# Economic feasibility of an experimental octopus fishery in South Africa

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**_Octopus vulgaris_ was identified as a new marine resource to be commercially exploited through an experimental fishery. A recent policy on developing fisheries in South Africa emphasizes the importance of investigating the economic feasibility of a fishery as part of its management framework. The study reported here generated baseline information necessary in the design of the experimental fishery, giving guidelines as to which vessels, fishing gear and markets would be most feasible. The proposed fishery, gear and vessel type, fishing techniques and expected catch rates are described, the results of market research are outlined, and the cost of fishing is estimated. The potential business should consist of small and medium-sized vessels deploying unbaited pots attached to long lines. The longline pot fishery could be economically feasible, provided a 30% catch in 6600 pots/month is attained. Only existing, debt-free vessels should be used. The minimum catch per unit effort (CPUE) for various fishing operation scenarios was calculated to determine economic feasibility. This is an estimated minimum CPUE, based on assumptions that cannot be confirmed until the fishery starts. Furthermore, this economic analysis also needs to be assessed by stakeholders with experience of fishery operations.**

## Introduction

The Marine Living Resources Act, promulgated in 1998, provided new goals for fisheries management, employment transformation, and other issues to rectify past imbalances in the South African fishing industry. Pertinent goals of this act are the sustainable utilization of marine resources through conservation of overfished stocks and the exploitation of new ones; equal access to marine resources by all South Africans; and economic growth among coastal communities. The species *Octopus vulgaris* was identified by the fishing industry as the basis of a possible new commercial venture. Later, it was discovered to be a species well suited to the proposed business in terms of geographical and depth distribution, biology, marketability and demand.[1–3] However, a new policy for the development of fisheries in South Africa requires that an experimental fishery be conducted for a limited period before a commercial venture can start.[3] This policy also identifies the importance of investigating the economic feasibility of a fishery as part of the management framework. The study reported here generated baseline information necessary in the design of the experimental fishery, giving guidelines as to which vessels, gear and markets would be most appropriate.

The aim of creating new fishing opportunities in South Africa is to achieve economic growth for coastal areas, focusing on small- and medium-enterprise development; and thereby creating jobs, developing skilled personnel and enhancing economic transformation in the fishing sector.[4] Fisheries provide social and economic benefits to society, and the way in which a fishery is managed will influence, for good or ill, those benefits.[5] It is thus important for the fishery manager to understand the underlying economic and social factors, and to comprehend the impact that the exploitation of the resource has on these conditions.[5] The economic and social analysis of a fishery should be presented, therefore, as biological and ecological data are, for the purpose of taking management decisions.

In establishing new fisheries, it is important to know the following to determine economic feasibility: first, a description of the fishery in terms of vessel and gear type, fishing techniques, gear selectivity and expected catch rates; second, local and international markets; and, third, the actual cost of fishing.[3,5–7] This information is not only necessary for the person responsible for proposing the experimental business venture, but also for the prospective fisher, who is now required to submit a business plan as part of the application for a fishing permit. Determining the economic viability, and other factors such as life history and population characteristics of the catch will contribute towards determining the future sustainability of the resource.[3]

The aim of this paper is to describe the octopus fishery and to calculate the minimum catch per unit effort (CPUE) for various fishing operations in terms of their economic feasibility. It is important to note that this is only an estimated minimum CPUE, based on assumptions that cannot be confirmed until the fishery starts. Furthermore, this economic analysis also needs to be assessed by stakeholders with experience of fishery operations.

## Description of the proposed fishery

### Vessel type

The proposed fishery should be compatible with existing fisheries to prevent both user conflict and unnecessary capital expenditure at the start of the new business. Vessels in the existing fleet should thus be suitable for the new fishery. Smith[2] suggested vessel sizes of 3–5 tons because similar boats are currently used in South African operations such as the linefishery, the rock lobster industry, the hake-directed handline fishery, and to catch squid. These businesses operate mainly along the western, southwestern, southern and southeastern Cape coasts. Similar-sized vessels are also used in other experimental octopus fisheries.[8] South African boats in the specified size class vary from 5–8-m chukkies and skiboats to 14–25-m deckboats.[2] They should all be fitted with an echosounder, a GPS plotter and a line-hauler. This equipment will permit the accurate determination of depth, fishing substrate, fishing areas, and location and retrieval of fishing gear. Smith recommended[2] only two or three crewmen for such a fishing operation.

This study focused on two types of vessel, a 14-m deckboat (Fig. 1) powered by two 285-hp inboard diesel engines, and a 8–10-m wooden 'chukkie' (Fig. 2) with a six-cylinder diesel engine. These smaller boats operate mainly in the western and southwestern Cape waters, generally out of small harbours, while the larger vessels are found along the entire coast. For the purpose of this study, three crewmen and one skipper will operate the deckboat, whereas only two crewmen and a skipper will operate the chukkie.

### Gear type

Smith[2] recommended pot fishing on long lines for the South African experimental fishery. This is the method used most commonly in other experimental octopus fisheries.[3] The fishing gear consists of lines with a number of pots (unbaited, no hooks) attached at intervals. The lines are anchored and buoyed at each end. The pots could consist of PVC pipe and half-tyres either closed off in the middle or at one end (Fig. 3). These are similar in

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**Fig. 1**. The larger deckboat (18–25 m) vessel to be used in the octopus pot fishery.

**Fig. 2**. Chukkies, the smaller (8–10 m) wooden vessels, moored in a small boat harbour in the Western Cape province.

structure to those described by Whitaker *et al.*[8] The specific configuration in terms of length of line and number of pots per line, as well as soak times (time spent in water), will be at the discretion of the individual fisher.

Two combinations of gear and soak times were compared in this study. The first consisted of a large number of short lines, with a short soak period, while the second comprised a few but longer lines with a longer soak period (Table 1). Pots described in this study consisted of PVC pipes, approximately 50 cm in length and 11 cm in diameter.[2,8]

### Fishing activity

The operational area for this fishery will be from Saldanha on the west coast to East London on the east coast, given the nature of the continental shelf along this coastline. Octopus occurs to a depth of approximately 200 m, with abundance decreasing with increasing depth. The fishing depth range will therefore probably be 10–100 m, on a relatively flat-profile bottom.

The smaller vessels have the capacity to make only day trips, so fishing activity will involve traps being deployed and hauled

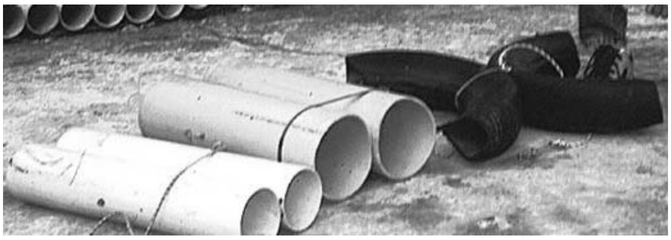

**Fig. 3.** Octopus pots consisting of PVC pipe and half-tyres, closed off in the middle.

each day. This might not apply to the larger vessels with capacity for trips lasting several days; these boats might engage in other fishing activities before and after gear deployment and retrieval. However, for the purpose of this study, fishing operations and cost calculations are limited to a daily fishing routine (see economic assumptions below regarding other fishing activities). Fishing days per month were calculated as follows (a detailed description of these operations is presented in Table 1):

- There are approximately 20 days available for fishing per month; the rest allows for bad weather and vessel maintenance.
- Fishing operation 1 deploys all pots (1000 in year 1; 2000 in year 2) on 40 lines (year 1) and 80 lines (year 2) for a four-day soak time (4 cycles of 4 days = 16 days). Ten lines are deployed each day for the first 12 days (12 sea-going days) and during the last four days, lines are only retrieved (4 sea-going days).
- Fishing operation 2 deploys all pots (900 in year 1; 1950 in year 2) on 6 lines (year 1) and 13 lines (year 2) for a seven-day soak time (3 cycles of 7 days = 21 days). All lines are deployed and retrieved during only four sea-going days (i.e. 4 fishing days)

Octopus will either be iced or frozen at sea, depending on the vessel type. The only processing required is removal of the beak and internal organs. The catch will be exported directly by the fisher or sold to an intermediary for this purpose.

### Gear selectivity

Pot fishing is a passive method and highly selective towards the target species. No bycatch is expected.[9]

## Expected catch rates

Catch rate is defined as the number of octopus caught per number of pots. Other experimental fisheries for octopus reported variable but low catch rates (Table 2). The average size of octopus caught in South Carolina waters was 0.90 kg, with larger diameter pots catching larger individuals.[8] Similar-size classes are caught on the Senegalese coast.[10] Biological studies on *O. vulgaris* around the South African coast indicate a mean size of approximately 1.0–1.2 kg. Seasonal size variation is evident, with the mean octopus size during winter (600 g) being substantially smaller than in summer (1.5–2 kg).[2,3,11] The expected catch rate for this study was set at 30%, with large individuals caught in summer and smaller octopus trapped in winter.

**Table 1**. A description of the two different fishing operations investigated in this study.

| Fishing and gear design | Fishing operation 1 | Fishing operation 2 |
|---|---|---|
| No. of pots | | |
| Year 1 | 1000 | 900 |
| Year 2 | 2000 | 1950 |
| Gear configuration Year 1 | 40 lines (220 m each) with 25 pots per line | 6 lines (1050 m each) with 150 pots per line |
| Gear configuration Year 2 | 80 lines (220 m each) with 25 pots per line | 13 lines (1050 m each) with 150 pots per line |
| Pot type | Single PVC pipe closed in the middle | Single PVC closed in the middle |
| Fishing trips | Daily, deploying 10 lines a day | Daily, deploying 6 lines |
| Soak time | 4 days | 7 days |
| Fishing days/month | 16 | 4 |

**Table 2**. Catch rates reported by other octopus pot fisheries.

| Fishery | Catch rate (%) | Reference |
|---|---|---|
| †South Carolina | 27.8 | Whitaker *et al.*, 1991 |
| †West coast of Florida | 45–90 | Roper, 1997 |
| †Spanish Mediterranean | 6–40 | Sánchez & Obarti, 1993 |
| *Canada: Barkley Sound | 0.63 | Adkins *et al.*, 1980 |
| *Canada: Vancouver Island | 0.26–8.44 | Hartwick *et al.*, 1982 |
| *Canada: Prince Rupert | 1.88–23.62 | Clayton *et al.*, 1992 |
| *Alaska | 21 | Paust, 1997 |

†Similar-sized species to *O. vulgaris.*
*Large octopus species.

## Markets

Prospective fishermen and import/export companies were interviewed to collect market-related information. Details on octopus imports, exports and local supply can be requested from the author.

### Local market

A very small local market exists for octopus and the only local species traded and consumed currently is *Octopus magnificus.* This large octopus is supplied by wholesalers, mostly to the Portuguese and Greek communities based predominantly in Gauteng and Cape Town (approximately 4 ton/month). Only *O. magnificus* is exported from South Africa, while imported octopus (from India and Asia) consists of 'baby octopus' (species unknown). This product is mostly used in seafood restaurants. *O. vulgaris* is rarely traded, and generally consumed only by subsistence fisheries.

### International market

The *O. magnificus* bycatch from the Namibian and South African west coast hake trawlers and south coast rock lobster traps are bought by local businesses and exported mainly to Portugal and Spain with some going to the United States and Belgium (total amount: approximately 170 ton/year). This species is frozen into 5–10-kg blocks and shipped abroad. The average ex-vessel price is R8–13/kg, while the market price is R 14–18 /kg.

Markets for *O. vulgaris* exist in various countries, including Australia, Japan, Korea, Spain and Portugal.[12] These are large commercial/agricultural outlets that sell fresh and frozen seafood, meat, fruit and vegetables, as well as other agricultural products. Octopus is generally graded into different sizes and usually sold frozen. Different grades (sizes) fetch different prices. Estimates of price, size ranges and product form of *O. vulgaris* sold on the European (Mercabana, Spain), Japanese (Tsujiki), and Australian (Sydney) markets are presented in Table 3.

## Cost estimation

Costs were determined at current prices (September 2003, in rands). All items were priced individually, while general running expenses were determined from vessel owners and from the economic and sectoral study conducted on the South African linefish industry.[13]

### Economic scenarios

Capital stock requirement was assessed for two different economic scenarios: first, when the vessel and all necessary gear are purchased at the beginning of the fishery (full capital outlay, FCO) and second, when a pre-owned vessel is used (use of existing vessel, UEV). These scenarios were elaborated as eight options for the two different fishing operations, for which costing sheets and the minimum CPUEs were calculated. Cash flow statements for years 1 and 2 and break-even analysis (years 1–5) were calculated only for the most cost-effective options.[14,15] The eight economic scenarios investigated for the fishery are as follows:

*Option 1a.* FCO, deckboat and gear purchased at beginning of fishery, fishing operation 1.

*Option 1b.* UEV, pre-owned deckboat used, gear purchased at beginning of fishery, fishing operation 1.

*Option 2a.* FCO, chukkie and gear purchased at beginning of fishery, Fishing operation 1.

*Option 2b.* UEV, pre-owned chukkie used, gear purchased at beginning of fishery, Fishing operation 1.

*Option 3a.* FCO, deckboat and gear purchased at beginning of fishery, fishing operation 2.

*Option 3b.* UEV, pre-owned deckboat used, gear purchased at beginning of fishery, fishing operation 2.

*Option 4a.* FCO, chukkie and gear purchased at beginning of fishery, fishing operation 2.

*Option 4b.* UEC, pre-owned chukkie used, gear purchased at beginning of fishery, fishing operation 2.

The assumptions on which cost calculations were based are listed below:

- 11 months of fishing, 1 month contingency (vessel maintenance).
- 10% increase in all costs and market prices per year (as a result of inflation).
- Year 1: Fishing with a minimum number of pots (900 or 1000). Permit conditions specify minimum number of pots to be used during year 1. It is assumed that some fishermen might use only the minimum number of pots during year 1.
- Gear maintenance during year 1 is the cost of replacing

**Table 3**. Examples of the sizes, product forms and prices of octopus sold in (**a**) Mercabana, Spain, (**b**) Japan and (**c**) Sydney, Australia.

**(a)**

| Octopus origin | Product size (kg) | Product form* | Price (€/kg) | Price (R/kg) |
|---|---|---|---|---|
| Morocco | 0.5 | Whole | 7.15 | 71.5 |
| Morocco | 1 | Whole | 8.11 | 81.1 |
| Morocco | 2.5 | Whole | 8.71 | 87.1 |
| Morocco | 3 | Whole | 10.22 | 102.2 |
| Morocco | 4–5 | Whole | 12.02 | 120.2 |
| Tunisia | 1 | Whole | 6.61 | 66.1 |
| Tunisia | 2.5 | Whole | 6.91 | 69.1 |
| Tunisia | 3 | Whole | 7.66 | 76.6 |
| Tunisia | 4–5 | Whole | 8.71 | 87.1 |

**(b)**

| Octopus origin | Product size (kg) | Product form* | Price (¥/kg) | Price (R/kg) |
|---|---|---|---|---|
| Morocco | 0.2–0.3 | Gutted | 640 | 44.6 |
| Morocco | 0.3–0.5 | Gutted | 705 | 48.6 |
| Morocco | 0.5–0.8 | Gutted | 775 | 53.5 |
| Morocco | 0.8–1.2 | Gutted | 795 | 54.9 |
| Morocco | 1.2–1.5 | Gutted | 950 | 65.6 |
| Morocco | 1.5–2 | Gutted | 1000 | 69.0 |
| Morocco | 2–3 | Gutted | 1050 | 72.5 |
| Morocco | 3–4 | Gutted | 1150 | 79.4 |

**(c)**

| Octopus origin | Product size (kg) | Product form* | Price (AU$/kg) | Price (R/kg) |
|---|---|---|---|---|
| Unknown | Medium | Unknown | 4.95 | 32.2 |
| | Large | | 6.21 | 40.4 |
| | 3–4 kg | | 5.19 | 33.7 |

*Frozen octopus. Source: Fisheries Information Services (11 September 2002). 1 € = c. R10; 1 ¥ = c. R0.069; 1 AU$ = c. R6.50.

**Table 4.** A description of the quantity and cost for the gear designs used in the two different fishing operations.

| Fishing operation 1 | Description | | Quantity | Cost | Total cost (R) |
|---|---|---|---|---|---|
| 40 lines (220 m each) | Pots | 1000 × UPVC 30 cm length, 15 cm diam. | 300 m | R64/m | 19 200 |
| 1000 pots (25/line) | Lines: drop | Ployprop. 16 mm, 220 m coil | 40 coils | R553/coil | 22 120 |
| | Main | 10 mm, 220 m coil | 40 coils | R220/coil | 8 800 |
| | Buoys | 250 mm × 4/line | 160 buoys | R168/bouy | 26 880 |
| | Anchors | 20 kg × 2/line | 80 anchors | R380/anchor | 30 400 |
| | Cement | 10 kg bag | 10 bags | R40/bag | 400 |
| | LL clips | Longline clips | 1000 clips | R9/clip | 9 000 |
| Total gear cost | | | | | **116 800** |
| **Fishing operation 2** | **Description** | | **Quantity** | **Cost** | **Total cost (R)** |
| 6 lines (1100 m each) | Pots | 1000 × UPVC 30 cm length, 15 cm diam. | 270 m | R64/m | 17 280 |
| 900 pots (150/line) | Lines: drop | Polyprop. 16 mm, 220 m coil | 29 coils | R553/coil | 16 037 |
| | Main | 10 mm, 220 m coil | 29 coils | R220/coil | 6 380 |
| | Buoys | 250 mm × 4/line | 20 buoys | R168/bouy | 3 360 |
| | Anchors | 20 kg × 2/line | 10 anchors | R380/anchor | 3 800 |
| | Cement | 10 kg bag | 10 bags | R40/bag | 400 |
| | LL clips | Longline clips | 900 clips | R9/clip | 8 100 |
| Total gear cost | | | | | **55 357** |

**Table 5.** Summary of the total costs (in rands) and estimated CPUE (in kg per year) needed to cover expenses.*

| Option | | | | | | **Deckboat** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Year: | | 1 | | 2 | 3 | 4 | 5 |
| 1a | FCO, FO 1 | Months: | 6 | 11 | 6 | 11 | 11 | 11 | 11 |
| | Total costs (R) | | **607.000** | **1 214.000** | **658.000** | **1 315.000** | **1 293.000** | **1 275.000** | **1 264.000** |
| | CPUE 1 (kg) | | 9.869 | 19.738 | 10.692 | 19.440 | 17.515 | 15.947 | 14.681 |
| | CPUE 2 (kg) | | 8.489 | 16.978 | 9.196 | 16.721 | 15.066 | 13.717 | 12.627 |
| 1b | UEV, FO 1 | | | | | | | | |
| | Total costs (R) | | **237.000** | **474.000** | **322.000** | **643.000** | **689.000** | **739.000** | **796.000** |
| | CPUE 1 (kg) | | 3.850 | 7.700 | 5.300 | 9.500 | 9.300 | 9.200 | 9.300 |
| | CPUE 2 (kg) | | 3.310 | 6.600 | 4.500 | 8.200 | 8.000 | 8.000 | 8.000 |
| 3a | FCO, FO 2 | | | | | | | | |
| | Total costs (R) | | **562.000** | **1 124.000** | **592.000** | **1 184.000** | **1 154.000** | **1 128.000** | **1 108.000** |
| | CPUE 1 (kg) | | 9.100 | 18.300 | 9.600 | 17.500 | 15.600 | 14.100 | 12.900 |
| | CPUE 2 (kg) | | 7.900 | 15.600 | 8.300 | 15.000 | 13.500 | 12.100 | 11.100 |
| 3b | UEV, FO 2 | | | | | | | | |
| | Total costs (R) | | **192.000** | **384.000** | **256.000** | **512.000** | **550.000** | **592.000** | **640.000** |
| | CPUE 1 (kg) | | 3.100 | 6.200 | 4.100 | 7.600 | 7.500 | 7.400 | 7.400 |
| | CPUE 2 (kg) | | 2.700 | 5.400 | 3.600 | 6.500 | 6.400 | 6.400 | 6.400 |
| | | | | | | **Chukkie** | | | |
| | | Year: | | 1 | | 2 | 3 | 4 | 5 |
| 2a | FCO, FO 1 | Months: | 6 | 11 | 6 | 11 | 11 | 11 | 11 |
| | Total costs (R) | | **205.000** | **413.000** | **251.000** | **507.000** | **505.000** | **506.000** | **509.000** |
| | CPUE 1 (kg) | | 3.300 | 6.700 | 4.100 | 7.500 | 6.900 | 6.300 | 5.900 |
| | CPUE 2 (kg) | | 2.900 | 5.800 | 3.500 | 6.500 | 5.900 | 5.500 | 5.000 |
| 2b | UEV, FO 1 | | | | | | | | |
| | Total costs (R) | | **113.000** | **228.000** | **167.000** | **339.000** | **354.000** | **372.000** | **392.000** |
| | CPUE 1 (kg) | | 1.800 | 3.700 | 2.700 | 5.000 | 4.800 | 4.700 | 4.600 |
| | CPUE 2 (kg) | | 1.600 | 3.200 | 2.300 | 4.300 | 4.100 | 4.000 | 3.900 |
| 4a | FCO, FO 2 | | | | | | | | |
| | Total costs (R) | | **185.000** | **371.000** | **222.000** | **443.000** | **441.000** | **440.000** | **442.000** |
| | CPUE 1 (kg) | | 3.000 | 6.000 | 3.600 | 6.600 | 6.000 | 5.500 | 5.200 |
| | CPUE 2 (kg) | | 2.600 | 5.200 | 3.100 | 5.600 | 5.100 | 4.800 | 4.400 |
| 4b | UEV, FO 2 | | | | | | | | |
| | Total costs (R) | | **93.000** | **186.000** | **138.000** | **275.000** | **290.000** | **306.000** | **325.000** |
| | CPUE 1 (kg) | | 1.500 | 3.000 | 2.200 | 4.100 | 3.900 | 3.800 | 3.900 |
| | CPUE 2 (kg) | | 1.300 | 2.600 | 1.900 | 3.500 | 3.400 | 3.300 | 3.300 |

*These estimates were based on European market prices.[20] The different scenarios in the experimental octopus fishery are as follows: FCO, full capital outlay; UEV, utilize existing vessel; FO, fishing operation. A total of 11 fishing months per year, with the costs and CPUE given for the first six months of years 1 and 2, due to the different fishing operations that occur during these years. CPUE 1, catch consists of 500-g size class sold at R71.5/kg; CPUE 2, catch consists of 1-kg size class sold at R81.5/kg.

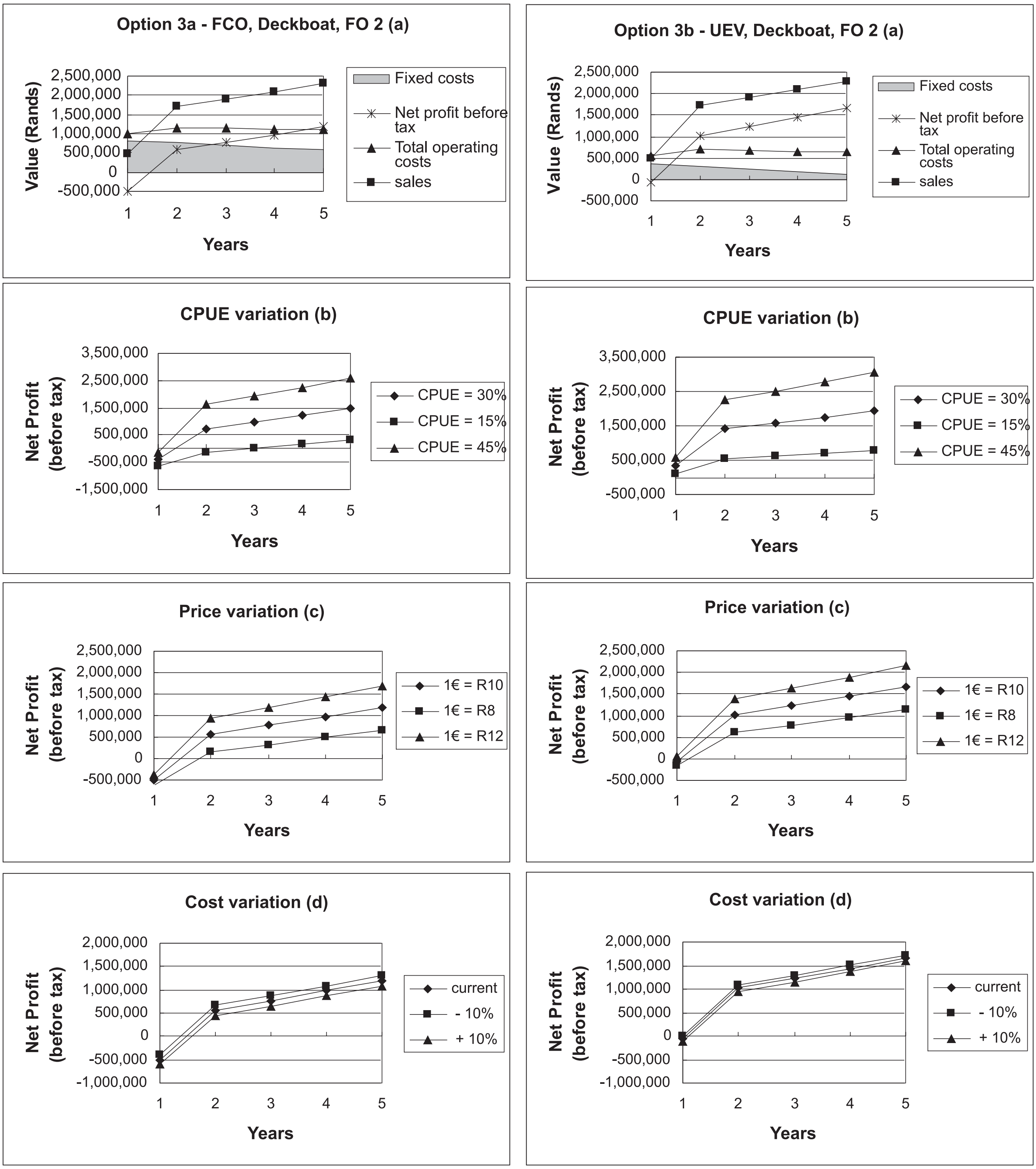


**Fig. 4.** Economic analysis of fishing options 3a (full capital outlay, deckboat, employing fishing operation 2) and 3b (use of existing vessel, deckboat, employing fishing operation 2). **a**, Break-even analysis and **b**, sensitivity analysis of the net profit (before tax) in relation to CPUE, **c**, price and **d**, costs.

approximately a third of the gear. This is an estimate, as the real rate of gear loss is unknown.

- Year 2: Fishing with maximum number (1950 or 2000) of pots (gear restrictions will include a maximum number of pots used).
- Gear maintenance during year 2 is the cost of replacing approximately two-thirds of the gear.
- Crew increase by one in year 2, because of extra gear and fishing activity. Salaries: skipper = R5000/month, crew member = R2500/month. These rise because the number of pots handled increases.
- Fishing days per month remain constant, but fishing activity increases with time.
- Fuel consumption increases by 20% in year 2 because of increased activity. The fuel consumption of fishing operation 2 is approximately half that of fishing operation 1 (R7500/2). This rises with the number deployed and retrieved lines.
- Vessel insurance is approximately 3% of vessel value.
- Administration cost of the smaller vessel (chukkie) is approximately half that of the larger deckboat.
- The permit fee of the chukkie is approximately half of that of the larger deckboat.

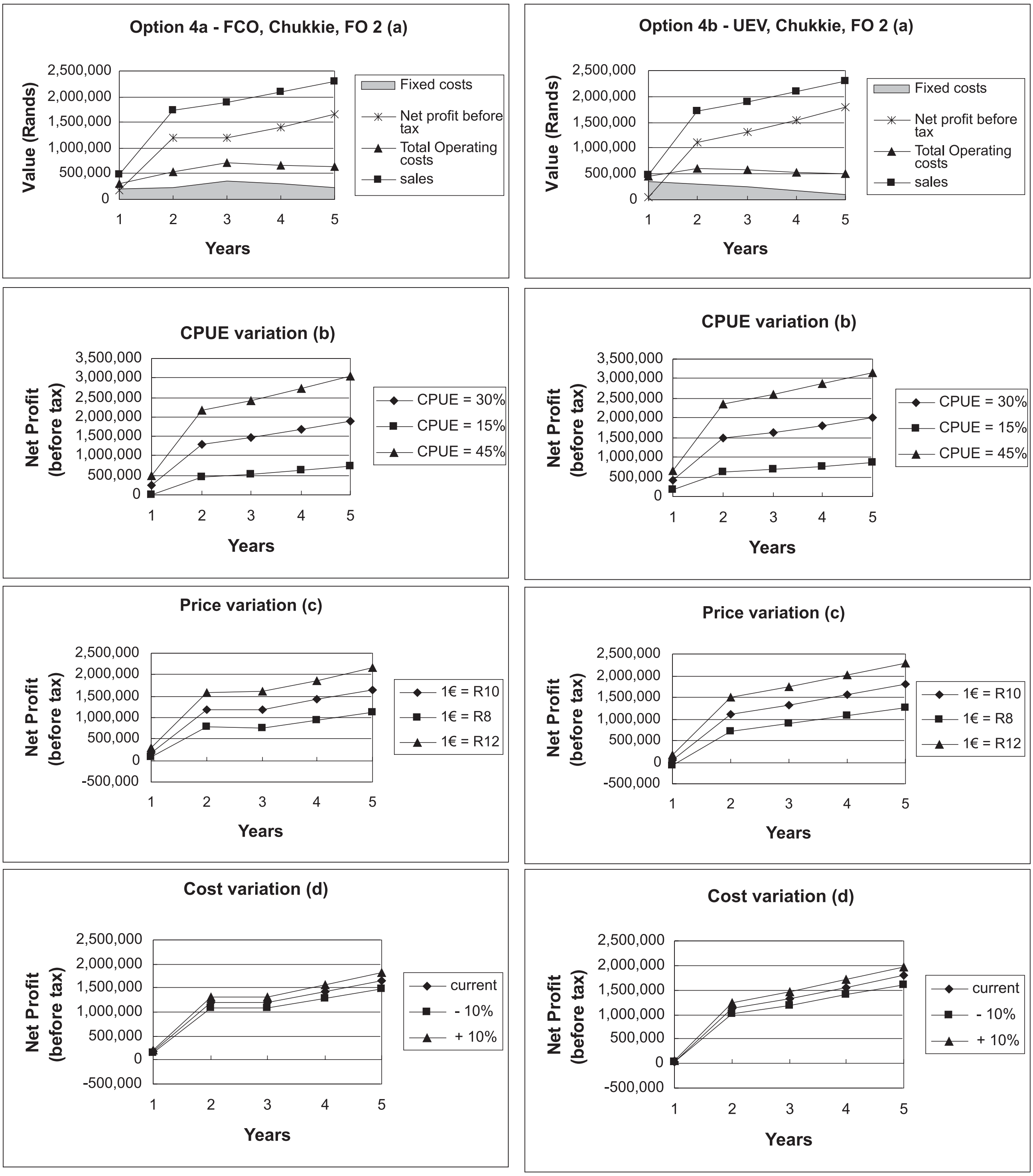


**Fig. 5.** Economic analysis of fishing options 4a (full capital outlay, chukkie, employing fishing operation 2) and 4b (use of existing vessel, chukkie, employing fishing operation 2). **a**, Break-even analysis and **b**, sensitivity analysis of the net profit (before tax) in relation to CPUE, **c**, price and **d**, costs.

- Protective clothing on the chukkie is approximately a quarter of that of the larger deckboat.
- If the fishery lasts only a six months, costs will be shared by other fishing activities.
- Assume that deck space on the chukkie does not prohibit the number of pots deployed.
- Catch rates were based on rates attained in other experimental fisheries.[8]
- Catch size composition (500 g vs 1 kg) was based on biological data from South Africa[2,11] and elsewhere.[8,10]
- The entire catch is exported to the European market.
- Export and packaging costs were estimated at R10 /kg (probably overestimated).

Table 4 describes the quantity and cost of the two gear designs used in the different fishing operations. The gear cost for fishing operation 1 was approximately double that of fishing operation 2. A small number of longer lines, with more pots per line, is more cost-effective than a large number of short lines, with fewer pots per line. The gear and fishing design also have implications for fuel use, since fishing operation 1 required 16 sea days per month compared to four sea days per month for fishing operation 2. A summary of total costs and estimated CPUE

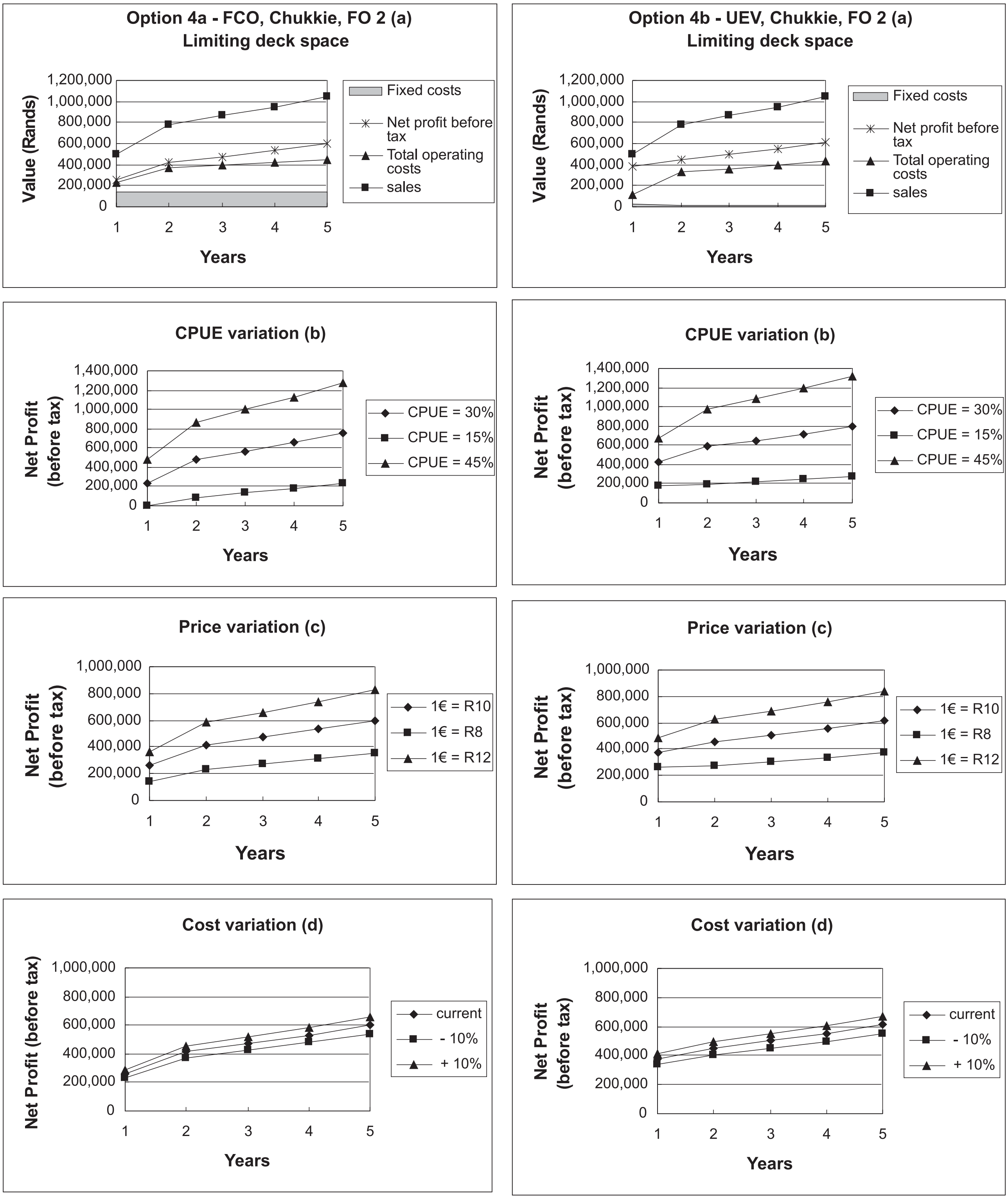


**Fig. 6.** Economic analysis of fishing options 4a and 4b; chukkie deck space is limiting. **a**, Break-even analysis and **b**, sensitivity analysis of the net profit (before tax) in relation to CPUE, **c**, price and **d**, costs.

needed to cover costs is presented in Table 5. The use of an existing vessel with fishing operation 2 was the most cost-effective scenario for both vessel types. Detailed costing sheets, cash flow statements, and break-even analysis may be requested from the author.

### Sensitivity analysis

The sensitivity of the net profit (before tax) to variations in CPUE (15%), market prices (20%), and costs (10%) was determined for five years. The sensitivity of the net profits of the most economical scenarios (options 3 and 4) is presented in Figs 4–6. The change in CPUE and price (in terms of currency fluctuation) had the most noticeable effect on net profit.

## Recommendations

This economic appraisal indicates that the pot fishery could be viable if a catch rate of approximately 30% were attained. All vessels engaged in the second fishing operation were considered profitable, breaking even within the first year. The minimum CPUE for the chukkie, operating in the western or southwestern Cape, was estimated at 2.6–4.1 t/yr, depending on the type of operation. Assuming that deck space did not prohibit the number of pots carried, the smaller vessels could show a profit of R1.5 million after five years. For the deckboat, the minimum CPUE was estimated at 5.4–7.6 t/yr, with a profit margin (before tax) of approximately R1.5 million. The options where new vessels were purchased at the beginning of the fishery were not feasible, with the deckboat FCO option being least profitable and breaking even only in the third year. Where deck space limited the number of pots, the smaller vessels would be less profitable at R 400 000–600 000. I therefore recommend that only wholly owned vessels engaged in the second fishing operation be considered for the experimental fishery.

### Comments from prospective fishers

Prospective fishers indicated that the octopus stock will probably support only a seasonal fishery that would supplement other fisheries during their off-seasons. Fishers in the southwestern Cape target mainly migratory linefish during summer. In winter they target the already overexploited reef fish species and see the octopus resource as a welcome supplement. In the Eastern Cape, fishermen who target squid and hake on handlines might consider moving to octopus during the off-seasons (mainly winter). The most accessible market will probably be Europe, to which local fishermen are already exporting squid (M. Craig, Robberg Seafoods, pers. comm.).

### Factors influencing commercial success

It is evident from the literature[3] that octopus fisheries can be successful on various scales. Nonetheless, there are various factors that influence the revenue of octopus fisheries. These include environmental, anthropogenic, and market-related conditions. For example, upwelling was indicated as the key environmental influence on the abundance of both larvae and adult octopus in Senegalese waters.[16] In Mexico, a red tide during 2001 forced octopus to move out of the fishing areas, causing a loss of revenue of over US$1 million, a rather large amount for a small-scale fishery.[17] Furthermore, *Octopus mimus* landings in Chile were influenced by both environmental factors such as El Niño-Southern Oscillation events and anthropogenic effects such as landslides and cholera epidemics. The biggest market-related factors to influence an octopus fishery were oversupply and stockpiling. This led to large price drops and strained relations between Morocco, the supplier, and Japan, its largest importer of octopus.[18,19] Octopus fisheries are thus vulnerable to a range of factors, and fluctuations in both catch and market demand can be expected.

If the local octopus fishery proves viable only seasonally, consideration should be given to permitting the participants to engage in other fisheries, provided that quota allocations are not exceeded.

The economic constraints that will have practical implications for the establishment of an octopus fishery were identified as follows:

- The vessel type must be chosen according to economic viability (i.e. wholly owned boats only).
- Large capital outlay is required for fishing gear and operations.

Furthermore, the fluctuating nature of the markets and stock might well dictate a mixed quota fishery to make this a feasible venture. This economic and operational information must be identified before the start of the experimental fishery, so that it can be incorporated into the experimental design and the business plans of applicant fishermen.

This work, combined with the results of biological[11] and octopus population[21] studies, has been integrated into a fishery management plan,[3] which will form the basis of the management of the proposed business.

I thank W.H.H. Sauer (Rhodes University) and H. Erstadt (Norway) for their contributions at the start of the project, B. Holmes and C. Smith (Marine and Coastal Management) for information on fishing operations, M. Craig (Robberg Seafoods) for comments on markets and exports, T. Wesson (Business Partners) for comments on a draft of this article, and T. Hecht (Rhodes University) for the use of the deckboat photograph. Rhodes University and the DAAD (German Academic Exchange Service) are thanked for financial assistance.

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