefit (R)	41.08*
10	Average beef cattle benefit per hectare (R)	150.16

* This is a weighed benefit; the other components of the livestock benefit are discussed below.

Table 1 Calculation of the beef cattle benefit in step form on the Kat River site

Step 1 : Determination of the number of hectares earmarked for clearing by the WfW.

Step 2 : The number of hectares actually cleared (100% infestation equivalents) was determined. It was assumed that the carrying capacity of the land would stay constant, regardless of the infestation level, and that only the area available for farming/ grazing that would decrease as a result of infestation. At the Kat River site, the average infestation level amounted to 3.5%, and 1196 hectares were earmarked for clearing. Hence the total area to be cleared of alien tree infestation was 36.5 hectares.

Step 3: The land that could be used for livestock farming was identified. Only 30% of land cleared was on private land (eleven hectares). Of this, only 25% was used for livestock activities.

Step 4: The beef cattle component of the livestock total was then identified. Beef cattle farming made up 10% of all livestock activity, as set out in the 1995 Veterinarian livestock census.

Step 5: The number of hectares available for livestock farming was adjusted for the proportion of livestock activity used for beef cattle (i.e. 10% of 2.74 hectares).

Step 6: The average of carrying capacities was determined from information supplied by the Döhne Agricultural Institute and agricultural extension officers.

Step 7: The additional number of LSU's held on the cleared land were calculated by dividing the hectares available for beef cattle farming by the carrying capacity. The cleared land would increase the amount of LSU's by a factor of 0.06.

Step 8 : The average profit of the two beef cattle enterprises per LSU included was determined. The margin above cost was expressed in terms of LSU (which is the standard). The margin above cost for an enterprise stays constant, but the number of LSU’s accommodated in the Kat River area would increase due to WfW activities.

Step 9 : The total benefit of increased cattle stocking was calculated as the margin above cost per LSU multiplied by the number of LSU’s kept on the cleared area.

Step 10: The average beef cattle benefit was divided by the number of hectares available for this activity.

The steps followed to determine the benefit of sheep and goats were essentially the same as those followed for cattle; the only exception being that the LSU values were replaced by SSU values. In the case of SSU's, the hectares/LSU unit ratio was divided by six, in order to acquire the carrying capacity per SSU, as it is estimated that the area of land required to carry one LSU is sufficient to carry six SSU's (Maphuma & Scheltema, pers. comm., 2001).

The Boergoat ewe flock from the Grahamstown area (weaned at five months and sold at six or ten months), and an Angora breeding ewe flock (from Grahamstown, sold at six or eighteen months) were used to estimate the value of goat farming (Dissemination of Information section, 2002:2,5). Dorper, Dormer and Döhne Merino ewe flock budgets were used to estimate the value of sheep farming (Dissemination of Information section, 2002:6, 7, 9). In the Dormer case, an Enterprise Budget from Cathcart, where the lambs were weaned at four months and sold at six months was used. A Dorper Enterprise Budget from the Grahamstown region, with ewes lambing three times within a two year period and sold at five months was used. In the Merino case, a Grahamstown enterprise was selected where lambs were weaned at five months, and sold at six months. In all cases similar figures could be expected for the Kat river area (Zeeman, pers. comm., 2002). These Enterprise Budgets were chosen as sheep were utilised for both meat and wool purposes. The livestock benefit is summarized in Table 2.

Description	Average margin above cost (R)	Hectares available for activity	Number of LSU/SSU on area	Livestock benefit (R)	Livestock benefit per hectare (R)
Beef cattle	690.73	0.27	0.06	41.08	150.16
Goat	211.61	0.71	0.93	196.34	276.01
Sheep	209.34	1.75	2.28	478.09	273.05
TOTAL		**2.74**		**715.51**	**261.52**

Table 2 The livestock benefit for the Kat River site

The total gain in agricultural output due to clearing at the Kat River site was estimated at R 715.51 per year. The contribution of each livestock activity per hectare, according to the amount of hectares assigned to each activity is as follows: R150.16 for beef cattle, R276.01 for goats and R273.05 for sheep[13].

[13] This benefit may well increase as more state-owned land is converted to productive use by private farmers. At the moment the ownership issue is still being negotiated.

1.3.1.2 Horticultural/ agronomic benefit

Citrus farming is the most important productive activity in the Kat River area (70% of all crops), but it was not included it in the estimation of a potential productive capacity. Most WfW clearing in this area is done in catchment areas, in narrow river valleys or steep slopes - fairly inaccessible areas not suitable for citrus farming (Buckle, pers. comm., 2002). However, there is some scope in the area for cabbage cultivation – on 10% of the land, i.e. 0.82 ha.

The preferred method for clearing of indigenous bush is through burning, as the burned organic material provides minerals for the soil. The only cost entails that of labour used for supervision of the fire (Weitz, pers. comm., 2002). Tractors and ploughs are also sometimes used for clearing bush, but the vegetation type in the Kat River area is predominantly grassland (Meyer, pers. comm., 2002). The cost of clearing indigenous vegetation in 2001 was approximately R150.00 per hectare (Cobbold and Weitz, pers. comm., 2002).

Farmers' cost of clearing alien infested areas entailed the digging out and removal of alien tree stumps. No follow up costs were provided for because it was assumed that the establishment of crops would out-compete alien regeneration. The average relative alien infestation level was used to estimate the number of stumps to be removed on a hectare of infested land. In the Kat River area, the average infestation level was estimated at 3.5%, which amounted to approximately 25 adult alien tree stems per hectare[14] (Buckle, pers. comm., 2003). It was estimated that a tractor would be used for stump removal for two hours, at a rate of R100 per hour, while the labour to dig out the stumps was estimated at R250 (R10 per tree). The difference in the cost of clearing alien vegetation as opposed to indigenous vegetation for crop cultivation – and hence the horticultural benefit – was calculated at R300 per hectare. This amounted to R246 for the area assigned to horticulture at the Kat River site (0.82 hectares).

The cost of land preparation was not included in the above calculation because this preparation would be done irrespective of the vegetation cover at the site[15].

1.3.1.3 Revised total benefit profile

The total water requirement for increased livestock activity (including cattle, sheep and goats) summed to 12.81 cubic metres per annum. The time of planting is a crucial factor in the determination of the water requirement of cultivated crops. The cultivation of cabbage in the Kat River area cannot take place without irrigation (Kruger, pers. comm., 2002) because dry land cultivation would lead to a loss of more than 50%. For this reason, a cabbage crop's water requirement varies between 3500 and 5000 cubic metres per hectare, depending on whether it was planted in early spring (September) or in summer

[14] Pine and Blackwattle trees are the predominant alien invaders, and their respective stem density per hectare data were used.

[15] Ripping and discing of grassland (at R400 per hectare) (Cobbold, pers. comm., 2002), together with fertilizer and phosphate treatment would be done in both cases after clearing.

(December). The assumption was made that a cabbage crop would be planted in late September, with a normal rainfall season and 100% cover. The water requirement in this case would be 5000 cubic metres per hectare per year (Kruger, pers. comm., 2002). For the Kat River area, this would amount to 4104 cubic metres for the 0.82 hectares set aside for cabbage cultivation[16].

The water requirements for increased livestock and horticultural activities on the areas earmarked for clearing amount to 4116.81 cubic metres per annum. At a price of 16.6 cents/ cubic metre (2001 prices), which excludes extraction and irrigation costs (Hosking et al., 2002), the increased water requirement for livestock and horticulture would amount to a value of R683.18. A summary of the agricultural benefit at the Kat river site, adjusted for the water requirement is shown in Table 3.

Agricultural activity	**Number of hectares available**	**Benefit (R)**	**Water use cost (R)**	**Net benefit adjusted for water use (R)**	**Net benefit per hectare (R/hectare)**
Livestock	2.74	715.51	2.13	713.78	261.53
Horticulture	0.82	246.00	681.05	0*	0
Afforestation	0	0	0	0	0
Unused (rotation)	7.39	0	0	0	0
TOTAL	**10.94**	**961.51**	**683.18**	**713.78**	**65.19**

*The water use cost for horticultural activities exceeds the benefit derived from such activities. For this reason no horticultural benefit is realised (the total benefit adjusted for water use is R0).

Table 3 Summary of the net agricultural benefit on the Kat River site

The water use from increased horticultural activities would offset the benefit derived from such activities. The total benefit adjusted for water use is zero for horticulture, leaving the livestock benefit as the only agricultural benefit. For this reason the net agricultural output benefit of potentially productive land from WfW activities at the Kat River site is R713.78, which equates to R65.19 per hectare per year.

The total number of hectares earmarked for clearing at the Kat River site will only be cleared over a period of seventeen years (Hosking, et al. 2002). For this reason only a part of the agricultural benefit would be realised in year one of clearing, increasing every year as more clearing is done. This increase was based on WfW managers' assumptions on the proportion of hectares cleared per annum (Hosking et al., 2002). For this reason the full benefit of R 713.78 would only be realised in year eighteen. This benefit would be the current one, based on a constant infestation level of 3.5%. However, alien infestation levels increase over time and without the WfW programme this level of infestation would also intensify. For this reason the agricultural benefit in future would be higher than the current benefit as a result of WfW clearing as alien trees are removed and would not be able to spread. The current benefit had to be adjusted for the rate of spread of alien trees.

[16] The computer programme Sapwat was used to determine the water requirement, as it provided the most up to date information on cabbage crops. Figures from the Winterberg Agricultural school, which is located at Fort Beaufort, were used.

The use of fire cycles in the determination of the rate of spread of alien trees could not be applied as done in other studies (Hosking et al., 2002). Fires diminish the amount of grazing land available. The assumption was made that the per hectare benefit would increase in future in line with the rate of spread of alien trees. This rate of spread was set at 1% per annum up to an infestation level of 40%, starting at year one. It follows that this infestation level would be attained in year 36, starting from an average infestation level of 3.5% in year one (Hosking et al., 2002). The agricultural benefit would increase from years one to 35, in line with the combined factor of increase in the rate of spread and the proportion cleared. The maximum benefit would be achieved in year 36 (R 970.74). The increase in the agricultural benefit over time is shown in Table 4.

Year	Rate of spread	Proportion cleared*	Factor increase in agricultural benefit**	Net agricultural benefit (R)
1	0.01	0.1563	0.1663	118.70
2	0.02	0.2341	0.2541	181.37
3	0.03	0.2817	0.3117	222.49
4	0.04	0.3294	0.3694	263.67
5	0.05	0.377	0.427	304.78
6	0.06	0.4247	0.4847	345.97
7	0.07	0.4724	0.5424	87.15
8	0.08	0.52	0.6	428.27
9	0.09	0.5677	0.6577	469.45
10	0.1	0.6153	0.7153	510.57
11	0.11	0.663	0.773	551.75
12	0.12	0.7107	0.8307	592.94
13	0.13	0.7583	0.8883	634.05
14	0.14	0.806	0.946	675.24
15	0.15	0.8536	1.0036	716.35
16	0.16	0.9013	1.0613	757.53
17	0.17	0.9489	1.1189	798.65
18	0.18	1	1.18	842.26
19	0.19	1	1.19	849.40
20	0.2	1	1.2	856.54
21	0.21	1	1.21	863.67
22	0.22	1	1.22	870.81
23	0.23	1	1.23	877.95
24	0.24	1	1.24	885.09
25	0.25	1	1.25	892.23
26	0.26	1	1.26	899.36
27	0.27	1	1.27	906.50
28	0.28	1	1.28	913.64
29	0.29	1	1.29	920.78
30	0.3	1	1.3	927.91
31	0.31	1	1.31	935.05
32	0.32	1	1.32	942.19
33	0.33	1	1.33	949.33
34	0.34	1	1.34	956.47
35	0.35	1	1.35	963.60
36	0.36	1	1.36	970.74

* Source: Hosking et al., (2002).
** This is the sum of the rate of spread and proportion cleared.

Table 4 Increase in the net agricultural benefit over time on the Kat River site

The rental income and annual rate of return on farms

The rental income of farms, as well as its capital value per hectare (and the resultant discount rate) were used as a cross reference to check the net benefit of potentially productive land. Although rental values exist and the Land Bank of South Africa also calculate the monetary value of farms, these values are extremely case specific and ultimately depend on the personal decision of the farmer renting out or selling his/her land. The increasing tendency of foreigners to buy land in South Africa for more than its domestic selling value due to the relatively weak Rand also restrains the accuracy of these calculations (Esterhuize, pers. comm., 2003).

The rental income for the area cleared in Kat River is estimated at R196.57 per year, or R71.74 per hectare per year. The average market value of veld, irrigation and dam-water type farming in the Kat River region amounts to R5600 per hectare (Esterhuize, pers. comm., 2003). As a percentage of this value the net benefit of land cleared by WfW (R261/hectare for livestock) at the Kat River site is 4.7%.

Results at the other WfW sites

Selective information used to calculate the agricultural benefit at the other sites is provided in Table 5.

Data	Albany	Pot River	Kouga	Tsitsikamma	PE Driftsands
Amount of hectares cleared	11 400	460	158 678	128 783	8700
Average infestation level (%)	7.5	0.55	7.5	15	7.5
Vegetation type	Grassy fynbos	Grassland	Fynbos	Fynbos	Coatsal fynbos

Table 5 Selected information on the WfW sites

The same methods were applied to determine the agricultural benefit at the five other sites. The PE Driftsands site falls under the control of the Nelson Mandela Metropole, with no agricultural activity. All WfW activities in the Tsitsikamma are carried out on government owned land (Buckle, pers. comm., 2002), under the management of the Tsitsikamma National Park (Jungbauer, pers. comm., 2002). For this reason no potential for productive capacity of land could be determined for these two sites. The agricultural benefit for the remaining three sites is shown in Table 6.

KOUGA SITE					
Agricultural activity	**Number of hectares available**	**Benefit (R)**	**Water use cost (R)**	**Net benefit adjusted for water use (R)**	**Net benefit (R/hectare)**
Livestock	771	25 287.27	387.30	24 899.97	32.80
Horticulture	6938	3 816 079.55	17 854 896.43	0	0
TOTAL	**7709**	**3 841 366.82**	**17 855 283.73**	**24 899.97**	**3.23**
POT RIVER SITE					
Agricultural activity	**Number of hectares available**	**Benefit (R)**	**Water use cost (R)**	**Net benefit adjusted for water use (R)**	**Net benefit per hectare (R/hectare)**
Livestock	1.62	333.40	0	333.40	206.19
Horticulture	1.08	486.00	0	486.00	450.00
Afforestation	0	0	0	0	0
TOTAL	**2.70**	**819.40**	**0**	**819.40**	**304.05**
ALBANY SITE					
Agricultural activity	**Number of hectares available**	**Benefit (R)**	**Water use cost (R)**	**Net benefit adjusted for water use (R)**	**Net benefit per hectare (R/hectare)**
Livestock	258.21	46 252	50	46 202	178.94
TOTAL	**258.21**	**46 252**	**50**	**46 202**	**178.94**

Table 6 Summary of the net agricultural benefit on the WfW sites

1.3.2.1 Kouga

WfW activities in the Kouga area span a vast area (158 678 hectares), including patches adjacent to Humansdorp, Joubertina, Hankey and the Gamtoos valley. The average infestation level is estimated at 7.5% (Hosking, et al, 2002). The average infestation level is estimrus (Gamtoos), honey bush tea and deciduous fruit (Joubertina) and dry land vegetable growing (Nyokana, pers. comm., 2002; van der Merwe, pers. comm., 2002). Almost all (99%) of the land being cleared is under private ownership (Moore, pers. comm., 2002).

Approximately 65% of the land being cleared has potential productive capacity (approximately 7709 hectares). This percentage was estimated by considering three possible situations of land reclamation from alien trees. The first situation is land next to rivers. When cleared, this ground has high potential for farming (approximately 80% could be used). The second situation relates to land with a slight gradient. This land holds potential for livestock farming of an extensive nature where farming activity takes place on a large area of land. The predominant vegetation in the Kouga area is a variety of fynbos, which can be used for grazing once it returns after clearing, but the carrying capacity is low because of the low nutrient content (van der Merwe, pers. comm., 2002). About 50% of this land can be used for livestock farming (about 771 hectares). The growing of honey bush tea is another land use, although less than 0.1% of farming activity in these areas is currently used for it. No wildflower harvesting currently occurs in these areas (Moore and van der Merwe, pers. comm., 2002). The third situation relates inaccessible areas in the Kouga mountains. These yield little potential for farming (van der Merwe, pers. comm., 2002).

Livestock benefit

Approximately half of the 771 hectares assigned to livestock farming in the area is devoted to beef cattle. The other 50% is used for sheep farming (especially for wool production).

The same beef cattle and Merino Enterprise Budgets used for the Kat River site were employed for the Kouga site. No Merino budget was available for the Kouga area, although various budgets were available for Merino's in the Cathcart and Stutterheim areas (eastern part of the Eastern Cape). The Grahamstown budget was chosen as appropriate due to the broad similarity in vegetation, namely fynbos. Grassy fynbos is found in the Grahamstown area, while mountain and coastal fynbos and renosterbos are found in the Kouga area.

It was deduced that the livestock benefit in the Kouga area was about R25 287.27 per annum, or R32.80 per hectare per year[17]. The average beef cattle benefit per hectare per year amounted to R22.10, while the average sheep benefit per hectare per year amounted to R43.50.

Horticultural/ agronomic benefit

Honey bush plants (for honey bush tea) grow wild in mountainous areas in the Kouga area, but the cultivation of honey bush has not yet taken off in this region. In a similar way, the area has potential as a supplier of wildflowers (proteas and fynbos), but this industry remains marginal (van der Merwe and Moore, pers. comm., 2002)[18]. For this reason both activities were excluded from calculations.

To clear indigenous fynbos for crop cultivation, farmers usually burn the area at an estimated cost of R300/hectare (van der Merwe and Moore, pers. comm., 2002). The cost of clearing fynbos infested with alien vegetation is estimated at R850 per hectare. This figure reflects the cost of a tractor for approximately 3 hours (at R100 per hour) and the cost of labour for digging up the trunks of aliens, estimated at 55 adult stems per hectare on average for Hakea, Pine, *Acacia spp*. and Blackwattle infestations of up to 5% (Buckle, pers. comm., 2003), at an average cost of R10 per tree (R550 for 55 trees).

The difference in the cost of clearing alien and indigenous vegetation amounted to R 550[19]. Of the estimated area that would be cleared through the WfW programme, an area of 6938.33 hectares could

[17] The rental income for livestock farming in the Kouga area is estimated at R10.16 per hectare, or R3014.46 for the area cleared and suitable for livestock farming.

[18] Thatch can also be grown in the coastal zones of the Kouga. At Port St Francis, a piece of land cleared by WfW was replanted with thatch, as climatic conditions were suitable for the cultivation of it and there is significant local demand for it. The Port St. Francis site did not form part of the Kouga area studied and was therefore not included.

[19] The difference in the cost of clearing alien and indigenous vegetation was deemed to be the horticultural benefit. The preparation costs of land for various crops are not included in this figure, as these costs would be incurred irrespective of the type of clearing done. For instance, if land is cleared in order to plant lucern for grazing purposes, land needs to be more thoroughly prepared (at a cost of approximately R800 per hectare) for nutritional purposes, than in the case of extensive farming (van der Merwe, pers. comm., 2002).

potentially be used for deciduous fruit farm practices. At an excess cost of clearing of R550/ hectare, this benefit amounts to R 3 816 079.55 for the Kouga site.

Revised total benefit profile

In the Kouga area, increased livestock activity on cleared land would increase the total water requirement to 495.2 cubic metres per annum (for both cattle and sheep farming). For the Langkloof area, the irrigation requirement for deciduous fruit during midseason would amount to 3290 cubic metres per hectare (Green, 1985:228-229). For this reason the 6938.3 hectares set aside for deciduous fruit farming would necessitate approximately 22.8 million cubic metres of water per year.

At a price of 74 cents/ cubic metre (2000 prices) (Hosking, et al. 2002), or 78 cents/ cubic metre in 2001 prices, the cost of water significantly alters the net benefit of potentially productive land. The cost of the increased water requirement is calculated at approximately R17.86 million. Farming activities on cleared areas would exert pressure on the water made available through the WfW programme. For this reason the horticultural benefit is completely offset by the increased water requirement of such activities and the livestock benefit is the only agricultural benefit. The latter amounted to R 24 899.97 per annum for the whole Kouga site, or R64.60 per hectare per annum.

The average infestation level at the Kouga site was estimated at 7.5%. If a rate of spread component was assumed, it follows that the agricultural benefit would increase from years 1 to 31, in line with the assumed factor of increase in the rate of spread and the proportion cleared, as estimated by WfW managers. The maximum (future) benefit would be achieved in year 32 (R32 867.96), when the assumed infestation level of 40% is reached. This future benefit was higher than the current benefit of R24 899.97 due to the rate of spread assumption.

The rental income and annual rate of return on farms

The rental income for livestock farming in the Kouga area was estimated at R10.16 per hectare per year, or R3014.46 for the area cleared and suitable for livestock farming.

The average market value of veld type farms (mostly for livestock) in the Kouga region amounts to R1750 per hectare (Nel, pers. comm., 2003). As a percentage of this value the net benefit of land cleared by WfW (R33/ha) in the Kouga area is 1.9%.

1.3.2.2 Albany

The Albany site spans an area of 11 400 hectares, with an average infestation level of 7.5%. Approximately 30% of the Albany WfW site is privately owned, and the other 70% is owned by the government (van der Merwe, pers. comm., 2002). The Albany region is suitable for ostrich, game farming, beef cattle and small stock enterprises (goat and sheep for wool and mohair purposes). Chicory, cabbage and pineapple growing are potential enterprises for areas closer to the coast (Department of Agriculture, leaflet; Morgan, pers. comm., 2002).

Livestock benefit

Cattle farming makes up approximately 6% of all livestock farming in the Albany area. Goat and sheep farming account for 17% and 37% respectively of all livestock farming (Veterinary livestock census, 1995), and game farming for 40%.

Most cattle farmed in the area are targeted for the beef market. Although some pastures are planted for dairy, this type of farming is relatively minor here. The Enterprise budget (Dissemination of Information section, 2002:3, 4) contains projected cost and income flows for beef cattle in the Queenstown area. Similar flows apply to the Albany region (Zeeman, pers. comm., 2002). The two budgets used for a beef cattle herd on the Kat River site were used. The net agricultural livestock benefit for cattle was calculated from the average of these budgets.

In order to establish the goat benefit, two budgets were used - a Boergoat ewe flock from the Grahamstown area, weaned at five months and sold at six or ten months, and an Angora breeding ewe flock, also from Grahamstown, sold at six or eighteen months (Dissemination of Information section, 2002:2,5).

Sheep are farmed for both wool and meat (Scheltema, pers. comm., 2001). Döhne Merino sheep are typically used to produce wool and Dorpers typically used to produce meat (Department of Agriculture, 1982:3). Two sheep Enterprise Budgets were included: that for a Dorper ewe flock from the Grahamstown region, assuming that ewes lamb three times in two years and that lambs were sold at five months and that for a Döhne Merino ewe flock, also from the Grahamstown area, assumed to be weaned at five months and sold at six months (Dissemination of Information section 2002:9).

The sheep benefit was calculated at R 23 210.45. This benefit amounted to R 242.95 per hectare per year.

The kudu benefit was determined assuming it constituted 40% of all livestock activity[20]. This benefit amounted to R 10963.13 per year, or R106.15 per hectare per year.

The agricultural livestock benefit was determined as the sum of the cattle (6%), sheep (37%), goat (17%) and kudu (40%) benefit. The total benefit amounted to R46 252.45 per year, or R179.13 per hectare per year.

[20] Game farming in the Albany region has steadily been increasing (Hahndiek, pers. comm., 2002). Ostrich farming used to be another productive enterprise, but has shown a steady decline in the last couple of years, and has not be included (Hahndiek, pers. comm., 2002).

Horticultural/ agronomic benefit

Most agronomic activities, such as cabbage, pasture, pineapple and chicory farming (Morgan, pers. comm., 2002), are established on farms closer to the coast, near Alexandria, Kenton on Sea and Port Alfred (Nyokana, pers. comm., 2002) and not in the area being cleared by the WfW programme. For this reason no horticultural benefit is relevant to this site.

Revised total benefit profile

The water use per LSU and SSU respectively is 50 litres and 10 litres per day (Zeeman, pers. comm., 2002). This use sums to an increase of 1017.8 cubic metres per year for livestock farming.

According to Hosking et al. (2002), the value of water in Albany is approximately 4.9 cents/ cubic metre (at 2001 price levels). This value was set by proxy-using the value of freshwater inflows into the Keurbooms estuary (Hosking et al., 2002). At this price, and with an increased livestock water consumption of 1017.8 cubic metres, the net benefit of potentially productive land at the Albany site would decrease to R 46 202.96. After making this deduction the agricultural benefit of the WfW programme in the Albany site works out to be R 178.94 per hectare per year [21].

The total number of hectares earmarked for clearing at the Albany site will only be cleared over a period of twenty years. The agricultural benefit would increase from year one onwards in line with the proportion of hectares cleared as set by WfW managers (Hosking et al., 2002), and the assumed rate of spread.

The rental income and annual rate of return on farms

The rental income for the hectares cleared for livestock farming in Albany amounted to R 15 492.60 or R60 per hectare per year. A total of 46.9 LSU's can be accommodated on the 258 hectares cleared by WfW, at R30 per LSU per month (Jones-Phillips, 2000).

The average market value of veld type farms in the Albany region amounts to R1250 per hectare (Nel, pers. comm., 2003). As a percentage of this value the net benefit of land cleared by WfW (R178/ha) in the Albany area is 14.3%.

1.3.2.3 Pot River/ Ugie

Pot River falls in the Ugie area. An area of 460 hectares, with an average infestation level of 0.55% is targeted for clearing. Farming activities in the Ugie area are concentrated around livestock (beef cattle, goats and sheep) and crops. The two major crops are potatoes and maize, while winter cereal is also

[21] In order to reach a per hectare figure the net benefit of the condensed cleared land is divided by the amount of hectares cleared if it was assumed that a 100% infestation level prevailed.

planted as pastures (Morgan, pers. comm., 2002). All WfW activities are conducted on privately owned land.

Sixty per cent of the area farmed is used for livestock farming and 40% for horticulture and crops (Morgan, pers. comm., 2002). This would imply that 1.62 of the 2.7 hectares being cleared would be used for livestock, and 1.08 hectares for horticultural production.

Livestock benefit

Cattle farming makes up 32.9% of all livestock activity, goat farming 0.57%, and sheep farming 66.5% (Veterinary livestock census, 1995). This implies that of the 1.62 hectares set aside for livestock farming, 0.53 hectares would be used for beef cattle farming, 0.01 hectares for goat farming, and 1.08 hectares for sheep farming. The Dissemination of Information section (2002:3, 4) contained budgets for beef cattle in the Queenstown area only, but similar figures could be expected to apply in the Ugie region (Zeeman, pers. comm., 2002). The same budgets as those used for beef cattle at the Kat River site were incorporated. The average of these two budgets was deemed to be the overall net agricultural livestock benefit for beef cattle.

The Boergoat ewe flock from the Grahamstown area, weaned at five months and sold at six or ten months, and an Angora breeding ewe flock, also from Grahamstown, sold at six or eighteen months (Dissemination of Information section, 2002:2,5) were used to estimate the value of goat farming.

For the estimation of a sheep benefit, three reference flocks were used: a Döhne Merino ewe flock from the Queenstown area, weaned at four months and sold at eighteen months (Dissemination of Information section, 2002:8), a Merino ewe flock, also from the Queenstown area, weaned at five months and sold at six months (Dissemination of Information section, 2002: 13), and Dormer ewe flock, from Cathcart, weaned at four months and sold at six months (Dissemination of Information section, 2002: 6).

These reference points were chosen because the sheep in the area are utilised for both meat and wool production. The Döhne Merino and Merino were chosen as examples of wool sheep, while Dormers were chosen because they are multi-purpose sheep (Department of Agriculture, 1982:3-4). The livestock benefit at the Pot River site amounted to R 333.40 per year for the total area cleared and used, or R206.19 per hectare per year.

Horticultural/ agronomic benefit

Forty percent of potentially productive land in the Pot River area is used for horticulture (Morgan, pers. comm., 2002). For this reason, of the 2.7 hectares freed up through WfW activities, only 1.08 hectares would be expected to be used for this type of farming. The major crops grown are maize (60%), potatoes

(30%) and winter cereal (10%) (Morgan, pers. comm., 2002). The growing of winter cereal was excluded from the calculation of the horticultural benefit, because it is usually planted by livestock farmers for winter grazing for their own livestock and not for sale in the market. The benefit of this crop is largely a reduction in farmers' grazing costs.

The cost of clearing indigenous vegetation in 2001 was approximately R150.00 per hectare, using the same methods as at the Kat River site. Farmers' cost of clearing alien infested areas entailed the digging out and removal of alien tree stumps. The average relative alien infestation level was used to estimate the number of stumps to be removed on a hectare of infested land. In the Pot River area, the average infestation level was estimated at 0.55%, which amounted to approximately 40 adult alien tree stumps to be removed per hectare, provided the density per hectare of predominantly *Acacia spp*. is used (Buckle, pers. comm., 2003). It was assumed that three tree stumps could manually be dug out per day (at a cost of R30 per day, or R10 per tree), while a tractor would be used for two hours at a rate of R100 per hour to remove the stumps (van der Merwe, pers. comm., 2003). The total would amount to R600: R200 for the tractor, and R400 for the labour. The horticultural benefit (the difference between the cost of clearing indigenous vegetation and alien infested land) was therefore R450 per hectare, or then R486 for the total number of hectares available for horticulture at the Pot River site.

Revised total benefit profile

Water is not a scarce resource in the Ugie area, and for this reason has a scarcity value of zero (Hosking, et al., 2002). It is deduced that the expansion of current land uses - and increased water requirement - via increased horticultural and livestock performances would not impact on the net water yield benefit. The summed net benefit of potentially productive land yielded through the WfW programme would amount to R 819.40 per year, or R 304.05 per hectare per year.

The total clearing of alien infestation at the Pot River site was expected to take four years. The agricultural benefit could be expected to increase in line with the WfW managers' projections of the proportion of land cleared every year (Hosking et al., 2002). As a result of the incorporation of a rate of spread component, the future agricultural benefit would exceed the current agricultural benefit of R 819.40 per annum. The total benefit would be realised from year 39 onwards, when the assumed alien infestation level of 40% is reached.

The rental income and annual rate of return on farms

The rental income for grazing for the 1.62 hectares freed up in Pot River amounted to R 125.79, or R77.6 per hectare per year in 2002.

The average market value of farms in the Ugie area amounts to R1600 per hectare (Els, pers. comm., 2003). As a percentage of this value the net benefit of land cleared by WfW (R 304/ha) in the Ugie area is 19%.

Conclusion

In the estimation of the increased agricultural capacity benefit as a non-water benefit of the WfW programme, all possible land uses for the WfW sites were included, and the assumption was made that current land practices would guide what would be established in the cleared areas. The main farming activities were livestock and horticulture.

The net agricultural output benefits of increased potentially productive land at the six sites are small in value. When the water requirement of the farming practices are taken into account and valued, using the water prices (adjusted to 2001 price levels) at the six sites generated by Hosking, et al., (2002), it becomes clear that the water requirement of these activities undermines the net agricultural benefit that can be derived from the WfW programme. This influence is particularly strong at two of the four sites where agricultural potential is present: the Kouga and Kat River sites. At these sites, the agricultural benefit consists only of the livestock benefit.

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