Appendices

APPENDIX 1 PAAT GIS DESCRIPTION OF W AFRICA

Figure A1.1 Observed Cattle Density

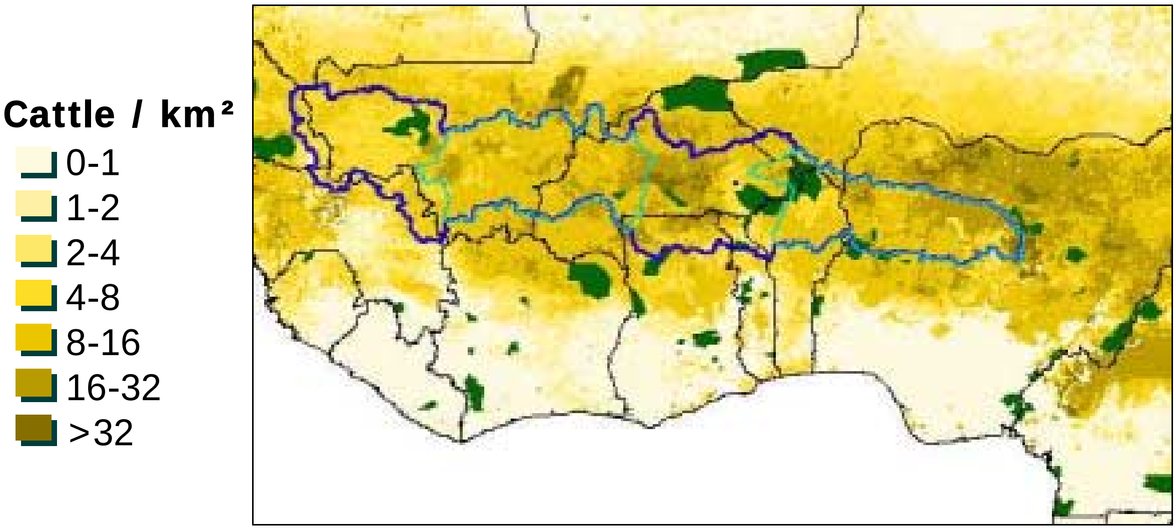


Figure A1.2 Predicted Cattle Density after Tsetse Control

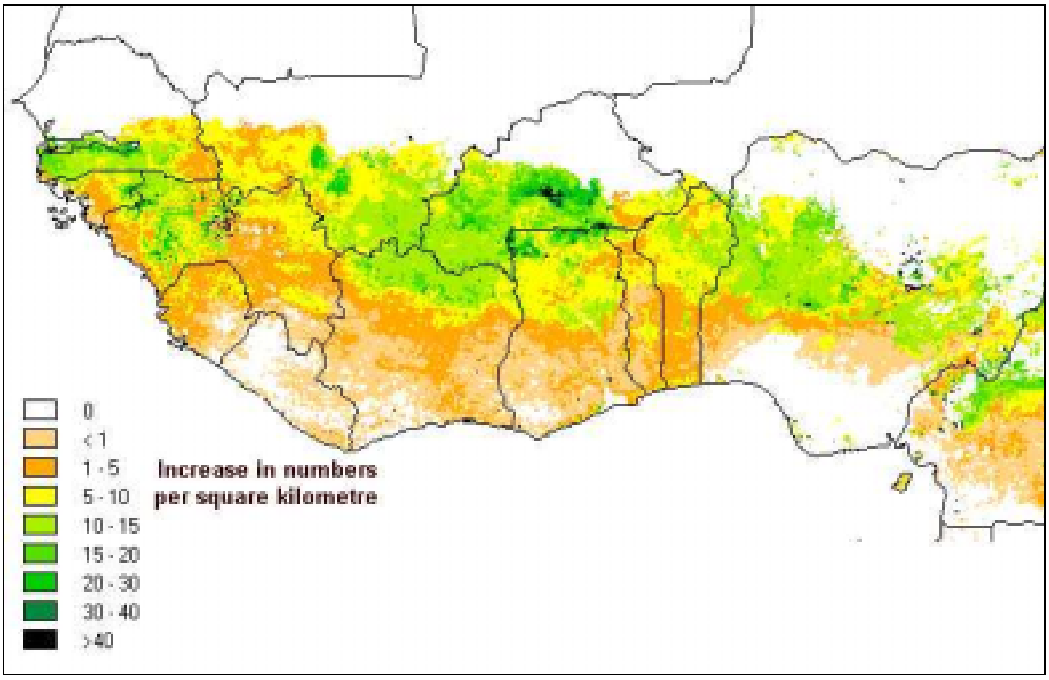


Figure A1.3 Digital Elevation Map

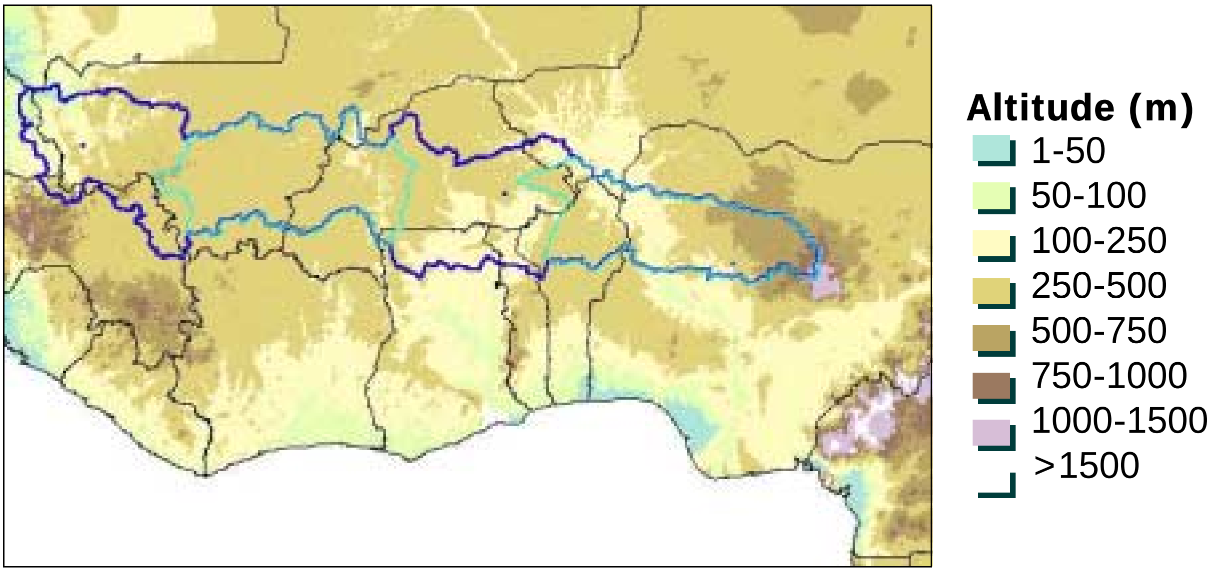


Figure A1.4 Ecozones

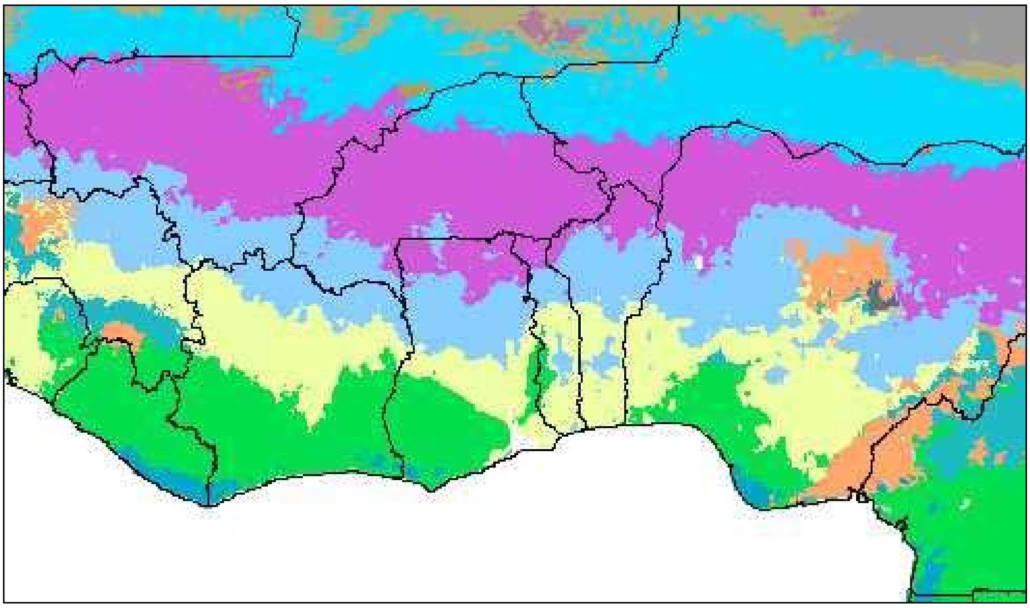


Figure A1.5 Length of Growing Period (LGP)

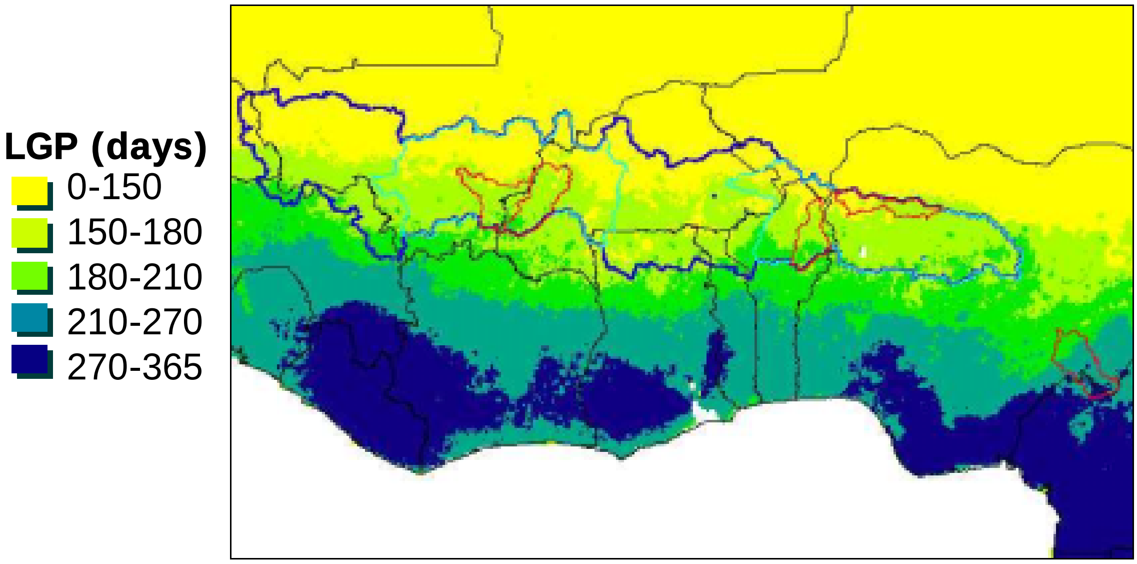


Figure A1.6 Human Population Density

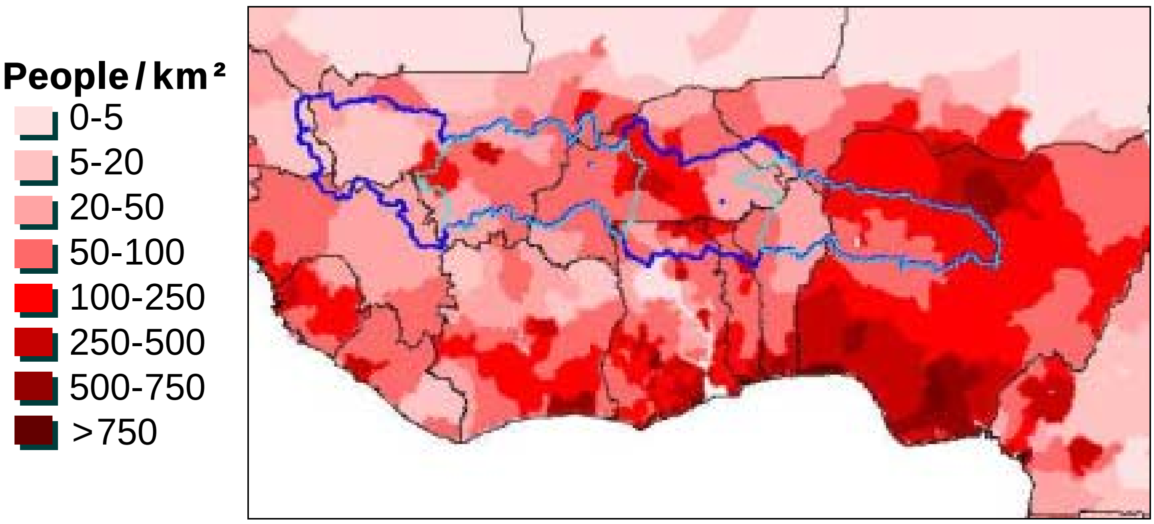


Figure A1.7 Percentage Areas Cultivated (based on 1 sq km pixels)

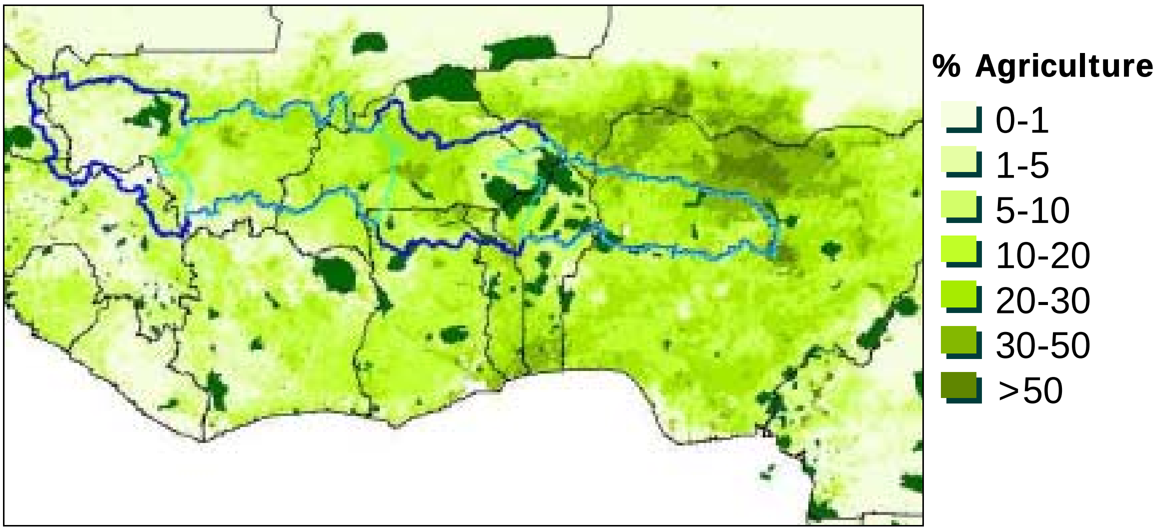


Figure A1.8 River Basins in West Africa Showing Study Areas

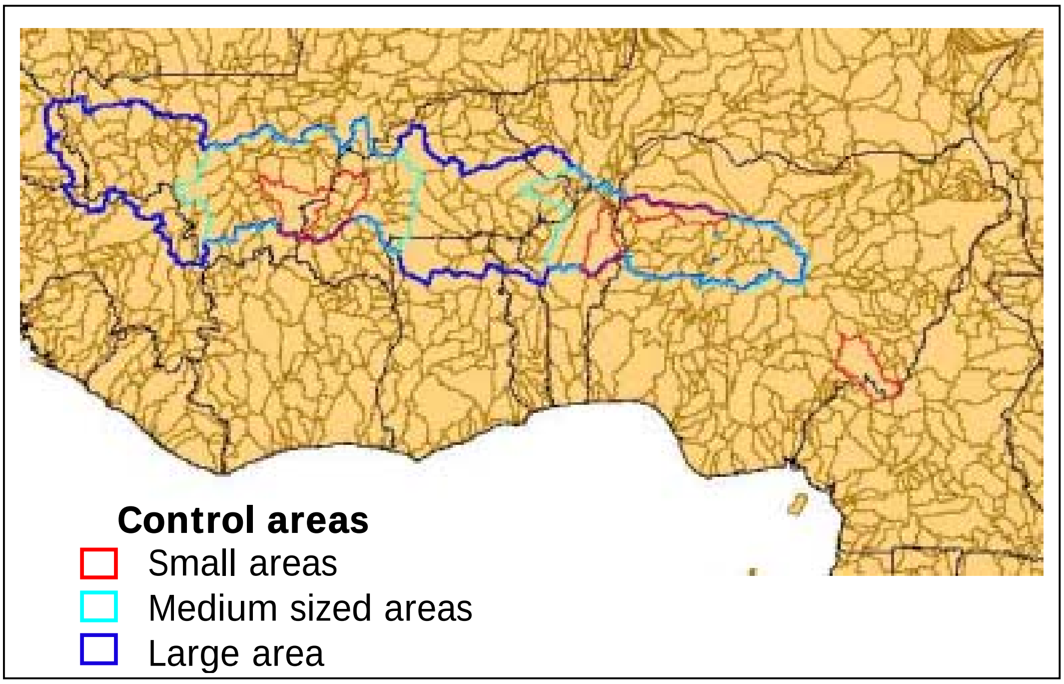


Figure A1.9 Farming Systems

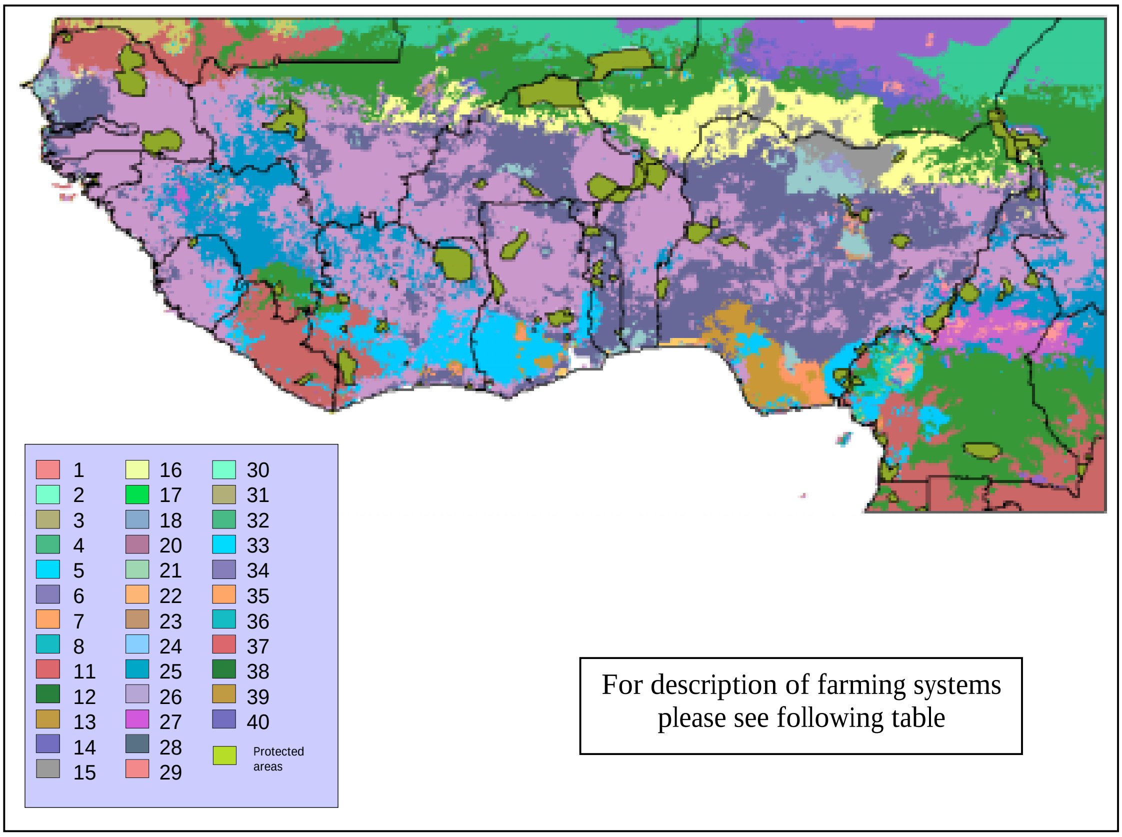


Table A1.1 Description of Farming Systems

System Ref. No.	Population density /km^2	% Cultivated	Cattle density /km^2	Elevation meters	LGP* days	TYPE	Ha. Cultivated / 100 people	Cattle /100 people
1	15	19	7	626	29	Agropastoral	569	177
2	778	6	1	172	18	Marginal	1	0
3	3	1	1	458	12	Marginal	49	156
4	49	3	34	369	28	Pastoral	18	464
5	3	0	2	258	14	Marginal	19	199
6	41	11	184	369	23	Int Pastoral	1112	72864
7	5	0	7	520	14	Arable	5	616
8	3	1	2	691	15	Marginal	58	97
9	4	1	2	1033	20	Marginal	50	418
10	3	1	3	1409	27	Marginal	35	370
11	31	9	15	313	97	Pastoral	38	117
12	9	3	6	222	85	Marginal	34	388
13	46	18	166	764	84	Int Pastoral	106	3693
14	10	3	4	542	85	Marginal	51	134
15	397	61	30	677	109	Mixed	21	9
16	52	32	11	357	98	Agropastoral	75	23
17	7	1	4	1020	92	Marginal	30	215
18	112	67	19	487	101	Mixed	124	33
19	40	9	22	1180	97	Pastoral	41	271
20	8	2	6	1403	88	Marginal	86	347
21	44	8	28	1392	175	Pastoral	41	166
22	142	84	39	933	167	Intensive	438	236
23	63	18	11	306	181	Mixed	54	29
24	139	11	68	1995	203	Int Pastoral	16	114
25	238	37	20	748	190	Mixed	38	18
26	23	5	8	276	182	Pastoral	35	80
27	13	2	4	666	202	Marginal	30	90
28	2145	30	39	608	201	Mixed	2	2
29	12	2	4	1250	185	Marginal	19	48
30	112	12	161	1377	188	Int Pastoral	37	1175
31	131	91	58	1486	308	Intensive	153	50
32	742	21	10	348	284	Agropastoral	3	1
33	23	2	0	264	300	Marginal	21	2
34	226	18	139	1834	288	Int Pastoral	20	968
35	269	15	0	189	291	Arable	6	0
36	133	20	32	1329	290	Mixed	22	34
37	10	2	1	516	324	Marginal	22	14
38	29	3	4	907	315	Marginal	14	30
39	90	11	1	230	289	Arable	21	2
40	63	3	15	1997	310	Pastoral	50	254

* LGP – Length of Growing Period

APPENDIX 2 COSTS AND BENEFITS OF SMALL PROJECTS

2.1 GEOGRAPHICAL DATA

Chapter 3 describes the small projects areas and outlines the principles of the shadow tsetse eradication projects. This appendix computes the costs and benefits of these projects in financial terms and Chapter 8 analyses them in economic terms.

Table A2.1 Small Shadow Project Area Data

	Study Area 1	Study Area 2	Study Area 3	Study Area 5
Area (km^2)	17361 Mali 3152 B/Faso 20513 Total	21630 Actual 21898 Nominal*	14125	19858
Perimeter (km)	1162 (Mali+BF)	1054	820	1034
Barrier length required (km)	100	350	275	390
Length of River infested	2000 km (Mali+BF)	1408	552	2000 (Est.)

2.2 COSTS OF TECHNIQUES

The costs of implementing the various tsetse control techniques have only been computed in the Mali study area and these will be applied in the cost analysis of all of the study areas.

The cost of fabricating, deploying and maintenance of one target, at $25, is substantially lower than that reported by Barrett based on surveys in Zimbabwe. The difference can not be obviously accounted for by differences in the costs of deploying between riverine and savannah woodland.

The cost used for SIT, $800 per sq km, is a standard global cost estimate as there has been insufficient experience of operating SIT in field conditions to establish a reliable costs database. As the production of sterile male flies can be regarded as an industrial process, there are large economies of scale available. However, these would not be available to these small projects if they were operated on a one-off basis. On the other hand, the existing fly rearing facility at Bobo-Dialasso would be capable of supplying sufficient flies to each of the small projects. On balance, therefore, there does not seem to be sufficient reason not to use the standard cost estimate in this study.

In order to avoid underestimating the shadow projects' costs, a high proportion of actual costs has been added to take account of overheads (25%) and contingencies (25%). For the formulation of actual project plans and project tender documents a more normal figure of 10% would be used.

Table A2.2 Cost of Tsetse Control Techniques

	Area 1	Area 2	Area 3	Area 5
Target/Trap Make+deploy	15 US$	15 US$ (est.)	20 US$	20 US$ (est.)
Target/Trap Servicing	1$ per time (up to 6 times only)	1$ per time (up to 6 times only) (est.)	1$ per time (up to 6 times only) (est.)	1$ per time (up to 6 times only) (est.)
Pour-on	75c US per time	75c US per time (est.)	21,000 CFA/ litre	
Ground Spraying	-	-	-	500$ per sq km
Aerial Spraying (SAT)	-	-	-	500$ per sq km (1500$ per river km)
SIT (Standard cost)	800$ US per km^2	800$ US per km^2	800$ US per km^2	800$ US per km^2

2.3 SHADOW PROJECT COSTS

All costs are denominated in US Dollars converted at a rate appropriate to the date of the basic data.

2.3.1 STUDY AREA 1

Area: 20513 sq km
Length of infested watercourses: 2000 km
Length of re-invasion barrier: 100 km

Phase 1 Project Planning:	
• Costs of initial surveys and project planning:	100,000 $
Phase 2 Suppression:	
• Costs of construction and treatment of targets :	
2000 river miles @ 20 targets/river km =40,000 targets x 15$ =	600,000 $
Costs of servicing targets (6 times @ 1$ per time)	240,000 $
Cost of replacing 20% of targets (8,000) @ 15$ each	120,000 $
• Costs of 2 insecticide treatments of cattle (15cattle/km^2):	
2(15cattle/km^2 x 20,000 km^2) = 600,000 cattle treatments	
600,000 x 0.75$/ treatment =	450,000 $
Sub-Phase 2a *G.M Morsitans* 10% of above (nominal)	141 000 $
Phase 3 Eradication - Costs of SIT in years 2 and 3	
2,000 river linear km x 800$/sq km =	1,600,000 $
Sub-Phase 3a *G.M Morsitans* 10% of above (nominal)	160,000 $
Phase 4 Protection - Costs of barrier establishment and maintenance(100 linear km over 20 years)	
1600 targets: Purchase, maintain and replace (20%) on 2 year cycle	
1600 targets x 5 cycles @ 24$ per target	192,000 $
Sub-total	3,603,000$
5. Overheads: 25% of total =	900,750$
6. Contingency: 25% of total =	900,750$
Total:	**5,404,500 $**

2.3.2 STUDY AREA 2

Area: 21,630 sq km
Length of infested watercourses: 1408 km
Length of re-invasion barrier: 350 km (estimated)

<u>Phase 1 Project Planning:</u>

- Costs of initial surveys and project planning: 100,000 $

<u>Phase 2 Suppression:</u>

- Costs of construction and treatment of targets :
  1408 river miles @ 20 targets/river km =28,160 targets x 15$ = 422,400 $
- Costs of servicing 28,160targets (6 times @ 1$ per time) 168,960 $
  Cost of replacing 20% of targets (5,632) @ 15$ each 84,480 $

  Sub-Phase 2a *G.M Morsitans* 10% of above (nominal) 67,578 $

<u>Phase 3 Eradication</u> - Costs of SIT in years 2 and 3
1408 river linear km x 1000$*/ km = 1,408,000 $

Sub-Phase 3a *G.M Morsitans* 10% of above (nominal) 140,800 $
* fly numbers released increased by 25% as live-bait technique not feasible

<u>Phase 4 Protection</u> - Costs of barrier establishment and maintenance (350 linear km over 20 years)
5600 targets: Purchase, maintain and replace (20%) on 2 year cycle
5600 targets x 5 cycles @ 24$ per target 672,000 $

Sub-total 3,064,218 $

<u>5. Overheads</u>: 25% of total = 766,054 $

<u>6. Contingency</u>: 25% of total = 766,055$

Total: 4,596,327 $

2.3.3 STUDY AREA 3

Area: 14125 sq km
Length of infested watercourses: 552 km
Length of re-invasion barrier: 275 km

Phase 1 Project Planning:

- Costs of initial surveys and project planning: 100,000 $

Phase 2 Suppression:

- Costs of construction and treatment of targets :
  552 river miles @ 20 targets/river km =11,040 targets x 20$ 220,080 $
  Costs of servicing targets (6 times @ 1$ per time) 66,240 $
  Cost of replacing 20% of targets (2208) @ 20$ each 44,160 $
- Costs of 2 insecticide treatments of cattle (15cattle/km^2):
  2(15cattle/km^2 x 14,000 km$^{2)}$ = 420,000 cattle treatments
  420,000 x 0.75$/ treatment = 315,000 $

  Sub-Phase 2a *G.M Morsitans* 10% of above (nominal) 64,620 $

Phase 3 Eradication - Costs of SIT in years 2 and 3
552 river linear km x 800$/sq km = 441,600 $

Sub-Phase 3a *G.M Morsitans* 10% of above (nominal) 44,100 $

Phase 4 Protection - Costs of barrier establishment and maintenance (275 linear km over 20 years)
4100 targets: Purchase, maintain and replace (20%) on 2 year cycle
4100 targets x 5 cycles @ 30$ per target 615,000 $

Sub-total 1,907,520 $

5. Overheads: 25% of total = 476,880 $

6. Contingency: 25% of total = 476,880 $

Total: 2,861,280 $

2.3.4 Study Area 5

Area: 19856 sq km
Length of infested watercourses: 2000 km
Length of re-invasion barrier: 350 km

Phase 1 Project Planning:

- Costs of initial surveys and project planning: 100,000 $

Phase 2 Suppression:

1. Construction and treatment of targets :
   1000 river miles @ 20 targets/river km = 20,000 targets x 20$ = 400,000 $

1a. Servicing targets (6 times @ 1$ per time) 120,000 $
   Cost of replacing 20% of targets (4,000) @ 20$ each 80,000 $

2. Ground spraying 500 river km (=100 sq km)
   100 sq km @ 500 $ per sq km 50,000 $

3. Fixed-wing Aerial spraying 500 river km (=1500 sq km)
   1500 sq km @ 500$ per sq km 750,000 $

   Sub-Phase 2a *G.M Morsitans* 10% of above (nominal) 140,000 $

Phase 3 Eradication - Costs of SIT in years 2 and 3
   2000 river linear km x 800$/sq km = 1,600,000 $

   Sub-Phase 3a *G.M Morsitans* 10% of above (nominal) 160,000 $

Phase 4 Protection - Costs of barrier establishment and maintenance (350 linear km over 20 years)
   5600 targets: Purchase, maintain and replace (20%) on 2 year cycle
   5600 targets x 5 cycles @ 30$ per target 840,000 $

Sub-total 4,240,000$

5. Overheads: 25% of total = 1,060,000 $

6. Contingency: 25% of total = 1,060,000 $

Total: 6,360,000$

2.3.5 SUMMARY

Table A2.3 Summary

Phase	Area 1 $	Area 2 $	Area 3 $	Area 5 $
Pre-project surveys and project planning:	100,000	100,000	100,000	100,000
Suppression	1,551,000	743,418	710,820	1,540,000
Eradication	1,760,000	1,548,800	481,700	1,760,000
Protecting against re-invasion (10 years)	192,000	672,000	615,000	840,000
Overheads	900,750	766,054	476,880	1,060,000
Contingency	900,750	766,055	476,880	1,060,000
Total	**5,404,500**	**4,596,327**	**2,861,280**	**6,360,000**
Equivalent to:	256 / km^2	212 / km^2	202 / km^2	320 / km^2

Table A2.4 Cost Categories by Percentage

	Area 1	Area 2	Area 3	Area 5	Average
Pre-project surveys and project planning:	1.9	2.2	3.5	1.6	2.1
Suppression	28.7	16.2	24.8	24.2	23.6
Eradication	32.6	33.7	16.8	27.7	28.9
Protecting against re-invasion (10 years)	3.6	14.6	21.5	13.2	12.1
Overheads	16.7	16.7	16.7	16.7	16.7
Contingency	16.7	16.7	16.7	16.7	16.7

2.4 THE BENEFITS OF TSETSE AND TRYPANOSOMOSIS PROJECTS

Based on a wide range of observations throughout the continent a generalisation has been developed with regard to the relative performance of cattle herds living in trypanosomosis risk and no-risk environments, viz. that herds in no-risk situations are twice the size and produce 20% more milk and meat than herds in areas infested with tsetse flies (Swallow, Budd). However, an examination of the particular characteristics of the shadow projects areas suggests that the moist savannah zone has a lower than average trypanosomosis risk (see table A2.5).

This assertion is supported by the empirical observation that, although they are present throughout the area, trypanotolerant cattle are not present in great numbers. Twenty per cent of the cattle in study area 1 and 70% in study area 3 are reported as being trypanotolerant. However, virtually all of the cattle in area 3 are reported as being crosses between trypanosusceptible Zebu types and West African Shorthorn, the latter being regarded as a trypanotolerant breed. It has been observed by Gbodjo Zakpa *et al* that cattle-owners owning trypanotolerant breeds tend to use Zebu bulls during periods of low trypanosomosis challenge and trypanotolerant bulls during times of high trypanosomosis challenge. Thus an extrapolation of this observation would suggest that the moist savannah zone is a below average trypanosomosis challenge area.

Table A2.5 Tsetse and Trypanosomosis Incidence

Trypanosomosis	**Area 1**	**Area 2**	**Area 3**	**Area 5**
Trypanosomosis Prevalence	0-15% (1977-87)		*T. vivax* 11.3% *T. c'lense* 10.1% *T. b.brucei* 1.1% Overall 19% (1989)	16-47%
Average Herd PCV			20%	
Tsetse				
Flies/trap/day *G Palpalis* *G Tachinoides* *G Morsitans* ((	3 (1989) 5 (1989) 0.07 (1989) 0.0? (2001)		0.05 - 1.07 0.27 – 20.0 0.06 – 0.5 (1989)	Present Present Present

Table A2.6 Estimated* Livestock Populations in the Study Areas

	Area 1	**Area 2**	**Area 3**	**Area 5**
Total No. Cattle/density	308,690 =17 per km^2 Mali 5 /km^2 B/Faso ?	109,084 =5 per km^2 ?	342,236 =24 per km^2	*210,000* (Est.) = *11* per km^2
Of which: Trypanosusceptible /Trypanotolerant	80% / 20%		30% / 70%* *mainly crossbreds	
No Draught cattle	107,518 (35%)		19,984 (6%)	*35,000* (Est) (15-18%)
Sheep	238,350 (includes goats)	297,357	166,731	-
Goats		391,550	172,207	-

* Extrapolated from government statistics relating to (larger) local government districts

The implications of this observation are that eradicating tsetse flies from the MSZ may bring less benefits than the continent-wide average. The PAAT-GIS data predicts that the cattle numbers will increase by between 52% (in the eastern MSZ) and 72% (in the western MSZ). However, the presumed cattle density with tsetse flies is significantly lower than reported in the individual shadow project area reports.

Table A2.7 Cattle Herd Data (Estimated figures in *Italics)*

	Area 1	Area 2	Area 3	Area 5
Male/Female Ratio	38% / 62%	36% / 64%	27% / 73%	
Offtake (gross)	7.2%		13.8%	
Introduction Rate	2.5%		2.5%	
Offtake (net) =Slaughter	4.6%		11.8%	10%
% of herd adult females	15%		35%	
Calving Interval (months)	18	22	18	
Total Milk Yield/Lactation	*180*/106 litres (*gross*/net)	*180*/108 litres (*gross*/net)	530/200 litres (gross/net)	520/*200* litres (gross/net)
Calf/human consumption			62.5%/37.5%	
Mortality Rate < 1 year Total Herd	16% 5.6%	23%	23% 7.5%	

Trypanosomosis significantly affects the reproductive systems of cattle thus increasing calving intervals through increasing abortions. The calving intervals reported in table do not suggest that, except for study area 2, this is a significant factor. However, calf mortality (16 - 23%) is relatively high which suggests that the disease is causing mortality in live animals. This suggestion is backed up by herd mortality figures of 5.6 and 7.5% (areas 1 and 3) which when the calf mortality rate is deducted suggest a mortality rate of animals over one year-old of 4 to 5%. In the case of study area 1 this is similar to the net offtake rate in numerical terms.

Whilst cattle densities in the MSZ are not as high as those in the zones to the north a significant increase would bring them up to levels that would be sufficient to cause potential overgrazing as has occurred in the Sahelian regions (see section 3.2.8). Bearing this in mind, it is possible that productivity increases resulting from tsetse control will arise from a combination of pastoralists becoming settled, upgrading of cattle breeds, improved cattle health and welfare and a moderate increase in cattle numbers.

TABLE A2.8 LIVEWEIGHT VALUES OF CATTLE

	Area 1	Area 2	Area 3	Area 5
Young Male (**160 kg?**)		70,000 CFA =450CFA/Kg	70,000 CFA =450CFA/Kg	
Mature Male (**350 kg?**)		135,000 CFA =390 CFA/kg	180,000 CFA =500 CFA/kg	
Cow (**240 kg?**)		90,000 CFA =375 CFA/kg	120,000 CFA =500 CFA/kg	
Heifer (**120 kg**)	65,000 CFA =540 CFA/kg		60,000 FCFA =500 FCFA/kg	
Oxen (**320 kg**)	65,000 CFA =540 CFA/kg		160.000 FCFA = 500 FCFA/kg	

Using the example of Area 1, herd numbers will inevitably increase as calving intervals fall and calf mortality is almost eliminated, estimated at 2% per year. Adult mortality will be reduced by half from 6% to 3%. As a result of better health and welfare, a change of management styles from transhumant to sedentary, animals offered for sale will be heavier (est. +5%) and have a better confirmation and killing-out percentage thus increasing their value per kg liveweight (est. +5%) (see table A2.8).

Current Annual Offtake / Productivity (Area 1):

Mature Males (5 years-old)	2% of herd	= 6200 animals (300 kg) at 150$ each =	930,000 $
Mature Females (8 years-old)	3% of herd	= 9300 animals (240 kg) at 120$ each =	1,115,000 $
Adult mortality	6% of herd		nil
		Total	2,045,000 $

Trypanosomosis-free Offtake / Productivity

Mature Males (5 years-old)	3% of herd	= 9300 animals (315 kg) at 165$ each	=1,535,000 $
Mature Females (8 years-old)	5% of herd	=15500 animals (252 kg) at 132.5$ each	=2,055,000 $
Adult mortality	3% of herd		nil
		Total	3,590,000 $
		Increase	**1,575,000 $** (+77%)

From the above calculation it is evident that even modest improvements in the health of livestock results in significant increases in the income of livestock owners. To this figure of 77% improvement in the value of herd sales must be added the increase in herd size through the reduction of calving interval and lower calf mortality. It is estimated that together these factors would raise the increase in the offtake value to 90%.

2.4.1 MILK

The production of milk will undoubtedly increase as the health of livestock increases. However, it is estimated that this extra production will be required to sustain the increased number of calves due to a reduced calving interval and improved calf survivability. Consequently it is assumed there will be no increase in the supply of milk but its value will be reflected through the increased number of animals that is able to be sold as herd offtake.

2.4.2 SUMMARY - LIVESTOCK

By applying the same formula and percentage increase (90%) to the livestock data of other projects areas predictions can be made as follows:

Table A2.9 Value of Extra Livestock Production in Study Areas after Tsetse Eradication

	Area 1	**Area 2**	**Area 3**	**Area 5**
Estimated Current Output	2,045,000 $	720,000 $	2,260,000 $	1,390,000 $
Predicted increase in output (90%)	1,840,000 $	650,000 $	2,030,000 $	1,250,000 $

The prediction for study area 2 seems to be much lower than would be expected. This is due to the low number of cattle reported, approximately one third of that in the neighbouring study area 2.

However, the area contains almost three times the number of small stock, i.e. sheep and goats, most of which are trypanotolerant breeds. This pattern of livestock ownership may be a response to trypanosomosis. Small stock tend to be more tolerant to trypanosomosis than cattle and the removal of this disease will not benefit them, and hence overall livestock production increase will be lower than in predominantly cattle areas. On the other hand farmers might respond to the eradication of trypanosomosis by 'grading-up' from small stock to cattle. It is beyond the scope of this study to predict the effect of such a move from small stock to cattle. The effect of trypanosomosis on small stock is something that needs further investigation.

2.4.4 CROPS

The PAAT GIS predictions for the increase in area cropped as a result of eradicating trypanosomosis are 6.5% in the west and 5.1% in the east of the MSZ (see appendix 3, table A3.1). This would seem to be a modest increase, particularly for areas 3 and 5 where the proportions of draught animals is low. In study area 1, however, there are sufficient draught animals to plough most of the cultivated area (based on the premise that a pair of oxen can cultivate 5 ha (see annex 1). Indeed, any increase in cultivation in that study area would further violate the local policy of keeping a reserve of 2 sq km for every sq km that is cultivated. Already the ratio is 1:1.4 and it is reported that the increase in area cultivated is already 6% per annum.

TABLE A2.10 CROPPING DATA

	Area 1	**Area 2**	**Area 3**	**Area 5**
Area (sq km)	20513	21630 (Actual)	14125	19858
Human Population /density	629,408 Total 31 per km^2	543,750 (1985) 25 per km^2	226,000 16 per km^2	643,043 32 per km^2
Cultivatable Area (sq km)	8411		-	
Cotton (sq km)	781 22%		569 36%	
Maize (sq km)	544 16%	411 44%	380 24%	
Sorghum+ Millet (sq km)	1101 32%	390 42%	263 17%	
Rice (sq km)	125 4%	-	14 1%	
Groundnuts (sq km)	-	-	103 7%	
Others (sq km)	932 26%	129 14%	259 15%	
Total/ Proportion of Study area	**3484** 19%(Mali)	**930 ?** 4.3%?	**1588** 11%	**2100** *11%*(Est)
Proportion of Draught cattle	35%		6%	15-18%
Proportion of household using draught animals				10-40%

However, the cultivated areas for study areas 2 and 3 are much lower as is the proportion of cattle that are used for draught purposes. In study area 5 the proportion of families that have access to draught power for cultivation is between 10 and 40%.

Individual project area reports did not predict the likely impact of tsetse eradication on cropping patterns. In the absence of such data the PAAT GIS data (see chapter 1) will be used in calculating the value of increased cropping resulting from eradicating tsetse flies.

2.4.5 VALUE OF CROP OUTPUT

It is reported in the Study Area 1 report that in terms of food security cereal production in Mali in 2000-2001 exceeded the FAO norm of 250 kg per person by 116 kg, a margin of 46%. It is therefore presumed that any increase in the cropping area will be predominantly used for cash crops in order to generate a cash income. In the study areas 1, 2 and 3 this is most likely to be cotton and in study area 5, groundnuts.

Table A2.11 Outputs, Costs and Margins per hectare

	Cotton*	***Maize* (Est)**	***Groundnuts* (Est)**
Yield	1250 kg/ha	1500 kg / ha	900 kg / ha
Price	170 CFA /kg	90 CFA / kg	300 CFA / kg
Gross Output	212,500 CFA / ha	135,000 CFA / ha	270,000 / ha
Less			
Machinery Costs	20,000 CFA / ha	7,500 CFA / ha	5,000 CFA/ ha
Employed labour	15,000 CFA / ha	10,000 CFA / ha	35,000 CFA / ha
Fertilizer, Pesticides etc.	54,000 CFA / ha	47,500 CFA / ha	20,000 CFA / ha
Net Output / ha (Return to family labour)	123,500 CFA	70,000 CFA	210,000
Equivalent to	175 $ US	100 $ US	300 $ US

* based on Project Area 1 Report (Annex 1)

Using the PAAT GIS predictions for increases in areas cropped along with the above net output figures it is possible to predict the total value of the extra crop production resulting from eradication of trypanosomosis and the consequent increase availability and usage of draught oxen. For simplicity only cattle and oxen are considered in this prediction although donkeys are already being used and without the risk of trypanosomosis it is quite feasible that horses could be introduced into this area for draught purposes.

(The figure for the proportion of the total area cultivated in study area 2 in the above table is sufficiently different from that of the adjacent study area 1 that it is likely that it is under-reported, especially as no figure for the area planted to cotton is given. A more likely figure is estimated in the table below.)

Table A2.12 Value of Extra Crop Production in Study Areas after Tsetse Eradication

	Area 1	Area 2	Area 3	Area 5
Current Area Cropped (sq km)	3484 19%(Mali)	*3250*(Est) *15%*(Est)	1588 11%	*2100*(Est) *11%*(Est)
Predicted Increase after Project - %	+ 6.5%	+6.5%	+5.1%	+5.1%
Predicted Increase after Project - Sq km	225	210	80	105
Extra area by crop and net output per sq km	67% Cotton @ 17500 $ 33% Maize @ 10000 $		50% Maize @ 10000 $ 50% Groundnuts @ 30000 $	
Average net output per sq km	15,000 $	15,000 $	20,000$	20,000 $
Predicted Total Extra Output	3,375,000 $	3,150,000 $	1,600,000	2,100,000

2.4.6 OVERALL BENEFIT FROM TSETSE ERADICATION

By adding the predicted benefits in terms of livestock and crop production together (see table A12.13) an estimate the benefit to the farming community is obtained. However, this benefit should not be seen purely in financial and numeric terms but in human terms. Most members of the farming community in the MSZ are living well below the 'Dollar-a-day' poverty level and this increase in productivity resulting from eradicating trypanosomosis will increase their income by 5-10%. Some will benefit as farmers and livestock owners in their own right, others will benefit from increased opportunities to work and the wider economy will benefit from the significant increase in economic activity resulting from activities downstream of the farm, e.g. marketing, storage, transport, processing etc.

Table A2.13 Predicted Overall Benefit of Tsetse Eradication by Study Area per Year

Predicted production increases per year	Area 1	Area 2	Area 3	Area 5
Livestock	1,840,000 $	650,000 $	2,030,000 $	1,250,000 $
Crops	3,375,000 $	3,150,000 $	1,600,000 $	2,100,000 $
Total	1 $	2 $	3 $	5 $

APPENDIX 3 COSTS AND BENEFITS OF MEDIUM PROJECTS

3.1 IMPACT OF TSETSE CONTROL IN MEDIUM-SIZE STUDY AREAS

The PAAT GIS is able to predict the consequences of a tsetse control project by resetting the number of tsetse species to zero. In this way it is able to predict the herd size and quantity of land being cultivated as a result of eradicating tsetse flies and trypanosomosis. Inevitably, these changes will take some time to occur an, as such, the new predictions reflect the new equilibrium situation. These predictions use formula and are based on the current *with tsetse* situation. They do not take account of any dynamic changes over time arising from movements of human and animal populations from adjacent areas of high land pressure. As this is one of the primary reasons for selecting these particular study areas it is considered that the GIS predictions are likely to be exceeded in real project situations.

In addition it is presumed that there are no factors acting as constraints on the transition to the new equilibrium. This is an oversimplification of the situation. It was reported in the Geneva workshop that without reform of the legal framework for land tenure which recognises the need for pastoralists and sedentary farmers and livestock keepers any change in the *status quo* could lead to conflicts resulting from the use of the land in newly created tsetse-free areas. In this way tsetse control projects could be counter-productive although whether in the long-term this would inhibit the optimum use of the land in terms of productivity is not possible to predict for these projects which are anyway hypothetical.

Table A3.1 Increase in Cattle Numbers and Cultivated Areas Predicted by PAAT GIS

	Western Project Area	Eastern Project Area
Cattle Population Increase after Tsetse Control (head)	1,798,000	1,233,000
Population Increase(%)	71%	53%
Cultivated Area Increase (ha)	163,000	138,000
Proportional Increase	6.5%	5.1%

3.2 COSTS FOR THE MEDIUM-SIZE TSETSE ERADICATION PROJECTS

For planning of real projects detailed surveys will be carried out before commencement of any tsetse eradication project. For the shadow project areas which are the subject of this study this is not feasible and simplifications need to be made in predicting the cost of such projects. The three main headings into which costs fall are:

i. The area which needs to undergo control measures where tsetse flies occur linearly and in pockets along watercourses

ii. The area which needs to undergo control measures where flies are distributed universally

iii. The area which needs to undergo measures to protect against re-invasion

The first category is based on the watercourse length in km. In the more northerly parts of these study areas the watercourses may be as little as 50 meters wide and in the south they may be as much as 500 meters wide. For the purposes of this exercise it will be assumed that for the whole of this category an average of 250 meters will be used. Whilst this is a correct estimate for ground-based measures it is probably an underestimate for air-delivered control measures (SAT and SIT) for which precision delivery is not possible.

For the second category control measures will need to be applied throughout and so no adjustments need to be made. For the barrier category it is assumed that an area of 4 sq km will need to undergo control measures on a permanent basis for every linear km of boundary that has to be protected. This 4 to 1 ratio is half that used against *G morsitans* in Zimbabwe with barriers based on target technology. Bearing in mind the lower risk of re-invasion from riverine flies and the consensus regarding the risk of re-invasion (see section 3.2.5) half the Zimbabwean rate of provision is considered adequate.

Table A3.2 Actual Areas Requiring Control Measures

	Western Shadow Project Area	**Eastern Shadow Project Area**
Project Area in Tsetse Belt	151,231 sq km	122,139 sq km
Linear and Pocket Tsetse distribution - Watercourse Km	13075	9618
Ubiquitous Distribution - km	3172	6312
Total Boundary - km	11,950	9900
Boundary to be Protected - km	3125	2700

Using these adjustment factors the basic areas in table A3.3 are converted into areas in which tsetse control measures need to be applied within a shadow tsetse control project.. These areas are based on the dry season distribution of tsetse flies. It is presumed that control measures would commence at the beginning of the dry season and that by the end of it populations would be sufficiently suppressed that the eradication stage using SIT could commence. The amount of sterile flies released is proportional to the number of flies present. Consequently, when the flies are more widely distributed in the wet season it is not necessary to release a greater number of flies but merely to release them over the wider area. As a result, there is only a marginal difference in costs of SIT between dry and wet season. Male tsetse flies have the characteristic that they actively seek out females for mating and the fact that females are more widely distributed during the wet season merely means that the released males have to fly further in order to mate with females. Provided that they are healthy this poses no problem for the male flies and the technique remains as efficient.

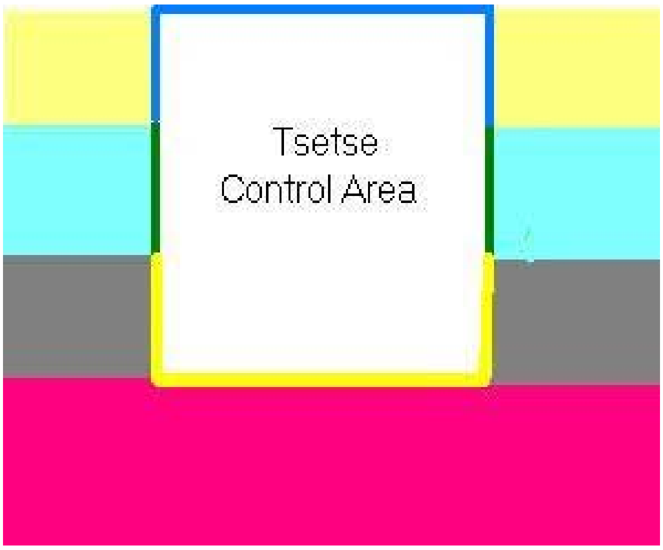
Table A3.3 Adjusted Areas Requiring Control Measures (sq km)

	Adjustment Factor	Western Shadow Project Area	Eastern Shadow Project Area
Linear and Pocket Tsetse distribution - Watercourse Km	0.25	3269	2404
Ubiquitous Distribution - km	1.00	3172	6312
Boundary to be Protected - km	4.00	12,500	10,400
Control Programme Total (sq km)		6441	8,716
Protection Programme Total (sq km)		12,500	10,400

During the wet season *G tachinoides* is widely distributed over most of the whole region where it is able to transmit trypanosomosis to animals and humans. However, during the dry season the whole population retracts back to the watercourses where its population density increases. By concentrating together in this way *G tachinoides* populations become vulnerable to control measures.

Table A3.3 uses the adjustment factors to calculate how large the areas are that will need to undergo control measures during the suppression and eradication phases as well as on an ongoing basis to protect the freed area from re-invasion by flies from areas in the south remaining tsetse-infested. The boundaries have been calculated using the PAAT GIS and are considered to represent the likely maxima.

Figure A3.1 Schematic Diagram of Barrier Location in relation to Tsetse Fly Distribution Zones



<u>Key</u>
Yellow = no tsetse flies present
White = area where fly is eradicated, no pockets left within area
Light blue = fly present but very fragile, no dispersion
Grey = distribution linear
Red = fly gradually more ubiquitous towards South
Blue lines = perimeter of medium sized project area where no barriers will "ever" be necessary
Green lines= perimeter where barriers very unlikely (in the light blue area no significant fly dispersion occurs)
Yellow lines = perimeter where barriers might be necessary.

In practice the linear distribution and the consequent increase of agriculture will reduce the areas in which a re-invasion barrier is required.

3.3 SUPRESSION AND ERADICATION TECHNIQUES – DISCUSSION

3.3.1 SUPPRESSION PHASE

Without the level of detail that can only be provided by ground-based surveys it is not possible to detail which of the appropriate techniques will be used in which locations based on GIS data alone. Using insecticide-treated cattle as **live baits** may be appropriate when targeting *G. morsitans* but it is unlikely to be used widely against *G tachinoides* or *G palpalis*. In the dry season livestock only move into the riverine habitat in order to drink and where they may come into contact with these species it is only for 15-30 minutes per day.

Ground spraying with organochlorines has previously proved effective and environmentally-benign in the medium term and may be used in limited areas provided that the this group of chemicals, or alternatives, is acceptable to host countries on environmental grounds.

Traps and targets have proved to be both technically and cost-effective against riverine species. However, access has often proved to be a problem for both installation and maintenance.

The **Sequential Aerosol Technique** (SAT) is effective but night-flying fixed-wing aircraft are only able to operate in straight lines rather than follow watercourses. As a result much larger areas need to be covered, much of which will be wasted as large proportions of these areas will not contain any tsetse flies in the dry season. Whilst this does not necessarily present an environmental hazard it does increase the cost in such a way that the adjustment factor used in table A3.3 would not apply.

Helicopters are more easily able to follow the line of watercourses, even at night, but they are 2-3 times more expensive than fixed-wing aircraft per sq km and would probably not be able to deliver a sufficiently even distribution of insecticide.

Bearing in mind the above it is considered that the most widely used technique for the suppression phase of a tsetse control programme is likely to be traps deployed within the watercourse and as near to the water as possible. Live baits will be deployed strategically and against *G morsitans* pockets. SAT will be used in remote areas where access is difficult.

Eradication Phase

Although in practice eradication of tsetse flies may be achieved in some of the areas through the application of the above population suppression techniques it will be assumed for the planning and costing of these hypothetical studies that a SIT campaign will be required to ensure complete eradication.

Post-eradication Phase – Prevention of Re-invasion

Once the flies have been eradicated from the project area it will be necessary to implement actions to prevent re-invasion of flies from areas from which flies have not been eradicated, predominantly from the south. It is hoped that once the infrastructure is in place for eradicating flies from the shadow project areas they will be applied to pushing the fly limit further and further south until the *G tachinoides* belt is completely eliminated. Such a ‘rolling programme’ would be the most positive way of preventing re-invasion. However, for the purposes of this study the projects can only be considered as stand-alone projects.

Figure A3.1 indicates schematically where barriers are most likely to be required. Whilst all of the techniques could be deployed as barriers, either individually or in combinations, it is most likely that traps will be the mainstay of the strategy to prevent re-invasion. One of the advantages of this method is that they can also provide information on fly distribution within the barrier zone as flies that have been caught are retained within the structure of the trap itself.

There is a body of opinion based on empirical evidence which considers that even in the areas where fly distribution is ubiquitous re-invasion will not prove to be a major threat. However, it is generally acknowledged that it will be necessary to continue to monitor the situation even after the threat is perceived to be nil.

At the maximum level of provision traps will need to be deployed in the same way that targets have been deployed for this purpose in Zimbabwe, albeit at the lower rate of 16 traps per linear km. This is considered to be the maximum level of provision required. In time, farmers will settle in this area and change the habitat in such a way that makes it uninhabitable for tsetse flies. Bearing this in mind, it is considered that a cost estimate based on a 50% barrier provision is considered to best represent the likely provision required over the whole life of the project. It is beyond the scope of this project to indicate whether such provision would allow for a full-width barrier for half the barrier length, a half-width barrier for the whole length or a full–width, full-length barrier reducing to nil over the project period, or indeed any other combination.

3.4 SHADOW PROJECT STRATEGY

It is envisaged that the basic strategy will be to commence the suppression phase at the commencement of the dry season when all *G tachinoides* are concentrated along the watercourses. Experience of previous control programmes indicates that using targets populations are likely to fall by more than 95% within 3 months. At this point SIT will be deployed through the release of flies on a weekly basis. It is anticipated that this release will need to continue through the wet season and into the next dry season if eradication is to be assured. During the wet season the pattern of release will be adjusted to the distribution of flies.

Once the control phase is over it will be necessary to implement measures against re-invasion probably using a trap-based strategy. This strategy will inherently include a monitoring component which will need to be continued well after the threat has been reduced to zero.

3.5 COST OF SHADOW CONTROL PROGRAMMES

Because GIS rather than survey data based on ground observations is being used as the data source for these shadow projects only an approximation of the costs of the medium-size projects can be possible in this study.

3.5.1 PROJECT PLANNING PHASE

Before any tsetse control project commences it will be necessary to carry out detailed surveys detailing tsetse distribution, cattle distribution, farming patterns and likely changes in addition to an environmental impact assessment before the project can be planned in detail. Provision will be made for these aspects of the shadow projects at the level of $10 per sq km; this level of provision is sufficient to cover the survey, project planning and financing phases.

3.5.2 SUPPRESSION PHASE

Based on the costs of control methods included in Budd, (1999 p33), the costs of ground spraying, aerial spraying using fixed-wing aircraft (SAT) and traps are each likely to be in the region of $300 - $400 per sq km. Treating cattle with insecticides is likely to cost about one-quarter of that and the use of helicopters rather than fixed wing aircraft is likely to increase the cost by 2-3 times.

Bearing in mind the conclusion in 3.1.8.1 above that traps will be the predominant technique and in order to simplify calculations one single cost of $300 per sq km will be used as the basic cost for the suppression phase. This figure is more conservative than that used for the small projects as planning at a greater level of detail has been possible for them.

3.5.3 ERADICATION PHASE

For the purposes of this study it is assumed that the Sterile Insect Technique (SIT) will be used throughout the control area in order to eradicate the remaining population of flies after the suppression phase. This technique has not been used against tsetse flies on this scale previously and, because the production of sterile flies is an 'industrial' process, very significant economies of scale apply to larger scale production. At the moment the technology for large-scale production has not yet been refined nor proven. It is predicted by IAEA that maximum economies of scale are likely to occur for projects of 25,000 sq km or larger. This programme will, therefore, enjoy the maximum benefit from economies of scale.

Because SIT has not been carried out on this scale before there are no precedents on which cost predictions can be made. A cost of $800 per sq km is used for the small projects. It is IAEA's prediction that this cost can be reduced to $400-$500 per sq km for large projects but against this must be set the higher cost of using more expensive helicopters rather than fixed-wing aircraft for distribution in order to be able to follow the course of the rivers and streams. Bearing this in mind a figure of $800 per sq km will be used which is considered to reflect local situations, be conservative and also embody a contingency element.

3.5.4 BARRIERS

Monitoring the dynamic situation of tsetse distribution along the boundary sensitive to re-invasion is an integral part of the phase during which action to prevent re-invasion is being taken. By using traps as the control technique the normal procedures of deployment and maintenance can easily encompass the monitoring function. Whilst it is acknowledged that there may be some extra costs involved it is considered that the basic cost estimate used for the suppression phase of $300 per sq km per year will be a sufficient provision. This is equivalent to $75 per trap per year. As the cost estimate is based on 50% of the maximum likely provision the total cost will be the equivalent of $150 per year over the whole barrier area where re-invasion might occur.

3.6 SUMMARY

Table A3.4 Summary

	Western Shadow Project Area	**Eastern Shadow Project Area**
Planning Phase (Total Project Area)	187,014 sq km	170,247 sq km
Project Planning @ $10 / sq km	$1,870,100	$1,702,500
Control Programme (Tsetse Area)	6,441 sq km	8,716 sq km
Suppression Cost @ $300 / sq km	$1,932,300	$2,614,800
Eradication cost @ $800 / sq km	$5,152,800	$7,587,200
Protection Programme (Barrier Area)	12,500 sq km	10,400 sq km
Total Cost over 10 years @ $150 / sq km / year	$18,750,000	$15,600,000
Contingency and Overheads (50% of above costs)	$13,852,600	$13,445,000
Total	$41,558,800	$40,335,000
Tsetse-infested Area*	151,231 sq km	122,139 sq km
Cost per sq km (Tsetse-infested Area)	$275	$330
Cost per sq km (Areas of control activities)	$6450	$4640

* Equivalent to the area that will benefit from tsetse control.

3.7 BENEFITS OF THE TSETSE CONTROL PROJECTS

3.7.1 CATTLE HERD AND CULTIVATION

Level 3 of the PAAT GIS encompasses a facility that allows a prediction to be made for an area of the consequences of tsetse control in terms of changes in cattle population and the amount of area cultivated. This is explained in detail in section 2.1. This facility has been applied to the two areas and the results are included in table A3.5.

Table A3.5 GIS Predictions for Cattle Population and Cultivated areas in Tsetse-free Scenario

	Western Project Area	Eastern Project Area
Cattle		
Present Population (with tsetse)	2521563	2322939
Predicted Cattle Population (without tsetse)	4319643	3556239
Difference	+1798080 (+72%)	+1233300 (+53%)
Crops		
Area Cultivated (with tsetse)	24963 sq km	26829 sq km
Predicted Area Cultivated (without tsetse)	26595 sq km	28212 sq km
Difference	+1632 sq km (+6.5%)	+1383 sq km (+5.2%)

The predictions resulting from the application of this PAAT GIS data layer are based on the current size of the cattle herd and level of cultivation to which a formula is applied. However, it is known that to the north of these areas there is a high degree of land pressure and that there is likely to be a movement of all types of farmers and their cattle into this area once the constraint of trypanosomosis is removed. The consequences are two-fold:

- Although it takes only a short time for the tsetse population to be eradicated and the trypanosomosis risk removed the slow rate of domestic animal reproduction means that it takes 10-15 years for the size of the *in situ* cattle herd to reach a new equilibrium. The GIS prediction indicates the level of herd size in this new equilibrium. Bearing in mind the anticipated influx of farmers and animals into these project areas it is anticipated that the new equilibrium will be reached in a much shorter period. (Whether this will result in the cattle population exceeding equilibrium level with the consequent risks of environmental degradation is a factor that must be considered in real project situations but is beyond the scope of this study of hypothetical shadow projects.)

- With regard to cropping levels the improved health and numbers of cattle will allow more cattle to be made available for draught purposes. This factor is not embodied in the GIS and so the increases in cultivated areas are, in real project situations, likely to be several times greater than predicted in table A3.5.

3.7.2 FINANCIAL

Assuming an on-farm liveweight value of animals of 500 CFA/kg (70 cents US/kg) and a 50% killing-out rate an on-farm value of meat of 1000 CFA/kg ($1.40 US/kg) is used in this part of the analysis. This compares well with a retail beef value of between 1000 and 1800 CFA/kg ($1.40 to 2.60 US/kg) reported in study area 3 (Annex 3, section 4.5) and $2019/tonne reported by Kristjanson. This would allow an approximate 30% marketing margin which is a normal level where a degree of processing, i.e. slaughtering, butchering, transport and possibly refrigeration, is involved.

Calculations are based on those used previously by Budd (1999) except for making the same assumption with regard to milk as used for the small project calculations, i.e. that all the extra milk produced is used for sustaining the increased number of calves.

3.7.1.1 Meat

Table A3.6 Increased meat productivity and on-farm value of existing herd per year

	Current No. Cattle	Increase in meat production Kg per animal per year	Total increase in meat production Tonnes/year	Value Per tonne $	Value of increased meat production $ per year
Western Project Area	2.5 m	3.5 kg	8823t	1400	12.4 m
Eastern Project Area	2.3 m	3.5 kg	8050t	1400	11.3 m

Table A3.7 Increased production and on-farm value from increased cattle herd size

	Increase in no. cattle	Meat output per animal per year	Total increase in meat production Tonnes / year	Value Per tonne $	Value of increased meat production $ per year
Western Project Area	1.8 m	18.5 kg	33262	1400	67 m
Eastern Project Area	1.2 m	18.5 kg	22806	1400	46 m

3.7.1.2 Crops

Using a net output value for crops of $15,000 per sq km and $20,000 for the Western and Eastern shadow project areas respectively (the values used in the analysis of the small projects), the value of the increased crop production resulting from the increased area cultivated is calculated in table A3.8. This is a purely arbitrary value and reflects an average value for the mix of crops that are grown in the MSZ. This is a net value thus taking into account the costs of purchased inputs. It is also considered that the increasing use of draught animals will enable timeliness to be improved with a consequent increase in crop yields. This factor has not been included in these predictions as there is no data available which quantifies this benefit.

Table A3.8 Value of Increased Crop Production

	Increased Cultivated Area sq km	Value of output per sq km $	Total increase on crop output $
Western Project Area	1632	15,000	24.5 m
Eastern Project Area	1380	20,000	27.6 m

3.8 FINANCIAL SUMMARY

Table A3.9 Total value of increased livestock and crop output (per year)

	Extra meat output from existing herd million $	Extra meat output from larger herd million $	Value of increased crop production million $	Total value of increased crop and livestock production million $
Western Project Area	12.4	46.6	24.5	83.5
Eastern Project Area	11.3	31.9	27.6	70.8

APPENDIX 4 COST AND BENEFITS OF LARGE PROJECT

The same GIS techniques and cost and benefits calculation methodology that were applied to the medium-size shadow project areas are applied to the large project area. Consequently the narrative for the large project is not repeated in this appendix. The same format for tables is used as in the previous appendix.

Table A4.1 Increases in Cattle population and Areas Cultivated after Tsetse Control

	Large Project Area
Cattle Population Increase after Tsetse Control (head)	5,314,000
Population Increase(%)	64%
Cropped Area Increase ha	4,975,000
Proportional Increase	6%

4.1 COST OF TSETSE CONTROL PROJECT

Table A4.2 Actual areas requiring control measures (Source PAAT GIS)

	Large Shadow Project Area
Project Area in Tsetse Belt	540,000 sq km
Linear and Pocket Tsetse distribution - Watercourse km	46044
Universal Distribution - km	6054
Total Boundary - km	29,200
Boundary to be Protected - km	7550

Table A4.3 Adjusted areas requiring control measures (sq km)

	Adjustment Factor	Large Shadow Project Area
Linear and Pocket Tsetse distribution - Watercourse Km	0.25	11,511
Universal Distribution - km	1.00	6,054
Boundary to be Protected - km	4.00	30,200
Control Programme Total (sq km)		17,565
Protection Programme Total (sq km)		30,200

Table A4.4 Summary

	Large Shadow Project Area	
Planning Phase (Total Project Area)	669,440 sq km	
Project Planning @ $10 / sq km		$6,694,400
Control Programme (Tsetse Area)	17,565 sq km	
Suppression Cost @ $300 / sq km		$5,269,000
Eradication cost @ $800 / sq km		$14,052,000
Protection Programme (Barrier Area)	60,400 sq km	
Total Cost over 10 years @ $150/sq km/year		$45,300,000
Contingency (25%) and Overheads (25%)		$35,658,000
Total		$106,974,000
Tsetse-infested Area*	540,000 sq km	
Cost per sq km (Tsetse-infested Area)		$200

* Equivalent to the area that will benefit from tsetse control.

4.2 BENEFITS OF THE TSETSE CONTROL PROJECTS

4.2.1 CATTLE HERD AND CULTIVATION

Table A4.5 GIS Predictions for Cattle Population and Cultivated areas in Tsetse-free Scenario

	Large Project Area
Cattle	
Present Population (with tsetse)	8,282,791
Predicted Cattle Population (without tsetse)	13,596,736
Difference	+5,313,945
Crops	
Area Cultivated (with tsetse)	81,150 sq km
Predicted Area Cultivated (without tsetse)	86,125 sq km
Difference	+4,975 sq km

.

4.2.2 FINANCIAL

Applying the same values for meat and milk ($2019 per tonne for meat) and the format used applied in Budd (1999), the above physical values are translated into financial values in tables A4.6 and A4.7.

4.2.2.1 Meat

Table A4.6 Increased productivity and on-farm value of existing herd per year – Meat

	Current No. Cattle	Increase in meat production Kg per animal per year	Total increase in meat production Tonnes per year	On-farm value Per tonne $	Value of increased meat production $ per year
Large Project Area	8.3 m	3.5 kg	28,988t	1400	40.6 m

Table A4.7 Increased production and on-farm value arising from increased cattle herd size

	Increase in no. cattle	Meat output Kg per animal per year	Total increase in meat production Tonnes per year	Value Per tonne $	Value of increased meat production $ per year
Large Project Area	5.3 m	18.5 kg	78,294	1400	110 m

4.2.2.2 Crops

Using an average net output value for crops of $17,500 per sq km the value of the increased crop production resulting from the increased area cultivated is calculated in table A4.8. This is a purely arbitrary value and reflects an average value for the mix of crops that are grown throughout the MSZ.

It is also considered that the increasing use of draught animals will enable timeliness to be improved with a consequent increase in crop yields. This factor has not been included in these predictions.

Table A4.8 Increased value of crops arising from increased Cultivation

	Increased Cultivated Area Sq km	Value of output per sq km (net) $	Total increase on crop output $
Large Project Area	4971	17,500	87.0 m

4.2.3 SUMMARY

Table A4.9 Total value of increased livestock and crop output (per year)

	Extra output from existing herd Meat million $	Extra output from larger herd Meat million $	Value of increased Crop Production million $	Total value of increased crop and Livestock Production million $
Large Project Area	40.6	110.0	87.0	237.6

Narrative	Objectively Verifiable Indicators	Means of Verification	Assumptions and Risks
Super Goal – Improvement of livelihoods and reduction of poverty in rural areas through the opening up and/or realization of full potential of extensive areas of land currently infested by tsetse fly.			
Goal – Rational selection and implementation of tsetse elimination programmes enables increased agricultural productivity.	-Improved livestock productivity -Improved crop/livestock integration -Increased crop yields -Increased areas under cultivation		Marketing systems enhanced to reflect the increased supply of crop and livestock products.
Purpose – To provide a sound technical and economic basis for the identification and selection of areas in which the removal of the tsetse/trypanosomosis constraint may provide a real and sustainable benefit to agricultural development.			Animal health and husbandry services will be facilitated to secure the new opportunities open to livestock production through the removal of this key constraint. Draught animal extension, training, and equipment programmes will be introduced in synchrony with tsetse elimination. Equitable and sustainable land tenure, usufruct and common property rights can be agreed and implemented.
Outputs – 1. Insight into the economics of tsetse elimination projects, with particular reference to project size.	A range of cost benefit analyses supported by sensitivity analyses, produced by March 2001	Phase 1 Final Report.	That the quality and margin of error of data garnered (through GIS for the large and medium sized 'shadow' project areas, and that ground truthed by West African Experts for the smaller and smallest areas) is sufficiently narrow to allow valid analysis and comparison.
2. Initial development of methodologies for identification, selection, demarcation, and planning of tsetse elimination programmes in the MSZ of West Africa.	Check list of factors, and their parameters, for consideration and evaluation in project planning, produced by March 2001.	Phase 1 Final Report.	
3. Proposal for further development of the methodology and associated capacity building in West Africa.	Concept Note (C.N.) and skeleton log-frame prepared by 20.12.2000	C.N delivered to FAO and IAEA.	

APPENDIX 5A LOGFRAME – PHASE 2

The second phase of the project will extend and develop the methodologies for strategic planning for tsetse elimination formulated in Phase I, and facilitate human and infrastructural capacity building and technology transfer to the West Africa Region.

Duration – 9 months Budget – Up to US$ 100,000.

Narrative	Objectively Verifiable Indicators	Means of Verification	Assumptions and Risks
Super Goal – Improvement of livelihoods and reduction of poverty in rural areas through the opening up and/or realization of full potential of extensive areas of land currently infested by tsetse fly.			
Goal – Rational selection and implementation of tsetse elimination programmes enables increased agricultural productivity.	-Improved livestock productivity -Improved crop/livestock integration -Increased crop yields -Increased areas under cultivation		-Marketing systems enhanced to reflect the increased supply of crop and livestock products
Purpose – Securing the infrastructural requirements and the human resource capabilities, at national and regional levels, adequate for the selection, definition and planning of tsetse elimination programmes.			- Animal health and husbandry services will be facilitated to secure the new opportunities open to livestock production through the removal of this key constraint. - Draught animal extension, training, and equipment programmes will be introduced in synchrony with tsetse elimination. - Equitable and sustainable land tenure; usufruct and common property rights can be agreed and implemented.

Outputs – **1** Further development and refinement of the strategic planning methodology **2** 'XX' staff trained and competent in strategic planning for tsetse elimination **3** Preparation of a Phase 3 proposal. (See section below) **4** The strategic planning group is co-ordinated and empowered under the auspices and authority of an appropriate regional organization.			Political and financial support for continuation of the process is forthcoming from national governments, PATEC, OAU and the donor community. Appropriate staff / personnel are, willing, able and available for training and subsequent involvement in the strategic planning process. Invitations are forthcoming from East and Southern Africa to extend this project into their areas in the third phase. A regional stream of funding is agreed for the operation of the group
Activities **1** Re output 1 – Preparation and implementation of a multi-disciplinary workshop, in Ouagadougou, on strategic planning methodology **2** Re output 2 – Identification or design, of training programmes to enhance the capacity of West African specialists to contribute to multi-disciplinary planning and decision making processes **3** Re output 2 – Suitable staff identified and enrolled in training. **4** Re output 4 – Consultation within the region to identify and agree an appropriate regional organization.			

Phase III

Outputs:

- Initiation of real location planning in sites selected as an outcome of the methodologies and capacities developed in Phases I and II.
- Extension of the programme to East and Southern Africa.

Activities:

- Preparation of a similar set of Phase I and II proposals relevant to extension of the programme into Eastern and Southern African regions.

APPENDIX 6 PARTICIPANTS IN THE STUDY

GENEVA WORKSHOP

Prof Albert Ilemobade, George Chizyuka, Dr. Guy Hendrickx, Dr. Issa Sidibe, Dr Oumar Diall, Dr. Victorin Codija, Dr Jan Slingenbergh, Guy Freeland and Leonard Budd.

Some preparation for the meeting had been carried out by Anita Erkelens (FAO / IAEA) and Leonard Budd.

ROME/VIENNA WORKSHOP

Dr. Guy Hendrickx, Dr. William Wint, Dr Jan Slingenbergh, Dr. Janet East, Guy Freeland, Anita Erkelens, Zowinde Kodougou and Leonard Budd.

INDEPENDENT WORKING SECTOR

Prof Albert Ilemobade, Dr Oumar Diall, Dr. Victorin Codija, Zowinde Kodougou, Leonard Budd. (Co-ordinator) with assistance from Dr. Guy Hendrickx and Dr. William Wint.