MALAWI ENVIRONMENTAL MONITORING PROGRAM

Environmental Indicators and Change

Results of a Qualitative Survey of Smallholders in Four Catchments

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Executive Summary

The Malawian Ministry of Research and Environmental Affairs (MoREA) is evaluating options for establishing an environmental monitoring capacity that (a) strengthens technical and line agencies, and (b) provides the foundation upon which an Environmental Information System (EIS) can be established. This document describes the survey of farmers undertaken so as to better understand farmers' perceptions of (a) environmental change and its causes, and (b) measures of this change. A third goal of the survey was to note the mitigative actions taken against environmental degradation so as to evaluate whether farmers can contribute to a national environmental monitoring scheme.

The survey was conducted during 1994/95 in four catchments (Njolomole, Kamundi, Chulu, and Chilindamadji) where MoREA had been collecting rainfall, sedimentation, and runoff data since August 1993. The survey team stayed eight days in each catchment, meeting with elders, "focus groups" comprised of both genders, and individual farmers. The results of the surveys can be summarized as follows.

Farmers observe changes in a wide range of natural resources but do not discern change systematically. The two indicators that are widely used by farmers are declining soil fertility and rainfall; both serve to indicate changes in yields. Rainfall also indicates the level of water in streams and wells, as well as the number of pests and weeds. Farmers noted changes in natural resources with verbal descriptors or alterations in their behavior.

Indigenous knowledge concerning the weed species that indicate changes in rainfall and soil fertility varies considerably among the catchments. There is also great variability in farmers' perceptions as to why these changes have occurred. Men with more education appeared to be better informed. Women were ill-informed about cause and subsequent environmental effect; there does not seem to be a good flow of agronomic information between husbands and wives, among women, or between communities.

Farmers obtain information about farming from parents, school, and extension. They acknowledge that the information is not always correct, that their skills are limited, and that lack of food and poor health impede their ability to work at full capacity.

Agricultural intensification is occurring with increasing population. It is characterized by a change in farming systems, namely fewer rotations, increased intercropping, and shorter fallow periods. In Njolomole with the highest population, most farmers cultivate continuously unless they are ill or the land is rocky. Harvest shortfalls are increasing, and farmers look to remaining forest and *dambo* areas for salable timber, charcoal, fuel, and reeds. They are also increasingly turning to off-farm employment, and seek opportunities for trade or business. Environmental decline can be expected in areas where farmers lack food self-sufficiency but possess few additional skills.

Farmers do not seem highly motivated to address environmental decline except where it affects production. There is only a very limited understanding of (a) cause and environmental effect, and (b) the concepts of choice and responsibility. Much of the impetus for mitigative action comes from outside the farming community. For the most part, farmers' behavior is conservative, restricted to what they are familiar with. Farmers cited many reasons for their conservatism: little access to information, an extension service that is not responsive to farmer-identified needs, administrative styles that discourage individualism and creativity, and a feeling that "government will look after us." Finally, the inability to meet immediate personal needs adds to the absence of incentives to focus on

longer-term planning horizons. There are however, farmers in every catchment who want information to assist them in protecting their livelihood. This desire was best encapsulated by the farmer from Njolomole who said, "*Just give us the skills and information and we'll make the decisions.*" Identifying the reasons for farmers' inaction provides the opportunity to begin a process whereby farmers become agents of change rather than recipients of aid.

Farmers are likely to voluntarily monitor the environment only if they perceive this as a possible way to improve productivity and profitability. Poor understanding of the causes of changes in natural resources, low levels of literacy, and the immediacy of personal needs pre-empts most farmers' participation. However, only a determination of community needs and priorities through a directed Participatory Rural Appraisal could accurately assess farmers' willingness to become involved in monitoring activities. Whether or not farmers choose to monitor does not in any way diminish the seriousness of continued tree loss, declining soil fertility, and soil erosion.

In addition, meeting MoREA's objectives requires that any monitoring system contribute quantitative data and trends in a way that can be extrapolated to the national level for use by policymakers and planners. Such a system requires consistent indicators, measurements, and methodology across catchments, a willing labor force, a conduit for information flows between collectors and government, facilities to process information, and the bureaucratic will and resources to return analyses in a timely manner and in a format useful to farmers. Government resources are very limited, and an environmental monitoring program would require a resetting of priorities within agencies for training, developing methodologies, and interpreting analyses. A modest pilot project in one or two catchments would enable the various agencies to determine techniques for (a) data collection, analysis, and interpretation, and (b) information dissemination and transfer.

Programs with concise objectives are favored by both donors and government for the ready feedback on their effectiveness. However, programs imposed on farmers from above are unlikely to have lasting impact due to the combined influences of social, economic, and ecological variables. To achieve the broader goal of environmental mitigation, a process approach driven by community-identified priorities is more likely to succeed in the long term. To that end, communities must be assisted in (a) identifying and prioritizing issues, and (b) setting goals and designing action plans. Such a process offers the advantages of being able to tackle a wider range of issues and make better use of agency resources; it will also speed up the dynamics of changing attitudes and allow a faster application of new information or systems. This proactive approach recognizes the social and environmental costs that accompany crises, and the exponential complexity in redressing the situation at this juncture.

The complexity of combined social, economic, ecologic, and agronomic factors precludes a systematic external process to affect change. The process for change must originate with individuals and communities at the grassroots, but the motivation for change is stymied by the need to deal with more immediate needs. However, we deny farmers the tools to decide their own future if we do not offer them the opportunity to participate in a wider process that will ultimately (a) improve their productivity and profitability, and (b) allow them to learn about cause and effect relationships in their own environment.

1. Background

The Ministry of Research and Environmental Affairs (MoREA), with funding from the U.S. Agency for International Development (USAID), is investigating options to monitor changes in Malawi's natural resources under the Malawi Environmental Monitoring Program (MEMP). The objectives of the MEMP were to:

a) determine possible environmental impacts of smallholder burley production; and

b) build a broader technical capacity within MoREA and line agencies upon which a viable environmental information system (EIS) can be based.

MoREA is a relatively new ministry investigating ways to coordinate environmental information from catchment, district, regional, and national levels for use by planners. This survey investigated the feasibility of farmers voluntarily collecting natural resource information for analysis by MoREA.

Farmers are the largest group of natural resource managers in the country, and their combined actions have a huge impact. The social and economic well-being of the largely rural population revolves around agriculture, so it makes sense that government seeks to monitor those natural resource variables useful to decision-making at the farm-level. Voluntary collection of information by farmers is only likely if it improves production and profitability in the short- to medium-term. Thus farmers were asked about what natural resources affect productivity. While indicators of environmental change need not link directly to sustainability, they may be used as signposts pointing to best options for farmers in given resource situations. Indicators are not to be confused with absolute thresholds, which are more problematic to determine.

Farmer collection of information potentially provides a huge and detailed information base, access to data currently unavailable to government or donors, and the opportunity to provide analyses and interpretations of these data in a way that is useful to farmers. Analyses of monitoring brings into focus farmers' immediate concerns, highlights those practices or sites that need ameliorating, and gives impetus for longer-term planning. Understanding the causes of change provides government with the opportunity to work in partnership with farmers, to seek voluntary change in natural resource use while moving toward land restoration, conservation, and more sustainable land uses. This process also allows farmers, extension agents, planners, and policy makers to identify interventions likely to be effective, and sequence them in a way that makes sense to farmers – a factor crucial to achieving policy goals.

2. Introduction

This survey identifies indicators of natural resource change at the farm and catchment level. In addition, it captures the broader social, economic, and political forces affecting smallholders to evaluate the feasibility of involving farmers in an environmental monitoring scheme. Identifying farmers' perceptions of issues would presumably illustrate underlying assumptions, knowledge, cultural norms, and perceived

opportunities, the sum of which are manifested as behaviors affecting resource use. Specifically, the survey was intended to clarify the following:

- What are farmers' perceptions of environmental change?
- What measures do farmers use to determine changes in natural resources?
- What are farmers' perceptions of the effects of their farming practices on the environment?
- What resource use issues have been identified by farmers and what mitigative measures have they taken to address them?
- What are the requirements for incorporating farmers in a monitoring program?
- How feasible is involving farmers in collecting data and information?
- What are the impediments to monitoring by farmers?

3. Methods

The MEMP has been collecting information on water quality, rainfall, sedimentation data, and cropping history in five catchments since August 1993. Four of these catchments were included in this study: Njolomole, Kamundi, Chilindamadji, and Chulu. Two villages in each of Njolomole and Chilindamadji were sampled, and three villages in each of Kamundi and Chulu. Villages representative of catchment conditions were chosen by Land Conservation and Resources Branch (LR&CB), which also hosted meetings to inform residents of the upcoming survey and its purpose. Every effort was made to choose a sample of farmers that was representative with respect to gender, wealth, age, and land size holding. Procedures were sequenced in accordance with respect for Government and Traditional Authority, proceeding from Program Managers (PM) in their respective Agricultural Development Districts (ADD) to their staff, the village headman, and finally to farmers.

The survey team lived in each catchment for eight days. During this period it interviewed separate groups of men farmers, women farmers and village elders. Groups of between 6-10 participants were requested and the high turnout at Nkuchila, in Kamundi, (150+) and Chimombo in Chulu, (150+) was unexpected. Further clarification from key informants was sought as needed. In addition, in-depth interviews were conducted with 35 men and 34 women, and their fields visited to verify information. Half of the women were heads of households. The number of men and women smallholders attending these interviews is listed by catchment in Figure 1.

The survey team consisted of two enumerators, Gertrude Songo and Yob Mkwinda, who were recruited through the Center for Social Research at Zomba, and the coordinator, Susan Moodie, from the University of Arizona. In addition, two women fluent in Yao were hired in Kamundi to assist the survey. The team used a separate questionnaire for elders, focus groups, and individuals. Interviews with elders were to obtain consensus on long-term change in both the environment and in farming systems, and demographic and services information. Focus group interviews provided gender-specific information pertinent to farming practices, decision making, and responsibilities. Individual interviews focused primarily on farming changes in response to changes in the environment. The questionnaire used for individual farmer interviews is contained in Appendix I.

Since time is measured by familial, community, and political events, the following prompts were used to estimate the time of change: independence (1964), end of work in South African mines known as *theba* (1985/86), and first talk of multi-parties (1990/91). Farmer responses usually led to follow-up questions by the survey team that uncovered greater detail concerning village history and customs. This provided the opportunity to place information on targeted issues in the larger context of village life, thus identifying constraints and opportunities to developing a farmer-based monitoring system.

Catchment	Njolomole		Kamundi		Chilindamadji		Chulu	
	Men	Women	Men	Women	Men	Women	Men	Women
Group participants	50	59	69	150+	65	34	102	150+
Individuals	6	11	7	9	9	4	13	10

Figure 1. Numbers of respondents.

4. Summary of Findings

4.1 Smallholders perceptions of change

Some general patterns of perceptions of change emerge from Table 1 despite variation in dates between catchments. There has been a contraction of the rainy season since independence, a gradual lowering of stream and well levels with very noticeable effects in the early 1990s, and decline in crop yields since settlement, briefly reversed with both the introduction of inorganic fertilizer in the late 1970s and hybrid maize seed in the 1980s. Farmers also noted steady loss of forest since settlement. Accelerated deforestation occurred in Njolomole with settlement by Mozambican refugees in the 1980s, and in Chulu, Chilindamadji, and Kamundi with settling of migrants. Farmers reported slower regrowth of trees in all catchments except Chilindamadji, and that the rate of change in both tree cover and soil fertility is increasing.

Other pressures farmers reported as impacting both farming practices and profitability included land sales in Kamundi and population pressures in all catchments. This has led to reduced fallow periods increasing pressure on existing land. Government policy requires smallholders to protect certain tree species in all catchments except Njolomole, leading to tree removal in neighboring forests. MoREA has requested the MEMP field assistants (FAs) to determine if different species are being protected in different catchments, or if they are the same species with different local names.

Conclusion Farmers were most aware of changes that had an immediate or clearly linked impact on productivity and household food security such as declining soil fertility and decreasing water tables.

Recommendation A farmer-based monitoring project should focus on those indicators most readily observed and salient to farmers. Other more sensitive indicators will require training and education before they can be introduced successfully.

Table 1. Farmers' Perceptions of Environmental Change

	Njolomole	Kamundi	Chilindamadji	Chulu
Tree Cover				
• **at settlement**	• full cover before 1900	• clearing began early 1900s, Kaupa since 1944	• full cover in early 1900's, clearing in Kambale began about 1940	• full cover in Chimombo in the 1930s, Mekembambo 1979 - forced resettlement from Ntchenda, Kaizwanga no data
• **population pressures**	• forest reserve divided in 1947, rapid tree loss with Mozambican refugees 1987-1992	• hillsides bought since the '60s, most in the '80s; munda and dambo land for tobacco bought in the early '90s	• gradual loss of forest resulting from new gardens as population increased and migrants settled	• gradual loss of forest since settlement as population increased. Group village headman forced local headmen to accept migrants.
• **tree health**	• declining; trees grow slower	• declining; slower regrowth and little regeneration	• no reports from farmers	• slower regrowth
• **restrictions**	• farmers preserve fruit trees on their own plots	• 1976 - dambo cleared of furniture timbers by the govt. • Forestry requires them to protect - m'bawa, mlombwa, naphini, ntanga ntanga, nkongo mwa • no cutting at graveyards	• hill top was cleared to accommodate Kamuzu Banda's visit in the '80s • Forestry requires them to retain ng'ona, muanga, katupa, mlombwa, mkulu, muona • Headman in Kambale prevents clearing steep slopes for cropping	• no cutting in Kasungu National Park. • Forestry requires them to retain - mlombo, mbawa, mlombwa, papadende, muwanga, kachere • no cutting at graveyards
Duration of rainfall				
• **independence**	• Oct - Apr	• Oct - Mar	• Nov - Jul/Aug	• Oct - Apr
• **current**	• Dec - end Feb	• end Dec - end Feb	• Dec - Apr	• Nov, then stop, end Dec - beg Mar
Water yield				
• **streams**	• level began dropping in early '80s	• level began dropping in mid 70's; most change since 1990	• noticeable change in 1991; some streams now seasonal	• noticeable change since 1991; some streams now annual
• **wells**	• less water from mid 80's on; longer waits for seepage in the dry season	• longer waits for seepage at wells and dambos in the dry season	• level dropped noticeably in 1992	• shallow wells in streams dry out earlier
Soil Fertility and Stability				
• **fertility**	• yields declined steadily since 60s, increased in 70s with introduction of fertilizer, gradually fell, rose again with hybrid seed, now falling with fertilizer price increases	• yields steadily declined since '49, rose with the introduction of fertilizers in 1977 and again in the early 80s with the introduction of hybrid maize	• steady decline since settlement attributed to shortening rotations. Some had never heard of crop rotations.	• steady decline in yields for all except those who can afford fertilizer and hybrid maize. Trend attributed to shortened fallows and declining rainfall.
• **stability**	• most practiced some conservation measures; need boundary ridges and plantings and buffers along streams	• hill side ridges are washed away annually	• many did not know about soil conservation techniques. Farmers say offset mounds work better than ridges on flatter land. Ridges wash away; on steep slopes. There are some terraces and boundary plantings.	• many people ridge but not necessarily to the contour and few have the labor, energy or knowledge to construct contour berms. Sheet erosion looks common and there are some gullies

• Information from focus groups and village elder interviews. Numbers of men and women respondents by catchment: Njolomole (53,44), Kamundi (75,164), Chilindamadji (63,34), and Chulu, (110, 170).

4.2 Causes of change

Table 2 illustrates that farmers in all catchments attribute lower yields to declining soil fertility. Changes in soil fertility have resulted from reductions in fallow periods and rotations. Farmers attribute these reductions to lack of land or food, or to a shortage of labor to work the land. When questioned further, farmers point to the effect of increases in household size and immigration on farming systems, yet most do not see any alternative to continued increases in population.

Men attribute contraction of the rainy season and increasingly erratic distribution of rains within the season primarily to tree loss. The majority of women say they "*don't know*" the reason for the changes in rainfall. Both men and women in all catchments reiterated Biblical prophecies, collectively summed in the quote *"God is whipping us"* (elder's meeting, Kaniymbo, Njolomole).

Men and women in both Njolomole and Kamundi felt weed numbers changed in response primarily to rainfall and then to soil fertility. The range of reasons for changes in weeds was wider for the other catchments without clear agreement between men and women. Men in both Njolomole and Chilindamadji felt lack of rainfall influenced pest and disease numbers, but women and men in other catchments were less sure.

Despite recognizing their own actions in reducing tree cover, there is a pervasive attitude that "somebody else" is causing loss of trees. Tobacco growers and migrants are the culprits in Kamundi, former refugees in Njolomole, settlers from outside in Chulu and Chilindamadji. Smallholders seem not to perceive the cumulative effects of incremental removal of small amounts of timber by many people over many years.

Conclusions Apart from the links between crop yields and soil fertility, and between fallow and the availability of land or labor, no widespread understanding exists as to cause and subsequent environmental effect.

Recommendation Any monitoring project should seek to use indicators whereby both men and women can clearly understand the relationship between cause and environmental effect.

Table 2. Perceived Causes of Change in Natural Resources

		Njolomole		Kamundi		Chilindamadji		Chulu	
		% M	% W	% M	% W	% M	% W	% M	% W
Variable	Farmers attribute change to:								
1. Tree decline	Firewood collection	75	20	71	71	40	50	25	45
	Refugees	75	40						
	Tobacco gardens & sheds		20	28	71			17	
	Migrants opening new gardens					10	25	33	
	Population increase & new gardens		10	43	28	10		58	36
	Charcoal & brick making	50				10			
	Less rainfall	100	10	28	14	30		25	18
2. Rainfall patterns	God	25	20	14	43	30	25	17	9
	Don't know	50	50	43	28	20		25	54
	Lack of trees	50	20	71	14	40		58	
3. Stream & well levels	Lack of rain	75	90	71	28	40		67	36
	Lack of trees	50	10			30		8	
	Don't know	25	20	14	43			17	9
4. Weed species & no.	Don't know			14		10	50	25	36
	Lack of rain	100	50	43	86	30	25	33	
	Declining soil fertility	25	20	28	43	30		8	9
	No change					10			9
5. Pest & disease numbers & frequency infestation	Don't know	50	80	28	28	10	25	33	27
	Lack of rain	75	20	14	28	80	25	17	
	Lack of native habitat			14	14				
	Increased wind dispersal							17	9
6. Crop yields	Declining soil fertility	75	80	71	86	80	50	75	64
	Lack of rain	25	20	14	43	10		8	27
7. Farm system: Fallow	Still fallow			43	57			25	
	No fallow: Lack land/inputs/labor	75	80	28	14	40	50	50	73
	Still rotate	25	20	28	71	70-	25	70	18
Rotation									
	No rotation: Lack land/inputs	30	50		43				
Total number of men and women respondents by catchment: (4, 10) in Njolomole, (7,7) in Kamundi, (10,4) in Chilindamadji, and (12, 11) in Chulu.									

4.3 Indicators used by farmers

Tables 3 through 6 summarize farmers' descriptions of changes in natural resource and production variables, and list the measures that indicate change in the variable.

Tree Cover: Farmers across all catchments noted a change in the amount of tree cover and in the height and amount of thatching grass available. Both women and men use the time to collect firewood or suitable building materials as a guage of availability of resources. However, women in Chulu did not mention firewood collection as an issue even though the countryside looked barren. Perhaps the nearby park was used to supply firewood.

Rainfall: Farmers everywhere were adamant that the rainy season had both contracted and become increasingly erratic. None of the indicators representing this change applied across all catchments. Farmers in Njolomole and Chilindamadji were switching to more drought-tolerant maize and cassava varietals respectively. However, farmers in all catchments reported increases in pests and diseases in years of low rainfall. They also noted that native vegetation is slower to regenerate in the past decade, except in Chilindamadji where there has been no change.

Streams and wells: Streams in all catchments carry less water year round than in the past and women are experiencing longer waits for water at wells and dambos beginning earlier in the dry season. Men use the need to irrigate dimba crops as a guage of stream levels, while women determine changes in stream and well levels by the time of year they begin waiting for water. Exceptions seem to be in Kamundi where men did not mention watering dimba crops, nor did women mention waiting for water in Chilindamadji.

Pests and diseases: Farmers reported an increase in all catchments. Measures used to indicate change include time and money spent on control measures, lack of rainfall, and reduced native habitat and food sources for pests. None of these indicators are widely used by farmers.

Weeds: Farmers in Njolomole and Kamundi, as well as men in Chilindamadji, report a decrease in weed numbers in response to less rainfall, while women in Chilindamadji and Chulu say weed numbers have increased in response to decreasing rains. Men in Chulu say that weed numbers are about the same. These differing perceptions may result from different cultural practices such as time of weeding, seed load from past cropping and weeding histories, and local variations in soil type, light, and weather conditions that favor one species over another. There does seem to be agreement concerning the change in weed density in response to changes in rainfall and soil fertility.

Crop type: Changes in crops were reported in all catchments in response to changing rainfall but mostly in response to the need for cash. Cash crops included beans or cowpeas, sunflower in Chulu, and tobacco in all catchments where farmers had sufficient land and labor. Cowpea is a crop grown only by barren or childless women. The indicator is economic and consistent across all catchments.

Crop Yields: The same response was echoed in all catchments: declining yields since settlement with brief rises after fallow, and after the introduction of fertilizers and improved seed. Agronomic indicators consistent across catchments include changes in response to declining soil fertility and rainfall.

The most important economic strategies to improve household food security in response to poor yields were off-farm agricultural work, and increased trading of food and agricultural commodities. Less important were the sale of forest products, use of wild foods, loans from relatives, and receipt of relief maize.

Recommended rotations: Those farmers practicing rotations noted that rotations are shortening in response to pressures for food and land. Farmers in Kamundi were unaware of recommended rotations, and women in every catchment were less informed then men on the value of rotating crops and on farming practices in general. The indicator for changing rotations appears to be declining yields. Lower yields is leading to more land being placed under maize or cassava cultivation.

Fallow periods: Fallow periods are least in Njolomole and Chulu, followed by Chilindamadji then Kamundi. Indicators of change consistent across catchments are the need for land and food.

Intercropping: Intercropping is increasing in all catchments, and in Njolomole the spacing between plants is diminishing in response to land pressures.

Sensitivity of indicators: Farmers use direct and indirect measures of environmental change and these can be categorized as agronomic, economic, and social indicators. Rainfall and soil fertility are direct measures of weed and pest numbers, changes in the levels of streams and wells, and crop yields. In addition, poor rains and declining yields affect farmers need for farm inputs, access to credit, requirements for cash with concomitant effect on forest, dambo, and lake resources, and off-farm employment opportunities.

Men's and women's awareness of indicators is for the most part reflective of their gender roles (Appendix II). Men are cognizant of the time it takes to find building materials and to water dimba cash crops; women noted both the increase in time to find firewood and longer waits for water at wells and dambos. The situation is different in Kamundi and Chilindamadji, where women were doing most of the cash cropping. This is understandable as approximately half of the women interviewed in both catchments are heads of households. In Chilindamadji, one-third of the men derive cash incomes from fish while most women obtain cash from farm products. Polygamous marriages amongst the Ngoni and Tambuka (both Muslims and Christians) leave women to work and raise children basically on their own. This makes women in Kamundi and Chulu, and to a lesser extent in Chilindamadji and Njolomole, primarily responsible for fieldwork even if they do not make decisions about what is grown or the inputs used.

Conclusions Farmer-identified links between variables and indicators seem strongest when they directly impact food production and profitability. These links are changing rainfall and declining soil fertility on crop yields, available land and soil fertility affecting farming systems, crop type being influenced by economics, and weeds changing density and species in response to changing soil fertility and rainfall.

Less sensitive indicators or slow incremental change in variables require longer documentation to conclusively show change. However, these changes in practices are clear signals to planners of stresses in communities, and may assist farmers to visualize and create a different future. Two clear sequences of environmental stress are changes in tree cover and declining soil fertility. They are described below.

Farmers used verbal descriptors such as “thinning” or “less than before” to describe initial changes in tree cover. Further losses in forest resources resulted in changes in behavior such as traveling further to obtain firewood or building materials. Finally, with extreme shortage of the resource, cultural practices normally avoided by the community are tolerated. These include removal of trees along stream sides, cutting of fruit trees, and digging up tree roots – normally avoided to ensure coppice regrowth and a semi-permanent source of wood close to home.

Declining soil fertility without external inputs has led to lower yields. Farmers have responded by changing their system of farming. Fallow periods and rotations are reduced to extend production of the staple crop. Better-off farmers use fertilizer and improved seed if available. Further declines in yields result in farmers cropping more staples, with subsequent yield reductions from both erosion and loss of the rotation effect.

Indicators are useful for revealing trends and gauging farmers' receptiveness to mitigative actions and policy. That indicators are qualitative and generally reflective of a number of variables makes it difficult to accurately quantify thresholds and so decide on points or times of intervention. However, knowledge of environmental trends may link more overtly in the community’s mind the connections between cause and effect, and between choice and responsibility.

Recommendations The discrepancy regarding changes in weed numbers in response to changing soil fertility needs to be clarified. It is proposed to sample knowledgeable farmers to link the indicator to farming system and microsite conditions.

Without ownership or managerial rights of resources, there is little incentive to extend planning horizons of communities and encourage responsibility for actions. The idea of finite resources would more directly link cause and effect, and thus make indicators more reliable. Farmers in all catchments are meeting shortfalls of fuel, building materials, and household food and income needs from nearby forests regardless of whether such extraction is legal. Given the proximity of forests, their cash potential, the absence of other income earning opportunities, and most villagers' skill levels, these forest resources provide the *only* source of ready cash

That so many of the apparent vagaries of farming are attributed to God raises a case for educating villagers on basic biological, physical, and economic processes to better understand cause and environmental effect. This may involve reorienting existing extension efforts, targeting elementary school curricula, and calling on NGO and donor resources.

Forestry policy must align with conservation goals. Currently farmers are required to forego yield and income by retaining timber trees on their own land, which forestry subsequently sells for profit. A sequence of satellite images of Phirilongwe Forest Reserve near Kamundi show that such restrictions, in conjunction with fuel and timber shortages, leads to encroachment of nearby forests and not conservation of trees as intended.

Table 3. Indicators and Measures of Change in Njolomole

Questionnaire prompts **Changes in: (*Variables*)**	Farmer description of change in natural resource	% M	% W	Measures used to show more or less change (***Indicators***)	% M	% W	Id.
1. The way the land looks	Amount of tree cover	67	67	Time to get firewood /building mat.	50	58	X
	Tree species indicating fertility			Kachere, muaphe, phaka,mango			X
	Rate of decline of tree cover	33	8	Only fruit trees are retained on farm plots	17	8	X
	Decline in grass cover and height	83	50	Digging up tree roots	17	17	X
2. Rainfall	Amount	100	83	Crop type/ yield	33	25	X
	Distribution	100	83	Regeneration of native vegetation	17	8	
3. a. Streams	Level of water throughout year	50	42	Dimbas require more hand watering	17		X
	Annual streams dry earlier	67	25				
	Dambos dry up	-	8				
b. Wells	Longer waits at wells/dambos	-	50	Length of women's workday		8	X
4. Crop yields & husbandry							
a. Pests & diseases	Numbers/ frequency of infestation	83	67	Increases in: aphids, kunfunbwa grasshoppers, termites, stalk borers, gonogompuchi, white ants kapuewi, leaf blight, snails, kaluvluvi	17	8	X
	Biggest increase			Stalk borer, leaf blight, white ants			X
b. Weed species	Increase in number	-	8	Changes in rainfall	50	25	X
	Decrease in number	50	57	Changes in rainfall and soil fertility			X
	Weed spp indicating infertile soil			Kaufiti, chilala, covani, nsiriu, msonthe, tsangwi			X
	Weed species indicating fertility	50	33	Manmnaligo	17	25	X
c. Crop type	Change in crop type	67	33	Need for cash	33	8	
				Changes in fertility/rains/pests	32	16	
				Lack labor	-	8	
d. Crop yields	Declining, brief rises after fertilizer or fallow	100	100	**Agronomic**: rainfall, soil fertility	100	100	X
				Economic: Household food security strategies			
				Off-farm work	33	42	X
				Trade	33	8	X
				Forest/dambo products	17	25	X
				Cash cropping	83	33	X
				Government relief	-	33	
5. Farm Systems							
a. Recommended Rotations	Shorter rotations than recomm.	50	83	Less land and lower soil fertility	50	33	X
	Continuous cultivation	50					X
b. Fallow periods	Continuous cultivation	67	50	Availability of land/need for food			X
	Shorter fallow than parents	17	17		17	25	X
c. Intercropping	Increase/ closer spacing of plants	33	33	More area intercropped	17	17	X
	No change in intercropping	17	17				X

* Total respondents: 6 men and 12 women. Percentages may add to greater than one where respondents gave several answers to a singe inquiry. Id. = Indicator, X = possible indicator

Table 4. Indicators and Measures of Change in Kamundi

Questionnaire prompts **Changes in: (***Variable)*	Farmer description of change in natural resource	% M	% W	Measures used to show more or less change (*Indicator)*	% M	% W	Possible Indicators
1. The way the land looks	Amount of tree cover	100	55	Time to get firewood /building mat.	16	44	X
	Rate of decline of tree cover	16	35	Widespread clearing for tobacco farms	16	44	
	Tree species indicating fertility			papaya, banana, mposa, ntete, ntanga ntanga			
	Decline in grass cover and height	33	22	Time to find good thatch	16	11	X
	Cutting of wild fruit trees		22	Availability of wild fruits		22	X
2. Rainfall	Amount	83	88	Crop type and yield			X
	Distribution	83	88	Regeneration of native vegetation	17		X
3. a. Streams	Level of water throughout year	16	22				
	Perennial streams now annual	16	22				
	Annual streams dry earlier		22				
	Dambos dry up		11	Water dimba crops except maize and sweet potato	17		X
b. Wells	Longer waits at wells/dambos	50	67	When the wait for water begins		22	X
4. Crop yields & husbandry							
a. Pests & diseases	Numbers/freq. infestation due to rain	83	100	Increases in: termites, grasshoppers, army worms, leaf blight, kodikodi, mephembzo, chiguduli, mice, monkeys, baboons	50	33	X
	Biggest increase in:			Stalk borer, army worms, grasshoppers, mice, monkeys	33	22	X
				Lack native vegetation	16	33	
b. Weed species	Decreased in numbers	100	100				
	Weeds indicating infertile soil			Kaufiti, msonthe, mbombomtale	83	100	X
c. Crop type	No change in crops	16					
	Change in crop type	16	44	Need for cash	11	33	X
				Insufficient rain/fertility		22	
				Lack access to inputs	11	22	
d. Crop yields	Declining; brief rises after fertilizer or fallow	83	100	Agronomic: rainfall, soil fertility			
				Economic: Household food security strategies			
				Off-farm work	67	55	X
				Trading	33	22	X
				Sales forest products	16		
				Use wild foods	83	67	X
				Cash cropping	16	44	X
				Government relief		33	
				Relatives	16	22	
5. Farm Systems	Recommended rotations	33	33	Availability of seed		11	
a. Recommended rotations	Shorter rotations than recomm.	67	22	Availability of information/land	50	44	X
	Continuous cultivation		33	Availability land / soil fertility		11	
b. Fallow periods	Continuous cultivation	50	22	Need for food. Fallow due to illness/ lack labor	49	33	X
	Shorter fallow than parents	50	66	2-5 years and declining		22	
c. Intercropping	Increase in intercropping		22	More of planted area intercropped		22	X
	No change in inter-cropping	16					

* Total respondents: 6 men and 9 women. Percentages may add to more than one where respondents gave several answers to a single inquiry. X = possible indicator

Table 5. Indicators and Measures of Change in Chilindamadji

Questionnaire prompts **Changes in:**	Farmer description of change in natural resource	% M	% W	Measures used to show more or less change	% M	% W	Possible indicators
1. The way the land looks	Amount of tree cover	50	25	Time to get firewood /building mat.	20	25	X
	Tree species indicating fertility			None reported			
	Rate of decline of tree cover	25		Gradual rate of clearing			
	Decline in grass cover and height	30	50				
2. Rainfall	Amount	100	100	Crop yield	50		X
	Distribution	100	100	Numbers of pests and diseases	60		X
3. a. Streams	Level of water throughout year	50	25	Watering of dimba crops	20		X
	Perennial streams now annual	10	25				
	Annual streams dry earlier	10					
b. Wells	Longer waits at wells/dambos	40	25	Month when waiting for water begins			X
4. Crop yields & husbandry							
a. Pests & diseases	Numbers/ freq. infestation due to rains	60	75	Increases in: army worms,, grasshoppers, kodikodi, mice, monkeys, baboons, makate, stalk borer	50	25	X
	Biggest increases in:			Kodikodi	50		X
	No change	20	25				
b. Weed species	Increase in numbers	20	50	Drop in crop yields	10		
	Decreased in numbers	70	25				
	Weeds indicating fertile soil			Chigu, mveka in decline	10		
	Weed spp. indicating infertile soil		25	Kaufiti	10		
c. Crop type	Change in crop type	70	50	Need for cash	10	75	X
				Lack labor	10		
				Lack access to inputs	10		
				Government prohibits millet- 1968	30		
d. Crop yields	Declining; brief increase after fertilizer or fallow	50	75	Agronomic: rainfall, soil fertility			
				Economic: Household food security strategies			
				Off-farm work	30	25	X
				Trading in fish	30	25	X
				Sales forest products	30	25	X
				Use wild foods	20	50	X
				Relatives			
5. Farm Systems	Recommended rotations	40			40		X
a. Recommended Rotations	Shorter rotations than recomm.	10	25	Availability of information		50	X
	Continuous cultivation	50	75	Less land and soil fertility	10	25	
b. Fallow periods	Continuous cultivation	20	50	Need for food. Fallow due to illness/lack labor			
	Shorter fallow than parents	60	50	3-5 years and declining	40		
	Same as parents	20					
c. Intercropping	Increase in inter-cropping	40		More of planted area intercropped			
	No change in intercropping	10	50		30	10	

* Total respondents: 10 men and 4 women. Percentages may add to more than one where respondents gave several answers to a single inquiry. X = possible indicator

Table 6. Indicators and Measures of Change in Chulu

Questionnaire prompts **Changes in:**	Farmer description of change in natural resource	% M	% W	Measures used to show more or less change	% M	% W	Possible indicators
1. The way the land looks	Amount of tree cover	100	70	Time to get firewood /building mat.	25		X
	Tree species indicating fertility			Muwanga			X
	Rate of decline of tree cover	55	30	Accelerating rate of clearing	58		
	Decline in grass cover and height	9	10	Number of new gardens	33	20	X
2. Rainfall	Amount	64	100				
	Distribution	64	100	Regeneration of native vegetation	25	20	X
3. a. Streams	Level of water throughout year	45	20	Dimba crops require hand watering	25		X
	Annual streams dry earlier	27	20				
	Dambos dry up	27	40				
b. Wells	Longer waits at wells/dambos	82	50	Month when waiting for water starts	18	30	X
4. Crop yields & husbandry							
a. Pests & diseases	Numbers/ freq of infest. due to rains	73	50	Increases in kodikodi, kapuchi, iwenya,	17		X
	No change	27					
b. Weed species	Increase in number	45	50	Changes in soil fertility	25		X
	Decrease in number	27	10	Changes in rainfall	8		
	Change in weed species	18	50	More kaufiti with declining soil fertility		20	X
	Relationship to fertility./ rain			Kabata, kadzandiyama, nyamalonda,			
	No change	36	10				
c. Crop type	Change in crop type	45	20	Need for cash	45	30	X
				Availability of new market nearby	9		
d. Crop yields	Declining; brief rises after fertilizer	73	90	**Agronomic**: rainfall, soil fertility	73	40	X
				Economic: Household food security strategies			
				Off-farm work	36	30	X
				Trade	27	40	X
				Forest/dambo products		30	X
				Cash cropping	54	20	X
				Relatives/ savings	27	50	X
				Government relief	9	50	X
5. Farm Systems	Recommended rotations	82	40	Availability inputs/ information/ land	42	40	X
a. Recommended	Shorter rotations	18	40				
Rotations	Continuous cultivation		20	Lack land / soil fertility/ inputs	8	40	X
b. Fallow periods	Continuous cultivation	45	90	Need for food. Fallow due to illness/lack labor	25	70	X
	Shorter than parents	45	10	2-5 years and declining	33		
c. Intercropping	Increase	64	100	More area intercropped	18	70	X
	No change	18			18	10	

* Total respondents; 11 men and 10 women. Percentages may add to greater than one where respondents gave more that one answer to a single inquiry. X = possible indicator

4.4. Mitigative measures used by smallholders and their efficacy

Farmer-identified concerns affecting farm productivity, profitability, and quality of life were broadly characterized into the three areas of agronomic, social, and economic concerns. Responses are illustrated in Table 7, with agronomic issues listed for individuals in the upper portion and the collective concerns displayed in the lower portion. Agronomic concerns, particularly the cost and availability of inputs, are a concern for the majority of farmers in all catchments. Collective concerns show that cost and availability of inputs, health issues, the availability of equipped clinics at a reasonable distance, and safe drinking water are all considered very important. These social issues dictate the efficiency of farming and the ability to expend energy and time on both monitoring and conservation work.

4.4.1 Soil fertility

Traditional methods of retaining soil fertility are the use of fallow, rotation, and the burying of plant residues. In Chulu before 1990 when most cattle died, farmers collected manures from corralled goats and cattle and incorporated these into fields. Adaptations to declining fertility include changing crop or variety, burying crop residues, increasing intercropping with legumes, alley cropping with pigeon peas in Chulu and Kamundi, and agroforestry in Njolomole. While the benefits to soil fertility from agroforestry will take some years to accrue, alley cropping with pigeon peas provides nitrogen and cash from sale of the peas within the same season. The small quantities of compost and animal manure available on most farms precludes their use on areas larger than home gardens. Compost is not made in Chulu or Kamundi, and in Chilindamadji most kitchen scraps are consumed by poultry.

Fertilizer is now seen by the majority of farmers as the ‘cure-all’ for low yields. Unfortunately it is expensive and frequently not available when needed. The expected boost in yields may not be forthcoming when rains are unreliable, and makes borrowing money at steep interest rates for fertilizer purchases a high-risk decision. In addition, the use of fertilizer masks the loss of nutrients, rooting volume, and water-holding capacity caused by sheet erosion.

Table 7. Farmer-Identified Issues and Mitigative Action Taken

Responses		Njolomole %M	Njolomole %W	Kamundi %M	Kamundi %W	Chilindamadji %M	Chilindamadji %W	Chulu %M	Chulu %W
Agronomic *(responses by individuals)*									
• soil fertility	burying crop residues	100	100	100	100	100	100	100	100
	addition of inorganic fertilizer	80	11			20		18	
	legume rotations	60		60	67	40	50	36	50
	fallow	20	22	20	33	30	75	9	
	alley cropping				20				10
	agroforestry	20	11		17				
	soil conservation works	60	44	60	33	30	25	36	30
• lack of labor at critical periods	fallow	20	55		17	20	25		
	informal work groups								
• lack of rainfall	change crop or variety	40	11	20		10	25		
	plant trees	60		40	17			18	10
• pest & disease management	guard garden			20	17	30			
	synthesized insecticides	20							
	botanical control		22						
• cost & availability of inputs	continue traditional methods		22			20			10
• few markets & low prices	trade in other commodities	20		20		80			
• insufficient land	encourage children to go to school	20		20		40			
• availability of credit	trade/business to increase income	20							
Data above drawn from individual interviews with men and women; (4, 10) in Njolomole, (5, 6) in Kamundi, (10, 4) in Chilindamadji, and (11, 10) in Chulu									
Services - Health *(responses by groups)*									
• lack safe drinking water	identified need		54	46	18	81	53	27	100
• illness affecting labor efficiency	fallow/ rent or lend land		33		73			27	
• money / distance to medical assistance	stay home/ use traditional medicine/ nothing	11		46	18	81	18	27	73
Services - Education *(responses by grps)*									
• school far or lacking in resources	nothing			27	2	31			59
• adult literacy and training opportunities		22			18	13	53		29
Economics *(responses by groups)*									
• lack of money for basic necessities	seek work/ trade/ sell forest products	51		47	21	13		1	15
Agronomic *(responses by groups)*									
• cost & availability of inputs/ fertilizer		88	78	64	86	63	18	53	59
• lack of rain				35	13			18	74
• pests & diseases					73	31		27	
• availability of credit				12	18			41	74
• lack soil fertility/ poor yields		20	54	16					
• lack land/ overpopulation			54	27	2				
• pests & diseases				72	2				
• availability of credit		38		12		50	41		
Collated from focus and village elder interviews. Total men and women respondents: (53,44) in Njolomole, (75,164) in Kamundi, (64,34) in Chilindamadji, and (110,170) Chulu.									

4.4.2 Soil conservation

Approximately one-third to one-half of farmers practice some soil conservation measures. Female-headed households and married women who farm alone knew fewer conservation techniques. These farmers reported increased surface runoff annually washing out some ridges and contours in Njolomole, Chulu, and Chilindamadji. Those few women who had enough energy and labor to construct contour berms and ridges were using their "*best guess*." In Chulu and Kamundi, farmers said that in the past extension agents had always constructed contour berms for farmers without transferring the 'know-how.' In Njolomole, increasing fragmentation of plots with rising population has resulted in more footpaths along plot boundaries, leading to erosion by foot traffic and water movement. Few farmers had heard about using raised footpaths and not one knew how to construct them.

In addition to limited knowledge of methods, farmers say that the recommended measures are not always effective. In Chilindamadji, farmers found that ridges are often washed out on steep land; and on flatter land, offset mounds of about one meter diameter are more effective than ridges at reducing runoff and produce higher yields of cassava.

In Njolomole, lowland farmers reported difficulty talking to upland neighbors who failed to check water movement on their properties that then adversely affected lowland crops. This points to the need for a common understanding and focus for catchment management.

4.4.3 Declining rainfall

Farmers are responding to contracting and erratic rainfall by staggering plantings and changing crop species or varieties. All farmers reported difficulty in locating the desired seed type. Almost all crops are intercropped in Njolomole, many in Kamundi, all except cassava in Chilindamadji, and all except burley and maize in Chulu. Dambo nurseries are being mulched, and farmers report that they require more regular watering than prior to 1991/92. Availability of wild foods is also declining in response to declining rainfall. Women in Nkuchila attribute the disappearance of 'nkhungudzu,' a native edible legume that used to self-seed near compounds, to declining rains.

4.4.4 Pest control

Control of pests and diseases was not mentioned as a high priority by most farmers but represents an important loss of food. One reason that losses are not higher in an essentially maize monocropping system is the high cost of hybrid maize seed, which ensures that the genetically diverse local varieties are still in use. Farmers in Kamundi and Chilindamadji noted that loss of bush habitat was driving monkeys, baboons, wild pigs, and birds into cropland in search of food. Several farmers reported success in keeping these pests from entering the field by locating banquets of dehusked maize on the perimeter of the field. Only the more knowledgeable farmers seemed aware that insect pest numbers and the frequency of infestation is linked to the destruction of predator habitat, maintenance of rotations, and crop diversity.

4.4.5 Tree planting

Tree planting is being undertaken by more than half the men farmers interviewed in Njolomole, with varying success. Failures are attributed to late arrival of seedlings, unsuitable species, and to lack of knowledge about how to plant seedlings. Given the financial divisions in households, it is possible that

planted trees would be used to boost men's cash income. Without explicit efforts to grow firewood and improve fuel efficiency, further loss of forest cover is inevitable. The availability of nearby forests in other catchments impedes more widespread planting, although several farmers in both Kamundi and Chulu said they *"should"* be planting.

4.4.6 Population pressures

Current pressures and growth rates are seen as inevitable by most farmers. Their beliefs are encapsulated in the comments "*go forth and multiply*," and, "*those in the future will have to take care of the future*." The cumulative effects of these attitudes are being seen in declining fallow periods, limited rotations, and the subsequent impact on soil fertility and yields. As population increases, lack of land will likely result in increasing numbers of landless whose only means of support will be poorly paid agricultural work.

4.5 Practices that contribute to decline on smallholders' land

Soil Management. Farming's most important resource is under pressure. The survey team noted poorly constructed erosion controls, changes in farming systems with declining legume rotations and reduced fallow periods, burning of crop residues, cultivation to the edge of streams and gullies, and the digging up of tree roots. All these practices adversely impact soil structure and fertility. Gully erosion was evident in parts of all catchments, and few farmers knew about the loss of nutrients through sheet erosion. Through extension and education, men appear to know more soil conservation techniques than do women (Appendix II). The use and efficacy of techniques are linked to skill, education, and labor availability. That few farmers practice effective controls on the steep slopes of Chilindamadji or on the flatter but easily eroded soils in Chulu is a cause for concern.

Use of fire. All farmers report burying crop residues yet the survey team observed stacked piles of maize stalks in Chulu that farmers intended to burn. Fire is fairly commonly used to clear new gardens in Chilindamadji and for ash fertilization of millet beds in Chilindamadji and Chulu. Farmers generally seemed unaware of the substantial losses of nutrients and biodegradable material that ensue, initially through volatilization and later in surface runoff with the first rains. Fires are generally attributed to children hunting mice, which may indicate that farmers are aware that burning is detrimental but did not want to indicate their awareness to the survey team.

Value of livestock. Except for poultry most livestock are kept as insurance rather than tradable commodities or sources of protein. Without common land for grazing, livestock feed along paths, roadsides, on fallow land, and on forest preserves. Given the small numbers, the nutrients they add as waste is negligible. Stock compact paths and edges of streams, their waste is a source of pollution, yet they offer needed cash during the *'time of hunger'* in the rainy season before harvest. Cattle were important for tillage and transport in Chulu up till 1990, when most cattle died. Farmers report spending less effort on soil conservation since then.

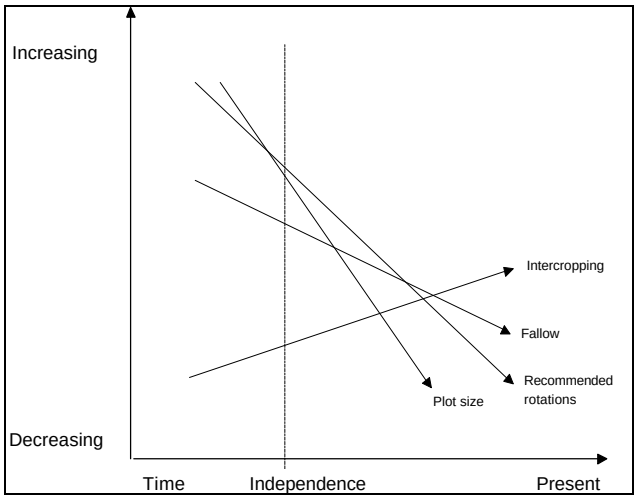

Figure 2. Farming trends.

Population. The effect of family size on farm viability is beginning to be realized by a small number in every catchment. Farmers reported that the family planning facilities to respond to this need are not readily accessible nor of good quality.

Land tenure. Adverse agronomic effects are exacerbated by land tenure arrangements that place pressure on remaining land. These arrangements include sizable leaseholds provided by the government to tobacco growers in Chulu leaving fewer forest resources for smallholders, private arrangements between village headmen and migrants to use customary land, and land sales by headmen to outsiders in Kamundi. Smaller farm size has resulted in shorter fallows.

Conclusions With increasing pressures on existing land, traditional methods of maintaining soil fertility are inadequate. Most farmers see fertilizer as the only solution to maintaining production.

Current information and skill levels to implement soil conservation techniques are insufficient in most catchments. This will continue to affect yields as erosion depletes nutrients. In addition, increasing runoff reduces infiltration and lowers water tables, contributing to declining stream and well yields.

Farmers mitigation efforts are hampered by health issues, lack of labor at critical production times and for conservation work, lack of knowledge, and limited access to information and inputs.

Lack of off-farm low-skilled employment opportunities and increasing population place increasing pressure on remaining forest and dambo areas for salable products, crop land, and wild foods.

Recommendations Provide education at adult and elementary level on the links between cause and environmental effect. Education needs to be interactive, hands-on, visual and probably include combinations of oral, pictorial, and theatrical methods. Information must encapsulate principles rather than just techniques to allow farmers to adapt methodologies to changes in sites and conditions. Holistic approaches to farm management (such as permaculture) embody this exploratory approach

while leaving decisions and knowledge in farmers' domain, and not within administrative orbits that often (a) are influenced by outside policy, and (b) tend toward broad solutions without adjusting for social, economic, and agroecological differences. Education on both the cause and effect of soil erosion and practical demonstrations on conservation techniques would provide farmers with the opportunity to evaluate different conservation methods (a) within their labor and skill requirements, (b) for their appropriateness for various soil types, slopes, and farming systems, and (c) allow them to adapt methods as conditions change. Data from the MEMP plots could be used to demonstrate soil loss by water erosion.

A PRA would accurately determine whether farmers are ready and able to monitor environmental change.

The use of geographic imagery with detail at the plot level would assist in targeting areas for improving farm management according to land capability.

Given the cost and dangers of pesticide use in illiterate societies without protected water, adding to the knowledge of farmers from extension, research, and literature would greatly increase their understanding and options for biological and cultural pest control.

On-going land restoration and conservation practices would be better served by local people knowing how to raise, establish, protect, and manage trees themselves rather than relying on outside sources of seedlings.

4.6 Conditions conducive to mitigative actions

4.6.1 Social organization and group achievements

Existing groups and clubs within villages are the natural focus for any new programs. Chilindamadji has a robust network of both formal business, civic, and recreation groups, as well as informal arrangements to assist with field tasks. One-third of villages in all catchments do not have a club. Achievements by village groups tend to be modest but important given the former political climate and continuous economic strain. Chulu residents constructed a post office now staffed by a government worker. Chimombo residents in that same catchment are helping each other with fertilizer loan repayments and making a commitment to get their children to school. Villagers in Nkulora are building a church/school, and 17 farmers in Kaniymbo are investigating the merits of agroforestry.

While villagers consistently cite lack of labor for field preparation and weeding, collective labor organization is not practiced. However, women neighbors in Chilindamadji help each informally and older women in Kamundi remember working in groups to prepare and weed fields. "*We were friendly then and lived closely*" (Kaupa woman). Apparently the famine of '49-'51 precipitated a change in this area. Women could no longer provide the expected feast in return for labor, and group assistance finally dissipated in the early '80s. Women involved in those groups reported everyone having their fields prepared before the first rains. Such a system makes sense when labor and cash deficits are

common. However, smallholders reported pervasive mistrust, suspicion, and jealousy among people due to unethical actions (selling of land), the legacy of the past political regime, and extreme poverty making many decisions potentially high risk. People did not want others to do well, and cited theft and witchcraft as efforts to maintain the status quo.

Conclusions Formation of goal-oriented clubs (for example, credit acquisition for fertilizer purchases) may not prevent subsequent autonomy and self-reliance. However, these may cloud more immediate individual and community issues such as lack of labor at critical times and the absence of safe drinking water.

Recommendation Identify community issues through a PRA and allow the villagers to set their own agenda and proceed in a way that makes sense to them. A skilled facilitator may be necessary to defuse mistrust and hostility in order to allow community action to proceed.

Moving toward a dynamic that instills group cohesion and harmony will take effort, skill, and a transparent and accountable decision making process. Some were willing to embark on this process but were unsure how to begin. As a younger woman in Chulu pointedly said, "*Show us some examples of how it could be different."*

4.6.2 Record keeping skills

Only the women's chicken club in Chilindamadji reported keeping written records. However, clubs were not asked if they recorded information by other means. Presumably they keep oral records or descriptors of some kind. This is of benefit to farmers but would require conversion and analysis to be of use to administrators.

Conclusions Collection of quantitative data may be difficult where illiteracy is common.

Collection of information and data will only make sense to farmers if the information directly relates to production. If information is collected on useful variables using measurements farmers understand, then farmers will utilize analyses and interpretations in a way that is useful to them.

Recommendations Possible options for monitoring where illiteracy is common are to (a) involve only the literate farmers, which would preclude most women, (b) develop a procedure that allows information to be recorded pictorially, and/or (c) involve literate schoolchildren who could assist their parents. This last option has the benefits of making monitoring both a school activity and a way to get parents and children talking together about farming, conservation, and the future.

Discussion and extrapolation of analyses may provide the stimulus to explore more complex and interrelated issues affecting natural resource use and conservation.

4.6.3 Willingness to try new ventures: risk assessment

Risk assessment can be defined as recognizing the implications of available options and having the requisite knowledge to evaluate alternatives. Much of what the team observed was individuals utilizing a single option presented as a universal solution by government or donors. These solutions included hybrid maize, blanket fertilizer application rates, tillage and soil conservation techniques that do not reflect variable soil conditions, and the introduction of burley and a formula approach to its management.

Additions to these technologies include living sheds for curing burley, agroforestry and alley cropping with pigeon peas to improve soil fertility, and the use of vertiver grass to control soil and water movement. While useful technologies from outside are to be welcomed, it is a cause of concern that farmers are either not looking for or not finding answers themselves. Exceptions were farmers utilizing native root crops (chilazi and bue) to extend food reserves in the dry season, and furrowing mid-season to reduce labor requirements. Almost all women dehydrate vegetables for dry season use.

Conclusion Farmers perceive few alternatives to current farming practices.

Recommendations Orient research to solving farmer-identified issues, and present the results in a form that allows farmers to evaluate the information's usefulness to their situation.

Older farmers said that agricultural films were extremely useful, and favored practical demonstrations.

4.7 Impediments to monitoring

4.7.1 Cause and effect

Farmers' awareness of cause and environmental effect is crucial to their self-identification as decision makers and resource managers. Awareness of basic biological and physical processes is a prerequisite of problem ownership and subsequent resolution. Responses in Table 2 point to farmers either not knowing the underlying causes of changes (for example changes in rainfall patterns or the species and frequency of pests, diseases, and weed species), or being unwilling to acknowledge the effects of their own actions. Despite recognizing their own actions in depleting tree cover, farmers are quick to attribute timber and fuel shortages to the actions of "*others*."

Farmers tend to simplify problems to only those elements that seem important. They focus on what is useful to them, make their best guess, and then test it in practice. Such an approach makes the problem simpler, draws on the farmers' instincts and experience, doesn't require further training or outsider's experience, and allows the problem to be tackled immediately. An example is the use of fertilizer being seen as the 'fix' for declining soil fertility. While this approach is useful in the short-term, other factors whose effects accrue over the longer-term are ignored. These include population pressures and its impact on the farming system, which affect productivity. This is one reason that farmers may miss the links and underlying causes of natural resource problems that accrue over the long-term. Another

reason is the rate of change. Knowledge of processes would assist smallholders to adapt with and anticipate change. Certainly there is considerable local knowledge of the natural environment held by some individuals, but not the deep, widespread knowledge that allows communities to adapt to changing resource conditions in a way that offers yield stability and ecological resistance.

Conclusion While most farmers perceive change in resources, they either do not have clear understanding of the causes, ignore them, or do not extrapolate the changes to their likely consequences.

Recommendation Provide education on cause and environmental effect at the elementary and adult levels. This needs to be coupled to mitigative measures that farmers could undertake. These steps require both suitable curricula and training for those involved.

4.7.2 Agronomic concerns

From Table 7, it is apparent that natural resource issues as they relate to conservation are dwarfed by both agronomic and socioeconomic concerns. The primary concern of communities shown in Table 7 appears to be the cost and availability of inputs, mainly fertilizer

4.7.2.1 Control over decision making

4.7.2.1.1 Inputs

Fertilizer and seed that could have boosted production were either unavailable, available late in the season, located far from the point of production, or were costly. Last year's free fertilizer required farmers in Kamundi to walk a 40 km round trip, half of it with a 50 kg bag of fertilizer on their head. Not surprisingly, most sold the fertilizer in Mangochi and bought other necessities. Low producer prices, access to affordable credit, and availability of markets were also of concern. At Chulu, the government agricultural trading company, Admarc, was buying groundnuts for 2 K per kg, while processed Tambala redskins sold for 27 K per kg in the local supermarket (PTC), a markup of more than 13-fold.

4.7.2.1.2 Information

Access to pertinent and timely information is crucial for decision making by farmers, extension agents, and planners. The information collected must be deemed to be useful by farmers, and it must proceed from the catchment through agricultural administrative units to MoREA for analysis and return. The return trip must be both timely and provide explanation of the results in a way that makes sense to farmers.

Extension agents are logical conduits for information. However, extension agents are clearly overburdened with the number they must reach (1537 families in Njolomole, 1958 in Chilindamadji), the programs they must present or implement, and the data they must collect for their own agency and other projects. Extension agents expressed concern that they cannot get information in a timely manner to assist farmers with their most pressing production needs.

Conclusion Farmers have limited access to information pertinent to their resource situations on which to make decisions.

Recommendation Use the current agricultural structure to feed information from research, literature, extension, and other farmers to farmers. Utilize graduate students at Bunda and elsewhere in conjunction with farmers to develop, oral, pictorial, written, and theatrical material to present new management concepts, perspectives, and ways to document, analyze, and use information.

Having farmers or literate school children conduct some of the monitoring services currently provided by extension agents frees extension to do what they were trained to do – assist farmers with agricultural queries.

4.7.2.2 Low yields

Low yields may result from many agronomic factors that are magnified by poor health and lack of labor at critical times. This may make it difficult for farmers to unravel cause and effect. For example, several farmers in Kambale felt they could considerably improve yields but lacked the money for quality hoes, essential for constructing the large ridges on steep, rocky land infested with bamboo. When asked how the situation would improve if they had new hoes, they responded that they did not have the food, and therefore the energy, to do the work anyway. In Njolomole, several women in Maonga foresaw "*fighting for food"* in the future.

4.7.3 Socioeconomic concerns

Smallholders report that the availability and quality of water, pervasive poor health, and distance to adequately-equipped medical clinics are the major socioeconomic concerns.

4.7.3.1 Land tenure

"*I needed the money so I sold the land*" (village headman, Kamundi). There is confusion about the repercussions of leasehold, the fine line between corruption and receiving gifts, and of responsibility and accountability. While the survey team noted discord resulting from abuses of land tenure, they did not attempt to unravel the complexities of such systems.

Continuing land scarcity and lack of security is crucial to conservation. Management shifts coincide with changes of ownership and control. Shifting cultivation gave way to permanent boundaries in the late '40s in Njolomole, somewhat later in the other catchments. The economic opportunities of population pressures on land have not been ignored by some village headmen. In Kamundi, steep hillsides with fragile soils were sold to newcomers from Dedza, Ntcheu, and Mulanje in the '80s. Liberalization of the burley market saw a fresh round of speculators. They bought the productive flatter fields and dambo areas that were often already occupied or assigned. In Chulu, village headmen are told to accept outsiders by the group village headman. Obviously this causes tension, and it is not uncommon for villagers to employ witchcraft to settle scores. Without security of tenure, conservation works are not a viable investment for smallholders on customary land. This situation contrasts with

owner-operators who seek to maintain productivity of the land for their lifetimes and that of their children. Longer term government leaseholds in Chulu are evidence of this as families actively plan how to both maintain productivity and limit family size.

Conclusions Resolution of land tenure issues is crucial for continued productivity, social stability, and conservation.

Recommendation Utilize a skilled facilitator and mediator to guide interested communities toward a more transparent and accountable decision making process. Refusing to provide land to relatives of villagers and migrants in need (or with money) goes against the grain: "*Charo mbanthu*" (in Tambuka, "the world is people"). A conversation with a village headman in Chilindamadji opened the possibility for a different way of dealing with the implications of migrants and family increase. In essence, the conversation was a move towards democratic and responsible decision making. All members of the village would participate in discussions and decision making. This builds ownership of the situation and some commitment to dealing with its implications. This scenario could easily be extended to cover longer-term resource use. It would engineer social conscience and responsibility and disallow actions, such as those of the village headman in Kamundi, while retaining the traditional reporting structure.

4.7.3.2. Poverty, population, health, and education

"*We never finish the work in the fields because we're always ill, or pregnant, or tired*" (woman at Kaupa, Kamundi). "*When we run out of food we just lie down and sleep to conserve energy*" (man at Maonga, Njolomole). When yields are low, days of one nsima meal a day may stretch into months.

The pattern in the catchments is consistent with consequences of poverty and inadequate access to essentials - sufficient quality food, clean water, adequate sanitation, health care, family planning options and education, that are found elsewhere in the developing world. The major socioeconomic concerns were access to safe and adequate water, illness, and distance to equipped health services, all of roughly equal concern. Distance to inadequately-serviced primary schools followed.

Smallholders experience periodic poor health and acute disability during the rainy season from malaria, diarrhea, respiratory infections, and in Chulu, bilharzia as well. This is the time of greatest energy need to prepare land, sow and weed crops, and work in others' gardens for food or cash to make up harvest shortfalls. Periods of greatest labor requirement are illustrated in Figure 3, the seasonal calendar for Njolomole. The other catchments follow a similar pattern. In 1994/95, these harvest shortfalls averaged 3 months in Njolomole and Chilindamadji, 5 months in Chulu, and 7 months in Kamundi. In every catchment, meat and oil are luxuries, while introduced vegetables are primarily a source of income rather than of vitamins. There was evidence of goiter from iodine deficiency in Njolomole, exacerbated by the reliance on cabbage and other thiocyanate-containing mustards that decrease uptake of iodine. Away from market outlets, a range of wild greens takes the place of cabbage in the diet.

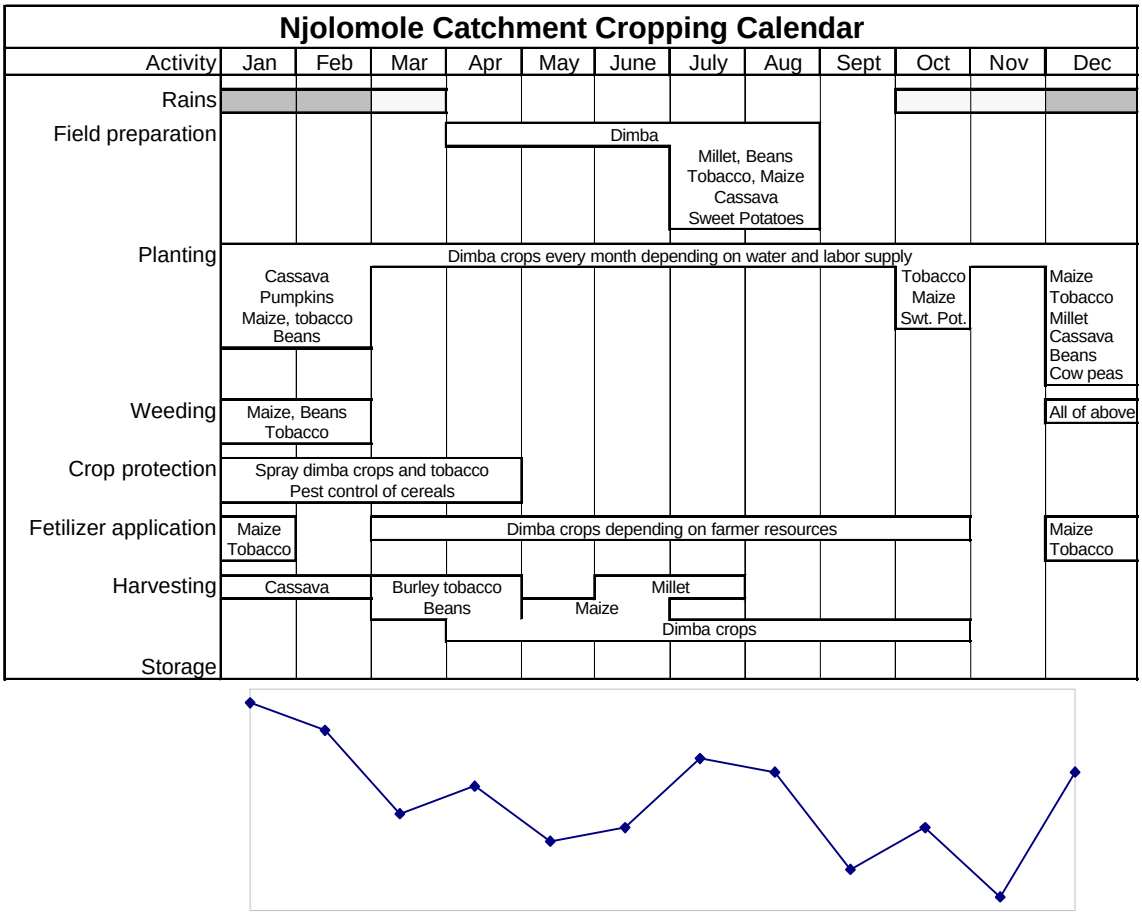

Figure 3. Seasonal calendar for Njolomole. The bottom graph shows relative labor demand by month.

4.7.3.2.1 Choice

"*We sure could do with some condoms around here... and how do you use them*?" (group of women at Nkuchila). Women often have little choice in reproduction, education, or skill development, or in the choice of crop or use of monies. The resultant impact on women's health and opportunities cannot be overstated. In Kamundi and elsewhere, girls are encouraged to marry young because parents cannot afford to feed or clothe them. Early marriage, repeated pregnancies, strenuous field work, child care, and long work days all take their toll. In the dry season, women in Malola spend up to 6 hours a day in collecting a single bucket of water.

Education for women and sensitive family planning services would give women a measure of control over their lives. With high infant mortality, no social security, and technology more expensive than labor, children remain the best option for providing security in old age. There is always the thought that children without land can migrate; to Mozambique from Njolomole and to the nearby forests (protected or not) from the other catchments. The effect of family increase on farm viability is beginning to be realized by a small number in every catchment. Except for a trained midwife in Chilindamadji and an "Under Five Clinic" in Chulu that women stated provided appalling service from a drunken medical

assistant, the attendant family-planning services, education opportunities, and infant care facilities necessary to respond to this need are neither readily accessible nor of good quality.

Conclusion Socioeconomic concerns may overshadow natural resource issues, and certainly impact farmers productivity and profitability.

Recommendation Undertake a PRA to determine communities' priorities.

4.7.3.3 Institutions

"*No one really listens*" - Program Manager - "*..not to women, not to men, not to villagers, not across ministries and not much up and down either....*" Wanting to learn from farmers and making the effort to develop trust is key to strengthening local institutions at the level below district administrations. Ideally, institutional arrangements would seek to include those who bear the costs of monitoring as well as those who benefit from resource management schemes. A specific question worth considering is: When are local institutions most likely to be both effective and sustainable in the management of natural resources? Bureaucracies are often objective driven, while community action relies on the process, the personal interactions between those involved being as important as the outcome. That so few donor projects continue after support is removed attests to the importance of communities deciding priorities, agendas, timing, and methodologies.

Local institutions are more likely to successfully implement environmental management programs if the resource is known and predictable rather than shifting and variable. Further success is achieved when the resource users themselves are an identifiable group or community with their own authority structure. Local institutions are not always able to resolve resource management conflicts, however. If local institutions are absent, all conflicts must be dealt with at higher levels, yielding slower and often less appropriate outcomes. Institutions encourage people to take a longer-term view by creating common expectations and a basis for cooperation that goes beyond individual interests.

While declining rainfall and soil fertility are common to all catchments, some agronomic and socioeconomic issues are village specific. The ability to respond to these issues varies with identification of the issue and local voluntary organization. Similarly, it could be expected that there would be considerable variation regarding responsibility for natural resource management. It is for this reason that any monitoring program must focus on receptive individual farmers and their information requirements in only one sector – agricultural production. If such a pilot proved successful, issues surrounding local institution capacity-building will surface. These issues could be resolved in future phases of a monitoring program.

4.8 A Brief Look at Burley Production

A total of fourteen growers and three club officials from the four catchments were interviewed. The results are to assist the HIID survey later this year to quantify findings. Issues pertaining to natural resource use are illustrated in Table 8.

Failure to repay last year's loan has meant that most tobacco growers used neither fertilizer nor pesticides this growing season. Obviously this lowers yield and quality, and has the added effect of slowing canopy closure that leads to increased surface runoff and sedimentation. In response to limited credit availability, the number of growers has dropped from 30 in 1992 to 7 this year in Chilindamadji. The vice-president of the Nkuchila club in Kamundi said that men can raise money from other activities besides farming to purchase fertilizer but that women could not, either because of household responsibilities or because their husbands associated women involved in business with prostitution. In the same catchment, two growers said the labor investment does not give the necessary profit and food security, and they are better off growing maize. Elsewhere, farmers reported that despite the labor demands, erratic rainfall and cost and availability of inputs, they would continue to grow burley. None of the growers interviewed said they had either reduced or stopped growing other crops as a result of growing burley, which suggests that only the larger landholders grow burley, that fallow land is brought into production, or that burley contributes favorably to household food security and income.

Few farmers report using pesticides. This may lead to lower tobacco quality and price received, but has the benefit of reducing the use of poisons near dambos where villagers in three catchments collect drinking water. The health risks and costs associated with pesticides make investigation of safer, cheaper biological and cultural alternatives an attractive option. One grower reported using a tincture of Elephant Killer *(m'mphanjovu*), a local plant to control pests in tobacco and maize.

The recommended rotation for burley is being followed by only two of the farmers interviewed. Inter-cropping with pumpkins is not recommended but widely practiced to pay laborers and to shade out weeds. The seed is sown one month after tobacco is transplanted to avoid competition for light.
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Table 8. Smallholder Burley Production

Source Indicators		Njolomole	Kamundi	Chilindamadji	Chulu
Agriculture					
• **input use**	• cost & avail causing declining soil fertility	• little fertilizer use - slow canopy closure - greater runoff and erosion expected.	• lack money for inputs	• lack money for fertilizer	• lack of credit limits fertilizer use • few use pesticides
• **rotations**	• lack of land limits rotations	• recommended rotations not followed - lack of land , need for maize	• biannual rotation of tobacco/ maize because of need for food	• enough land to use recommended rotations	• people walk far to their gardens and to available markets. Illness affects labor availability and productivity year- round
• **labor**	• dimba crops require work at same time as tobacco	• labor demand very high at tobacco harvest, moderate demand from dimba, and other crops	• some may stop growing - high labor needs conflict with food production and poor returns	• moderate to low demand for other crops when tobacco harvested	• risk heightened as rainy season becomes less reliable and cost of fertilizer increases.
• **risk**	• high risk when obtaining credit for fertilizer and rains are uncertain	• high risk if no rains	• high risk if rains poor	• farmers are more diversified here	• high risk if rains are poor
Forest					
• **shed materials**	• sheds need renewing about every 2 years	• shed materials from forest; one grower started a living shed	• high demand for timber from large estates - some met with own bluegum plantations	• forests thinning but still plenty of trees	• poles from fallow regrowth and probably the game park. Large estates growing flue cured have high timber needs
• **new gardens for tobacco**	• new gardens pacts soil fertility as little fertilizer is used and recommended rotations are not followed	• existing land converted to tobacco	• land being bought by outsiders for tobacco	• not known	• leaseholders who have more cash, and those capitalized by Limbe Leaf
Water					
• **use**	• bucket watering of tobacco nurseries has little impact	• bucket watering of nursery has little impact	• little impact	• little impact; farmers share watering	• nurseries are usually rain fed
Life Support Indicators					
• **Biodiversity**	• clearing for new gardens further fragments remnant forest threatening their genetic robustness.	• tobacco growers tend to be larger farmers	• clearing of land by speculators in tobacco	• clearing for new gardens by migrants	• clearing of leasehold
• **Special Lands (wetlands)**	• decrease in dambo vegetation with introduction of tobacco nurseries.	• increasing use of dambo ;nurseries moved yearly to reduce disease	• dambo areas well utilized for all crops	• few burley growers	• plenty of dambo land available
Human Impact Indicators					
Health					
• **Water quality**	• unprotected wells may lead to fertilizer and pesticide residues	• most wells capped	• open streams, lot of illness, few use pesticides	• open streams -illness	• open streams - illness.
• **Occupational hazards**	• no safety equipment for spraying pesticides	• no safety equipment	• no safety equipment	• no safety equipment	• no safety equipment
Food Security	• variable, depends on input use, agronomic practices, skills and timing, price received, rainfall	• can be positive or negative for the reasons described at left.	• some will stop - labor demand too high	• credit for fertilizer a problem	• will keep growing
Socioeconomic effects to be ascertained by Harvard Institute of International Development in 1995.					

4.9 Summary

This survey was initiated to understand farmers' perceptions, assumptions, and decisions that impact natural resource use. The study determined the feasibility and mechanisms by which farmers could assist MoREA meet its mandate of a national environmental monitoring capacity.

Many farmers perceive changes in a wide range of natural resources variables but do not discern change equally. Thus, measurements revealing more or less change in a variable were not always consistent within or between catchments or between men and women. Two indicators that are widely used by farmers are declining soil fertility and rainfall. Both serve to indicate changes in yields, and declining rainfall is an indicator of water levels in streams and wells.

Indicators of change were either descriptors such as those used to describe changes in forest cover ("thinning," "less"), or intensification of behaviors such as those used to describe the effect of pest increases (more time guarding the garden) and poor yields (needing longer periods of off-farm work and more salable forest products). Farmers obviously quantify yields, but this information was not collected by this survey. There was contradictory information about the causes of changes in weed numbers and species. The differences need to be correlated to cropping history, management practices, and microsite conditions.

Farmers obtain information about farming from parents, school, and extension. They acknowledge that the information is not always correct, that their skills are limited, and that lack of food and poor health impede their ability to work at full capacity. Women seem particularly ill-informed about farming practices and there does not seem to be a flow of agronomic information between husbands and wives, among women, or between villages. More farmers are growing burley tobacco, legumes, and sunflower to meet cash needs. Local forest and dambos or wetland areas are also being harvested for timber, charcoal, fuel, reeds, and wild foods for income. This is to be expected where farmers have few skills and employment opportunities. Without food self-sufficiency and commitment to manage natural resources for the longer-term, continuing environmental decline can be expected.

Much of the impetus for mitigative action comes from the donor community. Farmers report that the introduction of pigeon peas, as well as new varieties of cassava and maize, are useful. However, the majority do not seem motivated at the individual or community level to find solutions to declining tree cover even when the need becomes pressing. The reasons farmers gave are many: little access to information, an extension service that is not responsive to farmer-identified needs, administrative styles that discourage individualism and creativity, and a feeling that "government will look after us." There is limited understanding of cause and environmental effect, as well as of choice and responsibility. Finally, the inability to meet immediate personal needs adds to the absence of incentives to focus on longer-term planning horizons. There are, however, farmers in every catchment wanting information to assist them in protecting their livelihood. This desire was best encapsulated by the farmer from Njolomole who said, "*Just give us the skills and information and we'll make the decisions."* Identifying the reasons for farmers' inaction provides the opportunity to begin a process whereby farmers become agents of change rather than recipients of aid.

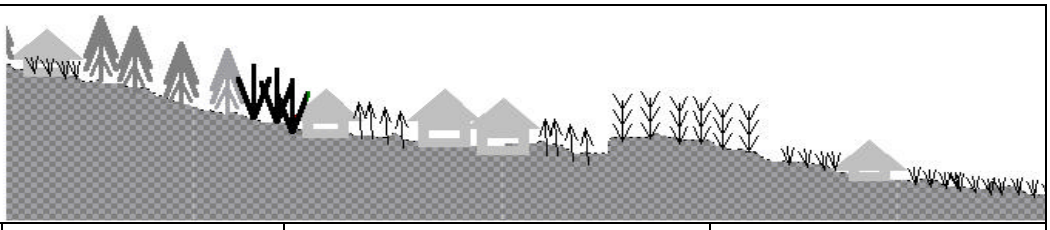
Farmers are only likely to voluntarily monitor if they perceive this as a possible way to improve productivity and profitability. Poor understanding of the causes of changes in natural resources, low levels of literacy to record information, and the immediacy of personal needs probably precludes most farmers from wanting to participate. However, only direct questioning and determination of community needs and priorities through a PRA could accurately assess farmers' willingness to be involved. Government resources are very limited, and an environmental monitoring program would require a resetting of priorities within agencies for training, developing methodologies, and interpreting analyses.

Meeting MoREA's objectives requires that any monitoring system contribute quantitative data and trends in a way that can be extrapolated to the national level for use by policy makers and planners. Such a system requires consistent indicators, measurements, and methodology across catchments, a willing labor force, a conduit for information flows between collectors and government, facilities to process information, and the bureaucratic will and resources to return analyses in a timely manner and in a format useful to farmers.

Monitoring change in natural resource provides the opportunity for education of the community in understanding environmental processes. The information could be used to affect productivity and resource planning. Such information may assist extension planners as they target and sequence useful interventions through their deepened understanding of farmers' knowledge, attitudes, and economic realities. The only way to determine if farmers are interested in this indirect longer-term investment in their livelihoods is to ask them directly. It is suggested that a skilled facilitator be employed to do this. If groups or individuals were interested in monitoring, a pilot is proposed for the upcoming season. This would enable farmers, extension, and MoREA to formulate a system for integration of collecting methodologies, compilation and transfer of information, and analysis and interpretation of results. However, MoREA's analytical facilities are currently over-extended and lack required equipment, and its technical staff require additional training.

Whether or not farmers choose to monitor does not in any way diminish the seriousness of continued tree loss, declining fertility and soil erosion. Materials currently available could be utilized by extension to show trends in resource use. These include farm and village resource maps, quantification of yields, catchment transects such as Figure 4, and GIS images displaying broad-scale changes. Planners also could use monitoring to verify changes in production patterns and farming systems.

Programs with concise objectives are favored by both donors and government for the ready feedback on their effectiveness. However, programs established in response to external stimuli when neither the goals nor sequence have been identified by farmers are unlikely to have lasting impact due to the combined influences of social, economic, and ecologic variables. With the larger goal of mitigation, a process approach driven by community-identified priorities makes sense. To that end, an attempt needs to be made to assist communities to identify and prioritize issues, and to set goals and plans of action. Such a process offers the advantages of being able to (a) tackle a broader range of issues, (b) make better use of agency resources, and (c) speed up the dynamics of changing attitudes and application of new information or systems. This proactive approach recognizes the social and environmental costs that accompany crises, and the exponential complexity in redressing the situation at this juncture.



	Hilltop	Slope	Dambo
Soil	Makande - sandy with organic matter	Katondo - red loam with/ without clay, gravel, sand Nchenga - sandy soil	Makande - alluvial sand
Water	Chimombo and Kaupa households obtain water from wells or streams.	Nkuchila has a protected well, Malola residents get water from perennial stream, N'godi or dambo.	Source of water during the dry season. Seepage is slow.
Vegetation	Native vegetation includes m'bawa, mlombwa, mitwana, mchenga, mtondo, muwanga, mkalati, mdyombo, mtsatanyani. Northern boundary cleared for maize and burley.	Native vegetation on fallow land includes msondoka, mpinji, thombozi, mtondo), chitimbe, napini, mapoza, mango, mtowo, mtangatanga, mthethe, kankhande, mpama. Lipe is a grass used for thatching, mlaza for mats.	M'bawa and mkundi cut down by government in 1976. Other trees include mkuyu and mpembu. Bango is used for mats and nsenjele (elephant grass) for thatching and doors.
Crops - mostly for food	Maize, Irish potatoes, beans, pigeon peas, sorghum (beer), groundnuts.	Maize, groundnuts, cowpeas, pigeon peas, sweet potato, cassava, pumpkins (pay laborers).	Sugarcane, bananas, maize
Crops - mostly for cash	Sesame (a few farmers)	Sunflower, burley, cassava (lake), sorghum (beer).	Vegetables, beans, soya beans (few), rice
Resources Management (Land Husbandry Practices)	Ridges, some stone boundaries and contour berms.	Ridges, some box ridges, stone boundaries, some boundary plantings with either sorghum, bananas or elephant grass, contour berms take too much labor.	Make very large ridges to hold moisture within the ridge, nursery beds for vegetables and tobacco.
Forestry Practices	No common lands; tree removal on smallholder and public land.	Clearing for new gardens on land purchased from village headman. Guavas and mangoes usually retained.	Clearing by government in 1976, and by farmers for gardens, tobacco farms, and firewood.
Food Security		Cook bananas and mangoes. Few wild relish species left - denje, nkuta, bononge, nkouta, ntambe, ng'ombe, mpurluse, chisoso, masanjala, chewe and chitimbe fruit/ banana bark for bicarb. of soda. Fruit - mapoza, mpama, mposa, masuku, mphinji, sakalawe, mbulukututu, ndawa, mbembu, nkangandembo.	
Issues		Steep slopes in places, loss of fertility through soil erosion, distance to get water, firewood.	Much energy required for clearing and making ridges, dambo dries out early, gardens require watering.
Opportunities	to be identified by PRA		

Figure 4. Transect of Kamundi catchment.

Appendix I. Farmer Survey Questionnaire

A: HOUSEHOLD INFORMATION

1. Sex..... 2. Age..... 3 . Education..... 4. Main occupation.....
5. Part-time work (when and where) .....
6. Marital status of Respondent. Single..... married..... divorced..... separated.....widowed..... polygamist.... spouse living away..... other (specify)..... Is respondent Head of Hhld? Yes/No
7. Number of children.....

QUESTIONS ABOUT LAND

8. When did you start farming here? .....
9. How did you get your land? .....
10. How many fields do you have? .....
11. How many munda fields? ..... dimba ?..... munda/dimba ..... fields in hills..... home garden ....
12. How big is your farm? .....
13. Do you rent or share fields? If yes, explain how this works .....
14. Do you have enough land to feed your family? .....
15. What do you do when you need land and all existing land is taken? .....
16. Are there any fields you no longer farm? .....
17. Why do you no longer farm them? .....
18. Do you hire people to work on your fields? ..Yes/No...If yes, what jobs do they do? .....
19. How long do you usually employ them? .....

QUESTIONS ABOUT CROPS AND SOILS

20. What crops do you grow on this field? 1= maize, 2= tobacco (burley/flue cured) 3 vegetables, 4= groundnuts, 5= ....., 6= ....., 7= .....
21. Is the crop mostly for sale or food? .....
22. What type of field is it? dimba..... munda..... dimba/munda ..... hillside..... home garden .....
23. What is the local name of this soil type? .....
24. What makes it different from other soils? .....
25. Where is it usually found? .....
26. What crops are usually grown on it? ....
27. What happens to this soil in heavy rains? .....
28. If it runs, why do you think this happens? .....
29. Is this soil type fertile? .....
30. What characteristics does a fertile soil have? .....
31. How do you compare the fertility of the soil now to when you started farming? .....
32. If soil fertility has changed, what do you think are the .....
35. What do you do with plant residues? .....
36. Do you incorporate animal manures into your crop fields? .....
37. Do you practice crop rotation?. YES/NO If yes, what is the rotation? .....

Why do you do this? .....

If no, why not .....
38. Do you fallow this field? If yes, for how long?.(years).....If not, why not? .....
39. What grows on the field during the fallow?.....
40. Are there any crops or varieties you used to grow but have now stopped? .....
41. When did you stop? .....
42. Why did you stop? .....
43. Are there any crops or varieties that you have recently started growing?.....
44. When did you start growing them? .....Why did you introduce them? .....
45. Are your maize yields higher or lower than when you started to farm?.....
46. When did they start to change? .....
47. Why do you think they changed? .....
48. If yields are lower, have you tried to raise them?....If yes, explain what and did it work?.....
49. Where did they get the idea from? .....
50. Have you done anything else to increase yields? .....
51. What are the most important factors to growing a good crop? .....

EROSION
52. Which soils are more likely to erode? (local names)
.....
53. Why do you think these soils erode?
.....
54. Is there any erosion in this field?
.....
55. Is there more or less erosion on your field than when you started cultivating it?
.....
56. Have you ever done anything to try to reduce erosion?. YES/NO If yes, what. and when? (IF NO GO TO 60)
57. If yes, where did you get the idea from? .....
58. Did it work?..... Why/why not? .....
59. Who did the work? .....

QUESTIONS ABOUT SOIL CONSERVATION PRACTICES

Practice	Use (Y/N)	Effective (Y/N)	Why?/Why not?
60. Contour berms			
61. Contour strips with trees.....			
62. Contour strips with grass.....			
63. Boundary planting.....			
64. Terraces.....			
65. Box ridges.....			
66. Silt traps in gullies.....			
67. Raised foot paths.....			

68. Where did you get the information about these practices?.....
69. Have you heard of other measures that reduce soil erosion?.....If yes, what? .....
70. Why haven't you tried them? .....
71. Are there things that you used to do to retain soil but no longer do? .....If yes what? .....

72. If yes to 68, Why are they no longer done? .....

TOBACCO

73. Do you grow tobacco? YES/NO If NO, GO TO 81. If yes, Burley? or Flue-cured .? (circle)
74. If burley, when did you start growing it? .....
75. What inputs do you use? fertilizer (type) ..... amount/ha? ..... Manure.....
pesticides? (type) .....Others .....
76. Where do you get seed? .....credit?..... material to cure tobacco? .....
77. What type of field do you grow tobacco on? .....dimba.....munda..... specify.....
78. Is your tobacco nursery right by the stream? Yes/No .....
79. Does the tobacco nursery displace other crops? .....
80. Are there other crops you no longer grow because you grow tobacco? If yes, what crops and why don't you grow them?.....
81. What rotation do you use with tobacco? .....
82. Are there any problems with growing tobacco? .....
83. Do you plan to continue growing tobacco? .... Yes / No Explain .....

FOOD SECURITY

84. How many months did last years' maize harvest last? .....
85. How do you make up the shortfall? .....
86. What proportion do you buy? ..... borrow (friend/relatives)..... trade ..... other .....
87. What do you do for food when the harvest is bad (such as in 1992)? .....
From the answers above, probe
88. Work?..... If yes, full-time or part-time..... where?.....
89. Sell? ..... If yes, what? (Personal items, livestock, other).....
90. Do you sell firewood, baskets, crafts, charcoal, bricks..... if yes,....where do you get the materials? .....
91. Is the amount of these materials declining?.....If yes, has the rate of decline changed?.....If yes, explain .....
92. If the amount of materials has declined, what has caused the decline? .....
93. What are you doing about it?..... If nothing, why?
.....
94. Do you plan to do anything about it? .....
95. Do you use **wild foods** to help make up the shortfall? If yes, what? .....
96. If yes, where do you get them? .....
97. Do you use wild foods when maize is **NOT** scarce? .....If yes, what?.....
98. Have there been changes in the supply of these foods?..... If yes, when did you first notice the change?
99. If there is a change, what do you think has caused the change? .....
100. Is there anything else that you do when the harvest is very bad? .....

LIVESTOCK

101. What livestock do you keep? .....Number? .....
102. How many do you sell each year? .....
103. Where do you graze them? .....

104. Is there a cattle dip in the village? ...If yes, how often is it used? .....

ENVIRONMENTAL CHANGES

105. Have the rains changed since you started farming? .....Amount?..... When did they start? .....
if there was a change, how.....
106. What do you think has caused this change? .....
107. Is there a stream nearby?...If YES, How has it changed since you started farming? .....
108. If there was a change, what do you think caused this?.....
109. Do you collect water from a well?. YES/NO If yes, has the level changed since you started farming?.....
110. If the well level has changed, What do you think has caused the change? .....
111. Describe how the vegetation has changed in this area since you started farming? .....
112. What are the main causes of this?.....
113. Are some species disappearing faster than others? YES/NO If yes, which ones and why?
114. Do you think it is a problem? YES/NO Explain.....
115. If you think it is a problem what are you doing about it?.....
116. Have the number and type of weeds changed since you started farming? YES/NO If yes, explain
117. If there has been a change why do you think this has happened?.....
118. Are there more crop pests than when you started farming? ..... If yes, state what type .....
119. If yes, why do you think this has occurred?.....
120. If yes, what are you doing to control them? .....
121. Are there more diseases than when you started farming? ..... If yes, what kind? .....
122. If yes, what are you doing about it? .....
123. What are the major problems you face as a farmer? List and explain. .....
.....
124. Which are the most important? .....
.....
.....

IS THERE ANYTHING ELSE YOU WANT TO TELL US?

.....
.....

ENUMERATOR OBSERVATIONS

.....

THANK YOU !!

Appendix II. Decision Making and Education Levels

Decision making by gender	Njolomole		Kamundi			Chilindamadji		Chulu		
	Kaniymbo	Maonga	Nkuchila	Malola	Chimombo	Nkhulora	Kambale	Mekembambo	Kaizwanga	Chimombo
Women say:										
choice of crops grown is made by:	women	women	both	men	both	women	women	men	men	men
work decisions are made by:	women	both	men	men	men	both	men	men	both	men
Decisions about work are made by:	both	men	men	men	men	men	men	women	men	men
payment for inputs is made by:	men	men	men	men	men	men	men	women	men	men
Men say:										
choice of crops grown is made by:	men	men	men	men	men	men	men	men	men	men
work decisions are made by:	men	men	men	men	men	men	men	men	men	men
decisions about inputs are made by:	men	men	men	men	men	men	men	men	men	men
payment for inputs is made by:	men	men	men	men	men	men	men	men	men	men
In Chimombo, crops grown on lands that both men and women work are for cash. In other villages and catchments, crops grown on lands that both men and women work are for cash and food.