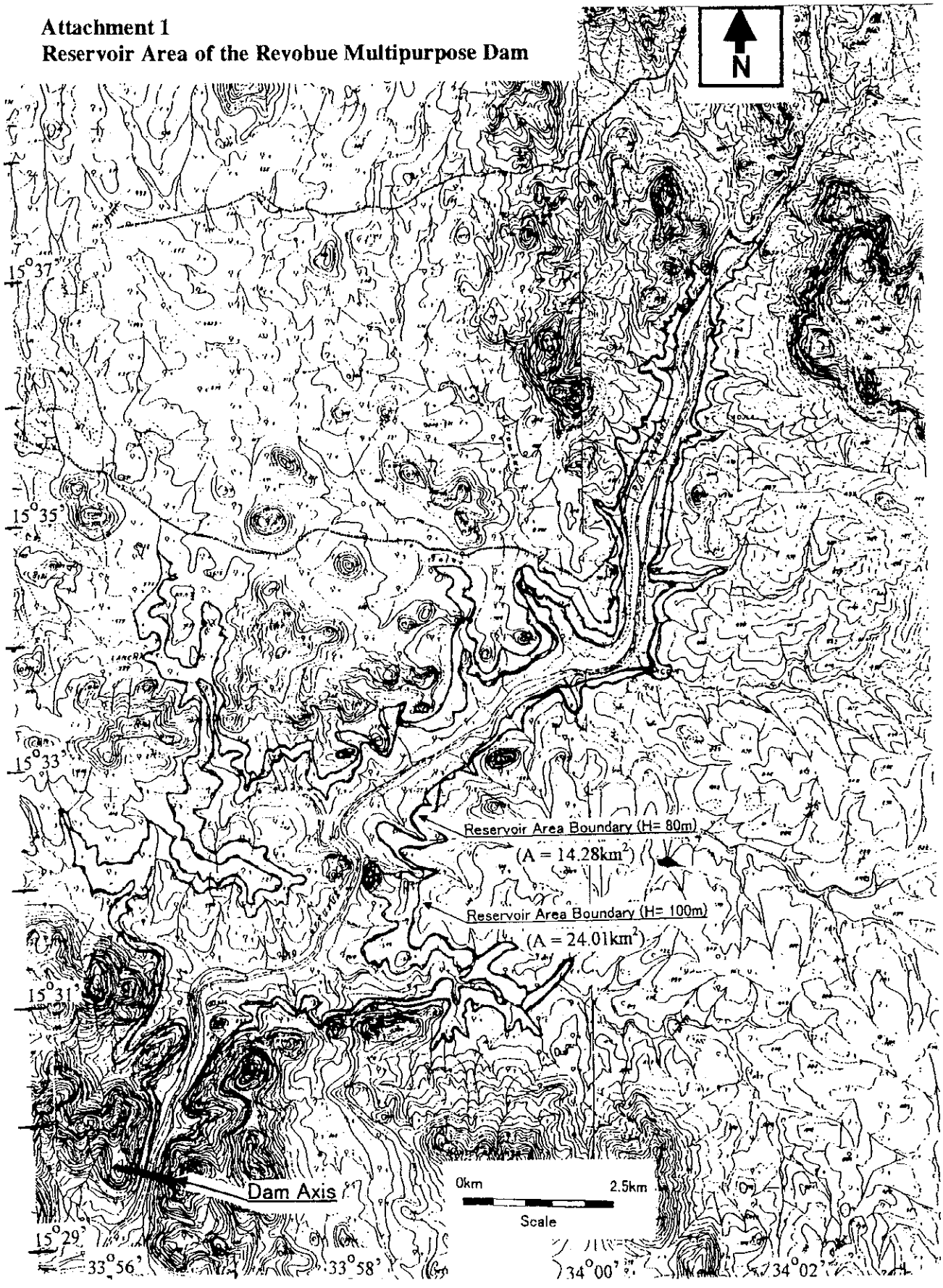
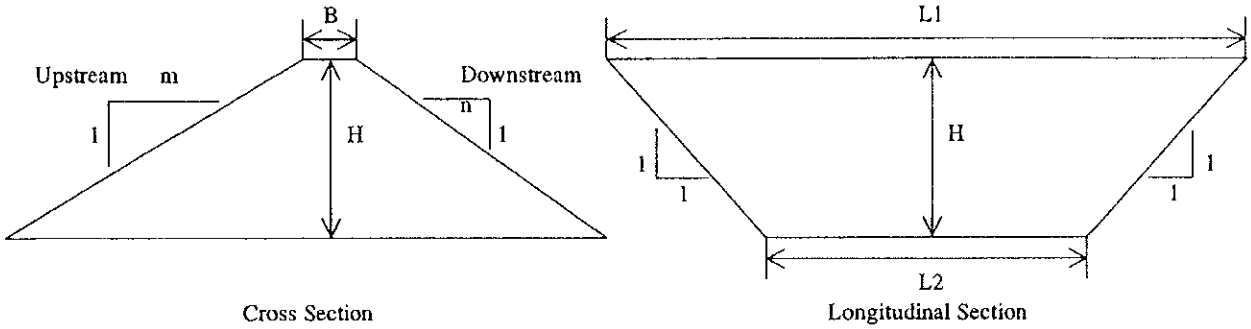
Attachments

1. Location showing reservoir area
2. Embankment volume and costs
3. H-V curve
4. H-A curve
5. Determination of irreparable area
6. Monthly discharge of Revobue river

Attachment 1
Reservoir Area of the Revobue Multipurpose Dam



Attachment 2. Embankment Volume and Cost



Cross Section

Longitudinal Section

Calculation of Embankment Volume and Cost (Rockfill Dam)

H	B	L1	L2	m	n	V m^3	Cost (US$)
100	**10**	**300**	**100**	**3.0**	**2.5**	**4,783,000**	**59,787,500**
90	10	280	100	3.0	2.5	3,735,000	46,687,500
80	**10**	**260**	**100**	**3.0**	**2.5**	**2,843,000**	**35,537,500**
70	10	240	100	3.0	2.5	2,095,000	26,187,500

Notes: Price per cubic meter=1,500 JPN yen / US$1=120 JPN yen

Calculation of Embankment Volume and Cost (Earthfill Dam)

H	B	L1	L2	m	n	V m^3	Cost (US$)
100	**10**	**300**	**100**	**3.5**	**3.0**	**5,617,000**	**60,850,833**
90	10	280	100	3.5	3.0	4,383,000	47,482,500
80	**10**	**260**	**100**	**3.5**	**3.0**	**3,333,000**	**36,107,500**
70	10	240	100	3.5	3.0	2,455,000	26,595,833

Notes: Price per cubic meter=1,300 JPN yen / US$1=120 JPN yen

Equation used for volume calculation: Volume (V) = 1/2*B*H*(L1+L2)+1/6*(m+n)*H^2*(L1+2*L2)

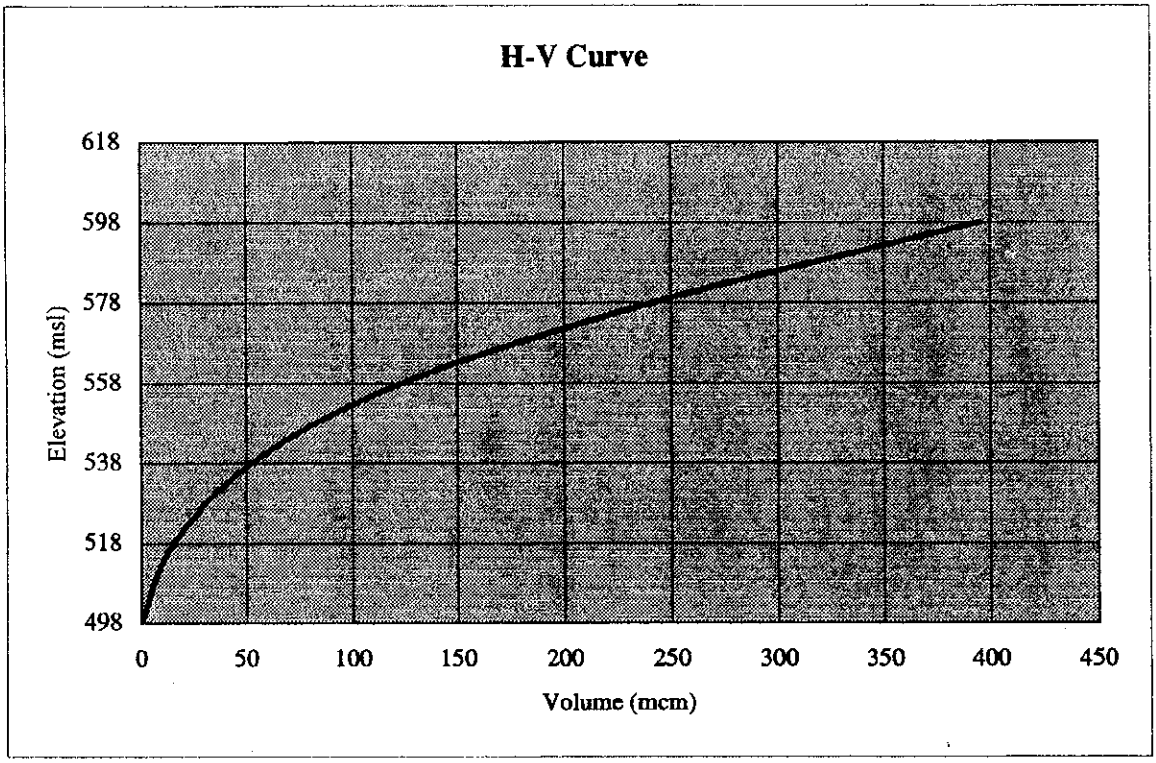
Power

H	Q	Power kW (P)	Power cost (US $)
100	**53.8**	**35,600**	**27,508,333**
90	53.8	32,000	25,708,333
80	**53.8**	**28,500**	**23,958,333**
70	53.8	24,900	22,158,333

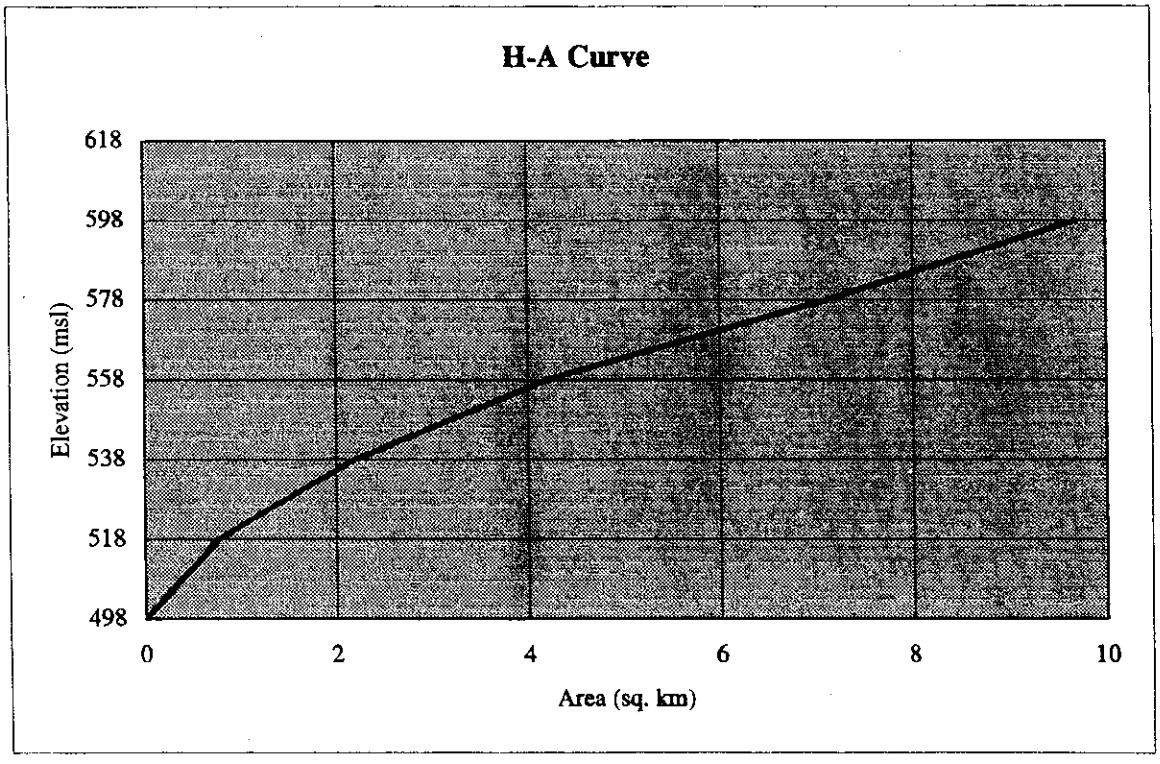
Total cost (US$)	
(Rockfill)	(Earthfill)
87,295,833	**88,359,167**
72,395,833	73,190,833
59,495,833	**60,065,833**
48,345,833	48,754,167

Equation used in calculating power: P = 9.8*Q*H*0.9*nt*ng (where nt*ng=0.75)

Attachment 3. H-V Curve



Attachment 4. H-A Curve



Attachment 5. Assumptions for Irrigable Area

Calculations

Elevation (msl)	Area (km^2)	Cumulative area (km^2)	Volume (mcm)	Cumulative volume (mcm)
498	0.0	0.00	0	0.0
518	0.8	0.76	15.2	15.2
538	2.2	2.96	37.2	52.4
558	4.2	7.17	86.1	123.3
578	7.1	14.28	155.3	241.4
598	9.7	24.01	239.5	394.8

Rainfall	1,027	mm/year
Catchment area	7,516	km^2
Runoff coefficient	0.22	
Inflow	1,698	mcm/year
Flow rate	53.8	m^3/sec

	100m-High	**80m-High**	
Total volume	395.0	239.5	mcm
Surface area	24.01	14.28	km^2
Depth	16.5	16.8	m
Loss	6.0	6.0	mm/day
Depth (for loss)	2.19	2.19	m
Actual depth	14.3	14.6	m (deducting loss)
Dead storage	0.25	0.25	of actual depth
Active Storage	**256,813,575**	**156,170,100**	**m^3**
Irrigable area			
Consumptive use	8	8	mm/day
Irrigation period	90	90	days
Q/ha/season	7,200	7,200	m^3/ha/season
Irrigable Area	**35,669**	**21,690**	**ha**
Power Generation	35,600	28,500	kW

Attachment 6. Monthly Discharge of Revobue River

CA = 15,540km^2 (Unit m^3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	767,334,816	1,248,041,088	809,412,480	196,447,680	125,991,936	68,117,760	51,371,712	32,221,152	21,772,800	13,900,896	11,508,480	88,146,144	3,434,266,944
1982	934,386,624	1,331,116,416	1,015,461,792	539,187,840	98,859,744	55,442,880	54,050,112	31,926,528	20,839,680	27,533,952	40,953,600	172,997,856	4,322,757,024
1983	401,224,320	568,536,192	181,943,712	61,689,600	50,889,600	22,705,920	25,391,232	20,998,656	16,070,400	12,240,288	11,119,680	135,848,448	1,508,658,048
1984	174,685,248	523,466,496	563,187,168	153,135,360	65,701,152	42,016,320	95,913,504	148,410,144	194,425,920	253,403,424	296,032,320	358,396,704	2,868,773,760
1985	517,547,232	915,473,664	668,287,584	535,559,040	186,309,504	96,940,800	62,835,264	42,961,536	35,199,360	17,864,928	23,561,280	570,981,312	3,673,521,504
1986	1,548,061,632	1,478,058,624	753,782,112	332,916,480	163,864,512	116,380,800	87,717,600	71,888,256	44,971,200	39,024,288	93,286,080	159,445,152	4,889,396,736
1987	445,739,328	314,979,840	251,394,624	99,506,880	56,032,128	33,436,800	31,792,608	25,150,176	15,474,240	15,909,696	7,620,480	88,467,552	1,385,504,352
1988	405,482,976	867,597,696	622,219,104	191,678,400	142,303,392	72,213,120	54,103,680	38,836,800	16,122,240	21,614,688	35,873,280	80,726,976	2,548,772,352
1989	280,187,424	1,317,157,632	942,957,504	413,812,800	252,358,848	170,527,680	120,206,592	101,243,520	60,626,880	42,532,992	48,237,120	196,085,664	3,945,934,656
1990	807,403,680	624,758,400	321,997,248	238,308,480	225,173,088	145,488,960	108,662,688	72,557,856	60,808,320	44,997,120	52,280,640	84,235,680	2,786,672,160
1991	414,294,912	325,842,048	307,212,480	245,462,400	200,103,264	161,792,640	149,052,960	129,420,288	76,956,480	70,897,248	105,416,640	250,108,992	2,436,560,352
1992	352,504,224	161,965,440	207,093,888	137,401,920	67,870,656	54,509,760	51,398,496	50,541,408	35,406,720	31,471,200	52,254,720	318,917,088	1,521,335,520
1993	655,618,752	627,951,744	598,970,592	486,492,480	270,598,752	131,751,360	114,769,440	98,029,440	85,224,960	75,477,312	82,010,880	134,321,760	3,361,217,472
1994	285,276,384	452,777,472	286,722,720	69,828,480	54,960,768	36,547,200	26,623,296	26,382,240	21,047,040	22,900,320	81,959,040	225,467,712	1,590,492,672
1995	366,271,200	240,855,552	167,025,024	85,898,880	32,569,344	36,650,880	37,551,168	30,533,760	25,168,320	21,855,744	40,124,160	441,346,752	1,525,850,784
1996	872,970,912	1,178,343,936	1,221,537,888	292,429,440	197,558,784	157,982,400	128,964,960	115,572,960	78,304,320	48,800,448	43,130,880	223,110,720	4,558,707,648
1997	807,859,008	1,837,745,280	869,274,720	690,327,360	340,290,720	236,027,520	239,073,984	169,221,312	131,310,720	143,026,560	136,728,000	504,905,184	6,105,790,368
1998	1,277,543,232	867,718,656	744,461,280	437,140,800	327,112,992	195,981,120	176,158,368	146,963,808	110,522,880	367,476,480	600,696,000	873,961,920	6,125,737,536
1999	1,127,231,424	1,122,726,528	1,215,511,488	954,348,480	482,808,384	382,993,920	332,523,360	299,230,848	252,771,840	241,082,784	249,454,080	253,028,448	6,913,711,584
Average	654,822,280	842,374,353	618,339,653	324,293,305	175,860,925	116,710,939	102,534,791	86,952,141	68,580,227	79,579,493	105,907,756	271,605,267	3,447,561,130

In-Depth Study on Pilot Farmers' Associations Promotion Program (PFAP) (Related to Project 2.7)

1. Background

An in-depth study is carried out on Pilot Farmers Association Promotion Program. The Trade and Market Survey (TMS) carried out in February 2001 revealed high sense of commitment and readiness on the part of farmers in formulating a farmers association as a breakthrough for rural development. Farmers have high expectation that a newly established farmers association would promote joint marketing of farm produce, joint purchase of farm inputs, implements and daily commodities and provide a financing function, which is totally unavailable in rural areas today. Based on this finding, the JICA Study Team selected the Pilot Farmers Association Promotion Program (hereafter "PFAP") as one of the priority projects for which in-depth analyses are to be carried out. Organizing farmers under their own initiative is the most essential step in accelerating any kind of rural development projects. Starting a farmers association would be an effective immediate action in finding and developing market outlets and increasing agriculture production.

2. Farmers Association Survey

In order to collect information concerning the important issues in promoting and supporting farmers association initiative, a Farmers Association Survey (FAS) was conducted from June 7 to June 26 for 11 communities. A screening was made for 37 communities previously contacted by the JICA Study Team, including 12 communities contacted through the Social Survey and 37 through the Trade and Market Survey. The screening criteria included a set of items in terms of market access, natural condition and production, social characteristics, readiness of the community and potential for growth. The following 11 communities were judged to be most appropriate for a detailed analysis.

- Chidzolomondo (Macanga district)
- Namadende (Macanga district)
- Luia (Chifunde district)
- Nsadzu (Chifunde district)
- Nadziboli (Angonia district)
- Mulangueni (Angonia district)
- Chimwala (Angonia district)
- Lumadzi (Chiuta district)
- Chipili (Chiuta district)
- Banga (Tsangano district)
- Amphande (Moatize district)

The location of these communities are shown in Figure 1. An outline of these 11 communities are presented in Table 1.

FAS was carried out in cooperation with Zambezi Farmers Association (hereafter "AAZ", Portuguese abbreviation), a newly established NGO based in Tete city with its major objective as supporting communities in starting farmers association, providing technical assistance on marketing and farming technology and financing.

3. Proposals for Pilot Farmers Association Promotion Projects

Based on the findings of the FAS, the JICA Study Team and AAZ cooperated in preparing proposals for each community. The major items of the proposals are an outline of each community, plan for farmers association establishment, proposed initial activities and financial management plan. The following 10 projects are proposed.

(1) Namadende Integrated Farming Project
(2) Chimwala Grain Storage and Women's Status Upgrading Project
(3) Nsadzu Small Business Promotion Project
(4) Lumadzi Road Construction Project
(5) Nadziboli Irrigation Project (application of simple irrigation techniques)
(6) Mulangueni Water Supply and Health Project
(7) Chipili Primary School and Health Project
(8) Banga/Amphande Poultry Restocking Project
(9) Luia School of Agriculture Project
(10) Chidzolomondo Sustainable Agriculture Project

Some of the proposals originally prepared by AAZ were suited more as a public investment program by the Government than as a community-led project in terms of the scale of investment required and type of project. Also there is another type of project, which should be initiated by some kind of community organization with broader perspective than farmers association. The proposals presented here are limited to those for which farmers association is the most suitable form of organization to initiate the project. Based on this consideration, the following five proposals are presented in this section.

(1) Chidzolomondo Sustainable Agriculture Project
(2) Chimwala Grain Storage and Women's Status Upgrading Project
(3) Namadende Integrated Farming Project
(4) Nadziboli Irrigation Project (application of simple irrigation techniques)
(5) Luia School of Agriculture Project

In preparing these draft proposals as pilot schemes, the two aspects were duly considered.

- Incorporation of innovative elements
- Replicability

Appropriate technologies not applied in the Study Area were recommended as much as possible since they are both technically and financially more manageable at community level. An important point in proposing a pilot scheme is that other communities are able to replicate the projects following the method shown by pilot schemes, both technically and financially. Appendix II presents an outline of the five proposals. It should be noted that an emphasis is placed rather on farmer association's management and financial aspects than on technical aspect. It is also stressed that the proposals presented here are prepared based on a set of assumptions that should be refined from a conservative perspective at the implementation stage.

4. Major Issues for Full-scale Promotion

Based on the findings of the FAS and proposal preparation for the selected communities, the following issues have become clear. These issues need to be carefully considered in implementing farmers association promotion scheme covering the whole Study Area.

(1) A strategic approach for farmers association promotion would be "top-down in bottom-up". The selected communities included both relatively advanced communities such as Chidzolomondo and least developed communities such as Luia. The advanced communities are more exposed to market-oriented practices and experienced in tackling new activities with the guidance of NGOs. Farmers were readier in starting farmers association, collecting contribution and proposing next actions. Less advanced communities have no experience in challenging new activities and their way of thinking is more receptive. Many of the projects proposed are highly profitable projects. Once a profitable project is successfully implemented, it will generate a resource that will be able to finance projects of similar magnitude, more than ten such projects in some cases. Richer communities will be able to support other communities behind in terms of finance and farming technology. An effective approach for the Government, therefore, is to concentrate resources for farmers' associations promotion on a number of strategic communities with high growth potential at an initial stage. An example of Chidzolomondo indicates that district posts might be good candidates for initial promotion.

(2) Equally important for the Government is to identify the communities which might not be reached by the communities growing with initial government support. Some communities with a certain level of growth potential might not be supported by advanced communities because of distance or required magnitude of resource. These are another type of communities that require initial support by the government.

(3) Grouping of established farmers associations is also an important issue. There

are certain services such as financing and joint purchase of vehicles that farmers are eager to receive from farmers association. A community-based association alone, in most cases, is not capable of purchasing and operating vehicles or providing loan scheme of certain level. Grouping of at least five associations or so would make this possibility real. A used pick-up costs about MT120 million or US$5,200. Assuming a farmer contributes US$1 for jointly purchasing a vehicle, the number of farmers needed would be 5,200, equivalent to 5-6 farmers associations. Contribution of another US$1 for operating the purchased vehicle can also be expected. Considering the amounts of contribution farmers actually agreed to make, ranging from MT7,000 to MT200,000, a total of US$2 per farmer could be a realistic possibility. Once a number of FAs are formed and initiated, grouping them would be an important next step to be encouraged by the government and NGOs.

(4) Grouping of farmers association would pave the way for other possibilities as well. Joint employment of extension service professional is an example. Since it is unrealistic to expect that the Government can increase the number of extension experts all of sudden, an alternative way would be for a group of farmers associations to employ such experts utilizing their own resources. These professionals can visit each community periodically to give training and guidance to member farmers.

(5) Support measures in enhancing management capability will be an essential task for the Government and NGOs. FA members, especially those responsible for accounting, will be placed in a position to handle an amount of money that they probably have never touched in the past. In order for an association to maintain credibility both to association members and external supporting organizations, an appropriate financial management is most important. This, however, is the very field for which local technique lacks. Increasing training opportunities in this regard is the most urgent measure.

Table 1. Findings of Farmers Association Survey (1/2)

$=MT 20,000
MKW= MT 280

	Item	Unit	Chidzolomondo (Macanga)	Luia (Chifunde)	Nsadzu (Chifunde)	Namadende (Macanga)	Chipiri (Chiuta)
1	Population	no.	17,448	8,918	10,370	5,120	1,077
2	Farm population	no.	12,070	2,407	5,600	1,206	800
3	Total farm area	ha	146,000	72,000	174,000	128,000	21,540
4	Total cultivated area	ha	37,000	12,035	25,000	20,480	4,000
5	% cultivated area (5/4)	%	25.3	16.7	14.4	16.0	18.6
6	Per capita cultivated area (5/2)	ha/person	3.1	5.0	4.5	17.0	5.0
7	Majority farm area	ha/farm	15	5	5	6	3
8	Number of crops grown	no.	13	11	14	15	10
9	Maize yield	ton/ha	2.0	2.0	1.9	2.0	2.0
10	% of maize marketed	%	50	50	30	50	50
11	% Metical for sales	%	80	100	10	50	100
12	Maize price	MT/kg	1,000	1,250	750	500	500
13	Number of cows	no.	10	25	235	18	0
14	Existing irrigation	yes/no				no	no
15	Primary school attendance	%	71	50	38	82	25
16	Health center/post	yes/no	yes	yes	yes	yes	no
17	Dependence on river water	%	70	90	98	90	50
18	Logest distance to fetch water	km	3.0	1.5	4.0	6.0	6.0
19	Extension service	yes/no	yes	yes	yes	?	no
20	Distance to closest river	km	5	?	5	3	?
21	Portuguese literacy	%	40	50	70	30	30
22	Local language literacy	%	100	100	100	90	100
23	Numeracy	%	40	40	70	30	30
24	Land mine	yes/no	no	yes	yes	no	no
25	Tsetse fly	yes/no	yes	yes	yes	no	no
26	Foot and mouth disease	yes/no	yes	yes	yes	no	no
27	NGO activities	yes/no	no	no	no	yes	no
28	Exsiting association	yes/no	no	yes (paprika)	no	no	no
29	Number of future FA member	no.	1,200	3,300	810	1,000	500
30	Majority farm area of future member	ha/farmer	10 or more	4-6	4-6	4-6	2-4
31	Majority contribution		90 kg maize	90 kg maize	100 kg maize	90 kg maize 200,000 MT 90 days labor	90 kg maize 200,000 MT
32	Total financial resource						
	In kind calculated in $	$	5,400	18,563	3,038	2,250	1,125
	$ cash	$	100	33,000	200	10,000	5,000
33	Most needed actions by FA (only top priority choices)	list	Buy implements Tech. guidance Buy inputs Finance	Ox-cart Buy inputs Finance	Ox-cart Buy implements Tech. guidance Finance	Buy truck Buy tractor Buy ox-cart Tech. guidance Finance	Buy truck Buy tractor Buy ox-cart Buy implements Buy inputs Finance
34	Development priority (only top priority choices)	list	Health Water Agriculture	Education Skill training Water Agriculture Transportation	Education Skill training Water Agriculture Transportation	Skill training Water Agriculture	Health Education Skill training Road water Electricity Telecom Agriculture Transport
35	Availability leading farmer	yes/no	yes/no				

Table 1. Findings of Farmers Association Survey (2/2)

$=MT 20,000
MKW= MT 280

	Item	Unit	Lumadzi (Chiuta)	Chimuala (Angonia)	Mulangueni (Angonia)	Banga (Tsangano)	Amphande (Moatize)	Nadziboli (Angonia)
1	Population	no.	4,057	11,000	7,200	28,720	5,900	4,834
2	Farm population	no.	1,822	2,750	1,800	14,117	3,540	788
3	Total farm area	ha	62,850	11,000	3,600	28,234	11,800	5,240
4	Total cultivated area	ha	4,767	8,250	3,000	21,176	4,720	3,275
5	% cultivated area (5/4)	%	7.6	75.0	83.3	75.0	40.0	62.5
6	Per capita cultivated area (5/2)	ha/person	2.6	3.0	1.7	1.5	1.3	4.2
7	Majority farm area	ha/farm	4	3	4	2	4	4
8	Number of crops grown	no.	15	9	11	13	17	9
9	Maize yield	ton/ha	2.0	2.0	0.8	2.0	2.0	1.1
10	% of maize marketed	%	10	10	25	10	10	10
11	% Metical for sales	%	100	95	0	10	10	0
12	Maize price	MT/kg	1,500	500	1,400	840	1,000	840
13	Number of cows	no.	0	60	132	6,000	3	300
14	Existing irrigation	yes/no	no	no	yes	yes	yes	yes
15	Primary school attendance	%	33	90	85	93	98	100
16	Health center/post	yes/no	no	yes	no	yes	no	no
17	Dependence on river water	%	100	98	100	93	90	90
18	Logest distance to fetch water	km	15.0	3.0	6.0	1.0	1.0	1.0
19	Extension service	yes/no	yes	yes	yes	yes	yes	yes
20	Distance to closest river	km	5	6	6	5.6	1	3
21	Portuguese literacy	%	10	10	20	20	80	30
22	Local language literacy	%	90	75	80	25	50	60
23	Numeracy	%	10	20	40	20	75	30
24	Land mine	yes/no	no	no	yes	no	no	no
25	Tsetse fly	yes/no	yes	no	no	no	no	no
26	Foot and mouth disease	yes/no	yes	no	no	yes	no	no
27	NGO activities	yes/no	yes	no	no	no	no	yes
28	Exsiting association	yes/no	no	no	no	no	no	no
29	Number of future FA member	no.	440	2,750	4,372	6,571	3,540	788
30	Majority farm area of future member	ha/farmer	10 or more	2-4	0-2	0-2	2-4	2-4
31	Majority contribution		100 kg maize 200,000 MT 30 days labor	12 kg maize 7000 MT 2.5 days	70kg maize 100,000 MT 3 days	75kg maize 160,000 MT 3 days	30kg maize 30000 MT 3 days	15kg maize 7,000 MT 1.5 days
32	Total financial resource							
	In kind calculated in $	$	3,300	825	21,423	20,699	5,310	496
	$ cash	$	4,400	550	609	16	5,310	276
33	Most needed actions by FA (only top priority choices)	list	Buy truck Buy ox wagon Buy inputs Buy daily goods Finance	Tech. guidance	Buy inputs	Tech. guidance	Buy implemen	Tech.guidance
34	Development priority (only top priority choices)	list	Health Education Skill training Road Water Agriculture Transportation	Road	Health	Health	Health	Health
35	Availability leading farmer	yes/no				yes	yes	yes

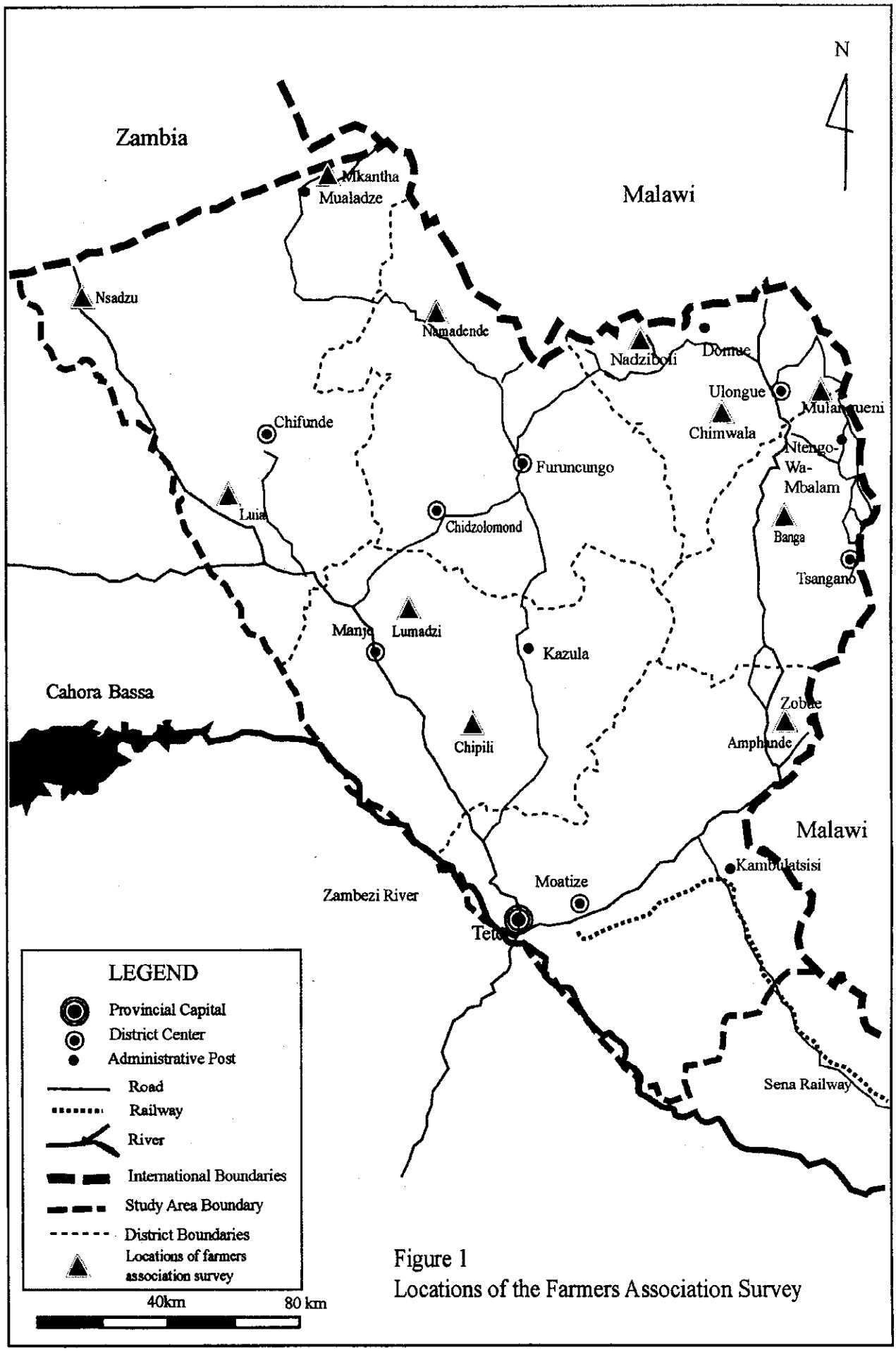


Figure 1
Locations of the Farmers Association Survey

Appendix

Proposals for Farmers' Association Promotion Pilot Program for Five Communities

Appendix 1

Chidzolomondo Sustainable Agriculture Project (CSAP)

1. Outline of Chidzolomondo Community

1.1. General Conditions

Chidzolomondo is the location of administrative post of Macanga district. Its total population is 17,448, comprising 8,120 males (47%) and 9,298 females (53%), indicating emigration of male population seeking job opportunities outside the community. The farming population is 12,070. The local languages spoken are Nyanja (60%) and Nyungue (40%). Road distance to the district center Furancungo is 38km. Out of the total farm area of 146,000ha, only 37,000ha or 25% is cultivated. Farm area per capita is 3.0ha per farmer. The crops grown are maize, tobacco, beans, groundnuts, cotton, sunflower, cassava, tomato, cabbage, nuts, and lettuce. The level of commercialization is relatively high in Chidzolomondo. The portion of maize sold is 50%. The most commercialized crop is tobacco for 100% sale to Mozambique Leaf Tobacco. Marketed portion of other crops is also higher than 50%. The payments made in Mozambican currency, metical, accounts for 80% of all, while the remaining is made in Malawian currency kwacha. The price of maize sold was MT1,000 per kg for year 2000 harvest, which was relatively high compared with other communities. The range of maize prices in the Study Area is between MT500/kg and MT1,500/kg.

The source of domestic water is mainly river water with 70% of the population depending on river water. The remaining 30% are served by borehole water. The longest distance villagers have to walk for fetching water is 3km. Portuguese literacy at 40% is at a medium level in the Study Area where it ranges from the lowest of 10% up to the highest of 80%. Lutheran World Federation (LWF) has been supporting farmers through providing various training programs. Soil is rich, black and sandy loam with 6-8pH. Mean annual rainfall is 800 to 1,000mm. Chidzolomondo is situated at an altitude of around 1,300m. The community leader interviewed put the highest priority of development to health sector and agriculture sector among all sectors. Joint purchase of farm implements and inputs, technical guidance and financing were regarded as most urgent tasks of farmers association.

1.2. Strengths and Weaknesses

Strengths

a. The community has been exposed to market-oriented business practice and various training programs by LWF. So community members are more prepared than other communities in expanding commercial activities.
b. A farmer association has been formed already showing strong sense of commitment

of villagers.

c. Technical training provided so far contributed to upgrading the skill level of villagers.
d. There is a weir constructed in 1956 by a Catholic mission, providing irrigation water to a small portion of the riverbank area.
e. There is a technical school complex where unfinished school buildings still remain. A new project could be planned and started capitalizing on this facility.
f. Some infrastructure is available such as road in a fair condition, boreholes, a primary school and a health post.

Weaknesses

a. Farmers have no confidence in market.
b. Farmers' knowledge is limited, concerning crop rotation, crop diversification, watershed management, warehouse facilities, food preservation etc.
c. In certain areas, there is a problem of tsetse fly.
d. There is no veterinary service available.

2. Farmers Association (FA)

A farmers association has been formed already. The contribution collected amounts to MT10,000,000, equivalent approximately to US$500. The registered number of farmers is 800. This could rise to 1,000, which would be an appropriate size of Chidzolomondo Farmers Association. It is agreed that MT200,000 or 90kg of bag per farmer be contributed by farmers for FA activities. Key personnel have been selected already by vote, such as president, vice president, accountant, committee members and office clerk. There is no farmer who might be able to act as a technical advisor on farming technology. Theoretically Chidzolomondo FA will be able to raise approximately US$4,000 in case of all contributions made in kind or US$8,800 in case of all contributions made in cash.

3. Proposed Activities

Chidzolomondo is a relatively commercialized community in the Study Area. Reflecting this fact, maize price is relatively higher and farmers' expectation is rather strong in the production side than in marketing side. Since there are already some market outlets, it would be sensible to increase the production of higher price crops capitalizing on the existing market channels and infrastructure. By this way farmers will be able to increase their income level.

Based on these considerations, the following activities are proposed for Chidzolomondo:

(1) Enhancement of irrigation water supply capacity either by introduction of a water pump (Alternative A) or dam heightening by 1 meter (Alternative B),
(2) Excavation of new irrigation canals to expand the irrigation area from present 4ha to 66ha with an increased amount of irrigation water,

(3) Increase in the production of some crops currently grown and introduction of new crops such as paprika, soybean, Irish potato, rape and cabbage through joint purchase of seeds, packaging materials and tools and equipment such as irrigation pipes, hoes, watering cans, rakes and axes, and

(4) Introduction of organic fertilizer, possibly shredded tobacco stems and leaves.

4. Financial Management Plan

4.1. Cost

The initial cost of the project is estimated as follows.

Initial Project Cost

Item	(MT 10^3)	(US$)
Water pump	85,000	3,744
Equipment	75,150	3,311
Seeds	143,350	6,315
Chemical	4,220	186
Packaging materials	10,500	463
Diesel	22,000	969
Pump maintenance	8,500	374
Total	348,823	15,362

Note: US$= MT22,700 assumed.

The cost of alternative A, installment of a water pump, is included here. The initial cost of Alternative B, dam heightening, is to be estimated at a later stage and compared with Alternative A cost above including the operation cost. Canal excavation will be carried out utilizing labor force of the community. The total initial cost is estimated approximately at MT350 million or US$15,000.

4.2. Revenue

The total revenue by the increased crop production is estimated to be MT1,275 million or US$56,100 per year. It is assumed that the whole production is divided into sales at 70%, self-consumption at 20% for self-consumption and the remaining 10% for seeds.

Financial resource that will be made available by farmers contribution is somewhere between US$4,000 and US$8,800. Taking the mid-point, US$6,400 could be assumed.

4.3. Cash-flow Statement

Based on the costs and revenue estimated and other assumptions, a cash flow statement of CFAP is prepared as shown in Table A-1. This cash-flow statement shows that CFAP is a highly profitable project. The project will be able to return 100% of the loan borrowed at

10% interest in the second year. The accumulated surplus in the third year will reach US$146,000. Once this project is successfully implemented, the cash surplus generated will be able to finance ten or so projects of similar magnitude. CFAP has a possibility to boost rural economic development.

Table A-1. Cash-flow Statement of Chidzolomondo Sustainable Agriculture Project

(Unit: US$)

Item	Year 1		Year 2	Year 3
	First half	Second half		
(Profit and loss statement)				
1. Sales	0	56,163	56,163	56,163
2. Operating cost *(1)*	7,484	0	1,992	7,484
3. Depreciation	0	0	1,411	1,411
4. Interest payment *(2)*	0	0	1,134	0
5. Profit before tax	(7,484)	56,163	51,626	47,268
6. Tax	0	0	0	0
7. Profit after tax	(7,484)	56,163	51,626	47,268
(Cash-flow statement)				
8. Source of fund				
Profit after tax	(7,484)	56,163	51,626	47,268
Depreciation	0	0	1,411	1,411
Equity *(3)*	3,200	0	0	0
Loan	11,339	0	0	0
Total	7,056	56,163	53,037	48,679
9. Application of fund				
Investment	7,056	0	0	0
Repayment	0	0	11,339	0
Total	7,056	0	11,339	0
10. Cash surplus	0	56,163	41,698	48,679
11. Accumulated surplus	0	56,163	97,861	146,541

(1) Operating costs include those of seeds for the initial year, packaging material, chemical for paprika and cotton, diesel plus maintenance of pump at 10% of pump cost.
(2) Assuming 1-year repayment at 10%/year interest.
(3) 50% of farmers' contribution at US$6,400 assumed.
(4) Diesel consumption is 2,000 liters/year.
(5) Seeds for next year planting is spared at 10% of the production. 20% is to be spared for crops other than paprika and cotton for self-consumption.

5. Further Works for Implementation

The present analysis was carried out based on a number of assumptions though with an attempt to fully reflect the detailed survey results by FAS. In the implementation stage, a number of critical issues will arise and accordingly modifications of the projection

presented here will become necessary. The important issues for further stage would include the following:

- Actual contribution to be collected from farmers,
- Need for marketing maize collected as farmers' contribution,
- Comparison of alternatives for water supply capacity enhancement, and
- Review of crop prices in the context of regional supply-demand balance.

Appendix 2

Chimwala Grain Storage and Women's Status Upgrading Project (CGSW)

1. Outline of Chimwala Community

1.1. General Conditions

Chimuwala is located in Angonia district, about 12km west from district capital Ulongue. Its total population is 11,000, comprising 5,315 males (48%) and 5,685 females (52%), a better balance compared with other communities. The farming population is 6,600. The local languages spoken are Chichewa (90%) and Nyungue (10%). Out of the total farm area of 11,000ha, 8,250ha or 75% is cultivated, one of the highest proportions in the Study Area. Farm area per capita is 1.7ha per farmer, indicating limited availability of land compared with western districts such as Chifunde, Chiuta and Macanga. The crops grown are maize, tobacco, beans, groundnuts, pigeon peas, paprika, sweet potato, cassava and tomato. The level of commercialization varies by crop. The portion of maize sold is only10%, while 100% each of paprika and tobacco and 90% of tomato are sold. Most production is self-consumed for other crops. Payments made in Mozambican metical, accounts for 95% of all, while the remaining transactions are made in Malawian kwacha. The price of maize sold was MT500/kg for year 2000 harvest, which was the lowest in the Study Area. The range of maize prices in the Study Area was between MT500/kg and MT1,500/kg. Water supply condition in Chimuwala is not satisfactory.

People depending on river water accounts for 98% of the total population, while the remaining 3% use boreholes as water source. The longest distance villagers have to walk for fetching water is 3km. Road conditions to market and district center are not satisfactory even in dry season. Portuguese literacy as low as 10%, indicating very low educational level of the population. There has been no activities by NGOs. Chimuwala is situated at an altitude of around 1,240m. The community leader interviewed put the highest priority of development to road improvement and second priority to health sector. Technical guidance is regarded as the most urgent task of farmers association, followed by joint purchase of farm implements.

1.2. Strengths and Weaknesses

Strengths

a. There is a good leadership.
b. There are already active women's groups for farming and sales of farm produce.
c. The community is well organized and cooperative, as shown by their joint activities on brick making for health post and school buildings.
d. There are land available and suitable for horticulture promotion.

Weaknesses

a. There are no appropriate storage facilities for farm produce.
b. Agriculture support services are weak.
c. There has been no NGOs active in the community.
d. The road to market is bad.
e. Settleements are scattered.

2. Farmers Association (FA)

The number of farmers showing interest in joining the newly established farmers association amounted to 300 farmers as of June 2001. This number is expected to rise to 1,000. It has been agreed that each member will make a contribution either by cash at MT50,000 or 25kg of maize per farmer. Theoretically Chimwala FA will be able to raise approximately US$2,200 in case of all contributions made in cash or US$550 in case of all contributions made in maize, assuming maize price at MT500 per kg.

3. Proposed Activities

Chimuwala is one of the least developed communities in the Study Area in terms of economic level and social indicators. One of its advantages is its closeness to Malawi. Limited access to Mozambican markets such as Lilongue and Tete City is partly compensated for by better access to the Malawian side. It would be sensible in a short-run to capitalize on this advantage and make an effort in increasing sales volume to the existing Malawian markets rather than tackling to improve access condition on the Mozambican side. The existing women's group should also be developed for upgrading women's economic and social status.

Based on these considerations, the following activities are proposed for Chimuwala community:

(1) Construction of permanent grain storages by male labor of the community, and
(2) Joint purchase of farm implements and inputs for horticulture promotion by women in an area of 4ha.

Once permanent structures for grain storage are constructed, grain will be stored free from damages by rats and termites. Besides grain will be stored at the center of the community in a large amount, which will make it very convenient for buyers to visit and buy maize in mass. Women's status will be upgraded both economically and socially by enabling them to control and use farm implements for horticulture in an expanded area. Crops to be grown are Irish potatoes, rape, tomatoes, onions, carrots, garlic, ginger and cabbage.

4. Financial Management Plan

4.1. Cost

Only grain storage portion is presented here, since women's status upgrading portion is an issue to be presented in Social Sector Report.

The initial cost required for CGSW is estimated at MT82.8 million, equivalent to US$3,648. Operating cost, the cost of grain bags, is estimated at US$46 per year. The labor cost is not included, since the major men's role in this project is to provide labor force for the construction of storages.

Cost for CGSW

Item	(MT)	(US$)
Warehouse	81,755,000	3,602
Grain bag	1,050,000	46
Total	82,805,000	3,648

Note. $=MT22,700 assumed.

4.2. Revenue

The total revenue to be generated will be MT54 million per year, equivalent to US$2,379 per year, assuming 54,000kg of maize, equivalent to 600 bags of 90kg at MT1,000/kg.

4.3. Cash-flow Statement

Table A-2 presents a cash flow statement of CGSW. It is assumed that equity will be paid in by Chimuwala Farmers Association at an amount of US$1,300, which is the mid-point of cash contribution at US$2,200 and maize contribution at US$550. As is clear in the statement, CGSW is a fairly profitable project. It will be able to return 100% of the loan borrowed at 10% interest in the third year. The accumulated surplus in the fifth year will reach US$6,800. Once this project is successfully implemented, the cash surplus accumulated in five years will be able to finance two projects of similar magnitude.

2. Further Works for Implementation

The present analysis was carried out based on a number of assumptions though with an attempt to fully reflect the detailed survey results by FAS. In the implementation stage, a number of critical issues will arise and accordingly modifications of the projection presented here will become necessary. The important issues for further stage would include the following.

- Actual contribution to be collected from farmers
- Need for marketing maize collected as farmers' contribution

- Review of crop prices in the context of regional supply-demand balance and marketability of crops
- Estimate of an increase in maize sale due to permanent storage and sales facilities

Table A-2. Cash-flow Statement of Storage Construction Component

(Unit: US$10^3)

Item	Year 1	Year 2	Year 3	Year 4	Year 5
(Profit and loss statement)					
1. Sales	0	2,379	2,379	2,379	2,379
2. Operating cost *(1)*	46	46	46	46	46
3. Depreciation	0	360	360	360	360
4. Interest payment *(2)*	0	117	0	0	0
5. Profit before tax	(46)	1,855	1,973	1,973	1,973
6. Tax	0	0	0	0	0
7. Profit after tax	(46)	1,855	1,973	1,973	1,973
(Cash-flow statement)					
8. Source of fund					
Profit after tax	(46)	1,855	1,973	1,973	1,973
Depreciation	0	360	360	360	360
Equity *(3)*	1,300	0	0	0	0
Loan	2,348	0	0	0	0
Total	3,602	2,216	2,333	2,333	2,333
9. Application of fund					
Investment	3,602	0	0	0	0
Repayment	0	1,174	1,174	0	0
Total	3,602	1,174	1,174	0	0
10. Cash surplus	0	1,042	1,159	2,333	2,333
11. Accumulated surplus	0	1,042	2,201	4,534	6,867

(1) Operating cost include that of grain bag.
(2) Assuming 3-year repayment at 10%/year interest.
(3) 50% of farmers' contribution at US$1,300 assumed.

Appendix 3
Namadende Integrated Farming Project (NIFP)

1. Outline of Namadende Community

1.1. General condition

Namadende is situated in Macanga district, about 36km northwest from distrit center Furancungo. Its total population is 5,120, comprising 2,080 males (41%) and 3,040 females (59%), heavily skewed population structure. The farming population is 1,206. The local languages spoken are Chichewa (70%) and Nyungue (30%). Out of the total farm area of 128,000ha, only 20,500ha or only 16% is cultivated. Farm area per capita is 106ha per farmer. The crops grown are maize, tobacco, beans, groundnuts, paprika, potato, Irish potato, sweet potato, cassava, tomato, rape, spinach, onion, garlic and cabbage. The level of commercialization is relatively high in Namadende. The portion of maize sold is 50%. The marketed portions exceed 80% for such crops as tobacco, groundnuts, beans, potato, Irish potato, rape, spinach, onion and garlic. Transactions are made both in Mozambican metical and Malawian kwacha almost half by half. The price of maize sold was MT500/kg for year 2000 harvest, which was one of the lowest in the Study Area. The range of maize prices in the Study Area was between MT500/kg and MT1,500/kg. The roads to market and district center are in a fair condition, meaning no problem in dry season, but problems in rainy season.

The source of domestic water is dominantly river water accounting for 90% of the population. The remaining 10% are served by borehole water. The longest distance villagers have to walk for fetching water is 6km. Portuguese literacy at 30% is at a medium level in the Study Area where it ranges from the lowest of 10% up to the highest of 80%. Lutheran World Federation (LWF) has been supporting farmers through providing various training programs. Soil is rich, black and sandy loam with 6-7pH. Mean annual rainfall is 800 to 900mm. Namadende is situated at an altitude of around 1,330m. The community leader interviewed put the highest priority of development to skill training, water supply and agriculture sectors. The most urgent tasks of farmers association are joint purchase of a truck, a tractor-trailer and ox-drawn cart, technical guidance on farming practice and financing in their opinion.

1.2. Strengths and Weaknesses

Strengths

a. The location of Namadende is advantageous in that it is located along the all weather road as well as close to Malawi enabling Malawian buyers to easily reach Namadende.
b. The soil is fertile.

c. There is abundant land suitable for pasture for animal grazing.
d. The community has an experience in raising cattle with the government support before the civil war time.
e. The community is well organized and cooperative.
f. Water resources are abundant due to the community's location surrounded by a number of streams and rivers.
g. There is a good leadership.

Weaknesses

a. Farmers' income is low.
b. There are almost no agriculture support services.
c. There are no appropriate storage facilities.

2. Farmers Association (FA)

A farmers association has been formed already. The number of farmers who have singed up for joining the association numbered 200 as of June 2001. The farmers' expectation in the number of association member is 800. The level of contribution agreed is MT200,000 in cash or 90kg of maize. Key personnel have been selected already by vote, such as chairman, vice chairman, secretary, vice secretary, treasurer and office clerk. There is a farmer who might be able to act as a technical advisor on farming technology. Theoretically Namadende FA will be able to raise approximately US$7,000 in case of all contributions made in kind or US$1,600 in case of all contributions made in cash.

3. Proposed Activities

A proposal for Namadende is prepared from the viewpoint of capitalizing on the community's experience and available natural resources. Farmers in Namadende have an experience in rearing 40 head of cattle before the war as well as running poultry business in Malawi while they lived there as refugees. There is good land for cattle pasture in the community. Feed for chickens will be supplied by maize and other crops grown in the community. Based on these considerations, the following components are proposed:

(1) Introduction of poultry farming, and
(2) Introduction of cattle raising.

Manure of cattle and chickens can be utilized as organic fertilizer for the existing crops already grown.

4. Financial Management Plan

4.1. Cost

The initial cost of the project is estimated at MT295 million, equivalent to about US$13,000.

Initial Project Cost

Item	(MT)	(US$)
(Poultry farming)		
Chicken pen building	12,500,000	551
Operating cost	29,197,500	1,286
(Cattle raising)		
Fencing	103,424,000	4,556
Cattle	111,250,000	4,901
Operating cost	38,400,000	1,692
Total	294,771,500	12,986

Note. $=MT22,700 assumed.

4.2. Revenue

NIFP will generate revenue of US$22,379 per year, comprising US$19,295 by milk sale and US$3,084 by chicken sale as the following table shows.

Sale of NIFP

Item	Values	
Milk		
Number of cattle	10	cows
Milk production per cattle	20	liter/day/cattle
Total milk production	200	liter/day
Milk price	6,000	MT/liter
Sales value	1,200,000	MT/day
	438,000,000	MT/year
	19,295	US$/year
Chicken		
Number of chickens	2,000	
Mortality rate	3	%
Sales quantity	35,000	MT/chicken
Sales value	70,000,000	MT
	3,084	US$

Note. $=MT22,700 assumed.

4.3. Cash-flow Statement

Based on the costs and revenue estimated and other assumptions, a cash flow statement of NIFP is prepared as shown in Table A-3. This cash-flow statement shows that NIFP is a highly profitable project. The project will be able to return 100% of the loan borrowed at 10% interest in the second year. The accumulated surplus in the third year will reach

US$50,000. Once this project is successfully implemented, the cash surplus generated will be able to finance three to four projects of similar magnitude.

Table A-3. Cash-flow Statement of Namadende Integrated Farming Project

(Unit: US$10^3)

Item	Year 1		Year 3
	First half	Second half	
(Profit and loss statement)			
1. Sales	0	22,379	22,379
2. Operating cost *(1)*	2,978	0	2,978
3. Depreciation	0	0	1,491
4. Interest payment *(2)*	0	0	0
5. Profit before tax	(2,978)	20,888	17,910
6. Tax	0	0	0
7. Profit after tax	(2,978)	20,888	17,910
(Cash-flow statement)			
8. Source of fund			
Profit after tax	(2,978)	20,888	17,910
Depreciation	0	0	1,491
Equity *(3)*	4,300	0	0
Loan	8,686	0	0
Total	10,008	20,888	19,401
9. Application of fund			
Investment	10,008	0	0
Repayment	0	0	0
Total	10,008	0	0
10. Cash surplus	0	20,888	19,401
11. Accumulated surplus	0	20,888	50,136

(1) Operating costs include those of seeds, fertilizers and chemicals.

(2) Assuming 1-year repayment at 10%/year interest.

(3) 50% of farmers' contribution at US$2,750 assumed.

5. Further works for implementation

The present analysis was carried out based on a number of assumptions though with an attempt to fully reflect the detailed survey results by FAS. In the implementation stage, a number of critical issues will arise and accordingly modifications of the projection presented here will become necessary. The important issues for further stage would include the following:

- Actual contribution to be collected from farmers,
- Need for marketing maize collected as farmers' contribution, and
- Review of crop prices in the context of regional supply-demand balance.

Appendix 4

Nadzibolli Small-Scale Irrigation Project (NSIP)

1. Outline of Nadziboli Community

1.1. General Condition

Nadziboli is located in Angonia district, about 20km and 48km west of Domue and district center Ulongue. Its total population is 4,834, comprising 2,167 males (45%) and 2,667 females (55%), indicating emigration of male population seeking job opportunities outside the community. The farming population is 2,900. The local language spoken is Nyanja (100%). Out of the total farm area of 5,240ha, 3,275ha or 63% is cultivated. Farm area per capita is 1.8ha per farmer. The crops grown are maize, tobacco, beans, Irish potato, sweet potato, cassava, tomato, rape, garlic and cabbage. The level of commercialization is high in Nadziboli. The portion of maize sold is 10%. All the production of tobacco and paprika is marketed. The marketed portions exceed 75% for such crops as beans, Irish potato, sweet potato, onion, garlic and cabbage. There is no payment made in Mozambican metical. All the transactions are made in Malawian kwacha. The price of maize sold was 3 kwacha per kg for year 2000harvest, equivalent to MT840, assuming 1kW at MT280. This maize price was almost the average of the Study Area where maize price was between MT500/kg and MT1,500/kg.

The source of domestic water is mostly river water with 90% of the population depending on river water. The remaining 10% are served by shallow well water. The longest distance villagers have to walk for fetching water is 1km. Portuguese literacy at 30% is rather low in the Study Area where it ranges from the lowest of 10% up to the highest of 80%. There is no NGO active in Nadziboli. Nadziboli is situated at an altitude of around 1,700m. The community leader interviewed put the highest priority of development to health sector and second priority to agriculture among all sectors. Technical guidance is regarded as the most urgent task of farmers association, followed by financing. In 1980's, Angonia Agro-Industrial Complex (CAIA) opened a branch in Nadziboli, which was active for some time. The branch, however, had to be closed due to the civil war.

1.2. Strengths and Weaknesses

Strengths

a. There is a strong and good leadership.
b. Soil is very fertile requiring no fertilizer for crops.
c. Farmers acquired farming technology from Agro-Processing Complex of Angonia (CAIA) in 1980's.

Weaknesses

a. Farmers are not active enough to implement the ideas they have.

b. Access to market is limited.

2. Farmers Association (FA)

A farmers association has been formed already. The number of farmers who have signed up was 134 as of June 2001. This could rise to 300. It is agreed that 25 kwacha, equivalent to MT7,000 or 15kg of maize per farmer be contributed by farmers for FA activities. Key personnel have been selected already by vote, such as leader, sub-leader, accountant and office clerk. There is a farmer who might be able to act as a technical advisor on farming technology. Theoretically, Nadziboli FA will be able to raise approximately US$167 in case of all contributions made in kind or US$93 in case of all contributions made in cash.

3. Proposed Activities

The components of (NSIP) include the following:

(1) Joint purchase of farm implements such as watering can, hoes, axes and rakes

(2) Joint purchase of three each of hand pumps and pedal pumps for irrigation

(3) Construction warehouses

(4) Joint purchase of seeds and packaging materials

The background for proposing these activities is as follows.

(1) Farmers have technical basis acquired from the experience in working for CAIA to introduce new, but simple techniques.

(2) Nadziboli is an especially productive area even in Angonia district with fertile soil.

(3) Temperature is good for the recommended crops.

The crops and irrigation areas planned includes maize (45ha) for food security and paprika (15ha), beans (10ha), groundnuts (10ha) and sunflower (35ha) for income generation. Horticulture cultivation is planned in an area of 6ha for Irish potato, cabbage, tomato, garlic, onion and rape, each in one ha area.

4. Financial Management Plan

4.1. Cost

The cost of the Nadziboli small irrigation project is summarized below.

Cost for Nadziboli Small Irrigation Project

Item	(MT)	(US$)
(Investment)		
Tools & equipment		
Watering can	3,200,000	141
Peddal pump	3,360,000	148
Hand pump	3,360,000	148
Hoes	6,030,000	266
Axes	900,000	40
Rakes	2,700,000	119
sub-total	19,550,000	861
Warehouse	54,250,000	2,390
(Operation)		
Seeds	353,295,000	15,564
Packaging material	8,750,000	385
Total	435,845,000	19,200

Note. $=MT22,700 assumed.

4.2. Revenue

The total revenue by the increased crop production is estimated to be MT1,481 million or US$65,000 per year, assuming 10% of produce reserved for securing seeds for the next year's plantation.

Financial resource that will be made available by farmers contribution is somewhere between US$167 and US$93. Taking the mid-point, US$130 could be assumed.

4.3. Cash-flow Statement

Based on the costs and revenue estimated and other assumptions, a cash flow statement of NSIP is prepared as shown in Table A-4. This cash-flow statement shows that NSIP is a highly profitable project. The project will be able to return 100% of the loan borrowed at 10% interest in the second year. The accumulated surplus in the third year will reach 173 thousand US$. Once this project is successfully implemented, the cash surplus generated will be able to finance about nine projects of similar magnitude. NSIP has a possibility to boost rural economic development.

5. Further Works for Implementation

The present analysis was carried out based on a number of assumptions though with an attempt to fully reflect the detailed survey results by FAS. In the implementation stage, a number of critical issues will arise and accordingly modifications of the projection

presented here will become necessary. The important issues for further stage would include the following.

- Actual contribution to be collected from farmers
- Need for marketing maize collected as farmers' contribution
- Review of crop prices in the context of regional supply-demand balance

Table A-4. Cash-flow Statement of Nadziboli Small Scale Irrigation Project

(Unit: US$)

Item	Year 1		Year 2	Year 3
	First half	Second half		
(Profit and loss statement)				
1. Sales	0	65,200	65,200	65,200
2. Operating cost *(1)*	385	0	385	385
3. Depreciation	0	0	411	411
4. Interest payment *(2)*	0	0	1,907	0
5. Profit before tax	(385)	64,789	62,497	64,404
6. Tax	0	0	0	0
7. Profit after tax	(385)	64,789	62,497	64,404
(Cash-flow statement)				
8. Source of fund				
Profit after tax	(385)	64,789	62,497	64,404
Depreciation	0	0	411	411
Equity *(3)*	130	0	0	0
Loan	19,070	0	0	0
Total	18,815	64,789	62,908	64,815
9. Application of fund				
Investment	18,815	0	0	0
Repayment	0	0	19,070	0
Total	18,815	0	19,070	0
10. Cash surplus	0	64,789	43,838	64,815
11. Accumulated surplus	0	64,789	108,627	173,442

(1)Operating costs of the second and third years include that of packaging material. Seed cost is not included as the seeds for the second and the following years are to be provided by the previous year harvests.
(2) Assuming 1-year repayment at 10%/year interest.
(3) 50% of farmers' contribution at US$130 assumed.

Appendix 5
Luia School of Agriculture (LSA) Project

1. Outline of Luia Community

1.1. General condition

Luia is located in Chifunde district, about 38km southwest of district center and 154km southeast from the border with Zambia. Its total population is 8,918, comprising 3,923 males (44%) and 4,995 females (56%), indicating emigration of male population seeking job opportunities outside the community. The farming population is 2,407. The local languages spoken are Chichewa (70%) and Nyungue (30%). Out of the total farm area of 72,000ha, only 12,035ha or 17% is cultivated. Farm area per capita is 30ha per farmer. The crops grown are maize, tobacco, beans, groundnuts, cotton, sunflower, cassava, tomato, cabbage, nuts and lettuce. The level of commercialization is fair in Luia. The portion of maize sold is 50%. All the production of tobacco, cotton and sunflower is marketed. Harvests of other crops are self-consumed and sold half by half. All the payments for farm produce are made in Mozambican currency, metical. The price of maize sold was MT1,250 per kg for year 2000 harvest. This maize price was fairly high in the Study Area where maize price was between MT500/kg and MT1,500/kg. The road condition to market is good without any problem even in rainy season, whereas the road to district center is fair with no problems in dry season but with problems in rainy season.

The source of domestic water is mostly river water with 90% of the population depending on river water. Two boreholes serve the remaining 10%. The longest distance villagers have to walk for fetching water is 1.5km. Portuguese literacy at 50% is on average in the Study Area where it ranges from the lowest of 10% up to the highest of 80%. There is no NGO active in Luia. Luia is situated at an altitude of around 1,510m. The community leader interviewed put the highest priority of development to education, skill training, water supply, agriculture and transportation. The most urgent tasks of farmers association are joint purchase of ox carts and farm inputs and financing in their opinion.

1.2. Strengths and Weaknesses

Strengths

a. There is a good leadership and cooperation among community members..
b. Soil is fertile with pH 5.5 to 7.0.
c. Climate is suitable for agriculture with mean annual rainfall from 800 to 1,200 mm.
d. Luia is located at a nodal point with the roads going to Maravia district, Zambia, Tete and Furancungo.

Weaknesses

a. Luia is one of the least developed areas in Chifunde district.
b. There has been no NGO activities nor government extension service other than for tobacco for which Mozambique Leaf Tobacco is providing extension service..
c. Knowledge of farmers are limited in terms of diversification of crops, irrigation, watershed management, food preservation, construction of proper grain storage facilities and nutrition management.
d. Access to market is limited.
e. There is a tsetse fly problem.

2. Farmers Association (FA)

A paprika association has been in existence for some time. In addition a general farmers association was formed recently. The contribution collected amounts to 120 bags of 90kg, or 10,800 tons of maize. The number of farmers who signed up for joining the association was 600 as of June 2001. An appropriate size of the association would be 1,300. Farmers are ready to contribute either MT200,000 in cash or 90kg of bag per farmer to start FA's activities. Key personnel have been selected already by vote, such as chairman, vice-chairman, secretary, vice-secretary, accountant, vice-accountant and committee members. There is no farmer who might be able to act as a technical advisor on farming technology. Theoretically Luia FA will be able to raise approximately US$6,400 in case of all the contributions made in kind or US$11,000 in case of all contributions made in cash.

3. Proposed Activities

The following are the components of LSA:

(1) Construction of an agriculture school building, and
(2) Provision of courses on various subjects such as watershed management, sustainable farming technology, nutrition, farmers association management and civic education.

The reasons for selecting these components are as follows:

(1) Luia's location is favorable because of relatively easy access from other communities,
(2) Extension service is limited to that of Mozambique Leaf Tobacco and there is no other extension service available, and
(3) Farmers are ready to contribute labor, bricks and sand for building construction.

An appropriate set-up for LSA would be for the government to support Luia community in constructing the school building and for farmers to bear the cost of teachers' salary. It makes sense for the government to support this project due to its expected effects on a broader area not limited to Luia community.

4. Financial Management Plan

4.1. Cost

The total cost of LSA is estimated to be MT118 million or US$7,700, including MT105 million or US$6,860 for school building construction and MT12.9 million or US$840 for toilet construction. A teachers' monthly salary would be about MT1.8 million. Salaries for two teachers to be employed by the community would be MT32.1 million or US$1,900 per year.

4.2. Financial Arrangement

The proposed financial arrangement is as follows.

a. School building and toilet are to be built with the support of government with contribution in labor and building materials by villagers.
b. Teachers' salaries will be paid by school fee. Assuming a school fee at US$1 per farmer per year, the number of students required will be 1,900, which is equivalent to two to three farmers associations. Luia villagers might be exempted from fee payment.

5. Further Works for Implementation

Luia is one of the least developed communities in the Study Area. Since there have been no NGO activities and exposure to market-oriented activities has been limited, farmers are not accustomed to an organized way of promoting new types of projects. They are not ready to operate the newly established farmers association on their own. There should be strong support for the operation of their farmers association, e.g., by government or NGO. Considering this weakness, LSA would be better initiated and managed with external assistance. Once it is started, Luia will be able to become a major center of technological information dissemination in the western part of the Study Area.

In-Depth Studies on Promising Mineral Resources
(Related to Project No. 2.11)

More promising mineral resources in the Study Area have been identified by the Angonia region integrated development master plan. An in-depth study is cariied out on iron deposits, copper mining, Moatize coal mining, and non-metallic mineral resources including graphite, fluorite, apatite, and limestone.

1. Iron

There are several types of iron deposits in the Study Area, including magmatic deposits of residual liquid injection, pyrometasomatic deposits and metamorphosed sedimentary deposits. Each type of deposits is assessed for reserves and quality, and prospects are indicated.

1.1. Magmatic Deposits

(1) Resources

Magmatic deposits are related to outcrops of the Gabbro-diorite Complex of Tete, a basic rock complex some 150 km long and 50 km wide, where many large titanomagnetites outcrops occur, namely in the Massamba, Machedua, Txizita, Inhantipissa and Antiga Caldas Xavier. These outcrops appear as elongated bodies some hundred meters long and 20 to 80 meters wide, and are surrounded by extensive eluvial deposits.

Titanomagnetite is always associated with anorthosites and gabbros, with some tendency for location in the anorthosites, but near contacts with the gabbros. These deposits may be included in the type of deposits occurring in Canada, in the Allard Lake-Tio Lake region, and in the south of Norway, in the Egersund and Storgan-gen-Tellnes regions.

In the Machedua deposits, some of the most important in the Tete area, magnetite and ilmenite are associated and intergrowths of these two minerals are quite common, thus allowing the proper naming of these ores as titanomagnetites. Chemical paragenesis of these deposits is characterized by the presence of Fe-Ti and V, with practically no P. In polished sections, these titanomagnetites show the composition of ilmenite with 20% Fe, magnetite with 30% Fe and hematite with 50% Fe. As a whole, the titanomagnetites of Tete reported so far have an average composition of 50% Fe_2O_3, 18% FeO and 20% TiO_2 with about 0.60% V_2O_5.

In the ore, ilmenite takes the sharp form of grains, laminate and needles, with the latter two set in intergrowth with magnetite and hematite. In some outcrops, these needles may be 0.025mm long. In other cases, the ore is a granular ilmenite-magnetite association, with 1-2mm size grains as in the case in Cacanga, thereby allowing magnetic separation.

Evaluations of the larger titanomagnetites bodies, reported on the surface, suggest probable

reserves of 7,614,000 tons in Machedua, 12,337,500 tons in Antiga Caldas Xavier, 705,000 tons in Txizita, 8,648,000 tons in Massamba, and 11,750,000 tons in Inhantipissa, and possible reserves of 204,666,500 tons in total.

(2) Prospects

Due to the potential of these deposits, as attested by the above reported figures, their exploitation possibilities have been investigated; however, the main difficulties are their geographic situation and their high medium titanium content.

Despite the fact that, for normal metallurgical procedures, these titanomagnetites contain too much titanium to be exploited as iron ores, there have recently been some semi-industrial scale tests conducted in North America to estimate the value of these ores at the Machedua outcropping near the Tete railroad and the coal beds of Moatize. These tests, performed by the Strategic-Udy Processes Inc., consisted of pre-reduction of the iron ore in a rotating oven employing Moatize coal and electric fusion of the pre-reduced material. The tests' results were promising, indicating the possibility of local industrialization utilizing titanomagnetites for steel production at reasonable prices to compete with those of the international market, provided that the annual output reaches at lest 750,000 tons. Sub-products such as titanium and vanadium, whose industrialization may favor the exploitation of the reported deposits, were not considered.

The following factors encourage the commercialization of the deposits:

a) The grate titanomagnetite reserves known to exist in the Gabbro-diorite Complex of Tete, including not only the Inhantipissa reserves but also those of the Chifulo and Chacocoma rivers and those of the Marara region, on the south bank of the Zambezi River, not yet surveyed;

b) The immediate proximity of coal basins under exploration, such as the Moatize and the Chicoa-Mecucoe, where large coal reserves exist;

c) The current industrial exploitation of similar deposits in Canada and Norway, such as the ones of Allard Lake and the Egersund region; and

d) The possibility of obtaining low-priced electric power is to be examined, provided that the already planned hydroelectric exploitation plan of the Zambezi river is executed.

Segregation deposits of titanomagnetites are also reported at N'Cateuaacoa and Mt. Lutingo in the Changara region. At Mt. Achiza, nickel-ferrous magnetite occurs in the Quera river area.

1.2. Pyrometasomatic Deposits

(1) Resources

Deposits related to skarn (Pyrometasomatic contact) are common at the Fingoe System formations' outcropping between the Zumbo-Fingoe region and Mt. Muandi of the Tete region.

Most important of these deposits are those of Messeca at Mt. Muengue and of the Luzina river. The Messeca deposits including those of Mts. Tumba, Tchiconcue and Mancupiti were formed basically through contact phenomena of intruding granites and grandiosities involving the Fingoe System limestone.

Skarn zones were formed with epidote, hedenbergite, ferric garnets (andradite), diopsite, and grossularite, with subordinate tourmaline, vesvianite and wollastonite. Their mineralization is fundamentally magnetite and hematite, and copperulphides are very rare associates. Ore bodies occur as pocket or stratiform lenses, irregularly shaped and up to 200m long and 30m wide. The compositions of most significant samples of these iron ore bodies show up to 90% SiO_2, 65.3% Fe, 0.037% P, 0.50% Mn, null amount of S, and slight traces of TiO_2.

(2) Prospects

The deposits in the Zumbo-Fingoe region, dependent on granite and gramodiorite intrusions, generally do not attain a large scale formation. However, since there are many deposits and the magnetite ore is of particularly good quality, they are valuable and thus deserve further exploration.

1.3. Metamorphosed Sedimentary Deposits

(1) Resources

As for the reservoirs of metamorphosed sedimentary deposits at Tumba, Tchiconcue and Mancupiti, a preliminary study of the region has confirmed that reserves reach 500,000 tons and possible reserves 1,500,000 tons. The iron deposits of Mt. Muengue, located at the origin of the Muanzi river, are similar to the Messeca deposits, frequently carrying 55 % iron and 5.32-9.28 % silica.

Probable and possible reserves are more than 2 million tons in total. The Luzina river deposits, located about 34 km west-southwest of Fingoevillage, also belong to the same type but the mineralization of their bodies is mainly magnetite with some hematite or martite. Generally, they have higher iron contents than the aforementioned deposits and their compositions are 68.37-69.03% Fe, 0.76-1.97 % SiO_2, 0.07-0.31% Mn, 0.18-0.23% Cu, 0.03-0.035%P, up to 0.015% S, and 0.10-0.11 % TiO_2. Therefore, they are optimum quality ores with a high tenor of iron and practically zero contents of S, P and TiO_2.

Nevertheless, these deposits are much smaller with the total of confirmed and probable reserves of only 700,000 tons. The deposits at Mt. Muandi east of Mavduzi river also belong to the pyrometasomatic type, whose formation appears to be the result of metasomatism related to gabbro-diorite intrusions, as suggested by the percentage of TiO_2 content that reaches 2.86% in some cases. Their mineralization is mainly disseminated magnetite and hematite, occurring as small flakes, masses and blocks in the limestone probably of the Fingoe System, which, due to meteorization, free considerable quantities of magnetite thereby resulting in the extensive surface deposits 2-3m thick. These high tenor ore deposits have fairly considerable reserves, over 1 million tons of eluvial ore and more than 4 million tons in total. Considering that these are of sedimentary origin, the iron deposits, resulting from the regional metamorphism of old sediments, contain iron oxides, hydroxides or carbonates that gave magnetite and hematite. They are usually stratified and occur in parallel bands.

The Milange, Nhacungue, Muiu-a-Chipungo, Camitala and Vuzi river deposits of the Zambezi river basin belong to this type. The deposits of the Milange circumscription occur near the Ruo river, in the Majauare. They are bodies of coarse granular magnetite interstratified with gneisses and granite as lenticular layers. There are 19 mineralized areas in a 12 km long, 1.5 km wide band. They contain 68.18% iron, 0.67% phosphorus, 1.47% silica, and 0.01% sulfur. Their small reserves are about 100 tons.

The Milange deposits are similar to the Nhancungue deposits located at Metengo-Balame, near the border of Malawi. They are also similar to occurrences in Malawi, such as the deposits in Dzondzi and Mindalle Hill. Hematitized quartzites of the banded ironstone type are commonly interstratified with the Fingoe System rocks, north of Mt. Achiza, in a band that stretches from Mt. Camitala to the east, passing north of Mt. Zezulo.

(2) Prospects

In Mt. Camitala, the hematitezed quartzites seem to have a synclinal structure. They reappear in small outcrops in the Vuzi river area. The ore is relatively poor but is worthy of detailed study conidering the size of the mineralized zone

2. Copper

(1) Early exploration works

From 1978 to 1986, the production of copper concentration in Mozambique ranged from 557 tons/year to 1,303 tons/year. In the Study Area, the crystalline limestone of Chidue bears tungsten, rare earths, copper and gold mineralisation. Mineralized zones are concentrated just in the Mt. Chidue contact zone of carbonatite rocks with Tete gabbro and the norite complex. Davidite or Mavudzi mined in the Mavudzi mine occurs in calc-quartz veins in share zones. The copper reserves are estimated at 5.884 million Cu ore (5% in

grade) by geological institute of Mozambique. The copper ore minerals mainly consist of malachite, bornite and chalcopyrite in the carbonate (dolomitic) rocks on this field survey.

After several borings at 1980' USSR survey around Chidue area, the geologists calculated the copper reservation around Chidue. However, a detailed survey of the copper mineral concentration area and distribution of economical copper deposit by more than several hundred borings and chemical sample analysis is necessary. Data on the characteristics of the Chidue copper mine were available in various reports compiled in the past by Soviet Union, Portugal and other countries. The deposit is localized in the limits of southeastern part in the topographic map of scale 1:50,000 (SD-36/V-IV-No., sheet number 500, 1533 D1), in Massamba, 66km north of Tete city.

According to the old report titled Natural Direction of Geological Survey of Geology and Mines of Tete (in Portuguese, 1981), the copper occurrences in Chidue area were known for a long time, and these zones were exploited for oxides copper minerals (malachite: $Cu_2CO_3(OH)_2$) and sulfides (chalcopyrite: $CuFeS_2$, bornite: Cu_5FeS_4, chalcocite: Cu_2S). The last excavation can be discovered by several drilling wells, pits and trenches in development belt of carbonate rocks. During 1955-57, "General Chidue Mining Company" conducted prosecutions works with excavation of trench, cleaning and sounding survey. During the work, 25 wells of 45.7-361.0m of depth were drilled in this deposit, and in almost all of these wells mineralization zones of copper ore bodies were found. However, the 25 drilling survey was insufficient to complete calculations of the copper reserves.

In 1979, the next survey in this mining area carried out prosecution works at 1:50,000 scale, and valuation works at 1:10,000 scale for the ore development belt of carbonated rocks associated with copper occurrences. Prior to the survey, the works were analyzed by geo-chemical materials of General Chidue Mining Company and compound of iso-counter map of copper.

In 1981, extensive drilling surveys were carried out at Chidue deposit. The electrical prospecting by PI-113km was performed for four wells of 63.0m and 191.7m of depth, and the total depth of drilling reached 488.4m, collecting samples in 222 channels and 73 drilling samples.

After the surveys, the obtained geological and geophysical materials were analyzed, and the conclusions were reached that the Chidue deposit was probably small, for the copper ore body's length and depth were not significant, and that the Cu content in the feature should be limited. Therefore, despite the presence of high quality oxides cupper ore minerals developed in the depth of 15-100 meters, further detailed geological research for the Chidue deposit was judged unnecessary and no further drilling survey was conducted.

(2) Resources

Calculations on the ore reserves of Mt. Chidue were made on the basis of the 25-well survey performed by General Chidue Mining Company. For the calculation of copper, the following parameters were: limited copper grade equal to 0.3%; minimum thickness of metallic body equal to one meter, and volumetrically weight equal to 2.8. The ore body No.1 is crossed by four wells Nos.5, 17, 25 and 6. The ore body No.1 exists as a seam in concordant with dolomite. The extension of ore body has 450m in E-W direction (strike) and 467.5m in dip. The average thickness is about 7.98m with grade average of 1.78% of copper. The copper reserve tonnage of No.1 ore body is 83,670 tons. The No.2 ore body is crossed by the wells Nos.3, 4, 8 and 5, has a seam body extended 887.5m in the strike and 245m in the dip. The average copper grade is 1.07%. The reserve of No.2 ore body is calculated to be 11,890 tons. Wells No.2 and 12 intercept the No.3 ore body. The seam of ore body is 133m in the strike and 290m in the depth with average thickness is 1.7m. The average grade of copper is 2.24%. The No3 ore body has 4,500 tons of copper reserves according to the calculation. The well No.4 intercepts the No.4 ore body. The seam of ore body extended 115m in the strike and 90m in the dip with the thickness average is about 1.2m with 0.35% average grade of copper. No.5 intercepts the No.5 ore body well, and the seam of the ore body extends to 142m in the strike and 127m in the dip direction. The thickness of No.5 ore body is 1.37m on averages with 1.33% of copper grade. The copper reserve of No.5 ore body is 920 tons.

The reserves of copper in five ore bodies are calculated to be 101,160 tons, with the average grade of copper ranging from 0.35 to 2.24%. The class of the copper reserves according to the classification by URSS is category C2 (possible). The ore contains lead by cent, and the average gold grade ranges in 0.01-0.9g/t.

Another report on Mt. Chidue (Recourses Minerals of republic de Mozambique, 1993) indicates that the mineralized belt of this mine is concentrated with bornite, chalcopyrite, malachite, and native copper, extending from Mavudzi river to Massamba village, with length of about 7.5 km and variable widths. The five ore boddies' total reserves are calculated at 5.884 million tons with the grade of copper 1.72% and of gold about 0.5g/t as reported in the report after an additional boring survey.

(3) International markets

The market price of copper in 1999 started from very low ranging from US$1,400 to US$1,800 at the end of that year. The major copper producing countries were Chile (41%), USA (15%), Australia (7%), Indonesia (7%), Canada (6%), Peru (5%), Mexico (4%), and Zambia (3%). The total copper mine production was 10.64 million tons. The main copper refined producers were Chile (23%), USA (18%), Japan (12%), Germany (6%), and Canada (5%). The total refined copper production was 11.582 million tons in 1999. In

Table 1. Mt. Chidue Copper Mine Project Feasibility Study (CASE-1)

Copper price (US$/lb): 80
Gold price (US$/oz): 280

			-1	1	2	3	4	5	6	7	8	9	10	11	12	Total
Production		Unit														
Crude ore production		KT		490	490	490	490	490	490	490	490	490	490	490	490	5,880
Gold grade		g/t		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	2.70
Cu grade		%		2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	0.76
Waste ratio (dilution)		%		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Waste tonnage		KT		49	49	49	49	49	49	49	49	49	49	49	49	588
Total production		KT		539	539	539	539	539	539	539	539	539	539	539	539	6,468
Recovery ratio of gold		%		92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	31%
Gold production		Koz		13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	156.53
Cu recovary ratio		%		90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Cu production		Mlb		21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	261.33
Income																
Gold selling price				3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	43.83
Cu selling price				17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	209.07
Total selling price				21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	252.90
Gold smelting cgarge $/oz	1.00	US$10^6		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.16
Smelting cost (TC+RC) $/t.	80.08	US$10^6		0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	9.49
Costs Mining cost $/t.rock	8.00			4.312	4.312	4.312	4.312	4.312	4.31	4.31	4.31	4.31	4.31	4.31	4.31	51.74
Treatment cost $/t.ore	2.50			1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	14.70
G&A $/t.ore	1.00			0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	5.88
Stock money 7.5%				0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	3.62
Total on-site cost $/t.ore	12.92			6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	75.94
Royalty to Mozambique Govt.	3.0%			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.6
Cash cost		US$/oz		595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3
Operating profits & losses				13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	159.72
Depriciation				4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00			40.00
Profit before tax				9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	13.31	13.31	119.72
TAX (ISLR+ACTIVOS)	35.0%			3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	4.66	4.66	41.90
Profit after tax				6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	8.65	8.65	77.82
Summation rofit after tax		US$10^6		6.05	12.10	18.15	24.21	30.26	36.31	42.36	48.41	54.46	60.51	57.06	65.71	65.71
Capital costs																
Drilling survey cost					5% of capital cost											0.00
Mining/road constructing charge																0.00
Construction cost																0.00
Stock money	7.5%															0.00
Total of capital costs		US$10^6	40.00	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	3.80
Depreciation				4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	0.00	0.00	40.00
Cash-flow			-40.00	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	8.34	8.34	114.02

Project net present value (10%) = 17.0
Project IRR = 21.9%

Table 2. Mt. Chidue Copper Mine Project Feasibility Study (CASE-2)

Copper price (US$/lb): 80
Gold price (US$/oz): 280

			-1	1	2	3	4	5	6	7	8	9	10	11	12	Total
Production		Unit														
Crude ore production		KT		490	490	490	490	490	490	490	490	490	490	490	490	5,880
Gold grade		g/t		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	2.70
Cu grade		%		2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	0.76
Waste ratio (dilution)		%		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Waste tonnage		KT		49	49	49	49	49	49	49	49	49	49	49	49	588
Total production		KT		539	539	539	539	539	539	539	539	539	539	539	539	6,468
Recovery ratio of gold		%		92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	31%
Gold production		Koz		13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	13.04	156.53
Cu recovary ratio		%		90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Cu production		Mlb		21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	21.78	261.33
Income																
Gold selling price				3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	3.65	43.83
Cu selling price				17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	209.07
Total selling price				21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	21.07	252.90
Gold smelting cgarge $/oz	1.00	US$10^6		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.16
Smelting cost (TC+RC) $/t.	80.08	US$10^6		0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	9.49
Costs Mining cost $/t.rock	8.00			4.312	4.312	4.312	4.312	4.312	4.31	4.31	4.31	4.31	4.31	4.31	4.31	51.74
Treatment cost $/t.ore	2.50			1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	14.70
G&A $/t.ore	1.00			0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	5.88
Stock money 7.5%				0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	3.62
Total on-site cost $/t.ore	12.92			6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	75.94
Royalty to Mozambique Govt.	3.0%			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	7.6
Cash cost		US$/oz		595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3	595.3
Operating profits & losses				13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	13.31	159.72
Depriciation				4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00			40.00
Profit before tax				9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	9.31	13.31	13.31	119.72
TAX (ISLR+ACTIVOS)	20.0%			1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86	2.66	2.66	23.94
Profit after tax				7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45	7.45	10.65	10.65	95.78
Summation rofit after tax		US$10^6		7.45	14.90	22.34	29.79	37.24	44.69	52.14	59.58	67.03	74.48	70.23	80.88	80.88
Capital costs																
Drilling survey cost																0.00
Mining/road constructing charge																0.00
Construction cost																0.00
Stock money	7.5%															0.00
Total of capital costs		US$10^6	40.00	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	3.80
Depreciation				4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	0.00	0.00	40.00
Cash-flow			-40.00	11.13	11.13	11.13	11.13	11.13	11.13	11.13	11.13	11.13	11.13	10.33	10.33	131.98

5% of capital

Project net present value (20%) = 5.3
Project IRR = 26.0%

addition, Russia produced 0.505 million tons in 1999. The total production from the copper mine is 13.846 million tons according to World Metal Statistics (June, 2000). The average rate of increase in copper mine production was 4.7 % in 1999.

(4) Preliminary feasibility analysis

Based on the estimated reserve and quality as outlined above and other assumed conditions, the feasibility of the Mt. Chiude copper mine is analyzed at a preliminary level. Two cases are examined under different tax rates. Cash flow tables are given in Tables 1 and 2. As shown, the internal rate of return is calculated to be 21.9% if the tax rate is 35%, or 26.0% if it is 20%. The sensitivity analysis shows that the viability is most sensitive to gold prices and gold recovery ratios. The copper price is not highly sensitive to mining costs, separation cost and capital cost.

3. Moatize Coal

(1) Resources

Data on the characteristics of the Moatize coal are found in various reports compiled in the past by Soviet Union, Germany, Austria, Sweden and other countries. Interpretation of these data has been complicated by the fact that there are only partial descriptions of 700 drilled holes referring exclusively to coal seam intersections. Descriptions of seam partings, dolerites and burden volumes are not always available. Besides, the drilling data in most cases do not include information on the recovery of drill cores. In some cases, this recovery seems to have been very low and it is an area of concern. The Moatize coal is bituminous with medium to low volatility, a relatively high ash content, low inherent moisture, and high friability.

Quality

A summary of the planned washed coal qualities for Moatize coking and steam coal is presented below.

a) Coking coal

*Ash (dry basis)	9
*Sulfur (dry basis)	0.7 - 0.9
*Volatile matter (dbaf: dry basis, ash free)	26.4
Dilatometric index G	1.04 - 1,09
DDPM fluidity	500 - 800
Average reflective power of vitrinite	1.16 - 1.31
Composition balance index CBII	0.6 - 1.5
Strength index - SI	3.0 - 6.5

b) Steam coal

Minimum heat value (kcal/kg ar)	6,300
% Maximum total moisture	10
% Maximum ash (db)	16
% Ash (db)	16
% Maximum sulfur.	0.8
% Sulfur (db)	0.8
% Maximum volatile material (db)	22.2
% Minimum volatile material (db)	22.2
% Volatile material (db)	22
Minimum HGI	90
% Maximum nitrogen (daf: dry ash free)	2.0
% Maximum chlorine (daf.)	0.07
Ash fusibility (min. ℃) - Initial deformation	1,300 - +1,500
- Hemispheric softening	1,385 - +1,500
- Total fusion	+1,500
Ash composition (% max.) - Na_2O	0.03
- Na_2O+ K_2O	1.8
- Maximum size (mm)	25

The coal of Moatize mine is considered to be low volatile and bituminous with modest good coking properties in part but with high ash contents. Typical in-situ ash values are in the range of 20-34% (average 21%) with 0.5-1% sulfur. Its thickness is highly variable up to or in excess of 65m and the lowest 5m or so as found in the Chipanga seam that appears to be the most consistent of all the coalfields. The phosphorous contents are small, which also vary greatly. A number of coking tests have performed on selected samples (mainly from the lower Chipanga Seam), which have shown good coking characteristics in general although one or two have produced results which may indicate that in certain places the coking properties do not hold up.

Reserves

A summary of the Lithological sequence, from top to bottom, is presented below:

a) Argilous-arenous organic soil within average 0.30m in thickness;

b) Arenites and conglomerates intercalated with fine arenites lenses and carbonaceous siltites;

c) Siltites;

d) Arenites;

e) Siltites and arenites;

f) Tillites; and

g) Crystalline basement rocks.

Generally, the most influential geological features of the mining project are:

a) Shape and thickness of coal seams;

b) Hardness and thickness of overburden and of interburdens;

c) Faults with displacements over 30m; and

d) The occurrence of dykes splitting the seams.

Figure 1 shows a vertical transverse cut in relation to the synclinal axis showing the coal seam sequences and their inclination. The six sections have been identified as most suitable for mining in the Moatize region. Table 3 presents the in-situ geological reserves as calculated by the geology working groups. It shows different in-situ, cut-off, strip ratios for different levels of geologic reserves. Taking into account the fact that South African open-pit mines operate on variable strip ratios from 3.5 of 6.7, the blocks under consideration could be exploited for open-pit mining because they present significant reserves for the 5:1 limit of strip ratio. It was found that for comparable underground cost, the breakeven strip ratio cut-off for all the blocks is 6.7:1.

Figure 1. Vertical Section of Moatize Coal Mine (Section 1 and 6)

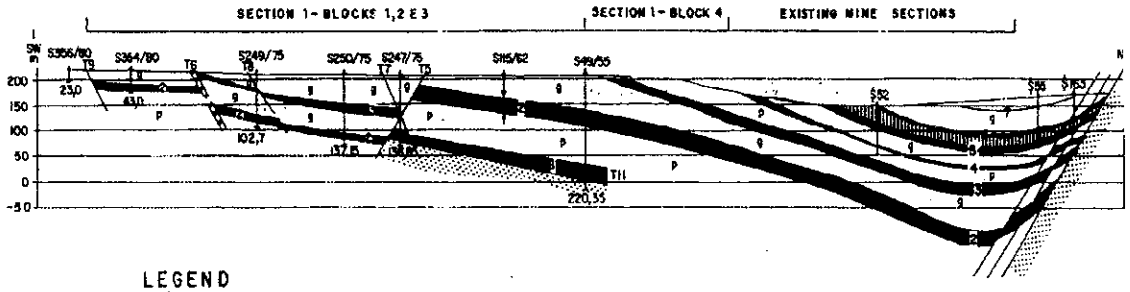


Table 3. In-situ Coal Reserves in Mining Sections of Moatize (ton x 10^6)

Seams	Section1	Section2A	Section3	Section4	Section5	Section6	Total
Andre	—	—	—	1.29	3.52	6.15	10.96
Grande Falesia*	—	—	—	14.93	25.08	52.93	92.94
Intermedia	—	—	—	34.95	30.54	46.85	112.34
Bananeiras*	37.09	—	—	66.47	87.06	214.06	404.68
Chipanga*	85.85	143.44	99.61	241.48	232.02	530.06	1,332.46
South Pinto	156.19	—	66.40	119.54	66.8	83.84	492.83
Totals	279.13	143.44	166.01	478.66	478.66	933.89	2,446.21

*Coal seams of economic interest

Mineable reserves

After completion of the geological calculation of reserves, the calculation of mineable reserves was performed in accordance with the following criteria:

a) Open-pit mining production costs should be less than the corresponding costs for underground mining using a large TRANS-NATAL colliery for comparison;

b) Costs could not exceed the breakeven point value.

The economic limit for open-pit mining is such that open-pit mining production costs are equal to underground mining costs. The limiting strip ratio, therefore, represents the condition in which marginal cost is equivalent to underground or breakeven cost. The operational costs for open-pit mining were calculated for several cut-off ratios and then compared with the US$6.40/t ROM operational cost for underground mining provided by TRANS-NATAL. This way, a maximum strip ratio of 6.7:1 has been determined for all the blocks. To calculate mineable reserves, the mining plan has been defined taking into account the three seams: Chipanga (CC), Bananeriras (CB) and Grande Falesi (CG). Taking 5% mining losses into account, the mineable reserves are estimated at 1.56 billion tons of in-situ coal as presented in Table 4.

In section 2A, the mineable reserves appear larger than those revealed by geology. This is due to the fact that the geological calculations did not include the sill area overlying the Chipanga seam. Part of this reserve has been included in mining activity calculations, on the assumption that part of this area will be utilized during operations.

Table 4. Mineable Reserves of Moatize Coal Mine

Section	Block	CG (Chipanga)	CB (Bananerirs)	CC (Grand falsi)	Overburden (BCM x 10^3)	Average strip ratio (BCM/t)
Section1	81N		17.954	38.511	118.474	2.10
	81S		1.828	25.698	50.412	1.83
Section 2A	82N			64.147	149.742	0.79
	82C			105.600	247.756	1.41
	82S			98.457	31.178	2.52
Section3	B3			87.457	77.326	0.36
Section4	84E		15.412	51.100	174.25	1.16
	84W	10.750	27.257	66.710	20.805	1.66
	84S			19.73	255.150	1.05
Section5	85N	19.410	63.476	99.126	216.654	1.40
	84N	1.313	14.075	100.577	333.357	1.87
Section6	86N	9.729	57.123	201.303	175.218	1.24
	86C	8.389	42.503	117.416	322.109	1.04
	86S	19.045	74.972	103.348	2,222.684	1.63
Sub-total		68.636	314.600	1,179.188		
Total coal reserves				1,562.424		

(2) Coal mining plan

Implementation schedule and scale

The project may be implemented on the schedule shown in Figure 2, which presents the timetable of Moatize coal mining implementation prepared by a Brazilian consulting firm (Companhia Vale do Rio Doce and TRANS-NATAL Coal Corporation Limited).

Figure 2. Timetable of Moatize Coal Mining Implementation

	Year					
Activity	-3	-2	-1	+1	+2	+3
Pit B-3 Project						
Pit B-3 contracts						
Construction and transport						
Assembly and pre-operation						
Start-up of excavations						
Start-up of production						
Pit B-2N Project						
Pit B-2N contracts						
Construction and transport						
Assembly and pre-operation						
Start-up of excavations						
Start-up of production						

The original production rate of coal is 22 million tons per year. At the beginning of the year-3, the project preparation will be started before Sena line rehabilitation. In case of mining, preparation includes equipment purchase and operational planning for first years of operations. After facilities are installed, initial activities will be restricted to inspection of manufacturing, equipment transportation and assembly and pre-operation tests. Pre-operation tests should always start one year prior to the start of production, and excavations should start six months before production starts for each pit. With this mining operation method, the ROM should be less than US$10/ton and salable irrespective of transportation excess charge.

As the maximum capacity of rail transportation by the Sena line is one million tons/year initially or up to six million tons/year at each stage of the project, the coalmine exploration should be able to produce the maximum six million tons/year in the first several years. If the open-pit mining could not be operated at Moatize mine for some reason, the maximum production of coal would be under one million tons/year with several incline shafts using an old mining operation method. The price of ROM would not become lower than US$15/ton for inefficient mining operation.

Production cost and price estimate

Coal was produced in the Moatize coalfields between 1949 and 1982, and at its peak the production from several underground mines (Chipanga 1~11) reached 575,000 tons/year. The total production during the 33 years was only 7million tons or 0.3% of the total coal reserves in Moatize coalfields. Production ceased soon after the closure of the Sena railway line. Moatize coal deposits represent a very large reserve of coking coal, and are the only known high-grade coking coal deposits in Africa. Numerous studies have shown that the coal can be washed up to a 10% ash content with acceptable yields. The production cost and prices of Moatize coal are estimated in the Table 5.

Table 5. Moatize Coal Production Costs and Prices

A. Coal reserves	
1. In-situ reserves	2,440 million tons
2. Mineable underground reserves (Max depth =18m)	640 million tons
3. Mineable underground reserves, Section 5 & Central	77 million tons
4. Mineable open cast reserves (Max overburden ratio= 5)	714-1,565 million tons
B. Yields	
1. Indicative yield of clean coal-underground	95%
2. Indicative yield pf clean coal – open cast (Chipanga bottom slice)	60%
3. Indicative yield of clean coking coal, 10% ash (MC10) (Underground, Chipanga unit 1)	47%
4. Indiicative yield of clean steam coal, 16% ash (SC16) (Underground Chipanga unit1)	15%
5. Indicative yield of coking coal, (MC10) (open cast, average total seam)	32%
6. Indicative yield of steam coal, (SC16) (open cast, average total seam)	7%
C. Estimated costs	
1. Prod/saleable ton, underground, FOR Moatize	US$16.32
2. Prod/saleable ton, open cast, year 1, FOR Moatize	US$10.82
3. Prod/saleable ton, open cast, year 10, FOR Moatize	US$17.57
4. Estimated rail transportation cost to Beira (per ton)	US$13.50
5. Estimated port handling and loading cost (per ton)	US$4.00
6. Estimated sale price coking coal MC10, FOB Beira (per ton)	US$43.00
7. Estimated sale price steam coal SC16, FOB Beira (per ton)	US$27.00

(3) International market

Coal prices

Coal reacts readily with oxygen in the atmosphere, and this results in a notable reduction in coking properties on stockpiling over relatively short periods of month. As can be seen in Table 6, there has been a steady decrease in coal prices in all the market segments over the last five years. Looking back further in history, coal prices remained more or less stable,

and in January 1986, the benchmark price was US$33.50. These long-term trends show that prices have not only been falling in real terms but also in nominal terms over a very long period.

Table 6. Benchmark, Spot and Average Australian FOB Value Movements

Price segment of world coal	Unit	1995	1996	1997	1998	1999	Total change (%)
Japanese benchmark JFY*	US$	40.30	40.30	37.65	34.50	29.95	-25.70
Spot price ex Newcastle (as of June of each year)	US$	37.50	36.00	30.00	23.00	23.50	-37.30
Ave exports FOB prices for Australian thermal coal to Asia	US$	35.70	38.38	34.57	31.26	27.16	-23.90
Ave exports FOB prices for Australian thermal coal to Asia	A$	48.28	48.94	46.94	49.61	42.80	-12.80
Ave exports FOB prices for Australian hard coking coal to Asia	US$	47.47	51.07	50.75	47.70	38.25	-19.40
Ave exports FOB prices for Australian hard coking coal to Asia	A$	64.21	65.09	68.99	75.77	59.29	-7.70

*JFY prices quoted for Japanese fiscal year.

Response by coal suppliers

Although prices have fallen steadily over the last five years, export coal sales have continued to increase in exporting countries including Australia, Indonesia and China with the exception of Canada, South Africa and the USA, which have lost market share (Table 7).

Table 7. Coal Imports by Exporting Countries

(Mtpa: 10^6 t/year)

Countries	1995	1996	1997	1998	Share in 1998 (%)
Australia	96.2	100.8	114.1	116.4	50.35
Canada	32.0	33.0	36.0	34.0	14.71
China	24.7	26.7	27.7	27.9	12.07
Indonesia	19.5	21.3	25.4	30.8	13.32
South Africa	20.7	18.7	17.1	12.0	5.19
USA	14.4	15.2	12.5	9.2	3.98
Total	207.4	215.7	232.8	231.2	100.00

Note: The drop in South African share to Asia is partly offset by its increased sales to markets in Europe and India.

There have been a few mine closures, however, to survive in the climate of falling prices. Mining companies have rationalized onsite operations, increased productivity and restructured corporate services. They have also been more flexible in establishing strategic joint ventures with neighboring leaseholders to improve extraction efficiencies and optimize reserves and infrastructure.

Governments have responded by reducing port and rail costs and in some cases increasing export rebates or eliminating hidden royalties. Rail freight reductions have occurred in Australia, Canada and South Africa while reduced hidden royalties or increased tax rebates have been offered by Australian and Chinese governments.

Rail and port infrastructure in Australia and South Africa is now mature. Although there have been few new greenfield projects in the last few years, several new low capital cost start ups with contractor support have taken advantage of proximity to rail or ports or towns to increase total production capacity. Brownfield expansions have been more common with a doubling of capacity in some cases with an incremental capital outlay compared to initial project development.

Currency devaluations have also assisted in reducing the impact of falling US dollar prices on Australian, Canadian, Indonesian and South African producers. The Indonesian producers however, have had cost exposure mostly in US dollars and therefore have not benefited as much as Australia, Canada and South Africa. Producers in the USA have had negative impacts on coal supply to Asia due to competitive pressure from currency devaluations in other export economies. Table 8 shows currency movements by the competing coal producing countries.

Table 8. Currency Movements for Asian Coal Suppliers

Country	Unit	1995	1996	1997	1998	1999	Annual change
Australia	A$1.00=US$	.7415	.7829	.7441	.6294	.6464	-2.71
Canada	C$1.00=US$	.7288	.7335	.7224	.6748	.6718	-1.62
Indonesia	US$1.00=RP	2,249	2,342	2,929	10,014	8,003	-22.42
South Africa	R1.00=US$	.2757	.2342	.2172	.1824	.1639	-9.88

The next result is reductions in FOB costs, which have matched or exceeded in some cases the reduction in export prices. These issues will be discussed below.

Mine closures

Mine closures have been minor with a limited number experienced over the last five years purely as a result of low export prices. Mines included in this category in Australia, Canada, and South Africa represent capacity of less than 6 million tones over the five-year period. In the USA several mines on the West Coast have either closed or redirected sales into the domestic market.

In many cases mines have closed and have been reopened by entrants acquiring the assets at a fraction of their original book value. Mines in this category in Australia are Brimstone, Clarence, Cook, Ellaong/Southland, Gretley/New Wallsend, Metropolitan, and Tahmoor. In Canada these mines include Elkview and Smoky River. Although these mines have opened at lower production rates constrained mostly by lack of higher priced contracts,

they are still producing at sizable rate, and capacity is available if market demand and prices increase.

(4) Restructuring of coal industry

Company rationalization

Most major coal exporters have significantly rationalized their operations over the last five years, including Rio Tinto, BHP, Mt. Isa Mines, Shell, Billiton, Fording, Tek, Luscar, Peabody and Cyprus. The rationalizations have included dramatic change to on site work practices with the introduction of enterprise agreements, the use of multi-skilling and work place redesign, head office rationalization and the increasing use of contractors and consultants to outsource non-key components of the work place.

For example, Anglo Coal in South Africa has increased turnover per employee by 12%, while profit per employee has increased by 8.2%. The BHP Central Queensland and South Coast mines in Australia have reduced the total labor force by up to 40% in the last two years. Extents of improvement vary by company and country but FOB costs are usually reduced at rates between 15% in US$ terms for some South African mines and 35% in US$ for some Australian mines. These savings have helped to offset the reductions in benchmark price of 25.7% in US$ terms over the same period.

Several new Indonesian producers have not only changed structure but due to high debt levels, have had to relinquish mine leases and assets to project bankers. They include PT Berau, PT Indominco Mandiri, and PT Bukit Baiduri. However, their mines have not ceased production and operate until they are sold to a new owner at a reduced capital value that reflects current pricing and reduced demand. It is important to note that the above Indonesian mines have not only been hampered by poor export pricing but have also suffered an additional penalty with the collapse of the IPP program and deferment of rapid growth in the domestic coal market.

Rail freight/government charges

The governments of the exporting countries have also assisted in reducing export costs. In China, this has occurred through the increase of a tax rebate from 9% to 13%, which offsets the company value added tax of 13%. The Chinese government has also upgraded rail and port capacity by eliminating bottlenecks, increasing electrification and the number of tracks on major rail corridors, and sponsored port expansions and new rail routes from the Shenmu and Shanxi coal fields.

In Australia, the Queensland and NSW governments have reduced costs and increased competition by allowing private rail operators. They have also reduced hidden royalties and rail access charges. Costs in NSW have reduced by over 20% on most lines and to most mines over the review period. In Queensland, costs have been reduced by up to 60%

for some Central Bowen Basin operators due to a change in hidden royalty payments.

In South Africa, Railink has reduced costs to RBCT from an average of US$7.97/ton in 1995/96 to US$5.29/ton in 1999/2000 a total reduction of 33.6% through increased productivity, improved capital utilization and reduction in bottlenecks.

In Canada, rail freights for metallurgical coal in particular have fallen from approximately C$18 to C$14. This is a result of the rail carriers trying to maintain rail throughput by supporting the coal producers. Thermal coal has also benefited by rail freight reductions but not to the same extent as metallurgical coal.

Most of these changes have been possible due to increased throughput, new technology, labor rationalization, improved capital utilization and increased private competition of both rail and port facilities. Although unit revenues have fallen total revenue has increased due to the additional tonnage and throughput.

Brownfield expansions/greenfield development

There have been very few greenfield development projects over the last five years and a number of potential projects are now in abeyance until the current market oversupply is in better balance. The bulk of new projects have been developed in Australia and Indonesia and these two countries have had the largest share of increased exports to Asia in the same period. A number of newly developed projects were based on decision making from 1992 to 1995 when coal prices were slowly rising. Under the current low price climate, it is unlikely that some of the larger capital-intensive projects would be approved.

In Australia, the new greenfields projects include Bengalla open cut mine in NSW, Mt. Owen open-cut mine in NSW Oaky, Creek North underground mine in Queensland, Newlands underground mine in Queensland, Crinum underground mine in Queensland, South Walker Creek open cut mine in Queensland, and Coppabella open cut mine in Queensland.

The latter two mines are typical of the new style of low capital entrants, which are able to utilize existing mature infrastructure in the form of rail and port facilities. There will likely be several more of these low capital cost entrants, for which new towns for mines or port facilities to establish production facilities no longer must be built.

These mines will make it difficult for major capital expenditure projects as they have opened up options for new entrants, which more easily achieve a return on investment in a low price environment.

In South Africa, the only new greenfields projects were TESA Forzando and Dorstfontein collieries. The remaining increases in capacity have been brownfield expansions. China has been very active in development of major new greenfields coal projects. Some of these projects have also received the support of Japanese energy loans. A number of these

projects will have new capacity targeting the growing domestic market with the new power stations being built along the Southern Coastline but also the export market to Japan, South Korea, Hong Kong and Taiwan. Those projects currently underway include:

- large Shenhua project in the Shenmu/Domngsheng coalfield with associated rail, port and shipping infrastructure;
- Jining No2 and Jining No3 underground coal mines being developed by the Yanzhou Coal Mining Group;
- Anjialing open cut mine being developed by the Pingshou Mining Administration.
- Chensilou and Cheji underground mines being developed by the Yongxia Coal Mining Administration; and
- Fucuan underground coalmine being developed by the Zhaozhuang Coal Mining Bureau.

Brown fields expansions have occurred at a number of bureaus including Daizhuang and Xuchang underground coalmines in the Zibo Coal Mining Bureau in the Shandong province.

In Indonesia, a number of new projects have been developed over the last five years. These include a number of mines all on the island of Kalimantan:

- PT Indominco Manidiri,
- PT Berau,
- PT Sebuku,
- PT Bentala,
- PT Kendilo, and
- PT Gunung Bayan Pratama.

Most of these mines were developed to underpin rapid export and domestic market growth forecast from 1998 to 2005. However, due to the Asian economic crisis, which has had a negative impact on domestic demand in Indonesia and falling export prices these mines have been left with high levels of US dollar debt that cannot be serviced by the low income streams currently experienced in the market. These mines are now in the hands of administrators or the mining titles and assets have been returned to the project banks. The mines should continue to operate but rapid expansion plans will be curtailed and the mines will need new owners to refinance debt before further expansion of capacity can take place.

Mergers/acquisitions

Mergers and acquisitions have been a feature of the supply structure in the last three years. Acquisitions in particular have continued on a global scale with companies like Rio Tinto, Glencore, Billiton, Anglo Coal, and RAG of Germany. This activity has mostly been concentrated in Australia, South Africa and Canada while the operations in Indonesia have remained with the original companies or project banks.

At present a large number of mines are up for sale in Australia, which include the Shell Coal group of companies, the North Goonyella mine, the Cyprus Coal, and the remaining ARCO Coal assets. The same key players as listed above are expected to be interested in these assets, and will further establish their positions in the Asian coal industry.

The advantage of a strategic acquisition or merger is that it provides the opportunity to further reduce mining costs or increase revenues by capitalizing on synergies of assets, infrastructure and marketing power. A good example of this is the merger of the Coal & Allied and Novacoal assets in the Hunter Valley. The two mines in the new Coal & Allied structure that have benefited with lower costs of up to 25% in the last 12 months are Hunter Valley No1 and Howick mines which have adjoining lease boundaries. These mines now have only one mine management and one technical services group, and share maintenance facilities and mining equipment across the combined lease. This, combined with the opportunity to rationalize on-site labor, has resulted in significant and sustainable cost reductions for the combined new mine, which is Hunter Valley Northern Operations. Rio Tinto also acquired the Kestrel hard coking coal mine in Queensland from ARCO. This now allows Rio Tinto to have a strong supply presence in the metallurgical and thermal coal markets with supply alternatives from NSW and Queensland. This presents a number of options for buyers of Rio Tinto products and further established the company as a key coal supplier to Asia.

Other changes include the acquisition by Billiton of the Coal Operations of Australia, making Billiton the largest thermal coal producer in the ASEAN region. Billiton is continuing to investigate other opportunities that combine synergies with their existing assets. Consolidation of Canadian coal exporters has also occurred in the past five years, decreasing the number of companies from six to three. This has provided the Canadian suppliers with increased market flexibility to supply from several sources and coal types.

(4) Changes in existing coal production and mining capacity

Some coal exporters in Australia, Canada, Indonesia, and the USA have chosen to limit production to service higher priced contracts and reduce additional tonnage that may have been sold into spot markets. These mines have considerable latent capacity that has been increased by improvements in capital and infrastructure utilization but has not been committed to production. Though it is difficult to estimate the total latent capacity currently available, it could easily be in excess of 30 million tons/year. This would require no additional capital but some changes in rosters and production schedules to shift to seven-day operation or in some cases from three to five-day operation. This latent capacity will meet current demand and expected short term increases from ASEAN countries.

A combination of this latent capacity and low prices will limit expenditure on major greenfields projects over the next three-year period. Although suppliers have managed to

curtail costs as prices have fallen, the reduction has had a negative influence on confidence in new investments and reduced any reasonable returns on capital expenditure.

The major mining projects currently on hold are:

- Kayuga, Maules Creek, Wyong and Glendell in NSW,
- Togara North and Hail Creek in Queensland,
- Cheviot, Willow Creek, Telkwa, Tsable River in Canada, and
- Expansions at PT Kaltim Prima, PT Kideco, PT Berau and PT Indominco Mandiri.

It is important to note that South African market share has fallen to Asia; however this is not a function of reducing capacity but of increasing coal sales to Europe and India. The South African interest in coal sales to Asia is dependent on access to better-priced markets to Europe and India. In late 1999 the South African producers were looking to increase sales to the Asian markets due to increased competition in the European market from Russian, Colombian and Venezuelan supply.

Producers in the USA are swing suppliers to Asia but have been squeezed out of the market due to currency movements and increased productivity from other supply countries. It is not attractive to supply coal from the West Coast markets, mostly due to transport costs. Mines supplying into this market have either re-entered the domestic coal market or placed mines on care and maintenance until export revenues become more attractive. These producers in the USA must be considered as an upside constraint on prices as they will quickly re-enter the market if thermal coal prices increase to a point where exports become more profitable. At this point a significant tonnage of exports will become available and would have the immediate effect of capping price.

(5) Conclusion

Table 9 shows the pre-feasibility calculation of the new Moatize coal project from the starting of operation to 25 years later. The coal mining of Moatize coalfield should be the highest potential in Angonia region among other metal and non-metal deposits in this area. The two major companies (JC in South Africa and Austral coal) and national coal mining offices have been waiting for the restoration of Sena line for many years. The open cast operation has a scale merit of coal mining operation rather than underground mine. Even if the Sena railroad has the maximum capacity of transporting about 3 million tons/year, the coal should be transported by newly reconstructed road from Moatize to Beira through CAIA and Dondo along the Sena line. All in all, Moatize coal has good economic advantage in the world coal market. When the Sena line is completed, several companies will start to operate coalmines in Moatize. Considering the maximum limit of transportation capacity of the railroad, the maximum production should be three million tons/year. Table 10 shows a case of four million tons/year with the use of 1.2 million-ton coal for new 100MW power generation in Moatize. This will also result in high IRR.