6.5 Verification of the Erosion Hazard Map

(a) Outline of the Area Studied

The following table shows the monthly rainfall records from December 1999 to April 2000 at six observatory gaging stations in and around the SA. The mean annual rainfall in these records gives 820 mm with monthly maximum, 251 mm falling in January. According to the result of an interview survey ordinary rainfall occurred the last season bringing about favorable harvest of maize. Limbe city seems more active in cereal trade than last survey period. Maize was already harvested in the SA, where pigeon pea and few others still remain in the field. Current crop growth in the SA shows a remarkable contrast between two parts crops divided by the highway M6 running in the center of the SA from north to south. In the eastern side of the highway, pigeon pea and millet mixed-cropped with maize, bear grain and groundnut or vegetables are also cropped. In the eastern side, pigeon pea just began flowering and the crop growth seems retarded than that in the western side. However, weeds thrives in most part of cropped and fallow farmland in the DSA, showing drastically different scenery from that in last dry season. Site survey was made mainly at ten sites where soil run-off was measured, however, observatory tracing of soil erosion caused by rainfall was difficult due to thick coverag of weeds. By the way, paddy cultivation was observed in some parts of marshy area of Chileka Dambo and periphery of Mbvoniha reservoir (Makata TA).

Table 6.1 Monthly Rainfall Data at Six Observatory Stations

(Dec. 1999 – April 2000)

(Unit; mm/month)

Gaging Sta.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Chileka	78.4	268.6	205.7	90.3	16.4	659.4
Chichiri	92.8	312.2	339.6	127.3	32.1	904.0
Makoka	37.5	170.3	238.8	120.2	n.a.	566.8
Chiradzulu	61.9	377.2	229.2	111.5	n.a.	779.8
Zomba	112.8	211.5	191.1	133.5	176.9	825.8
Chingale	129.5	223.3	215.0	157.4	n.a.	725.2
Average	85.48	260.52	236.57	123.37	58.97	764.91

Source: The Director, Meteorological Department ,Chileka

(b) Results of on-the-site Measurement of Run-off Soil Amount

The measurement of run-off soil amount was made for the period of around 60 days, from 17 December 1999 to 11 February 2000, by the cooperation of one of the counterparts of DF, Mr.J.Mwampulo, at ten selected site, six times per site.（refer to II-E,Table E.1of the Annex）. Table E.2 of the Annex gives the summary of measurements at these sites, of totalling six times. The data collected at ten different sites have a wide variance depending on topographic gradient, soil texture, vegetative cover, configuration of measured parcels, number of rainfall status and rainfall intensities, with the maximum run-off taking place at site No.6 in Fred village of Makata TA. Acording to a site interview, rainfall was higher than average year during the period of measurement. Besides, the measured plot was not tilled with contour ridge nor rectangular section ridge, so the downward running ridges served as drains that fostered more runoff from the plot. Whereas, site No.2 at Kabango village in KuntajaTA, site No.8 Likhoswe village in Machinjiri TA and site No.10 Nakhwala village in Mpama TA where the runoff soil amounts were less than 1ton/ha had been tilled with box ridges that retained rainwater and controlled the soil runoff down to the plots, thus minimzing soil loss. Also, distribution of soil particle size in the case of Sandy Lithosol shows predominance of coarser size, about 50% of the total accounting for the size coarser than 2mm. This is followed by the size of 0.85mm, 0.425mm accounting for both around 25% each. Particle size distribution of Lateritic soil has finer texture, with only about 20% of the total accounting for the size over 2mm and that of 0.85mm, 0.425mm accounting for 25% and 55%, respectively. Likewise, as to size composition of an Entisol found in the Site No.10 as cited above,

72% of the total has particle size of 0.85mm or less.

(c) Results of the Measurement of Soil Particles suspended in River Flow

During the same period as mentioned above, five times of measurements were conducted with the cooperation by the same counterpart to measure concentration of soil particles suspended in river flow（refer to II-E,Table E-3.of the Annex）. The results were compared with those of "National Environment Action Plan" carried out by the World Bank in 1999. The study measurement indicates a value five times as much as those obtained by the survey of the WB.

Table 6.2 Results of Measurement of Suspended Soil Particles in River Flow

Site of measurement	Measured weight	Results obtained by NEAC
Lirangwe RGS IC	100-1,200mg(640ppm)	-
Lunzu RGS 109	200-1,500mg(680ppm)	200-300mg(250ppm)
Kamuzu Barrage (Shire River)	-	100-200mg(150ppm)

An HQ (water level~flow quantity) curve at the observed site that was obtained in 1999 suvey was used for the estimation of river flow quantity from the reading of water gauge. The river flow quantity is roughly estimated at 5.85MCM for Lirangwe river, and 1.97MCM Lunzu river during the observation period. Calculating from these flow quantities and measured concentration of suspended particles, the load of annual soil runoff comes to around 7 thousand tons (refer to Annex II-E, Table E-4).

6.6 Revised Erosion Hazard

Based on the newly provided topographic map (1/20,000), erosion hazard estimated in the first year home work is reviewed and finally revised. In reviewing this, the same empirical formulae by "SLEMSA", Soil Loss Estimation Model for Southern Africa was applied, but the following items were revised.

- The size of the section was changed from 1km x 1km to 500mx 500m
- Accompanying with the change into 500m section, topographic gradient was recalculated to obtain more detailed estimation of erosion hazard
- As to other factors inclusive of vegetation cover, these are inputed into the 500 m section using the same values.

(a) Topographic Gradient

The result of calculation by 500m section is given in Table 6.3, where the number of section adds up to 2882, of which gentle slope with less than 4%(2.3degree) accounts for around 77%, while mean gradient comes to 3.47% (2.0degree), implying that flat portion occupies major part of the SA. Though a few mountaneous landscape with the gradient steeper than 25%(14degree) is observed in Small Michiru located in north-western SA and in Ndelande moutain, such portion covers only 0.2% of the total area of the SA.

Table 6.3 Distribution of Topographic-gradient from 500m Mesh Section

Rank (%)	No. of mesh	Total	Average (%)
Less than 1.0	194	138.19	0.71
1≦ ～＜4	2,016	4,560.36	2.26
4≦ ～＜8	447	2,530.21	5.66
8≦ ～＜12.5	148	1,466.7	9.91
12.5≦ ～＜17	49	695.72	14.20
17≦ ～＜25	22	446.9	20.31
≧25	6	166.25	27.71
Total	2,882	10,004.33	3.47

(b) Comparing the Results of Soil Runoff Measurement with Calculated Erosion Hazard

Table 6.4 shows the comparison between measured runoff soil weight during the period from Dec. 1999 to Feb. 2000 and calculated values for the same sites. The calculated values for site No.2, No.7, No.8 and No.10 where box ridges were practiced are quite different from the measured soil runoff. The difference is likely attributable to the failure of selecting right value of soil erodibility for these sites. In SLEMSA, value of soil erodibility factor (F) ranges 3.0～7.5 depending on the combination of soil types with tilling methods (contour ridge), but box ridge is not considered. It is predicted that this value will take higher value (i.e., less erodible) in the case of field where box ridges are practiced, judging from the measured quantities of soil runoff. Yet, the discrepancy between the calibrated values and measured ones lies in the range of 20%～30% (larger for calibrated ones) at the sites where contour ridges are practiced. Taking account of the fact that the measurement was actually made in March while the maximum runoff is predicted in January, empirically derived formulae of SLEMSA can be served as an estimation tool of soil runoff from the plots tilled with contour ridges in the SA.

Table 6.4 Comparison between Measured and Calibrated Values for Soil Runoff

Measurement site	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10
Section lattice (x) (y)	6.5	02	09	16.5	16	25.5	18.5	22.5	28.5	27
	89	79	71.5	75.5	68.5	79.5	62.5	60.5	76.5	72.5
Erodibility	5.5	7.5	6.5	7.5	5.5	5.5	7.5	8.5	7.5	8.5
Crop growth period (days)	130	130	146	135	145	145	145	145	140	140
Topographic gradient (o)	3	2	4	5	1.5	4	6	4	5.0	6.5
Ditto (%)	5.24	3.49	7	8.75	2.62	7	10.51	6.99	8.74	11.39
Calibrated soil runoff K	3.28	1.78	3.16	2.02	3.79	3.79	2.46	1.80	2.24	1.55
K value	26.48	5.94	23.60	7.51	44.16	44.16	11.70	6.03	9.41	4.72
X value	3.38	2.12	4.92	6.75	1.60	4.92	8.87	4.91	6.74	10.03
Z valueton/ha/year (1)	5.36	0.76	6.97	3.04	4.24	13.05	6.23	1.78	3.80	2.84
Calibrated runoff ton/ha (2)	4.84	0.27	6.31	2.44	3.56	9.53	2.05	0.63	3.14	0.11
Ratio of (1) / (2)	110.82	279.8	110.51	124.55	119.21	136.89	303.72	282.04	121.13	2581.11

6.7 Re-estimated Erosion hazard

Since formulae of SLEMSA were empirically derived from sample measurements, from which soil runoff is calculated for predicting runoff from the SA, verification of the calibration by means of on-the-site measurement is inevitable. So, the Study Team measured the weight of runoff soil at ten sites within the SA in order to compare with the caribrated results. Likewise, whether the calibrated values are reasonable or not was verified through a site survey on the spots where steep slope predominates and gully erosion fairly

develops. As a result, it was evidently identified that F value derives prohibitive soil runoff value over the inclined area steeper than 12% as compared with the measured amounts. This is because surface soil had already been washed off at such steeper slope where exposed rock outcrop covers most of surface area. To adjust this divergence, soil erodibility coefficient value is redefined for predicting soil runoff from steep slope with rock outcrop, as well for providing the erosion hazard map.

Great variation is observed in the results of soil runoff measurement at ten measurement sites where the minimum was recorded as 0.11 ton/ha and the maximum as 9.53 ton/ha, and these values are greatly different from the calibrated values. Taking the mean value for instance for these ten sites, SLEMSA gives 4.8 ton/ha, with measured ones averaging at 3.3 ton/ha. Since there inevitably occurs considerable measuring errors and some leakage from the trap frames, measured value tend to be underestimated. Taking all these into consideration, the average calibrated values fairly accord with the measured results.

Another way of verification was tried at Ntenjela Dam, in Zone B (southern TA Kuntaja) by examining the sediment deposited in the dam. The dam was constructed in 1958, and so 42 years has elapsed. It has a catchment area of 1,530 ha with the designed effective storage of around 40,000m^3, but currently 34,000 m^3 equivalent to 85% of the storage capacity has already been filled up with sediments. Soils found in the watershed thereof have medium texture with particle size of 0.84mm or less accounting for 55.6%. The remaining 44.4% is most probably composed of quartz sand / gravel based from the sieving test of soil samples taken from catchment area and sediment from the resevoir. Only these coarse size particles are deposited in the dam and finer ones were flown down stream together away with the spilled water. The bulk density of the deposit weighs 1.6 kg/cm^3 and based on these measured values finer soil particles equivalent to 122,000 ton has been flown out of the dam. This amount of soil run off is equivalent to 1.9 tons / year / ha. .

It can be said that the amount of soil runoff has recently been augmented in a progressive way beyond this level. According to the verbal information from villagers living around the dam, the rate of sedimentation has been accelerated since 1980s, which coincided with land reclamation in the catchment area of this basin. Recent rate of runoff is estimated at about 3.8 tons / year / ha, equivalent to double of the mean runoff value, taking an accelerated evolution of sedimentation into account. The basin of Ntenjela river is located at the periphery of Chileka pineplane with an average gradient at 2~3%, current vegetation cover of which is estimated at 3~4%. Estimated soil runoff from the catchment area by SLEMSA ranges from 0.6~5.6 ton / year / ha with the mean value of 3.2ton. From this result, it is considered that empirical runoff values over gentle slope (2~3%) fairly accord with the actually measured ones.

The fact that overall gradient within the SA lies at 3.5% (gentle slope) implies that SLEMSA can mostly predict actual runoff. In order to estimate the erosion hazard in the SA, annual soil runoff values were calibrated by 500 m mesh based on the above cited formulae with the inclusion of erodibility coefficient at steep slope on condition that the soil depth ranges from 50~100 cm and average crop growth period stays at 140 days per annum. The result is tabulated Table 6.5. Out of the total 2,879 lattices of 500 m mesh, 62% or 1,784 lattices gives less than 5.0 ton/ha/year. On the other hand, those with higher runoff rate, 10 ton/ha/year accounts for 19% or 542 frames, mainly distributing at Small Michiru in TA Chigaru (north-western part of the SA) and around Ndirande mountain (south-eastern part of the SA). Overall soil runoff from the SA constitutes 6.4 ton/ha/year. From this value it is estimated that about 461,000 ton of soil is annually lost from the SA. This is equivalent to 1.5 times as much as the tentative estimation at the first year study, where the discrepancy is mainly attributable to underestimation of topographic gradient (by 1 km mesh). By the way, soil loss from this area to Shire river was estimated at about 3,800 thousand ton / year by DfID (British High Commission) in 1996 recorded in ”The Study to Identify Sources of Siltation in The Middle Shire River Catchment Area”, out of which soil load from Lunzu-Lirangwe basin to Shire river is estimated at 760 thousand ton / year. Both of these values exceedingly outweigh the result obtained by this Study.

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Table 6.5 Calibrated Soil Runoff by 500m mesh Lattice

(unit:ton/ha/year)

rank(%)	No. of mesh	weight (%)	Mean
Less than 1.0	188	6.6	0.7
1≦ ～＜2	580	20.1	1.5
2≦ ～＜3	447	15.5	2.5
3≦ ～＜5	569	19.8	3.9
5≦ ～＜7	318	11.0	5.9
7≦ ～＜10	235	8.1	8.3
≧10	542	18.8	18.9
Total	2879	100.0	6.4
Calibrated soil runoff	460,541 ton / year (6.87ton/ha/year)		

6.8 Conclusion and Issues

As cited above, the total estimated annual soil runoff from the SA amounts to about 460 thousand tons. The runoff is firstly deposited at the edge of parcels and at the bottom of reservoirs or dambos, then a part of which is flown out but again accumulated at riverbed or basin of two major tributaries of Shire River. Finally, a small portion reaches Shire River as carried by river flow. Estimation of flown-out soil quantity based on the measured concentration of suspended soil particles contained in river flow reveals that approximately seven thousand tons of sediment is washed out from mid-January to February. The estimated value during rainy season, or the period from December to next March, will presumably be two to three fold as much as this level, or on average 17.5 thousand ton, equivalent to nearly 3% of the eroded amount.

Soil runoff values are far less than the calibrated values at sites that practice box ridges. Hence, soil erosion can greatly be controlled from the tillage by box ridges. Additional consideration of box ridges should be introduced into SLEMSA formulae in this case. During the measurement the Study Team had to utilize farmers living adjacent to the measurement sites to collect and dry soil samples, also entrust counterparts to perform on-the-spot measurement. This must have affected with loss of the weight in the process of collecting and drying samples. For more accurate measurement, regular monitoring / measuring by specialists is indispensable. Moreover, rainfall measurement at the site of soil collection is desirable to grasp the correlation between the amount of rainfall and quantity of soil runoff, if such measurement is resumed in future. Further, since traversing sections at the water-level observatory stations along Lunzu River and Lilangwe River have changed and a part of staff-gauges was washed away by floods, clear correlation between water level and flow quantity is hardly obtained. In this regard, it is essential to establish other observatory sites for more precise H~Q measurement.

CHAPTER 7 ZONING

CHAPTER 7 ZONING

7.1 Rationale and Objectives of Zoning

The SA was divided into zones by environmental factors, for reference to formulate a water rehabilitation plan in vast area covering 67 thousand hectare. This is necessary in applying relevant project components to particular zone(s) delineated with common conditions, constraints prevailing in them. Zoning is also useful in determining priority and techniques of land conservation and of control of soil erosion, as well in strengthening of project implementation system. Factors employed in zoning included socio-economic, natural or physiographic factors that affect or influence life or livelihood of the inhabitants in the SA. The map of these adopted factors are tabulated in Table 7.1 and illustrated in maps in Annex I-A.

The entire area of SA was divided into five zones through the zoning (refer to Table 7.2), so that they are referred to as a base of planning, such as watershed rehabilitation plan (MP), land use of the SA, formulation of preventive measures against soil loss, reforestation, livelihood improvement and plan of firewood supply.

7.2 Zoning Criteria

Zoning was made on a topographic-map of a scale 1/50,000, making use of aerial photographs of a scale 1/25,000 applying various criteria as proposed below, based on the results of socio-economic baseline survey and spot interview / site observation surveys.

(a) Socio-economic Conditions

Population density and demographic growth by TA changes in the decade 1989 ～1998）, arable land area per farm household, distance from urban markets (Blantyre)[1], and density of such social infrastructures as wells, schools and clinics by TA.

(b) Natural Conditions

The natural conditions constitute division of watershed, annual precipitation, topographic gradient, soil distribution, potential on development of water resources etc.

(c) Land use and Vegetation

This consists of cropped fields, forest reserves, estates, urban quarters, individual woodlots for firewood, grave yards (indigenous tree species), community forests, independent tree standings etc.

(d) Others

Possibility of organizing VNRMCs and villager's intention of participating in watershed rehabilitation projects, initiatives and leadership of TA chiefs and other cadres concerned are also taken account of.

The following table shows classification of SA area for zoning.

Table 7.1 Factors for Delineating the SA into Zones

Point	Distance to Urban market	Population density person./km2	Population. growth rate	Annual rainfall	Water Resources
	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
1	30 km～ to U.	400～	3% or higher	Below 700mm	weirs
2	20～30 km to U.	300～400	2～3%	700～800	Reservoirs and weirs
3	10～20 km to U.	200～300	1～2 %	800～900	Dambo and weirs
4	Peri-Urban	100～200	0～1 %	900～1,000	Dambo, reservoirs and weirs
5			0 below	1,000 above	

Point	Soil types	Topography	Canopy coverage %	Reforestable area	Villager's initiative
	Ⅵ	Ⅶ	Ⅷ	Ⅸ	Ⅹ
1	Loamy Sand Lithosol	Mountain slope	Urban Area	0～50 ha	No
2	Sandy Loam Lithosol	Hilly / undulated	3% below	50～100 ha	moderate
3	Sandy Loam Latosol	Mild slope area	3～５%	100～200 ha	positive
4	Clay Loamy Latosol	Flat basin	5～８%	200～300 ha	
5				3000～	

7.3 Zoning of the Study Area

The results of the zoning shown in Table 7.2 and Figure. 7.1

Table 7.2 Areas and Characteristics of the Zones

Zone	Area (km^2)	Characteristics by zone
A	20.27	Urbanized area, with reforestation of reserved forests needed
B	254.62	Reforestation of village forests needed, Higher potential of tapping water resources
C	146.01	Semi-arid,, heavily reclaimed zone with reforestation on undulated hills needed
D	78.15	Eco-system conserved by estates, but land in TA has been barren and narrow
E	170.70	Semi-arid, reforestation on degraded TA land with aridity tolerant tree species

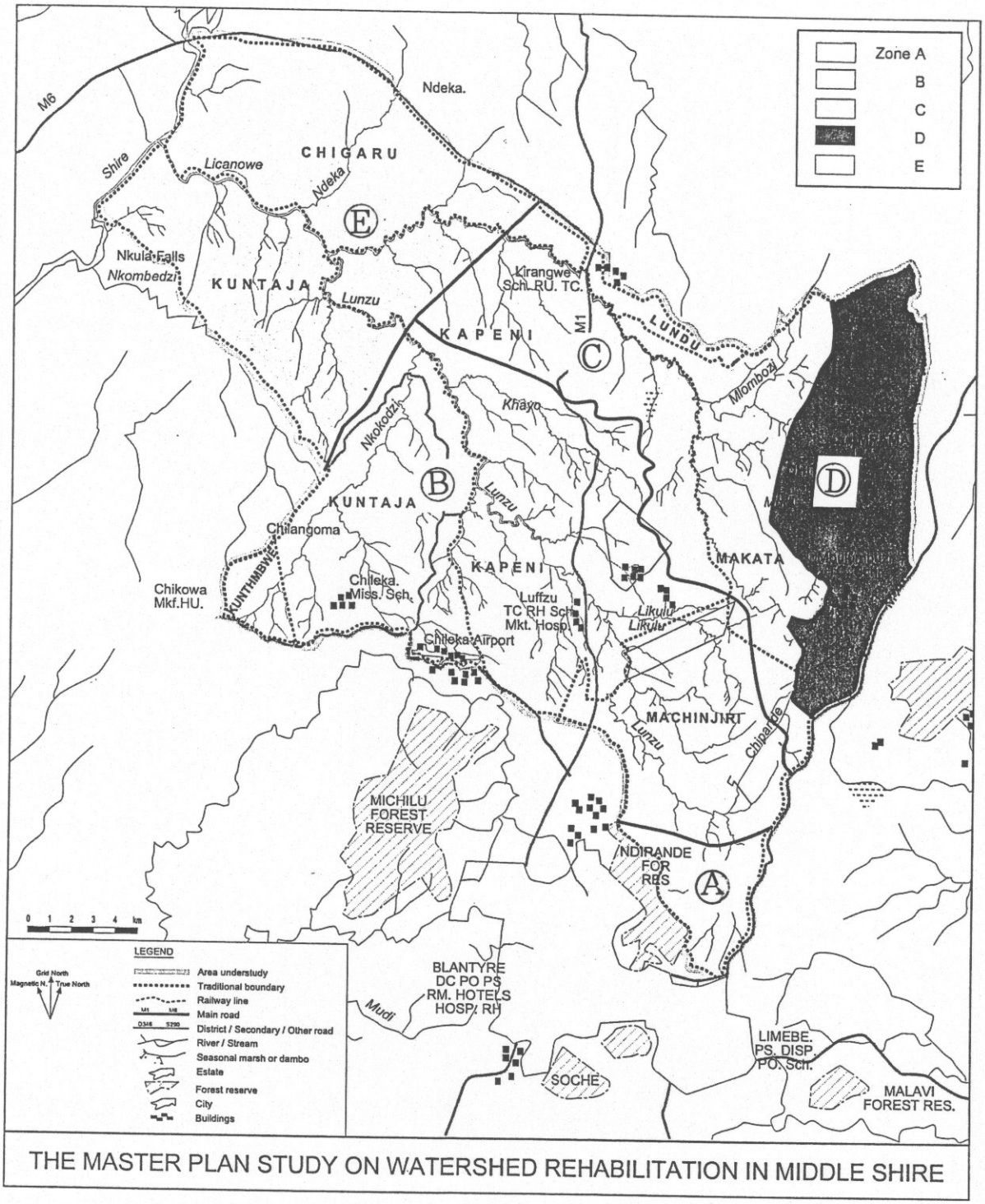
7.4 Evaluation of the Zones

Zones shown above are evaluated with numerical values, and the result is given in Table 7.3. The lower the total value of assessment, the more adverse social, natural conditions prevail with more limited land use and vegetative cover, leading to more difficulty in managing watershed. Zone E, where reforestation of semi-arid zone is required, is evaluated at 20.4 point, the lowest of all zones, while zone C marked highest, 29.1 point. From the result of assessment it can be deduced that the higher the annual rainfall the easier the watershed management becomes owing to thicker vegetative cover, though any marking methods inevitably accompany some arbitrary figures.

Table 7.3 Evaluation of Zones in the SA

Zone	Remote ness	Popl. density	Popl. Gr.rate	Annual Rainfal l	Water Resources	Soil types	Topo- graphy	Veget. cover	Area of planting	Positive- ness	Total point
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	
A	4	1	5	5	1	1	1.5	1	5	2	26.5
B	2	2	2.5	3	4	2.1	3.5	2.5	1	3	25.5
C	2	2.7	3.7	4	3	4	2.8	3.9	1	2	29.1
D	2	2.5	1.8	3.2	4	3	3	2	3	3	27.5
E	1	4	1.1	1.5	1	2	2.8	2	3	2	20.4

Figure 7.1 Zoning Map



CHAPTER 8 WATERSHED REHABILITATION PLAN

CHAPTER 8 WATERSHED REHABILITATION PLAN

8.1 Basic Concept of the Plan

In this Study. Watershed rehabilitation is defined as environmental conservation as well as the restoration and creation of depleted resources available to the villagers. However hard one may try to completely retrieve the lost natural forest cover that formerly thrived in the SA, the efforts would end up in vain on account of current explosive population pressure. Bearing this in mind, the following realistic plan is recommended for the inhabitants to pursue from the environmental conservation point of view, setting the targets that should be fulfilled for short-medium and long term.

Watershed rehabilitation indicates both environmental conservation within the deteriorated watershed and restoration and creation of resources available to villagers concerned. Knowing that complete retrieval of the once existing forests is practically impossible under current heavily populated conditions, the following plan with the targets to be realized in short-medium term and in long term is examined here, based on a concept of environmental conservation.

Short and Medium Term	Long Term
1. Self sufficiency in firewood	1. Water conservation (surface / ground water)
2. Conservation of farm soils	2. Self supply of logs for house repairing and constructions
3. Enriching soil fertility	3. Flood control

The Plan will be established in the context of the established usufruct right of land in TAs as it prevails now. Any land expropriation of the existing cultivated or fallow fields is not planned so as not to disturb the present established traditional order of land holding. For this reason, none of the on-going projects ever includecompulsory land expropriation. This may confine the range of feasible projects as shown below:

- ✧ As far as conservation and fuelwood supply measures over the existing (individually alloted) farmland (including fallow parcels) are concerned, the Plan prescribes only agroforestry practices without including any type of afforestation / reforestation of woodlot for fuel supply.

- ✧ As for individually allotted land other than cultivated one or fallow, however, it is possible to create / expand individual woodlot for conservatory land use and for fetching firewood.

- ✧ In the case of any land belonging to TA s but not yet allotted to individuals, village woodlot can be created for conservatory land use to rehabilitate deteriorated watershed. Such land is often found at the summit, slope side of hills or along the river-banks.

- ✧ In planning the conservation or rehabilitation of any deteriorated / degraded land, multi-purpose restoration plans are proposed , taking account of the necessity of creating income generation sources, of developing untapped resources and water conservation in the semi-arid zone.

Introduction of agroforestry plan by hedge-row would not only meet the objectives of securing fuelwood supply as well of raising soil fertility and saving chemical fertilizers, but also the long-term goals of mitigating soil loss by erosion. Agroforestry, especially hedgerow best fits to sloped fields where soil fertility rapidly depletes and soil loss seriously accelerates. Suitable tree species should be chosen to meet the objectives stated above, for the contribution to improving local resources.

In planting woodlots for fuelwood, appropriate species should be selected to meet the objetives not only of producing firewood, but of preventing soil erosion, preservation / recharge of groundwater, conservation of bio-diversity, securing the sites for raising guinea fowls, also sources of nectar for apiary, thus contributing to

income generating activities.

Afforestation of community forests will be planned carefully avoiding species susceptible to forest fire and termite damages, or those of fast-growing but are often stolen by poaching gangs, but rather adopting slow-growing (often hardwood) ones that are useless for early poaching (matured hardwood trees are difficult to fell in short time with hatchets).

Formulation of the Plan requires information on land ownership, usufruct right etc., but land registration lists or cadastral maps are not available in any TA s. It follows that the Master Plan only proposes component projects without identifying actual land users, except estate land tracts that are registered with surveyed border. Accordingly, identification of usufruct right will be necessary at the detailed design stage for project implementation.

8.2 Extent of Degradation in the SA

The five zones have been identified in the SA, the countermeasures to be applied to, their relative priority and methodology of implementation are deliberated and examined below. The measures are examined in the light of the current status of watershed deterioration, problems encountered and physiographic characteristics by zone. Population pressure gives the most serious influence on environmental degradation among the related problems. It is impossible to withstand overwhelmingly powerful consumption demand for natural resources however hard and sincere one makes his efforts trying to control environmental hazards, especially forest destruction. For instance, rural electrification requires such prohibitive cost as above one thousand dollar per kilometer for extending the electric grid, plus annual tariff for household electricity set at a much higher level than the mean annual household income. Notwithstanding, urban electrification is going on in the southern tip of the SA as a process of urbanization. In Zone A where urbanization has taken place consolidation measures is applicable.

On the other hand, Zone E, located in the northern edge of the SA still has some indigenous woodlots where charcoal is produced in earth kilns and hundreds of bicycles commute to urban areas to carry charcoal bags. Sooner or later these remnant resources will be depleted and woodlots will be reduced to barren fields. Some of the villagers feel guilty in felling the trees to sell charcoal, but they don't have any alternative means to get cash income. Yield of indigenous trees as material of charcoal per hectare ranges from 4 ~ 5 ton at maximum, from which only 0.6 ~ 1.5 ton or 12 ~ 30 bags of charcoal are produced with a farm-gate value of MK 700 ~ 1,800 as of September 2000. It will take more than 20 years to retrieve the lost forests, for which cost of planting seedlings and rearing them would amount to over MK 3,000 / ha. The most acutely needed measures in this Zone E seems diversion of off-farm income sources, or other means of income generation that can replace charcoal production, as well of designing improved stove / fireplace to save ligneous resources.

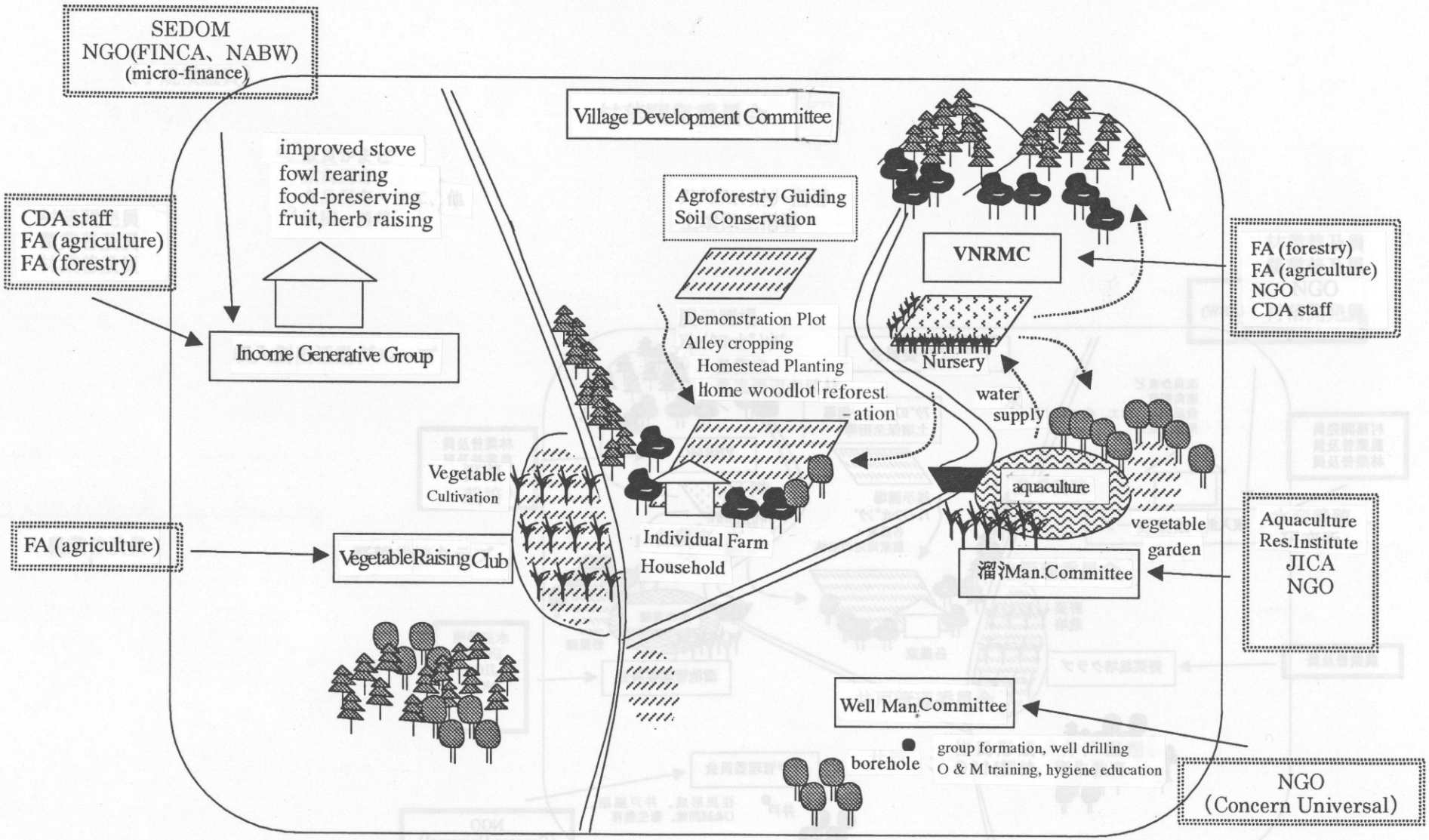
As watershed in Zone A is most severely deteriorated, engineering measures for consolidating urban quarters will increasingly be needed rather than reforestation or any other means of restoring NR. On the contrary, watershed in Zone D has less damage because of higher annual rainfall and lower population pressure. Nevertheless, indigenous vegetation cover has barely been conserved in the private estates, just because villagers are not allowed in to fetch firewood, otherwise the environmental situation would have become as devastated as other zones. Though some tree stands still remain in of Zone E for felling as material of charcoal, the vegetation has already been too severely exploited. That in Zone B and Zone C the trees stand are fairly deteriorated, but it is not yet completely impossible to restore / retrieve lost nature, although it depends on the sustained efforts of the inhabitants.

The MA is located in Zone B where vegetative cover, population pressure and other factors have not yet come to an extreme. Nevertheless, excessive percentage of land reclamation into arable field has brought obvious detrimental effect which are more or less observed in all zones.

From these background situations, it may be concluded that both active and passive efforts are needed to rehabilitate the damaged watershed. The former is composed of planting efforts of trees and other materials of forestry or agro-forestry activities, over any fields / woodlots / forests regardless of whether they belong to

private holders or public. The latter consists of saving firewood by means of new type of fireplace, rational use of existing resources and observance of civil minimum in order to refrain from all detrimental deeds to nature, such as over-grazing, field burning, rampant tree felling. In addition, what cannot be overlooked is the pressing necessity of energy substitution on the side of urban consumers. BCFP successfully supplies firewood to them, but its wood production hardly catches up with ever expanding urban demand for ligneous resources. For example, charcoal produced in central Malawi can be served for meeting part of industrial/commercial demand (not urban household demand) to ease the acceleration of wood consumption, if the price is competitive with that of for biomass resources.

Figure 8.1 Development Concept Map



8.3 Methods of Formulating Watershed Rehabilitation Plan

A digital synthesizing method is applied to provide a map of draft watershed rehabilitation plan with a set of input data including topographic gradient, estimated annual rainfall, erosion hazard, current vegetation / canopy status and current land use including distribution of observed gully erosion stripes. Base maps (sectioned by a lattice of 0.5 km) comprising topography (with slope gradient), erosion hazard, vegetation cover, and land use, are converted into a table with coordinated numerical values that correspond to countermeasures to be taken on the spot expressed by a crossing point of coordinates.

Table 8.1 Relationship between Location Status and Countermeasures

Employable measures	Current land use	Topo-gradient	Erosion type	Target zones	Planned area
AF for flat farmland	Cultivated land	0 ~ 4	Wind Erosion	All zones	9,175 ha
AF for sloped farmland	Cultivated land	5 ~ 8		All zones	4,833 ha
AF (Alley CR, Hedge-row)	Cultivated land	0 ~ 4		B, C, D	1,045 ha
AF (Alley CR, Hedge-row)	Fallow parcels	5 ~ 8	Gully Outbreak	B, C, D	1,061 ha
AF (Alley cropping)	River-side dimba-field	0 ~ 4		A, B, C, D	229 ha
AF (Hedge-row) orchard tree	Cultivated steep slope	5 ~ 8		A, D	985 ha
Woodlot rehabilitation	Cultivated land	0 ~ 4	Gully Outbreak	B, C, D	410 ha
Woodlot rehabilitation	Cultivated land	5 ~ 8		B, C, D	102 ha
Conversion into village forests	Steep fallow parcels	> 8		All zones	487 ha
Creating village forests	Fallow/degraded parcels	5 ~ 8		B , C	803 ha
Woodlot Regeneration	Degraded woodlots	0 ~ 8		C, D, E	962 ha
Village conservation forests	Upstream of reservoirs	> 8		B, C, D	120 ha
Bamboo planting	Outcrop / bare Land	> 8		B, C, D	80 ha
Bamboo/mulberry planting	Terrace, parcel drains	0 ~ 15		C, D	29 ha
Reforestation / Regeneration	Grave yard	0 ~ 4	Gully Outbreak	All zones	166 ha
Regeneration / expansion IW	Old degraded woodlots	0 ~ 4		B, C, D	2,366 ha
Reforestation / Regeneration	Deteriorated woodlots	5 ~ 8		E	480 ha
Reforestation / Regeneration	Outcrop / bare Land	0 ~ 8		E	39 ha
Reforestation on waste land*	Long-term fallow area	0 ~ 4		B, C, D	15 ha
Regeneration of degraded brush	Collapsed river-bank#	> 8	Developed Gully	C, D	769 ha
Creating village river-bank wood	River-side terrace	0 ~ 4		B, C, D	388 ha

Employable measures	Current land use	Topo-gradient	Erosion type	Target zones	Planned area
Expansion of irrigated parcels	Dam surroundings	0 ~ 4		B, C, D	573 ha
Expansion of irrigated parcels	Dam catchment area	0 ~ 4		B, C, D	92 ha
Sugar-cane Field	Marshy Area (dambo)	0 ~ 4		B, D	1,450 ha
Paddy Field	Marshy Area (dambo)	0 ~ 2		B, D	1,150 ha
Gabion protection	River head	> 8		A, C	250sites
Gabion protection	River Banks	0 ~ 4		B	570sites
Green belt / parks	Planned Urban Area			A	25sites

Note : * land not used but held by absentee landlord, # also including hill-side slope,, IW; individual woodlots

8.4 Components Proposed as Watershed Rehabilitation Plan (M/P)

A base map of watershed rehabilitation was created through an application of overlaid mapping where topographic gradient, estimated annual rainfall amount, calibrated estimation result of erosion hazard, current canopy cover, current land use and observed site distribution of gullies. These factors indicating extent of watershed degradation were plotted on lattices of 0.5 kilometer mesh, so that corresponding rehabilitation measures can also be plotted on the map of the same configuration. For this purpose, base maps comprising topographic map, isohyet map, erosion hazard map, vegetation map and land use map were utilized, from which the following WRP was proposed in the SA.

The measures proposed for conserving watershed within the SA are summarized in Table 8.2. These should be applied as pertinent countermeasures corresponding to the current state of land degradation by zone within the SA., indicating contents of works to be applied to each zone according to the status of particular zone.

The proposed components of watershed rehabilitation plan in the study area are summarized below:

I. Agro-forestry This component is to be applied to cultivated and fallow land for firewood production, provision of green manure / fodder and prevention of soil runoff.

I – 1 Establishment of an Agro-forestry Material Center to distribute seedlings / scions to village nurseries,

I – 2 Creation of village nurseries to produce planting material for AF practices and

I - 3 Provision of agro-forestry demonstration plots to display and demonstrate practical techniques.

II. Reforestation and regeneration of existing woodlots This component aims at restoration of deteriorated, extinct or dwindling woodlots as far as possible,

II – 1 Self-supply of firewood through expansion and regeneration of individual woodlots and recommended conversion of steep farm plots into woodlots,

II – 2 Wood supply to poverty-prone or landless villagers by creating village forests over hillside and summits of hills where land in common still remains,

II – 3 Prevention of land collapse through reforestation over slope at river banks, rocky or

outcrop patches where land in common still remains and

II – 4 Expansion and regeneration of degraded grave yards and school woodlots where land in common still remains.

III. Activities for organizing groups and technical assistance oriented to income generating measures

IV. Consolidation of social infrastructure related to watershed rehabilitation

IV – 1 Cultivable land conservation using gabion at collapsing sites over river banks,

IV – 2 Water intake through weirs made of gabion across stream basin (related to IGAs),

IV – 3 Creation of all season (perennial) crop field with irrigation / drainage channels (related to IGAs) and

IV – 4 Expansion of irrigated field through elevating dikes of existing reservoirs (related to IGAs),

V. Other components

V – 1 Implantation of concept of environmental conservation among adults and school children by means of education on environmental care,

V – 2 Revival of livestock activities through preventive measures against prevalent animal pests and restoring measures of combining crop husbandry with animal one,

V – 3 Quality improvement and functional activation of extension / instruction staff by providing strengthened training courses.

The listing order of the above components corresponds to relative priority or urgency, readiness of implementation and generality of applying components. For example, agro-forestry has a character of easiest extension on almost every farm parcels with cheapest cost requirement among the listed components. Some important items are not listed above, for instance practical organization of villagers groups constitutes an indispensable components related to all the proposed items in order to put them into a sustainable practice. The illustrative diagram shown in the next page implies this concept. As to IGAs, the effort to introduce IGAs to the villagers without any experience would not be successful or hardly be deep-rooted. Instead, it is rather easier to apply them to those who already have some experiences or to introduce them to the villages with existing resources that can be mobilized for IGAs. Thus, traditional IGAs can be improved or expanded, both on qualitative and quantitative dimensions. Similar strategy can be applied to consolidation of social infrastructure, for new construction is not in the scope but broken or dilapidated facilities are planned for repairing or replacing to facilitate environmental improvement.

Table 8.2 Project Components by Zone

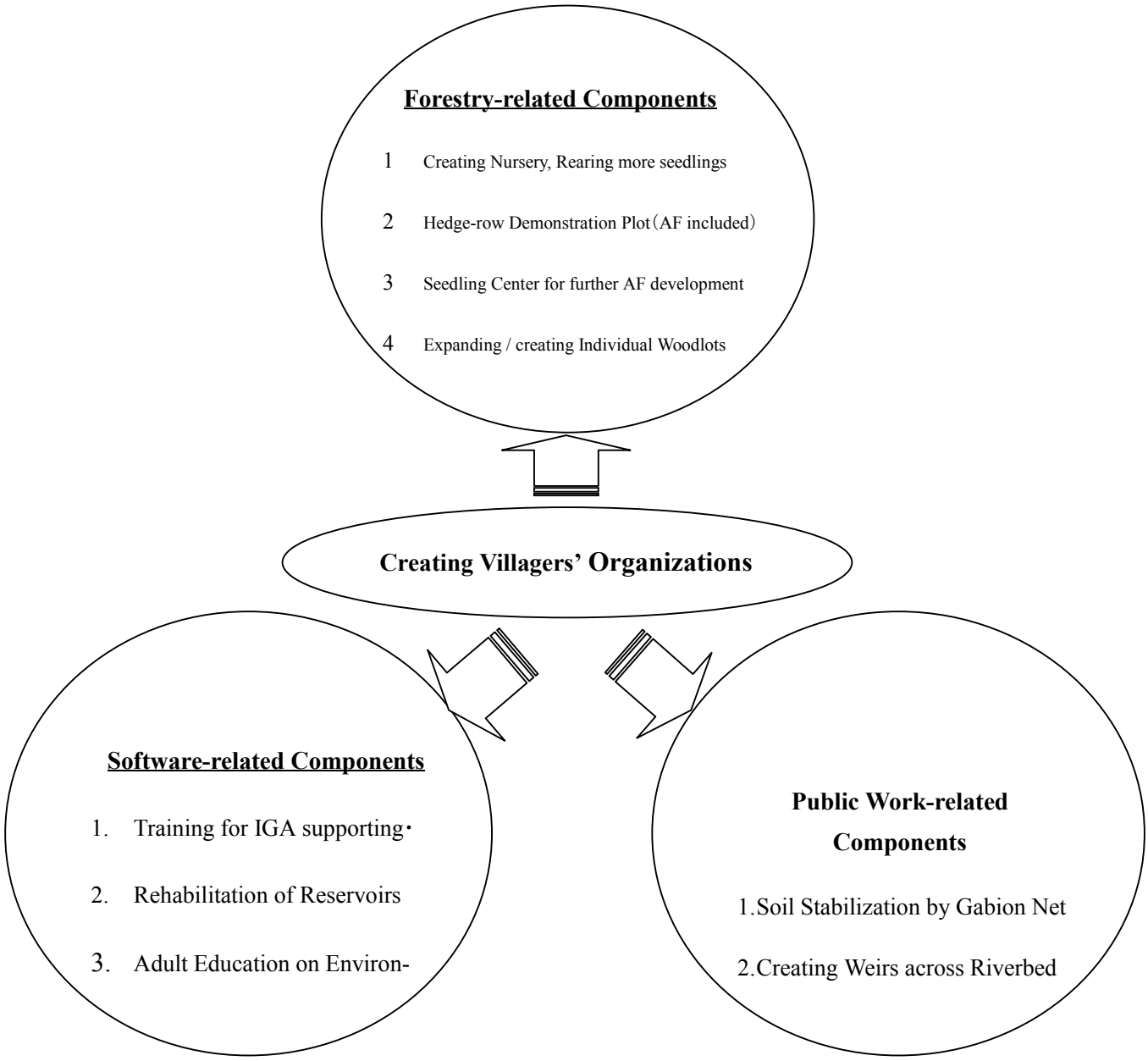
Proposed Project Component	related zone					project objectives	Priority	Project span
	A	B	C	D	E			
Components Related to Forestry								
creation of nurseries and seedling raising		◎	○		△	supply of seedlings	1	S ~ MT
demonstration plot for hedge-row＊		○	◎	△		Diffusion of AF	2	MT
establishment of agroforestry nersery center		◎		◎		Diffusion of AF	3	S ~ MT
expansion/creation of individual woodlot		◎	○	△		Fuelwood supply	4	M ~ LT
reforestation of river side forests		◎	○		△	Soil/water conserv	5	S ~ MT
reforestation of hill-side/hill-top forests		△	◎		○	Soil/water conserv	6	S ~ MT
restoration of denuded Forest Reserves	◎				◎	Soil/water conserv	7	M~LT
Components of Software Activities								
assistance / training for income generation		◎	○		△	Assisting the poor	1	S ~ MT
improvement of reservoirs		◎	○	△		W.C., flood control	2	ST
adult education for environm. Conservation		◎	○		△	Concept implantation	3	LT
Components Related to Public Works								
soil conservation by gavion net	◎	○		△		Ground stabilization	1	MT
construction of weirs in the streams	△	◎	○			Runoff prevention	2	LT
intensive utilization of dambos		◎		◎		Higher land use	3	M~LT
vaccination against livestock epidemy	△	○		◎		knowkledge diffusion	4	MT

Note; ◎ ; major applying zone ○ ; the next important zone, △ ; applicable but the third important zone,
ST; short term, S ~ MT ; short ~ medium term, MT; medium term, M~LT; medium ~long term, LT; long term,

including boundary planting, AF; agro-forestry, conserv.; conservation, WC; water conservation

The period required for implementing these proposed components is termed as project span and given in Table 8.2, taking account of relative urgency, available amount of funds, the years required to bear project benefits etc.

Figure 8.2 Components of Watershed Rehabilitation as M/P



Note 1: The above listed components shall be applied to each zone in conformity with the characteristics of needs of the zones.
Note 2: The number attached to the described components indicate relative priority.
Note 3: The zones where these should be applied to and period of implementing them are given the text of 8.3~4.

Short term (envisaged within five years): the components falling under into this category are small size that can be promoted in village development plans in a participatory way.

Medium term (6 ~ 10 years): as the short term components proceed on, the stage shifts to expand to cover larger areas with green canopy by applying medium term components that require longer period of implementation.

Long term (11 ~ 20 years): spreading short and medium term components to extend green belts parts to wider areas, components requiring long periods should be sustained until the degraded environment and natural resources are acceptably recovered.

Concerning the estimation on the balance of firewood supply~demand, the envisaged areas where the above-listed components are applicable are estimated in Table 8.3, based on the map of watershed rehabilitation plan.

Table 8.3 Estimated Areas of Applicable Major Components by Zone

(ha)

Component	Zone A	ZoneB	ZoneC	ZoneD	ZoneE	SA Total
Reforestation on land under TA	98	327	432	386	414	1,607
Expansion of individual woodlots	259	593	1,552	774	668	3,847
Application of hedge-row	9	1,215	898	361	1,132	3,615
Application of alley-cropping	150	4,571	3,377	1,357	4,257	13,712
Area increment firewood-lot per HH*	0.07	0.06	0.25	0.26	0.20	0.14
Mean area of AF-applied plot per HH*	0.03	0.36	0.53	0.39	0.99	0.44

Note：* HH; household. Alley-cropping is applicable to flat and inclined fields, whilehedge-row is planned mainly on fallow land

8.5 Measures Commonly Applicable to All Zones

Immediate Action: It takes a far-reaching time-span to restore the watershed, and it also needs serious efforts of villagers concerned who should be fully conscious of proper utilization and replenishment of biomass they consume. Villagers are advised to begin with the easiest measures, that is the regeneration of individual woodlots, replacing vulnerable stumps that have weak coppices with seedlings by killing the stumps with oil painting over the surface. Then, efforts of expanding individual woodlots should be made with a target that tree branch (nkhuni) : agro-forestry coppices : crop residue (mapesi) = 0.3 m3 : 0.2 m3 : 2.0 m3 for a household with five persons on condition that the household uses improved type of fireplace (mafwa), as traditional three-stone fireplace requires double the amount of fuel. Average holding size of the households in the MA is estimated at 0.6 ha (with farmland and homestead, equivalent to 45% of the surface area), of which 450 m2 or 13% of holding will have to be sacrificed for producing 0.3 m3 of branches from E.camadulensis. Smaller farm households will have to rely more on community (village) forests for which they should share labor to create them. So, village headmen should mobilize the poor in their villages to establish, expand or enrich community forests guaranteeing them to use resources that are created from their labor contribution.

Medium-term Measures:The second step constitutes wide spread diffusion of agro-forestry, that provides farmers with plant nitrogen source, fodder and firewood, though ordinary farm households with very limited land for their own use. Practice of agro-forestry in such form as alley cropping and contour ridge, hedge-row over slope can retain surface run-off of rainwater, thus preventing soil loss from crop fields. These techniques

have already been practiced by the villagers in Mulanje, Dedza districts and in many other places under the instruction of MAFE, ICRAF and other organizations promoting agro-forestry. The following land areas comprise target spots for intensive extension of agro-forestry techniques:

1) A tract of crop fields with a slope gradient steeper than 4 %,

2) Crop fields on slopes steeper than 8% where a gully erosion has already taken place,

3) Areas with erosion hazard degree higher than 6 ton / hectare / year, often coincided with the areas where soil textures of loamy sand ~ sandy loam are distributed.

Long-term Sustainable Measures: The third step is reforestation to clear-felled, denuded or degraded woodlands which can be promoted as a village project for creating community forests in a participatory way so that all the participants who share labor can take advantage of the products (firewood etc.) from what they have created. The targets are set at the following land areas from land conservation points of view:

1) degraded land along stream banks where collapse of soil wall at the cliff of banks is observed,

2) slope land at hill-side where indigenous vegetation still remains,

3) deteriorated grave yards with scanty canopy coverage and

4) any other tracts of un-cultivated or non-allocated land to individual households because it is located in stony patches, on steep slope or at remote and hardly accessible places.

The above illustrated components are proposed taking account of conditions of each zone including land degradation, currently facing environmental problems and those of depleting resources as well as examining conceivable measures for conserving watershed in each zone. Proposed projects as tabulated in Table 8.2 are categorized into the following three terms;

8.6 Core Components Zones

As to Zone A where annual precipitation reaches above 1,000 millimeter, measures for preventing urban disaster as mentioned above will be required. As soils distributing in the upper-most watershed of Lunzu river are subject to liquidation, collapse and scouring by rain-water, it is essential to take such measures over steep slope as protecting works over side-slopes, surface stabilizing works with gavion or sausage at the un-paved road-side gutter drain and also at the torrential part of riverbed in order to minimize collapse of banks. In addition, sewerage drains stemming from hospitals should be separated from rain water drain to treat sewerage disposal with aeration taking due account of use of river water by the inhabitants at downstream. In the consolidation plan of housing quarters making use of hill slope, green belts should be provided along steep stream basins so as to prevent bank collapse during the period of lingering and torrential rainfall.

In Zone B, a long-term demographic control measures are indispensable so that current population can be maintained without allowing any more growth. Because this Zone, together with Zone E, coincides with semi-arid zone where vegetation cover remains poor and sites for creating village forests are hardly possible due to heavy population density, the inhabitants cannot but depend more on agro-forestry. Also, saving of fuel through the introduction of improved fireplace (stoves) is acutely needed. What's more, perpendicular collapse of stream banks has too often taken place in this zone, thus sand and gravel have been deposited over river basin, forming so-called "raised bed rivers". This stream structure tends to foster damages from flooding in vegetable gardens in dimba, from loss of bridge by floods. To cope with such disasters, it is advised to create river bank forests to control peak run-off so that collapse of banks and washing / scouring of dimba fields can be prevented.

With regard to Zone C, where gully erosion has widely developed over highly undulated areas, it is recommended that agro-forestry practices such as alley cropping and box ridge fortified with shrub trees with

robust and well-developed root zone. Likewise, since annual rainfall in this zone exceeds 800 millimeter and natural bamboo bushes are observed, planting of bamboo along drains from slope fields will serve as measures against soil erosion.

Zone D has the thickest vegetation cover in the SA owing not only to the land occupation by remaining estates but to higher annual rainfall reaching around 1,000 millimeter. Run-off of soil out of the area can be controlled not only by denser canopy cover but though sedimentation on Lirangwe dambo, the largest dambo in the SA. Taking measures against soil erosion is therefore somewhat less urgent than other zones , but basic efforts to protect remaining natural vegetation as well as to restore indigenous, open forests so far damaged by over-exploitation are essential.

Zone E belongs to semi-arid climatic zone with less than 700 millimeter of annual rainfall. This zone has been exposed to denudation process for the last decade on account of heavy charcoal production and secret, illegal felling / poaching, leading to the lowest canopy cover in the SA. On the other hand, the zone has only over ten hectare of Eucalyptus reforestation implemented by MASAF over hill slope of Small Michiru hills. Overall population density remains sparse except Lirangwe Township, so sites for reforestation seems more readily available than other zones. However, survival and growth rate of planted seedlings / saplings especially of fast-growing species remain low. Taking these conditions into consideration, it is proposed to create village forests with indigenous tree species as steady means of recovering severely damaged vegetation cover.

Proposed project components by zone that correspond to the measures cited above, their relative urgency and priority are summarized in Table 8.4, where components are selected according to currently observed natural and socio-economic conditions of each zone, also judging from extent of environmental deterioration or rate of watershed degradation, as well as from availability of existing public facilities. In any zone it is difficult to give priority to the proposed various components, for all the recommended components are equally important to restore watershed in a zone, and lack of any one component will affect the recovery rate of degraded watershed.

Table 8.4 Contents of Proposed Project Components by Zone

Zone	A	B	C	D	E
Social infrastructure	(Consolidation of Urban structures)	Consolidation of Irrigation facility	Consolidation of Irrigation facility	Repairing of Rural bridges	Consolidation of Irrigation facility
AF Nursery, seedling production		Creation /Expan-sion of nurseries	Creation of nurseries	Creation of nurseries	Expansion of nurseries
AF extension Improved farming		AF diffusion, Combined farming	AF diffusion, Combined farming	AF diffusion, Combined farming	AF diffusion, Combined farming
Reforestation and Management of VF	(Consolidation of Green belts , parks)	Reforestation of VF	Reforestation of VF	Expansion of VF	Regeneration of VF
IGAs for better livelihood		Apiary, dimba vegetables	Apiary, dimba vegetables	Rearing of Guinea fowl etc.	Rearing of Guinea fowl etc.
Village organizing, Verification of techniques		Planning verefi-cation program	Organizing Village groups	Organizing Village groups	Organizing Village groups
Extension, education, Enlightenment and CB	Environmental education	Environmental education	Environmental education	Environmental education	Environmental education

Note：AF ; agro-forestry, VF; village forests, including river terrace forests and grave yard rehabilitation。CB; capacity building, IGA; income generating activities

8.7 Strengthening of Implementing Frameworks for Watershed Rehabilitation and Conservation

8.7.1 Consolidation of Implementing Systems for Watershed Rehabilitation and Conservation

Given the current rate of deterioration of watershed in the SA, all the remaining tree stands and woodland including grave yards, estimated at 1,500 hectares, will vanish within the coming decade. This will hasty both depletion of water from borehole wells and loss of surface soil moisture caused by strong wind during dry season, possibly affecting the growth of sugar cane, sweet potato, cassava and garden vegetables. Since any TAs can hardly afford to implement measures against long-term environmental changes nor have basic knowledge on environment issues, the following action will be essential to protect and rehabilitate their watershed. Firstly, Blantyre district should begin to provide cadres of TAs, group villages and villages with massive information campaign to help them fully aware of environmental care. Since, district staff has neither enough instructing capacity nor consciousness on environmental status and surrounding ecosystem, pertinent training and seminars provided by donors, environmental NGOs and staff of central government are indispensable for them to acquire the capacity. It is therefore recommended to identify and coordinate actions of stakeholders and promoters through the following procedures, so that the watershed rehabilitation plan can be prepared at the district level and submit them to the central government.

1) The Blantyre district commissioner calls for the urgency of taking environmental measures in a regular TA chief conference, proposing a district long-term plan to this end.

2) Each TA chief is requested to report current status of degraded watershed and problems of environment in the TA.

3) Donors, environmental NGOs and representatives of central ministries concerned should explain the possible extent and contents of assistance provided by them.

4) How to establish an efficient implementation system for organizing participatory action for restoring living environment should be discussed within the TAs concerned. In this context, a draft action plans have to be provided by group villages and villages in the TAs concerned under the instruction of village organizing staff of Blantyre district, related donors and environmental NGOs etc. Then, the district government reviews them and compiles them into a district plan so that it can be submitted to the MNREA as the district program.

So far as the establishment and management of the framework for implementing watershed rehabilitation and conservation projects in the SA are concerned, VNRMCs as described below in the VNRMP at the MA are responsible for establishing participatory groups and guiding them so that they function well to achieve the target performance.

8.7.2 Estimated Size of Areas by Component

The size of nurseries and community forests to be established by village as proposed is shown in Table 8.6.. The principal countermeasures to cope with currently encountered issues and problems are tabulated in Table 8.6.

Table 8. 6 Zone-wise Watershed Rehabilitation Measures Corresponding to Current Issues

Zone	Current issues / problems	Corresponding W.R. measures
A	Steep, urbanization, acute firewood shortage	Greenization around houses, reforestation on the slope
B	Excessive reclamation, P.P. desertification	Agro-forestry practice, improved individual woodlots
C	Excessive reclamation, P.P.,erosion on the slope	Agro-forestry practice, field conversion into woodlots
D	Steep slope, accelerated erosion on sandy soils	Ditto, conservatory erosion control over escarpment
E	Illegal charcoal production, land denudation	Creation & regeneration of village forests

Note: P.P. ; population pressure, W.R.; watershed rehabilitation

Table 8.6 Components of Watershed Rehabilitation Plan (WRP) by Zone

Unit：ha

Components of ERP	Total SA	Zone A	Zone B	Zone C	Zone D	Zone E
1. Agroforestry on flat land with L ~ CL	8,343	4	2,828	1,564	539	3,407
1. Coupled with river-bank reforestation	834	0	302	285	100	147
2. Agroforestry on gentle slope with L ~ CL	4,746	83	1,243	2,002	25	1,393
2. Coupled with river-bank reforestation	608	0	397	133	0	77
3. Agroforestry on flat land with S ~ SL	1,176	0	253	65	569	289
3. Coupled with river-bank reforestation	96	0	32	46	18	0
4. Agroforestry on gentle slope with S ~ SL	450	72	127	65	110	76
4. Coupled with river-bank reforestation	90	0	12	65	13	0
5. Agroforestry with rain-fed fruit trees	981	0	592	46	344	0
5. Coupled with river-bank reforestation	4	0	0	4	0	0
6. intensive dambo・cultivation, higher C	351	0	43	0	307	0
7. Creating/ expanding VF on・steeper slope	803	4	222	301	235	40
8. Creating bamboo brushes on steep slope	109	0	36	9	63	0
9. Village F. reforesting on hill-top / side	294	77	22	123	58	13
9. Coupled with river-bank reforestation	18	0	0	0	18	0
10. Conversion from farmland to wood lot	487	4	68	183	219	13
10. Coupled with river-bank reforestation	18	0	0	0	18	0
11. Regeneration/expansion of existing forests	512	17	83	8	43	361
11. Coupled with river-bank reforestation	8	0	0	0	0	8
Excluded (urban area, public facility)	1,750	700	450	75	450	75
Excluded (river basin, confluent points)	475	0	125	0	125	225
Excluded (private estate, plantation)	1,375	375	475	75	450	0
Total project area planned (1 ~ 11 above)	19,979	266	6,268	4,929	2,690	5,826
Additional land for individual woodlots	3,847	259	593	1,552	774	668
Total surface area of each zone (share%)	66,975 (100)	2,027 (3)	25,462 (38)	7,815 (12)	14,601 (22)	17,070 (25)

Note: topographic gradient of the planned area under 1~ 4 flat land falls 1 ~ 4 %, while that under 5 ~ 8 gentle slope ranges 4 ~ 8%. Steep slope under the category 10 has the gradient steeper than 8%. The difference (1,525 ha) between the total cropland area in the SA (2,1504 ha) and the total planned area (19,979 ha) indicates the area of small parcels on steep slope.

Source : identified by the Study Team through site observation and aerial photo interpretation

The land area excluded from the Watershed Rehabilitation Plan consists of river bed of principal streams, urban housing quarters and utility areas such as site for the facility of Blantyre Water Board, areas where microwave easement is settled or public housing accommodations are built), and existing estates where dense vegetation cover is commonly well conserved owing to off-limits to inhabitants (the area of estates accounts

for 2% of the SA, but the real area planted with tree crops or firewood trees for tobacco curing is less than 0.5%). It follows that majority of land resources within the SA is included in the WRP. In addition, another 3,847 ha should be required as the site for individual woodlots to be expanded or newly created from demand-supply of firewood viewpoint, though the planned sites cannot be plotted in the watershed rehabilitation map.

8.8 Proposals on How to Implement Projects

8.8.1 Authority and Local Population

It is commonly observed that any government agencies of Malawi can make use of external assistance where government staff can be engaged in the aid projects as a routine official job. It means that the government offices have got accustomed to exert a recipient agency of ODA action plans. However, major activities of RFOS are confined to the administrative works for national forests such as forests reserves and forest plantations and it takes charge of limited administrative actions only, concerning private woodlots owned by villages and individuals. As far as activities of reforestation in private owned land are concerned, it relies more on the assistance by aid agencies such as World Bank and NORAD. Thereby it is considered that capacity of RFOS in implementing forestry projects for private forests such as village forests is limited.

Also, it is conceivable that any government agencies and their staff tend to have limited experience in project implementation as compared with administrative ones in such a way that grass-root opinions are well employed and reflected in the projects, though they have ample experience of top-to-down approach where they can exercise leadership. Likewise, most government agencies have adopted self-sustenance system on their fiscal account just like private enterprises. As for revenue, all the official revenues from the sale of produce of forest plantation under the control of Forestry Department (FD) and fees collected from inhabitants who fetch firewood from forest plantation are kept as national revenues. In this context, the government recently decided to privatize plantations, and FD is now promoting the procedure of privatization.

On the other hand, official administration for forestry has not been a satisfactory one to villager's interest. Some have an opinion that village forests were destroyed because of poor forestry administration, and very few of them had been cut by the villagers themselves. It follows that the government is fully responsible for the reforestation over the barren sites of forest clearance, while villagers do not any duty thereon. However, it is the inhabitants themselves who suffer from wood shortage, and the establishment of project implementing framework should pay due attention to the sentiment of inhabitants and the capacity of the government staff on project implementation.

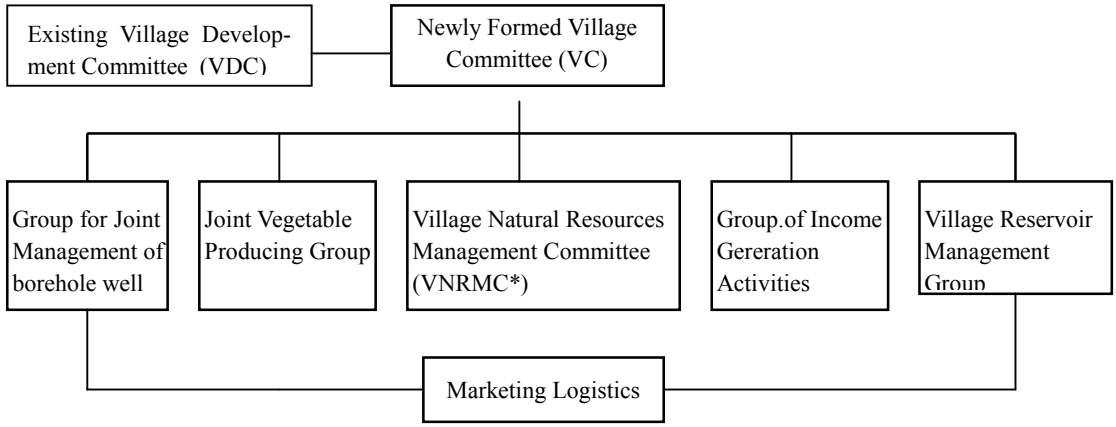
8.8.2 Basic Approach to Community Organizations to Implement Components in a Participatory Way

In implementing the project components, the following procedure should be on prior to the detailed design.

- ✧ Feasibility and compatibility should be examined for the entire project area,
- ✧ The practical planning process should be discussed with the representatives of the beneficiary,
- ✧ Capacity building to strengthen the capacity of beneficiary to sustain the project should be provided and formation of rural organizations as well as project management systems in the beneficiary should be promoted. The following are proposed as a basic approach and procedures to organize communities concerned.

(a) Expected Status of Community Organizations (VC)

The existing VNRMCs have not been established by a single village, but they have been organized by a village group. In implementing the proposed watershed rehabilitation project, many of the components are planned beyond the boundaries of each single village. Accordingly, VNRMCs are considered most suitable and compatible as a coordinating organization capable of managing the whole components included in the proposed project, adjusting the activities rendered by various committees or groups under VC.



(b) Role of Organizations and Organizing Villagers Groups

In of implementing each component, villagers groups will be organized through the instruction and arrangement of assisting organizers taking account of what is stated in 8.5. The following indicates the conceivable context of pertinent groups / organizations at current stage assuming the implementation of the above-proposed components.

Borehole well management committee

The committee aims at group management of a borehole well by the beneficiary members who jointly use the well. The committee requires assistance from NGOs experienced NGOs in well drilling. Such NGO shall develop activities for enlightenment of the beneficiary, formation of the committee by the users and well drilling. The community concerned should procure as much material and labor required for the drilling and installation of the pump as possible at its own burden sharing. Operation and maintenance cost of the drilled borehole should be collected from the users for 2 sustainable management.

Vegetable producing club

This club aims at income generation through vegetable production during dry season. Vegetables can be raised by irrigation with treadle pumps, lifting water from weirs in perennial streams and reservoirs. Advice from FA is available to the club on how to organize villagers, production techniques including rotation pattern to be observed, procurement of indispensable inputs, selection of promising and marketable species / varieties. It can also utilize such farm-credit institution as MRFC.

VNRMC

This committee is responsible for proper management of commonly utilized natural resources in the villages. It calls for participation in the management activities, including husbandry of tree seedlings in nurseries, planting and management of village woodlots, planting in individual woodlots, AF practices, operation and

management of the forests established by DF but later handed over to villages. It can expect assistance by forest extension workers (FA) on such matters as participatory group organization of villagers concerned, instruction for nursery and reforestation techniques, supply and logistics of seed / scions. It is essential to have running capital by self-help for sustainable and sound activities, and to this end it should plan components for income generating like apiary, raising of herb and edible mushrooms, poultry activities with wild but domesticated fowls.

Income generation group

This group has an objective of generating subsidiary income through jointly run, small scale business like fowl keeping, vegetable sale, processing of storable food, running flour mills by joint business etc. It can rely on pertinent advice from CDA or FA on such subjects as group formation, technical training, managerial and operational skill, expansion of market outlet. Existing small scale credit institutions like MRFC, SEDOM, NABW and FINCA are available to the group for the preparation of initial investment for the business.

Reservoir management committee

The committee's goal lies in a group management of a reservoir by the users. As reservoirs can be utilized in a multi-purpose way, so the activities thereof include aquaculture of tilapia (Chambo), irrigation of vegetable gardens. that of tree nurseries, reforestation for groundwater recharging and for preventing soil erosion, it also has adjusting function for keeping reasonable water allocation to stakeholders concerned. As for villagers' group formation and selection of committee members, the advice from Wild Life Society of Malawi, MATAMA and other NGOs that are coordinated by CURE is anticipated. Likewise, with regard to sweet water pisciculture, technical assistance can be obtained from the instructors belonging to fishery department in Zomba, while fry or fingering can be purchased from the Fishery Experiment Station located at Domashi. A part of the profits gained by each activity can be collected by the committee to provide O&M cost of the reservoir and appurtenant facilities.

(c) Planning Procedures for Implementing Project Components

Prior to planning of any component, the villagers and the stakeholders should come to recognize and agree to the necessity of well-managing natural resources by means of PRA techniques that allow villagers themselves to make their needs and problems clear. [31] Then, the plan of managing natural resources that can meet the needs of villagers is formulated by themselves, eventually concrete form of project components is proposed as means of assistance in line with the formulated plan. Adaptability and feasibility of the proposed components to the planned area are reviewed and elaborated at this stage.

The following are the suggested planning procedures and points for the project components proposed in 8.4.

Establishment of nurseries

Establishment / activation of VNRMC → identification of land tenure / usufruct right → selection of site for nurseries → creation of a nursery construction / management sub-committee within VNRMC → assignment of sub-committee members including liaison officers of DF as well as a representative of the assisting organization as associate members of the sub-committee → commencement of technical transfer to the villagers through the associate members → selection of proper tree species → initiation of technical transfer from member from DF → donation of planting implements → assistance payment of O&M expenses → procurement of water source (stream/well) → receiving seed / material from DF → identification of program for seedling multiplication with the identification of required numbers thereof → propagation of scion on the

[31] In the case that it fails to come to a recognition or an agreement, it should be judged that the discussed component(s) do(es) not fit into participatory approach even though it (they) were strategically feasible.

plot → distribution of seedlings to village households

Demonstration plots for hedgerow plantation

Establishment of VNRMC (if the committee is existing, its empowerment only) → consultation with VAC (village agriculture committee) → coordination to establish closer link with ADD, NGOs and other assisting agents → selection of site for the plot, proper tree species → creation of a demonstration plot management sub-committee within VNRMC → formulation of management plan (- review / organizing logistics to supply scions and planting implements by DF and assisting agents, - strengthening of technical transfer to the villagers through AF of DA, - provision and granting of initial management expense and discussion on the method of self-sustenance to provide fund for running expense, - creation of management system by villagers) → arrangement / planting of the demo-plot with land preparation, planting mother trees and installation of a panel-board for explaining plot alignment → multiplication program with the propagation of scions on the plot → distribution of produced scions to village households

Expansion or establishment of individual woodlots

Establishment of VNRMC (if the committee is existing, its empowerment only) → coordination to establish closer link with ADD, NGOs and other assisting agents → establishment of village organization for expanding and newly-planting of individual woodlots (as a division of VNRMC or independent organ) → investigation on the sites to plant, demand of fuelwood, desired tree species etc. → provision and granting of initial management expense and discussion on the method of self-sustenance to provide fund for running expense → creation of tree nurseries (applying the same procedure as shown above) → creation of mutual assisting groups if necessary → instruction of afforestation and forest husbandry techniques → delivery / distribution of seedlings / scions

Reforestation over deteriorated customary land (as riverbank forests and hill-side ones)

Consultation among TA chief, headmen of village groups concerned for investigating candidate sites → establishment of VNRMC (if the committee is existing, its empowerment only) → coordination to establish closer link with DF, NGOs and other assisting agents → establishment of pertinent organization for → reforestation on customary land → selection of site for the plot, proper tree species → creation of tree nurseries (applying the same procedure as shown above) → identification of the system for instruction / technical transfer from member from DF → provision and granting of initial management expense and discussion on the method of self-sustenance to provide fund for running expense → burden-sharing among village groups on labor provision for reforestation → instruction of afforestation and forest husbandry techniques and arrangement for monitoring patrol over reforested sites→ delivery / distribution of seedlings

Rehabilitation of reservoirs / village ponds

Establishment of VNRMC (if the committee is existing, its empowerment only) → coordination to establish closer link with ADD, NGOs and other assisting agents →establishment of users organization for efficiently utilizing reservoirs → investigation on current water use by household and future prospect (covering irrigation, nursery provision, aquaculture etc.) by DF staff → instruction of afforestation, rehabilitation of pond and aquaculture by FA and staff of fishery department → provision and granting of initial management expense and discussion on the method of self-sustenance to provide fund for running expense → rehabilitation works by villagers → provision of water users' agreement among beneficiary / stakeholders

8.8.3 Proposed Strategies on the Project Implementing Framework

Watershed management and reforestation in the SA are not planned on the state-owned public land but on private, or allocated land to individuals or to villages. In other words, it is required to try to restore the watershed through the initiative of those who live in the SA and have ownership or usufruct right on land. It

is therefore recommended that private groups be employed as the agencies in charge of software sector covering formation of villagers' groups, sensitization prior to organizing them, instruction on the management and control of organizations as these private agencies are well acquainted with villagers sentiment in the SA, and they can be engaged in the public activities along with the villagers.

On the other hand, as to extension and education on agricultural and forestry techniques towards villagers, the present system has been deep-rooted enough and has already performed on administrative activities. However, its low performance cannot be denied due to budgetary deficit and insufficient technical capacity as observed in the past activities by the extension workers in FROS and Blantyre ADD. Admitting this fact, it is recommended that the existing system be mobilized for technical diffusion in terms of agro-forestry, forestry, agriculture, IGAs etc. through their leverage applied to both RFOS and Blantyre ADD

8.8.4 Agroforestry

The major objective of introducing agro-forestry resides in soil conservation, however, there are other roles tree crops can play, such as supplementary supply of firewood, green manure and fodder. In heavily populated areas where land reclamation has been developed beyond the admissible extent for environmental conservation (especially Zone A and B), too many villages suffer such acute land shortage as many households fail to hold woodlots. Agro-forestry can play an important role in securing firewood for daily use, and in such areas adoption of agro-forestry is considered more urgent than those with some room for additional land use.

Capacity of agro-forestry to supply firewood is expected at an average of 0.25 m3 per hectare at static growth period of planted tree species. Though it depends on age of tree crops after transplanting, share of space occupied by them, tree species, soil fertility and climatic factors, coppices can be harvested as firewood from *Senna spectabilis, Gliricidia sepium* at the rate of 0.2 ~ 0.6 m^3 per hectare when they grow for three years or longer.

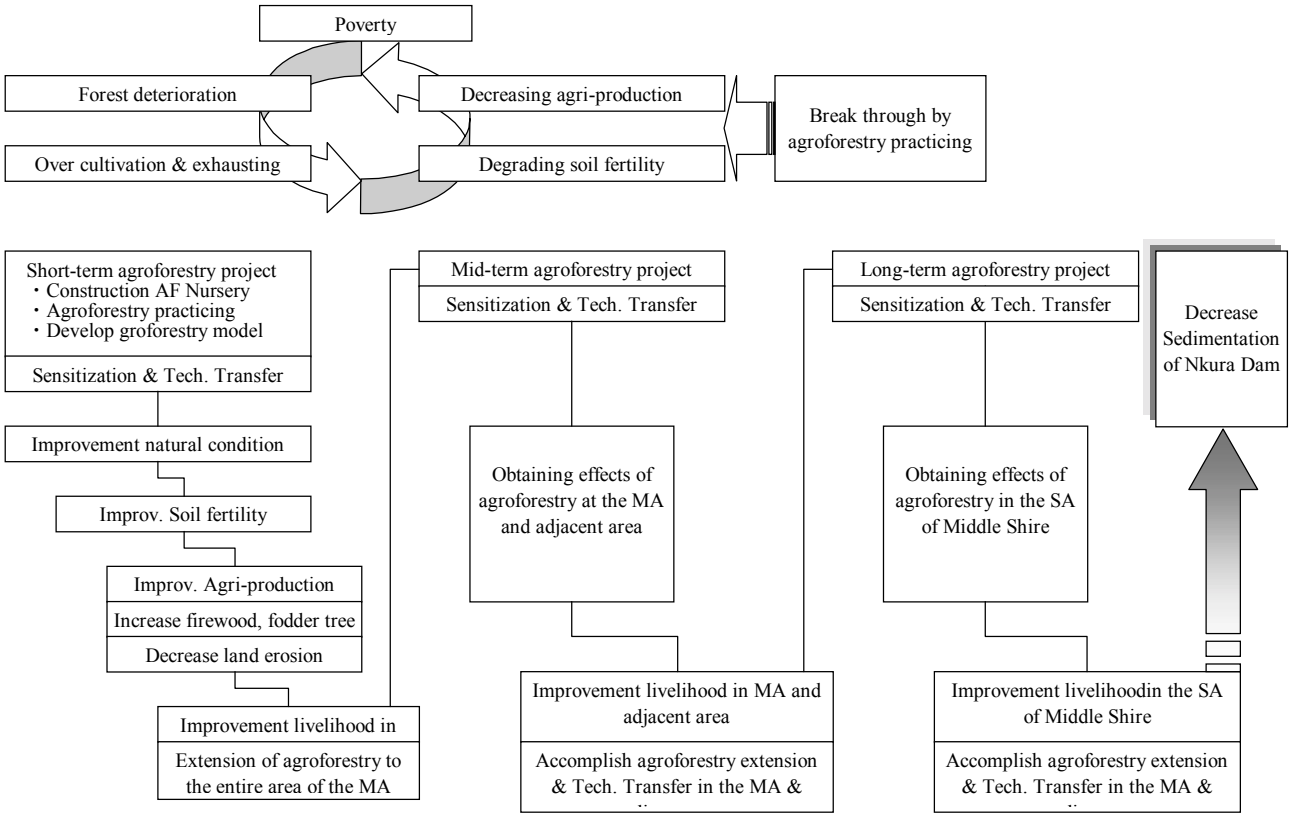
Likewise, as to effect of improvement in crop yield, a long-term increment of yield at around 30% can be expected, and even if leguminous brush trees for green manure are planted every four ridges, still few percent of yield gain and harvest of firewood can be counted on. This yield of firewood is equivalent to 0.1 ~ 0.3 m^3 per household, given the mean acreage of land holding. Provided that smooth adoption of improved stove / fireplace and wide-spread penetration of agro-forestry are realized, heavy dependence on firewood lots can virtually be mitigated.

In case hedge-rows are applied to inclined field, some additional and substantial reserve of crop nutrients and soil water can be expected in addition to the above-cited benefits, since this practice enables to control loss of field soil and run-off of rain water. From conservation effect and self-supply of firewood points of view, it is recommended to delineate northern part of Zone A, eastern part of Zone B and northern part of Zone C where crop field has been developed on steep slope as priority area for the introduction of agro-forestry. It is also desirable that nurseries to produce seedlings and other material of agro-forestry are created in this priority area. Nevertheless, development of agro-forestry does not suit for farm-credit utilization because it takes long years before it offers positive effects. Under such circumstances, it seems indispensable, from the experiences of on-going extension projects, for its rapid diffusion to distribute, free of charge, planting materials among poor farm households.

Table 8.7 Future Outlook of Agroforestry Development

Stage	Short term (1 ~ 5 years)	Medium term (5 ~ 10 years)	Long term (10 ~ 15 years)
Target area	Model Area (MA)	Surrounding areas around MA	The entire SA
Organization	Enlightenment, formation of VO. (VO.: village organizations)	Formation of VO in wider areas, reflecting experiences of VO in MA	Covering areas with different conditions with feed-back process
Extension Methodology	Creating core demo-farm / nursery in the center of target village	Techniques and material of AF is disseminated to planned core sites	The same as the left column
Assisting staff	Agricultural extension workers are only eligible for AF services	Forestry extension workers can join the task after proper AF training	CDA can also join the task after receiving proper AF training
Target farmers	Starting with those who can afford to adopt AF practices in their fields	Target strata can be expanded with PR of realized performances in MA	Even small holders can join group activities for practicing AF
Material supply	Provision of material supply center/ demo-farm for service to farmers	Surrounding areas receive from MA where ample material is available	Meeting demand by diversifying species to suit field conditions
Goals of AG	Livelihood improvement by cash crop production in AF plots in the MA Immediate soil conservation Improved farm-productivity Saving of firewood by I.S.	Income generation by producing fruit and other cash crops than vegetables Restoring farming environment Higher farming productivity Increasing output of firewood	Recovery from biotope damages Increasing crop production Self-supply of firewood Better nutrition status Minimized sedimentation in Nkula Dam / Shire River
Prospect in the next stage	Positive influence of AF exerting on people living in neighboring areas	Fostering positive attitude of rural population towards AF practices	Chain reaction in the expansion of AF practices over the entire SA

Figure 8.3 Vicious Circle Caused by Poverty and Expected Effects by Agroforestry Practicing



The process of agro-forestry practices shall begin with the establishment of a short term strategy to select suitable tree species to be introduced, method (configuration) of planting, rearing works like thinning, pruning and selective felling. At the same time, monitoring is pursued to regularly check soil fertility, extent of soil erosion, supply capacity of firewood material from the practiced fields and entailing improvement in agricultural productivity and subsequent betterment in livelihood etc. Then agro-forestry practices are spread into adjacent areas taking account of these findings, leanings and problems so far obtained. Further, the eventual maximized benefits can be expected from expanded beneficiary of the entire area of mid-Shire watershed in the long run.

8.8.5 Forestry

Major task of forestry lies in self-supply of firewood and timber wood, but reforestation and recovery of vegetation cover are greatly affected and limited by insufficient land resources resulting from higher population pressure. So, the base of the self-sufficiency in firewood should stand on creation, expansion and regeneration of individual woodlots for firewood fetching. Many small land holders, however, do not hold any individual woodlots, nor land is available for them to establish new lots. Consequently, they will have no other choice but to rely upon community forests and other resources they don't own. Common types of individual woodlots are observed in border planting at the periphery of farm parcels, homestead canopy for wind breaker and shading, planting along rain water drain or gullies inside farm tracts, random planting of leguminous brush species on fallow parcels that were wasted due to depletion of crop nutrients.

As regards to sites to be provided for reforestation, there still remain some unallocated land within a village. In this case, if the village headman who manages the land is willing to create community forests, participatory reforestation can be organized. A nursery can be established, and the land preparation for reforesting site, reforestation and tending of planted trees can be carried out through a participatory works offered by participants from small holders who need to fetch firewood. Even in this case, village headman and small holding farmers are both too poor to afford to reforest at their own expense. It means that offering a reimbursable fund to establish a nursery is an indispensable precondition to facilitate project implementation. The recommended types of reforestation include woodlots over hill slope available for firewood supply, conservatory reforestation to prevent collapse of river banks or to protect river terrace parcels, tree planting over wasted land under extensive land use and village enclave, reforestation, regeneration and expansion of grave yard forests as a forest reserve etc.

As to selection of suitable tree species, future usage / demand and availability of seed or seedlings should be taken into account Fast-growing species like Eucalyptus camadulensis can be sustainably introduced in southern part of the SA, where firewood supply is getting tight to the extent that part of home consumed firewood has to purchased. Desirable indigenous species for village forests that are traditionally utilized should be included. For instance, those that are more suitable for medical use of bark, root and leaves as substitutes of expensive pharmacy drugs, use as such subsidiary foods as fruits, fungus and edible insects, use as free barn lots and fodder material, use of trees as nectar source for apiary, use of bark and trunk as fiber, binding strings and material of cottage industries as well as potential use as charcoal material. For these purposes, mixed afforestation with fast-growing exotic tree species except Eucalyptus are recommended. In this context, reforestation with the hardwood species suitable for replenishing pillars and beams of huts, furnitures like pestles and mortars, appropriate combination of nectar trees with different flowering seasons, introduction of those bearing edible wild fruits or of medical use should be planned. Both seedling production and direct sowing of these species are tried.

8.8.6 Agriculture

Agriculture in the SA will undergo gradual shift from sedentary nature to commercial cropping. Since availability of credits for procuring farm inputs will constitute a precondition for promoting cash crops, such efforts of farmers as organizing syndicates, saving cooperatives etc. that are eligible for receptors of institutional loans are essential key elements. On the other hand, agricultural extension service activities still remain unsatisfactory to the beneficiary farmers while active NGOs as Christian Service Committee (CSC), OXFAM, World Vision International, Malawi Wild Life Society have rendered supporting activities in and out of the SA. Taking this into consideration, it is recommended that NGOs with valuable performance be involved in the proposed project, at the same time Blantyre ADD be mobilized with the assistance in the form of supply of motor bicycles and fuel so that extension workers can play their role in the fields. It is proposed to deploy comprehensive agricultural approach with activated agro-forestry activities involving donors including both NGOs and non-NGOs, as currently observed in Mulanje ADD. Current tactics employed by NGOs follows the method of selecting villages with willingness to join the project, advising them to organize groups, to which both techniques and inputs are supplied, regardless of whether environmental care is really needed or not. On the other hand, it is desirable to apply necessary measures to the areas with specific natural and social conditions that require particular measures for environmental conservation. In this connection, ADD has longer and ampler experiences to identify priority of project implementation corresponding to the real necessity than these NGOs. This is the reason why both public and private supporting agencies should be involved to realize desirable targets of improvement in agricultural productivity.

It is also recommended that proper assistance should be directed to crop conversion from infested species, virus diseases or damaged ones by pests, to healthy, immune ones. Farmers in the affected areas are advised to refrain from propagating the problem crops for several years until such time that the pathogens or pests become extinct completely. The eradicating measures can be successfully combined with other newly introduced techniques such as agro-forestry practices aimed at interacting effects. As an illustration, all cassava plants are pulled out in heavily infested areas with mealy bug to convert into sweet potato coupled with Gliricidia sepium, or farmers agree to refrain from planting tomato in affected areas with mosaic virus, switching it into other vegetables than solanaceae species, such as okra and onions. Free distribution of

disease free seedlings is applied to the farmers who agreed with crop conversion. Likewise, conversion of livestock can be recommended in such a way that poultry is lifted for five years where new-castle disease is prevalent now, to make a shift into rearing of only Guinea fowl that is immune to the disease by distributing chick of Guinea fowl free of charge.. Higher effect can be expected from such type of institutional assistance targeted at specific but limited areas.

8.8.7 IGAs

IGAs applicable to the SA are nothing but the expanded and improved activities that have already been practiced therein. Since IGAs always accompany with or are linked to commercial activities, it is imperative to foresee demand/supply trends of commodities concerned. Diversification of activities and commodities is also required to avoid internal competition as much as possible, along with quality improvement and that of investment efficiency. Easier access to proper institutional credit facility is desirable in a way that technical transfer can be provided coupled with micro-credit service for farmers who try to utilize currently available rural resources. IGAs are always interdependent with agricultural and forestry activities especially in rain-fed farming. It is planned in this rain-fed SA to put emphasis on rational utilization of idle labor force during dry season oriented to vegetable production in dimba, also to such value adding activities as weaving of bamboo baskets and grass mats, processing of dried fruits and tubers, fattening of livestock kept in barns etc.

The above-mentioned off-farm or cottage activities lower risk of failure if firm techniques are properly transferred from experienced instructors to the vocational groups willing to participate in these activities. While, apiary and rearing of Guinea fowls require higher skills or ample experiences to make these successful or to avoid risk such as damage by predators. This implies that it is best to limit these activities in the villages where traditional bee-keeping and wild fowl keeping have been practiced and available environmental resources related to these activities still remain. For expansion and modernizing improvement of these activities require more investment than those off-farm activities mentioned above.

8.9 Principles of Development and Planning of Components

(a) Forestry and Agroforestry

Generally, landholding size of farm household tends to be narrower in densely populated zones where most of the available land area has already been allocated to individual families. Hence, there remains less customary land on which reforestation as village forests is possible, nor less area under individual woodlots for fetching firewood. Besides, there remains little room for introducing agroforestry on account of narrower arable land. In such a zone, the administration's last resort would be on long-term energy substitution and demographic control policies. Nevertheless, in areas where arable land holding size per household exceeds 0.8 ha possibility of introducing agroforestry is higher since capacity of self-supplying staple food from the owned land is easier. In such an area, creating village forests still possible. However, elaborated preparation inclusive of strengthening / empowerment of extension activities as well as adults education followed by perseverant extension efforts are essential to introduce and settle agroforestry practices over a wide area.

Creation of village forests depends heavily upon the availability of commonly served land resources. In general, available customary land is too often located at the remotest part of villages, distributed over hill-side, summit of hills, along streams, near the banks, on escarpment of valleys, land patches where stony soils cover the ground and not yet allocated individually due to adverse tillage conditions. It follows that such land has serious constraints on land use, facing difficulty in afforestation and forest husbandry operations. Indeed, land accompanied with such handicapped conditions had better remain untapped, covered with natural vegetation. However, as population pressure heavily increases, as especially observed in southeastern part of the SA, all the available land has been subject to reclamation or conversion into residential quarters irrespective of land quality. In utilizing such remaining lands that has been left uncultivated, the following must be made clear through dialogue among cadres in charge of the area concerned, project promoters, assisting organizations and administrative agencies responsible thereof:

- whether headmen concerned recognize the necessity of utilization or not,
- whether villagers concerned willingly cooperate with reforestation works or not, and if they agree, on what conditions they can cooperate,
- whether there are any other competing land use on the proposed site for reforestation or not,
- who or which organization(s) can take care of, or monitor the reforested land,
- how the necessary inputs like seed, seedlings and planting implement for reforestation projects can be supplied, or provided,
- how the labor force for implementing reforestation projects can be procured and how the return for labor is provided for those who contribute to the projects,
- who, what organization(s) can play role of orienting / mobilizing villagers concerned to the proposed reforestation projects,
- who can provide together with the project implementors the essential techniques and capital funds,
- what tree specie(s) to plant and at how much rate of spacing would be,
- when and how much harvests and benefits from the reforested area can be expected,
- how the harvests and benefits from the reforested area should be distributed to the participants and
- whether unexpected burden or hardship would arise on the participants during the implementation of the proposed reforestation projects, or not.

Growing of Eucalyptus species are commonly considered advantageous in woodlots for fuelwood supply. They have such merits as fast growing, high domestic popularity with the readiness of seed production and availability throughout the country. They are also suitable for fuel owing to soft xylem tissue and strong regenerative power after felling, but have such shortcoming as susceptible to termite attack and forest fire, forming only single forests because excretion of an allelopacy compound makes coexistence with other species prohibiting or difficult. These defects can be offset to some extent by sandwiching fire break belts in between woodlots, also by regular clearing of understory etc. In ordinary nurseries seed is sown in October or later, then seedlings are transplanted into pots and finally marketed and planted with a spacing 2m × 2m taking the planned thinning (twice) into account. The established woodlots are planned to be harvested every six years, regenerated with coppice, four times before restocking. Since charcoal is mainly consumed within urban areas while it is seldom consumed daily in the SA, it is not necessary to consider reforestation with the species appropriate for charcoal production in the SA where serious shortage of firewood for home consumption is foreseen in near future.

Thorough vigilance or monitoring is difficult if area is located at the remote site from village center, often observed in the case of land not yet allocated within a village. In such a site illegal felling (poaching) can hardly be avoided as fuelwood is increasingly depleted. For this reason it is considered best to employ indigenous tree species that are far from suitable for fuelwood because of sluggish rate of growth, but are capable of producing valuable hard-wood timber in the future. To this end, *Khaya anthotheca, Cordyla africana, Julbernardia paniculata, Terminaria sericea* and *Pterocarpus angolensis* can be adopted because these species can be used as hardwood material for carving wood, furniture, mortars etc. and they are tolerant against drought and wild fire.

These species have already been recommended by DF since seedling supply thereof is not difficult and survival rate of seedlings is fairly high. As regards to propagation, selected seed is directly sown into pots, covered with dried hay to prevent drying up. Hay is removed after 1 ~ 2 weeks as seed germinates, and saplings are kept under shade for 2 ~ 3 months until height reaches 15 cm and the are marketable for reforestation. Spacing of planting is adjusted to 3m × 3m with planned thinning (only once). Rotation period of these species depends on land fertility and moisture regime, but it takes more than 30 years. In this context, the planters have to consider their works as dedicated to environmental, soil / water conservation as well as hereditary donation to the next generation (what is suggested here is a tentative proposal and many alternatives are possible to apply to the different parts of the SA).

Concerning reforestation (including restocking) of existing individual woodlots, only farm households with medium ~ large land holding can generally afford to provide land and capital expense for this purpose. On the contrary, small scale ones cannot afford but in some cases they can enjoy surplus benefit from this project through offering labor service for planting or tending / management of woodlots owned by well-off farms. In this case, fast growing Eucalyptus species are considered most suitable from the aspect of the project objectives, as supplementary supply of fuelwood, to meet partial deficit caused by expanded family size etc. Suitable sites to expand woodlots are often chosen near drain channels within farm plots, around farm yards and parcels, corners of crop field where gravely and stony soils unsuitable for cropping develop, etc.

The goal of introducing agroforestry practices is firstly in the control of soil loss from parcels, secondly as supplementary supply of fuelwood, followed by supply of nutrients (mainly nitrogen) from incorporated green leaves or nodules to crops, as well as supply of fodder to livestock. Since soil loss tends to increase on the plots with a slope gradient steeper than 8° , it is recommended to employ "hedge row" system to surround a parcel with rows of brush trees, so that soil leakage from crop field can be checked at the border of inclined plots. Though the fastest growing brush is Euphorbia that can easily be propagated with scion, it burns too quickly as compared to leguminous brush trees, so the latter is more suitable for firewood.

On the other hand, it is recommended to introduce ordinary alley cropping and other techniques of agroforestry to parcels with gentler slope, i.e., a slope gradient gentler than 8° . In this practice it is advised to plant leguminous brush trees etc. inserting an alley brush every 2 ~ 3 ridges. Then rows are shaped into low head pollarding to minimize sunshade caused by canopy of brushes, at the same time to control water competition with annual crops. As to propagation, the planters can make use of scions and seedlings according to tree species.

Table 8.8 Available Tree Species for Agroforestry Practices in the SA

Tree specie for agroforestry	applicable area	purpose **	planting style	propagation	fuelwood*	rotation span
Gliricidia sepium	humid zone	manure, fodder	hedge-row	seedlings	0.5	over 10 years
Sesbania sesban	intermediate zone	fodder	alley cropping	scion, seed	0.8	1~2 years
Leucaena leucocephala	semi-arid zone	fodder	hedge-row	seedlings	0.7	2~4 years
Cassia (Senna) siamea	intermediate zone.	manure, fodder	alley cropping	seedlings	0.8	5~6 years
Acacia(Faidherbia) albida	semi-arid zone	manure, fodder	scattered stand	seedlings, seed	0.9	over 10 years
Acacia tortilis	intermediate zone	fodder	alley cropping	seedlings, seed	1.0	over 10 years
Ziziphus mauritiana	semi-arid zone	edible fruit	hedge-row	seedlings	0.4	over 10 years
Prosopis cinera	semi-arid zone	fodder	alley cropping	seedlings	0.7	5~6 years

Note : dry matter equivalent ton / ha / year. The yield indicates that of matured stage, few years after planting.

Currently, livestock herds have sharply declined on account of damages by theft, shortage of fodder and pasture. In addition, reduction of organic matter to soils has been observed partly due to overcutting / overfelling of stands, and partly to shortened fallow period. All these negative factors led to degradation of topsoils with lower soil-water retention, soil-nutrient retention and higher soil-erodibility. It has become

increasingly difficult to control soil erosion by contour ridging only currently practiced by majority of farmers in the SA, because these ridges often collapsed due to torrential runoff of rain water, resulting in loss of precious soil nutrients and moisture from the plots. To rectify current soil problems, agroforestry can provide fast recovery of lost soil fertility and prevent further soil degradation.

In Zone B where sandy topsoils, highly susceptible to sheet erosion are widely distributed, it is recommended to consider such tree species as *Molus alba* (a naturalized plant) and *Tephrosia voghelii* (an exotic shrub) because they can develop the root zone near soil surface to control development of scouring and gully as agroforestry species. An alternative species includes vetiver grass and other gramineae species with shallow root zone, in combination with brush trees, for planting in rows along downstream side border of a parcel or along drain channels. This planting can minimize soil loss from the parcel while, brush species can also serve as source of green manure, of litter and decayed roots enriching top-soils with organic matter.

In employing agroforestry practices, attention should be paid to behavior of practicing villagers who tends to give up the introduced practices only because the effect does not appear from the next year after the introduction. It takes 1 ~ 2 years as a gestation period until the employed shrubs completely settle on the plated plots. Coping with this issue, initial selection of model farmers is confined to well-off ones with substantial off-farm income or with enough cropping acreage in the case of social forestry activities in Kenya. Therefore, it is also recommended to take reasonable measures to cover embryonic period for agroforestry. For example, selecting the farmers holding more than one hectare of arable land to whom agroforestry demonstration is entrusted as a representative farmer in the villages concerned, or choosing those who hold average size of arable acreage, applying a planting subsidy for the first year as an incentive.

Also, as listed in Table 8.1, it is recommended to establish an Agroforestry Nursery Center in order to meet the requirement of introducing agroforestry into a vast acreage in the SA. This Center may directly belong to DF to which technical and financial aid should be oriented from international organizations or from bi-lateral assistance institutions. It may also be managed as a facility attached to an NGO that envisages and supports the agroforestry development projects.

The following are some concepts for afforestation of VF in the customary land based on a result of 1st site survey and lessons learned from similar projects.

Afforestation plan

- Poverty of the local people who are supposed to participate in afforestation project should be taken into consideration.
- Afforestation projects should be started at the adjacent homestead area and then shifted to the project sites such as hillside that seems difficult to practice and manage from technical point of view. This should progress in line with the progress of other livelihood projects and also local peoples' capability.
- Plan should include preventive protection system against illegal felling or poaching.
- Preparing clear and simple project purpose and component for obtaining understanding and cooperation of the local people e.g. soil conservation, harvesting, shipping, transportation, benefit allocation, etc.

Organization for the project's implementation

- Participatory projects
- In consideration with a limitation of FD activity and budget
- In consideration of fair minds among participants, or between committee member and other villagers, project village and other adjacent villages, etc.

Target area for reforestation

Any vacant space should provide reforestation such as an area where it has no value as farmland, homestead space, etc.

Reforestation site should be delineated in consideration with administrative borders e.g. TA or group villages borders.

・River bank, surrounding area of pond, small dam, etc

・Planned VF area

・Road, public land space

Other points to be regarded

・Good relation ship between and among neighboring villages

・Proper equipment plan in consideration with forest management and sustainability

・Forest fire Protection (regulation, patrol, species, wind breaks, etc.)

Area of reforestation target area

Estimated area for afforestation in 2006 based on demand and yield of 3.75 m^3/year is 21,000ha for TA Makata. In the SA, area for afforestation as VF is so limited that the only best recommendation is that of increasing tree yield capacity.

Table 8.9 Necessary Afforestation Area based on the Deficit

	TA	Rate of self-supply	Deficit (2010)	First step 50%	Second step 75%	Third Step 100%
4	Kapeni	4%	-34,990	4,665	6,998	9,331
8	Chitera	12%	-5,734	765	1,147	1,529
7	Machinjiri	21%	-17,983	2,398	3,597	4,795
3	Kuntembwe	20%	-1,160	155	232	309
9	Mpama	20%	-3,190	425	638	851
2	Kuntaja	32%	-8,405	1,121	1,681	2,241
5	Lundu	40%	-1,146	153	229	306
1	Chigaru	42%	-4,098	546	820	1,093
6	Makata	47%	-3,423	456	685	913
	Avg/Total	26%	-80,128	10,684	16,026	21,368

Note: Third step is satisfying full

Note: Adopted 3.75 m3/year of yield of TA Makata

Required necessary number of seedling for 1st Step

Number of seedling was calculated on the basis of 500 seedlings/ha that can yield 3.75 m^3/ha/year. Survey data on yield in the field is 0.7 m3/year by 100 of Eucalyptus. It is necessary to plant 500 seedlings per hectare to obtain 3.75 m3/year of yield. Based on this calculation, it is necessary to afforest 14 thousands ha, a programme which requires 7 million seedlings to satisfy 50 % of fuelwood demand. See Table 8.10

Table 8.10 Number of Seedling for 1st Step

	TA	Area of 1st Step 50% (ha)	Number of Seedling
1	Chigaru	744	372,000
2	Kuntaja	1,351	675,000
3	Kuntembwe	191	95,000
4	Kapeni	5,860	2,930,000
5	Lundu	194	97,000
6	Makata	568	284,000
7	Machinjiri	3,528	1,764,000
8	Chitera	877	439,000
9	Mpama	465	233,000
	Total	13,778	6,889,000

Concept for increasing yield for fuelwood lots

Table 8.11 shows the current concept of tree planting measures for woodlots and VF. It is necessary to plant different varieties of tree species to achieve higher yields.

Table 8.11 Recommended Proper Tree Planting by Zone

Zone	Species	Purpose	Agroforestry Technology	Propagation Method	Rotation
A, C, D	*Gliricidia sepium*	Manure / Fodder	Hedgerow	Cutting	>10 yrs
B, C	*Sesbania sesban*	Fodder	Alley cropping	Seedlings	1-2 yrs
B, E	*Leucaena leococephala*	Fodder, Nitrogen fixation	Hedge row	Seedlings	2-4 yrs
B, C	*Cassia siamea*	Organic manure	Alley cropping	Seedling	
B, E	*Acacia faidherbia*	Fodder Nitrogen fixation	Scattered trees	Seedlings, seed	> 10 yrs
B, C	*Acacia tortilis*	Fodder	Scattered trees	Seedling, seed	> 10 yrs
B, E	*Ziziphus mauritiana*	Edible fruit	Live fence	Seedlings	> 10 yrs
B, E	*Prosopis chilensis*	Fodder	Alley cropping	Seedlings	5 – 6 yrs
B, C	*Azadirachta indica*	Fodder	Scatter	Seedlings	>10 yrs
B, E	*Tamarinda indica*	Fodder	Scatter planting	Seedling	
B, C	*Senna siamea*	Rehabilitation of degraded areas	Boundary planting	Seedlings	>10yrs
B, C	Eucalyptus species	Fuelwood / Poles	Woodlot	Seedlings	6-10 yrs

(b) Capacity Building and Extension

The improved capacity of extension staff, their mutual coordination in diffusing activities and activation of existing community-based organizations are essential for the technical instruction and capacity building in promoting the above-cited components including adult education, forestry and agro-forestry. The following is proposd for these purposes.

Capacity building and strengthening of extension staff

Currently, effective environmental education can hardly be performed in the curriculum of primary school,

due to insufficient numbers of teachers, classrooms or teaching material. However, it is surely effective to employ a basic environmental education in view of current improved rate of enrollment and attendance under free schooling in primary education. Similaly, a long-run benefit can be envisaged from this attempt to convey key message to children, because they have more flexible brains to readily absorb modern information than that of adults whose valuation pattern has rigidly been built, without any room for other matters than their daily bread.

Hence, it is proposed that agricultural and forestry extension waokers make a habit of regularly visiting local primary schools to participate in the curriculum as guest speakers. They are requested to make plain presentation of current problems of rural areas, to pose ideas to solve or ease the problems of their living environment for discussion with pupils. Thus, both staff and children can identify their technical needs and what can be done for better environment through their own efforts. When children become fully aware of, and come to concern about their environment, conveyance of environmental messages to their parents can also be expected.

Coordination between extension staff

The staff of forestry, agriculture and community development has been in service for extension work in the SA. The number of staff in each office is limited and they basically work alone without any coordination. Some people are complaining that only FA visits, them while Forestry Staff doesn't, so they failed to buy tree seedlings to plant. Coordination system should be developed to meet and exchange information between all extension staff in charge of the same area and to provide service to farmers promptly in accordance with their needs. Problems and solutions, and future development plan in their area can be discussed together, and duty allocation can be confirmed to do effective work if there is coordination.

Although FA are supposed to visit each block twice a month, farmers attending this block meeting are few. It is recommended to organize block meeting which provide both forestry and agriculture information together at the same time. CDA who are good at organizing groups are asked to support them in organizing and strengthening MNRMC or block committee.

Strengthening every kind of committee

A block constitutes the extension unit of agriculture and each to have block committee to coordinate extension activities. However, many blocks have no committee, and even in the blocks equipped with committees their activities vary from site to site. The committees, experienced gender or leadership training by FA prior to the election of their members, are mostly doing great job to support other farmers. On the other hand, in hastily elected committee after brief explanation by Field Assistant, they do not feel much responsibility and their activities tend to be stagnant.

Whatever committee is established, extension staff has to raise awareness of all group members by providing enough training or seminar. If the elected committee members are strengthened enough, they can play the role of an extension worker. PRA method already introduced in forestry department can be fully utilized to help farmers to realize sharing responsibilities.

Environmental education at schools

At present, effective environmental education can not be seen at school. Since school enrollment has been increased dramatically thanks to the Free Primary Education policy, the message of environment conservation would reach many pupils if effective education is provided at school. In addition to that, they can easily absorb new idea compared to adults with ready-made concept but without any room for caring for environment.

The extension staff of agriculture and forestry should visit primary school regularly to explain current conditions in the area using simple and easy term and let children have chance to think about present

problems and what kind of activities they can contribute to. Extension staff should facilitate them, provide technical information and confirm how to share the responsibilities to conserve environment. It is expected that they can spread the idea from school children to their parents, brothers and sisters, or friends afterwards.

Campaign of environmental conservation targeted at adults

While environmental education is to be provided to rural children who must sustain future community, education on environmental care should be targeted at adults who directly influence environment in and around their living space. As to the contents of campaign, first and foremost message should be: environmental care is never realized without active participation of rural population in the conservation activities. Planners should make the villagers fully conscious of their major role in area restoration through their own efforts. In order to facilitate rural population to assemble in the campaign field, some attraction should be provided to them as suggested below. The campaign staff can propose the audience to play an impromptu skit based on their own, currently encountered problems, offering award to the best player, so that they can identify themselves environment issues as their own ones to confront and to tackle. Such a campaign is most desirable to be provided prior to the implementation of the proposed components so as to enhance the consciousness of rural population.

The canpaign can be provided with entertainment in a form of itinerant caravan, consisting of musicians, actors / actresses, dancers and comedians accompanied with official staff in charge, and they play dramas and songs in the villagers. In these campaign programs the villager's eager participation from the planning stage of environmental conservation activities, importance of their self-help must be promoted.

(c) Agricultural Promotion and Efficient Use of Water Resources

Since excessive reclamation is going on in the SA, there is a growing concern about sustainability of current type of farming. For example, excessive drying of top-soils has been occurring in many farm plots due to depletion of soil organic matter and scanty vegetation cover, where rainfed farming is increasingly subject to drought damages, coupled with decline in the efficiency of manuring through loss of fertile top-soil. To make the matter worse, area under fallow inevitably tend to expand owing to shortage of seed or hazard of continuous mono-culture despite high population growth and dwindling arable land availability per person, leading to inefficient land use. The following are proposed as rectifying measures against these constraints.

- ✧ Facilitation of AF techniques as mentioned earlier,
- ✧ Trying to diversify crop species, shifting from monoculture of maize to crop rotation,
- ✧ Putting measures of fertility enriching measures (like AF on fallow) into practice instead of leaving fallow plot barren where soils are subject to erosion and soil loss,
- ✧ Consolidating reservoirs and other perennial water sources through repairing or reinforcing dykes so that more vegetables, sugarcane can be raised or fodder and water for livestock are secured.
- ✧ Diffusing tilling practice with box ridges to harvest more rainwater into top-soil, minimizing runoff, especially in semi-arid zone for retaining more water in crop field,
- ✧ As regards to promotion of livestock, confining to raise such small animals as fowls, goats, rabbits and pigeons (domestically kept), so as to prevent frequent theft losses.

Likewise, the following ideas are proposed for efficient use of available water resources:

- ✧ To instruct how to repair and reinforce existing dykes, to repair spillways through inclined culvert intakes or with flume pipes, in order to restore existing 22 reservoirs in the SA,
- ✧ To jointly review methods of technical and financial leverage for the preceding proposal of repairs by

ADD and DF,

- ✧ To orient the beneficiaries to organize water users' associations for water control and management so that they can be engaged in such activities as aquacuilture, irrigated farming during dry season, ample use of shallow wells to be drilled around the existing reservoirs and procurement of water for daily home-use and

- ✧ To provide by-laws for equitable water use within the beneficiary, and in pursuance of the by-laws the association establishes annual water use plan, water quality conservation and water retension plans.

(d) Livelihood Improvement

Plan for rearing chicken and guinea fowl

Rearing of chicken and guinea fowl in the SA is important means for obtaining protein in daily diet and cash income by selling those as well. In the area where production of food and feed is poor, farmers cannot help keeping chicken in open field. Obtaining feed is important for development plan, if farmer can obtain feed for rearing in future, they will be able to rear systematically. Chicken and guinea fowl rearing is comparatively easy because of short duration from chick hatching to sale, for example chicken rearing needs only 8 –10 months and guinea fowl for about a year.

First stage

Establishment of production and selling groups

Establishment of such group requires the help of FA, who shall formulate rules and regulations, hold periodical meetings and casual ones, if necessary, following the evaluation and feedback system. From the beginning of group establishment, it is necessary for group to consider, discuss and obtain the results of the basic issues. What kinds of animal should be bred, how to obtain chicks and feed, what are production problems, how to produce, sell, protect diseases, obtain funds, etc. shall be discussed. It is useful for farmers to obtain instructions and suggestion from FA. At present, chicken is more preferable than guinea fowl due to egg laying characteristics.

Establishment of suitable conditions for rearing

It is essential to obtain the favorable conditions such as chicken shade, feed storage depot, places for rearing before purchasing chicks.

Obtaining of chicks

Funds will be required for buying chicks. It is necessary to obtain instruction and suggestions from FA how and where to buy chicks, if necessary, how to obtain funds.

Feed

At the beginning of the first stage, open space, or farmyard rearing may be suitable because of the high cost of feed at the market. Even during the rearing method, a little bit of feed is needed in the cage house. It is essential to provide feed and vaccine because chicks are prove to fall sick. It is necessary to obtain instructions from FA. It should be required that feed production around the homestead, agroforestry production, plants for environmental protection are considered in the development plan.

Selling

At present, chicken can be sold to traders. At the beginning of this stage, this system should be followed.

Second stage

Expand the production places. Among the groups, lands, funds and feed should be gathered to collectively produce chicken through a cooperative.

Expand selling methods. According to suggestions and instructions from ADD, direct selling should be tried to nearby cities and big cities of Blantyre and Limbe.

Fruit production plan

In the SA, fruit trees are not planted intentionally. Planting fruit trees should be aggressively promoted for the purpose of protection against soil erosion, securing nutrition as well as of food security. The following should be considered for fruit production:

- Acquiring of the land to be planted,
- Obtaining suitable seedling for environment, soil suitability and natural conditions,
- Learning of production technology, and
- Establishment of marketing route.

Considering that there are no intentional plantation and fruit tree growing will take not less than 5 years, development of fruit treed should be undertaken step by step.

First stage

Acquisition of land

Group should be established for acquiring and accumulating land. Rules / regulations should be agreed and the evaluation and feedback system should be employed. Group's land and/or cooperative land should be used. At this stage, discussions with related government agencies and institutions is necessary to promote the methods of production and selling taking into consideration that fruits production will be carried out for farmers, by farmers and to farmers themselves.

Acquisition of seedling

Technology transfer by the FA and Forestry staff should be required to select the suitable seedlings. One of recommendable selections is that seedling, which has long harvesting period and different harvesting season from those of other agricultural crops, should be selected, so that farmers can avoid labor breaks. It may be necessary to provide loans for farmers to buy selected / treated seedlings.

Second stage

Promotion of technology transfer

It is essential that the technology transfer should be provided, such as technologies for watering of young tree, protection of diseases and application of insecticides.

Third stage

Establishment of marketing route

Marketing route should be exploited and extended step by step. At primary stage in which production volume and quality are not yet stable, private selling will be recommended. It is advised that group selling

would be much more profitable than individual selling. Group selling should be made only after having decided a quality standards and constant volume. Then, it will be able to sell in large cities, Blantyre and Limbe by group's own marketing route. At final stage, processed products can be offered for sale not only for domestic but also for overseas consumption.

Bee-keeping promotion plan

Apiary has just been introduced in the SA, by traditional type with a large drum of log. Yield is confined to few liter of crude honey per harvest that is performed three times a year, but this level is much lower as compared to that obtained from modern type of beehive often observed in Kenya. Honey yield of a modern beehive reaches 15 kg that has recently been installed by GTZ in a project located just outside of the SA. However, some of them are still empty without any bee-colony settled inside, probably because they are installed on sunny side, always exposed to direct sunshine. For the promotion of efficient bee-keeping, vast forest space with diversified flora with sources of nectar is required to expect good harvest. Forests remaining in the west ~ north of the SA is proposed as candidate sites for beekeeping, but the area is quite limited. In future, a large scale of fixed type beekeeping can be planned in parallel with watershed rehabilitation projects by reforestation and agroforestry, but currently it is better to start from a small size trial. Beekeeping can be readily introduced in the SA because it requires less cost for initial investment but can raise stable profit from periodical harvesting.

First stage

Acquiring of source of nectar, group establishment

Sources for nectar such as *Acacia* spp., *Brachystegia* spp., *Julbernardia* spp., *Syzygium* spp., *Combretum* spp., etc. should be planted for obtaining a long span harvesting season in forest and watershed. Establishing group, composing rules and regulations and formulating a system of evaluation and feedback should be taken.

Acquisition and installation of bee-hive

On introduction of beehive, technically qualified bee-hive should be used as to shape, size, material, etc. In such case, suggestions and instruction from FA would be necessary. Currently, there is no FA who has acquired techniques of apiary, therefore, it is useful that a member of beekeeping cooperatives in the central region will be invited for technology transfer. Funds are also needed by farmers who want to participate in but have not enough capital cost.

Second stage

Harvesting season and method

Harvesting should be carried out periodically and systematically. In the SA at present stage, harvesting is done from May to July. In harvesting, the off-farm season, reduction of heavy works, easiness of marketing, etc. should be taken into consideration

Marketing and its route

At the beginning stage, the harvest is targeted for self-consumption. However, after attaining constant volume systematically, it will be able to sell to nearest cities. One of marketing methods is direct selling to big market or contract-selling to traders. In future, a grading and primary processing will have to be promoted.

Promotion of home industries

Home industries have been promoted mainly by MOWYCS by means of establishing group at village level.

One of the problems arises from financial evaluation of applicants. It is considered that CDAs of MOWYCS have general techniques for promotion and for group establishment. However, they are apt to promote the introduction of facilities not suitable to the present conditions, without any reasonable benefit-cost ratio such as Bakery Facilities in rural society. It is promoted without any proper countermeasures because of lack of feedback system. Operators of such facilities, who obtained the funds or loans at high interests, are hounded by repayment and cannot afford to keep the good maintenance of facilities.

In such conditions in the SA, home industries should be promoted as variously or alternatively as possible. Expected cottage industries include soap making, bakery, sisal bag making, mat making, pot making furniture making, etc. These can be promoted by MOYCS, along with dry banana making, dry mango making, grading of honey which will be able to be promoted in future after the implementation of forest and watershed rehabilitation development. Overall promotion plan is suggested here because they are different in kinds but similar as to ways of promotion:

First stage

Selection of kinds

Group should be established and rules and regulations should be drafted and a feedback system should be designed. Such home industries should consider that raw materials to be used are readily obtained within the planned area. Industries whose raw materials have to be imported from other distant places should not be promoted, unless the development of marketing route has already been established. Production methods, procurement of materials, required facilities, site, marketing, fund provision, etc. has also to be considered with the help of FA. Important things are that the benefit-cost ratio proves it as highly profitable.

Before Production

If the selected home industry belongs to off-season type, it is easy for local people to adopt. If not, it should be kept in mind that the heavy works or working period does not overlap with the crop planting or harvesting season. Individual roles in the group should be understood by everyone.

Production

It is necessary to obtain information from agencies how to select a place, install facilities and obtain funds. After obtaining a reasonable estimation on cost-benefit ratio, technical operation and maintenance method, development plan should be figured out.

Selling

Primary selling will be started for near by areas.

Second stage

Production and sale

When the business becomes good the next step should be to expand production scale in a similar manner to the first stage. Sales will target the big cities with help of FA.

Distribution plan of livelihood improvement (modern cooking stove, deep well, maize mill)

- Modern Cooking Stove
- Improved Fireplace

Although CDA and NGOs have endeavored to introduce improved fireplace for saving firewood, it has not so far been fully accepted by villagers. Major constraints that limit acceptance are the lack of definite type and

immature recognition among villagers of necessity of using it. Therefore, it is required to firmly establish a definite type of fireplace to be promoted for wide extension. It is proposed that a forum be created in which CDA orients users, or village women to discuss on how to improve it, by introducing them the successful trial performed in Enzaro village in Kenya. The discussion will cover what type of fireplace or stove is convenient for daily use and efficient to save fuel, accompanied by actual trial using with available materials. The material to be utilized includes bricks, clay, gypsum and other heat-insulating and durable ones. In case of brick, heat-tolerant bamboo or wooden rope (fiber of *Brachystegia*) can be applied to fortify the ceiling of fireplace, but steel is too costly for villagers. It is not the repeated trials in few villages and then the determination of final prototype that actual extension can be launched. FAs and forestry extension should participate in the extension campaign.

First of all the reason why an improved fireplace is necessary should be explained to women, and the new type of fireplace be displayed. The extension staff should then let them consider what type, what material should be used by themselves, according to their preference of creating new fireplace.

- Deep Well

At present, the number of deep wells has not been enough to meet demand. It has expanded step by step with the help of government agency, MASAF and other NGOs. The method of deep well distribution such as group establishment, operation and maintenance and collection of water fee have been settled. Constraint is lack of funds at present. For further development, present development plan like the above should be promoted after selecting and ordering the priority regions and areas by means of discussing with the government agencies, NGOs and related institutions. Funds from other financing sources are expected.

- Maize Mill

In general, maize is milled by women at home. It takes 30 minutes for each meal preparation and it comes to 1.5 hours a day. Maize mill distribution has grown by the help of MOWYCS, private entrepreneurs and NGOs, however, it is still in primary stage. Type of maize mill machine is hammer type not employing grinding type. This is because finer flour can be milled by means of the hammer type but not by grinding type, and it may be preferred by the consumers. There are a few distributors in Blantyre and they sell several dozens of sets of machine a year. Maize mill distribution requires the suggestion and instruction from well-experienced engineers because it is expensive and operation and maintenance require mechanical techniques. There are some groups in the SA who operate the maize mill with loans, but are pursued by the repayment and cannot afford to secure the good maintenance of the machines. It should be understood that only the business with a profitable benefit-cost ratio, will be feasible to implement.

For development milling, it is promoted after selecting and ordering the village judging from population density. It is difficult to introduce milling in the villages with low density because a profit is hardly obtained. Establishing groups by a help of FA, it is recommended that the member discuss such issues as on the selection of site, methods of materials collection, methods of operation and maintenance, benefit-cost ratio, supply method of facilities. They should use an evaluation and feedback system. It may be necessary to obtain the consents with the related residents, or potential users. It is important to ask for the suggestions and instructions from the experienced personnel step by step. Before introducing the machine, technical transfer for operation and maintenance should be provided by the experienced distributors or technicians. Individual roles in the group should be clarified and understood. Presently, one of the heaviest constraints is lack of funds, so fund from others, especially from machinery suppliers is expected.

8.10 Provision for the Management of Nurseries and Village Forests in VNRMP

VNRMCs make decision on and take charge of the following matters: establishment of nurseries to supply seedlings and planting material to individual woodlots, agro-forestry practices and village forests, joint use and proper storage of equipment donated from donors for producing, distributing and transplanting seedlings, planning, mobilization and supervision of participatory works including organizing participants and division of works or burden sharing among them, institutional commitment and provision of monitoring system on sharing and utilization of the products and benefits gained from group activities. A nursery management

sub-group can be organized in a VNRMC to cater for operating and managing practices for the established nurseries by group village or single village, responsible for the mutual consultation and agreement among the candidate participants on participatory working schedule for all households in the village, their role sharing / labor division, management and use of equipment / implements, benefit sharing among the participants. Similarly, A community forest management sub-group is organized for managing village forests, under which reforestation plan is debated and decided with the assistance of the extension agency concerned, and all the rights and duties to be observed by the participants, including contents of participatory practices, can be conferred in the meetings of the sub-group in a similar manner. Participating households in the creation and management of village forests may be confined to those which hardly hold individual woodlots on account of limited land holding, to which the relevant VNRMC identifies participant households, their burden-sharing and contribution of manual labor, constitutes rules of management and guarantees usufruct right for all the participants in return for the offered labor. The details of consultation are recorded to report to the staff of Blantyre district in charge, for the sake of protecting due right to be enjoyed by the participants. Likewise, similar reporting to the same district staff is to be made on the performance of joint use of village forests so as to secure equity on common use of forests by group.

8.11 Mutual Cooperation among Related Government Agencies in Implementing Watershed Rehabilitation

Since the implementing bodies of watershed rehabilitation measures are villages in the SA, the village headmen/headwomen and related committees are responsible for their implementation. However, it is essential to sustain close coordination among FROS, Blantyre ADD and CDA in order to adequately instruct or give advice to these implementing bodies. To this end, it is pertinent to create a liaison committee, "Middle-Shire Watershed Rehabilitation and Conservation Committee" consisting of three divisional government agencies as mentioned above, local government divisions concerned and related TAs. It is suggested that the committee holds regular meeting to consult on the strategies, targets of rehabilitation, distribution / utilization of fund disbursed from donors, with the attendance of related donors and contributing NGOs.

8.12 Estimated Effects of Proposed Measures on Watershed Rehabilitation

8.12.1. Envisaged Benefits of the Measures to Local Population

Various effects can be expected from the proposed measures on watershed rehabilitation. Among others those for reducing soil loss from the watershed are remarkable coupled with augmented water retentive capacity. The proposed measures never fail to bring about higher self-sufficiency of firewood and material to construct / repair houses. Estimated value of these effects during coming two decades amounts to a substantial level over the SA. Each of the proposed components has tentative target to be realized during this period, but the expected value depends on the degree of achievement towards the targets of proposed project components. It is estimated that the implementation of the proposed measures adds the additional value to the SA, worth 14.3 million MK, equivalent to 370MK per household per annum.

As mentioned earlier, destruction of eco-system and deterioration of watershed is ever more accelerated, the trend can be estimated in such a way that during these five years from the period that aerial photos were taken in 1995 to that of our study the canopy cover in the SA has reduced to a half, or from 4% to 2.4%. According to the observation by the Study Team, charcoal bags and split firewood pieces are loaded on more than 80 bicycles per day coming from TA Chigaru, TA Lundu and TA Kuntembwe to urban centers, amounting over 2 ton / day, equivalent to 15 ton of material (indigenous tree), collected from 1~ 2 ha of woodland that disappears every day (Trucks deliver charcoal and fire wood from outside the SA). The rate of destruction of forests comes to 550 ha per annum, implying that it will take only a few years until all the remaining woodlots (equivalent to 1,600 ha in the SA) vanish from the SA, eventually leading to irreversible barren land. If this really happens, inhabitants in the SA who neglect or fail to make efforts of conservation cannot get

along unless they purchase all the required quantity of firewood from outside. Since the annual firewood requirement per household amounts to over 1 ton, a household should pay 350 MK for firewood assuming the currently prevailing price rate at 3kg / 1MK, or it amounts to 16 million MK for all the households living in the SA. Logwood or pole for repairing huts has also to be procured from markets, at farm-gate price of 150 MK per pole. Repairing is generally made every three years, so the total annual purchase of lignous resources as housing expense (by 46.6 thousand households) in the SA will amount to 8 million MK. It accounts for 5 ~10% of the annual household expenditure. Thus, the project will create resources, with the value equivalent to 24 million MK per annum.

8.12.2 Estimated Benefits expected from the Proposed WRP Measures

As cited above, various benefits can be envisaged from the proposed measures for watershed rehabilitation, of which mitigation of soil loss from the watershed comes to substantial value coupled with the increase in the water retention capacity in the watershed. The proposed measures also secure to bring about firewood and house-repairing material that otherwise would deplete year after year. Including IGA measures, the expected value gained from the implementation of these components during two decades from now on will reach sizable level, though it depend heavily on the degree of fulfillment against the set targets. The following table gives the estimated benefits envisaged to be obtained from them, amounting to 308 MK per household assuming the family member averaged at 4.21 persons (equivalent to above 5 % of annual cash income)

Out of the proposed measures, effect of agro-forestry controlling soil erosion has not yet been measured in the SA. Hence, mean measured amount of soil loss from the field of tree crops with cover crops in the tropics reported by Bruzinzeel in 1990 and Wiersum in 1984 was referred to as a base data of estimation.

Table 8 .12 Surface Erosion in Tropical Forest and Tree Crop Systems

(unit: ton / ha / year)

Land Use Type	Natural Forests	Shifting cultivation fallow	Plantation	Tree crops with cover crops	Shifting cultivation cropping	Tree crops cleared~weeded	Forest litter removed / burned
Maximum	6.20	7.40	6.20	5.60	70.0	183.0	105.0
Minimum	0.03	0.05	0.02	0.10	0.40	1.20	5.9
Medium	0.30	0.20	0.60	0.80	2.80	48.0	53.0

Source：JIRCAS International Symposium Series No.1, Rehabilitation of Degraded Forest Lands in the Tropics, page 23

Table 8.13 Estimated Costs and Benefits of the Proposed Components

Unit : million MK and MK for per capita value

Zone	Zone A	Zone B	Zone C	Zone D	Zone E	Total SA
Total Input	4.1	79.0	56.2	41.7	59.0	240.0
Agro-forestry	1.4	56.6	38.7	18.5	48.2	163.4
Reforestation*	1.4	6.9	8.5	13.8	5.9	36.5
IGAs	8.6	27.6	13.7	7.5	9.2	66.7
Related F.I.	1.3	15.5	9.0	9.5	4.9	40.1
Total agro-forestry	2.4	73.9	51.8	23.8	67.2	219.0
Firewood supply	0.7	26.1	19.3	7.7	24.3	78.1
Crop nutrition	1.1	41.4	30.5	12.3	38.5	123.8
Erosion control	0.5	6.5	2.0	3.7	4.4	17.1
Total forestry	4.2	22.9	12.3	17.9	8.0	65.3
Firewood supply	1.1	5.0	6.6	10.2	4.6	27.5
Material supply	0.0	7.8	0.7	5.0	0.0	13.5
Water conservation	3.1	10.0	5.0	2.7	3.4	24.3
Total IGAs	9.9	71.1	35.4	19.4	23.7	159.5
Bee keeping	0.0	4.3	2.2	1.2	1.4	9.1
Guinea fowl rearing	0.0	11.4	5.7	3.1	3.8	23.9
Vegetable raising	0.0	23.7	11.8	6.5	7.9	49.9
Improved fireplace	9.9	31.7	15.7	8.6	10.6	76.5
Total agriculture	3.7	29.4	22.4	18.1	8.8	82.5
Dambo utilization	0.0	1.6	4.6	2.0	2.6	10.9
aquaculture	0.0	16.1	12.0	12.9	2.3	43.3
Food processing＊	3.7	11.7	5.8	3.2	3.9	28.3
Total value created	20.1	197.4	121.9	79.2	107.7	526.2
Overall B/C ratio	4.9	2.5	2.2	1.9	1.8	2.2
Annual gross margin	0.8	5.9	5.9	1.9	2.4	14.3
Annual per capita M	31.6	72.8	72.8	84.4	89.8	72.9
B / C ratio AF	1.67	1.31	1.34	1.29	1.39	1.34
Ditto, forestry	3.06	3.32	1.44	1.29	1.36	1.79
Ditto, IGAs	1.15	2.58	2.58	2.58	2.58	2.39
Ditto, farming etc.	2.88	1.90	2.50	1.92	1.21	2.06

Note： ＊including envisaged saving of tariff payment to maize mill by the use of stone mortar. The effect of feed supply of livestock is negligible and omitted. AF : agro-forestry, B / C; benefit cost ratio, M; mean margin.、

Similarly, as to effect of increment in crop yields, the result by ICRAF as measured in the periphery of the SA is adopted as the basis of estimation. Furthermore, with regard to the effect of agro-forestry on replenishing firewood, results obtained in ICRAF and other domestic research institutes are available to the estimation on volume. As concern effect of forestry on the supply of firewood, housing materials, estimation is made based on current production level. and planned ones. Also, as for the effect of forestry activities on the control of soil erosion, it is estimated from the difference between the value given in the above table (tree crops with cleared and weeded understorey) and estimated value by means of SLEMSA for estimating erosion hazard given the observed surface vegetation cover and topographic gradient (mean gradient in the SA falls 6%).