DEPARTMENT FOR INTERNATIONAL DEVELOPMENT

NATURAL RESOURCES SYSTEM PROGRAMME

Hillsides production System

FINAL TECHNICAL REPORT

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Biophysical and socio-economic tools
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FINAL TECHNICAL REPORT

CONTENTS

EXECUTIVE SUMMARY

The Project Purpose has been the development and promotion of biophysical and socio-economic analytical tools for assessing soil fertility. Four outputs have been key to this.

Output 1 Improved understanding of factors affecting the adoption of soil management technologies has been partly achieved through: i) a substantial Word-based database, ii) a review of farmer perspectives, iii) development of soil fertility indicators and iv) partial development of a systems framework household model.

Output 2, Means developed for evaluating soil management technologies is well on the way to being achieved through the development of a Participatory Learning and Research (PLAR) approach (encompassing the use of participatory tools).

- Diagnostic phase (pairwise ranking, scored causal diagrams, community mapping, resource ranking transect walks and key informant interviews
- Planning phase (inter farmer, inter area and experimental station visits and discussions)
- Experimental phase (use of farmer soil fitness indicators)
- Evaluation phase (pairwise ranking, participatory budgeting)

The PLAR process has facilitated farmer interaction, farmer identification of problems and potential improvements as well as monitoring and evaluation of trials. It has shown that farmer evaluation criteria are in many ways more applicable than scientific ones. Above all the process empowers farmers giving them the confidence to continue the process without outside facilitation.

Security considerations and a ban on travel to Nepal by DFID and the Foreign Office severely effected activities during mid 2002 as UK reserarchers were unable to provide the support required.

Output 3: Capability of local professionals in collaborating institutions to provide useful information to farmers strengthened delivers the tools and facilitating skills that allow improved extension and farmer to farmer contact. This process is well underway and a number of community based NGOs and community groups are using PLAR to encourage farmer testing of improved soil management technologies. They have undertaken the diagnostic phase themselves. ARS-Lumle has facilitated the planning phase through inter area and experimental farm visits and have assisted in some cases with the experimental phase. There now remains a need to monitor, assist with and develop this process, as was programmed during the remaining twelve months of this project.

The development of the systems model as a tool for use primarily by other researchers is well advanced and needs to be taken through to the stage where researchers can interact with it and use it for planning and evaluation.

Output 4: Access to useful NR management information by farmers improved has been addressed through a three-stage process in which

- Researchers have worked with farmers to identify and evaluate potential SFTs-(Year 1 activities)
- Farmers are carrying out their own evaluation trials with researchers monitoring and learning from the process (Year 2 activities).
- Farmers establishing their own trials calling on local professionals when required (Year 3 and beyond activities)

The first stage has been successfully completed. The second stage has been embarked upon, but now requires support. The third stage would have started as the project was completed.

Contribution of outputs to development impact.
The expected Outputs of the project have only been partly achieved, due to early termination. This particularly concerns the systems framework analysis (computer model) and the testing and modification of the participatory tools. Notwithstanding, a range of organisations is now using the PLAR approach either wholly or in part. The concept of farmer empowerment to identify and solve their problems has found favour. There is active involvement of Government extension and NGO agencies in helping to develop the methodologies and a solid platform has been set for using these on a wider scale. However until the following activities have been undertaken, development impact will remain limited.

- Monitoring, evaluation and improvement of the four Phase PLAR process
- Monitoring its use by institutions using the approach
- Monitoring farmer testing of SFTs to learn from the process, in particular:
    - which technologies are being tested
    - the source of the innovation
    - modifications and further adaptation that may have occurred since the innovation was identified
    - what indicators farmers are using and
    - who is benefiting form the results
- Completion of the systems framework

BACKGROUND

Importance of the researchable constraint

The natural resources of many hillside areas are of great social, economic and ecological importance with great potential to improve the livelihoods of their populations. However deforestation, loss of vegetative cover, soil erosion, nutrient and organic matter loss, and deterioration of soil structure have meant that many areas have become degraded. Technologies for restoration include many soil and water conservation and soil fertility technologies (SFTs), including the use of fodder legumes, manures, composts as well as purchased fertilisers and tillage systems that conserve soil moisture. Some are currently used, but farmers have rejected many. The development of an appropriate methodology allowing best-bet technologies to be more readily identified is likely to promote more widespread adoption.

Demand for the project

There have been many requests (e.g. Ashby, 1999, Bunch 1998) for socio-economic methodologies for evaluating soil management options. Swift *et al*. (1994) advocated linking biological processes, individual farmer aspirations, environmental sustainability and local land use policy imperatives. Gregory (1995) stated soil fertility research must incorporate social as well as technical factors. Yet there has been no consistent methodology for linking the two components that allows such assessment. Helvetas-SSMP have indicated that they are keen to see “simple”, “robust”, “rough and ready” tools that development workers and farmers can use to appraise soil fertility management options (Weber, personal communication). Such methodologies need to capture both scientists’ and farmers’ perspectives in a form that can be readily used by extension and research personnel.

By basing methodologies on both farmers’ knowledge and scientific understanding and actual costs/benefits faced by farmers, the project will be able to establish the returns to investments in SFTs as well as establishing the risks inherent in their use. This will allow an assessment to be made of all farmers’ abilities to benefit from them. This in turn will ensure that SFT development initiatives are better targeted and allow the most appropriate options to be more readily identified by farmers, research and development institutions as well as policymakers.

Previous research

Investment appraisal methodologies linking biophysical and socio-economic factors have been developed for evaluating soil erosion and conservation measures, (Clarke *et al*., 1998, Ellis-Jones and Tengberg, 1999, Ellis-Jones and Sims, 1999 and 1995). There is now a need to build on this work taking a wider perspective of not only soil erosion, but also soil management practices in general. Farmer experimentation on soil fertility is an essential part of a participatory learning and action research process (PLAR) which helps farmers to improve their soil fertility management by diagnosing and analysing their situation and then by planning, experimenting and evaluating different ways of managing soil fertility (Defoer *et al*.,2000). In this approach farmers, researchers and extension agents work together to achieve solutions that are practical, applicable and adapted to individual farmers’ specific situations. This project has used a PLAR process and is developing straightforward assessment tools based on farmer’s assessment criteria that can be used by local extension personnel, outreach workers and lead farmers.

PROJECT PURPOSE

The Project Purpose is derived from Output 1, Activity 1.2 and sub-Activity 1.2.2 of the Hillsides NRSP logframe, namely:

"Improved hillside livelihood strategies relevant to the needs of marginal farmers developed and promoted", and "Means for local professionals to identify "best bet" and "win-win" technologies and target them to relevant households".

The Project Purpose is therefore:

Biophysical and socio-economic analytical tools for assessing soil fertility and targeting relevant farming strategies developed and promoted.

As such the project has been developing simple but robust methodologies for linking biophysical and socio-economic factors for assessing the many soil fertility enhancing technologies that are currently being promoted or developed. These have been based on linking farmers' perspectives with scientific knowledge through close work with farmers taking cognisance of advantages and disadvantages as well as costs and benefits actually faced by farmers.

RESEARCH ACTIVITIES

Improved understanding of biophysical and socio-economic factors (Output 1)

Development of a data-base of soil fertility enhancing options (Activity 1.1)
Information on soil fertility enhancing technologies including both those currently in use or being promoted in hillside environments was collated (Ellis-Jones *et al*., 2001). This provided a description of different measures related to their primary function, variations in type, principal uses, resource requirements and main issues surrounding the use of each including constraints to their adoption. At the initial planning workshop (Ellis-Jones and Tripathi., 2000) it was agreed that this should initially be a Word-based report that could be updated as the project proceeded. The report describes the nutrient cycles of small scale farmers, reviews existing information on farmers' indicators of soil fertility and provides a description of different soil management measures related to their primary function, variations, principal uses, resource requirements and the main issues surrounding the use of each. It was noted that there is currently little systematic information available on farmers' knowledge in relation to soil fertility and soil management. This requires that soils research should move forward from documenting management practices and classification systems of farmers' knowledge and practices to understanding the conceptual and theoretical frameworks that underlie such practices (Garforth and Gregory, 1997). Key points from this report are shown in Annex 1. As such the conceptual framework has provided the initial input to the development of a systems framework for linking livelihood strategies to biophysical and socio-economic constraints, which is being implemented in the form of a whole-farm computer simulation model (see Activity 1.4).

This model is presently being developed with the intention that it was available for testing and validation by December 2002.

Review of local farmer perspectives (Activity 1.2)
A review of local farmer perspectives of soil fertility was carried out in contrasting areas using a three-step approach, i) reviewing local literature (Tripathi *et al*., 2001), ii) participatory discussions in case study area (Tripathi *et al*., 2001)and iii) a household survey (Ellis-Jones *et al*., 2002). These provided opportunity to gain a better understanding of farmer perceptions of soil fertility and how improved soil management practices could contribute to increasing

productivity. It also provided the basis for an evaluation of farmer testing allowing farmers' knowledge to be used with that of scientists in development of tools for developing and evaluating soil fertility management options.

Reviewing local literature
The review of local literature confirmed that maintaining and improving soil fertility is seen as important in contributing to increasing productivity and improving rural livelihoods in the mid hills. Considerable research has been undertaken and a number of technically proven soil fertility management strategies have been recommended, but generally adoption remains low.

Farmers use a variety of criteria to characterise their soils but soil colour was the dominant criteria confirming findings of Maskey and Joshy, 1991. The black colour group has soil characteristics (such as good moisture retention, good internal drainage and medium texture) with management practices requiring definitive amounts of labour, compost and fertiliser application to obtain reasonable productivity. Tamang (1996) had also reported that soil colour, texture, depth consistency, interval drainage and moisture retention capacity, temperature regime, slope, aspect and elevation and management implications (source of water, labour requirement, compost and/or chemical fertiliser required and yield) were factors considered by farmers when characterising their soils. Tamang noted that the physical characteristics of the soil determine the management regime. With sufficient water, compost, labour and a suitable climate and appropriate management, any soil can be made fertile and productive.

Key points from this review are shown in Annex 2.

Case studies at Bhakimli, Chambas and Pakuwa
Participatory appraisals were undertaken in four different agro-ecological zones (AEZs): Bhakimli (high hill, 1600-2200m), Upper Pakuwa (1000-1600m, mid hill), lower Pakuwa (600-1000m, low hill) and Chambas (<600m, river basin) to gain an appreciation of farmers' views on soil fertility indicators, management practices, soil fertility and crop productivity trends. In each area, 15-20 male and female farmers participated in group discussions and later as part of the participatory learning and research process were invited to test those soil fertility management options that they considered were suitable for their conditions (Tripathi *et al*, 2001). Participatory tools used included scored causal diagrams, transect walks, and pair wise ranking of alternative soil fertility technologies, historical trend analysis and resource ranking of farmers. (Annexes 3.2-3.5)

This process was important in building relationships that provided further opportunity to work closely with farmers in testing and developing those soil management options they considered most suitable for their management conditions reported under Activity 2.1

<u>Soil fertility management</u>
The group discussions confirmed four principal management practices were used, namely: manures mixed with leaf litter and bedding, composts (primarily leaf litter), legumes either grown on their own or intercropped and chemical fertilisers and one sometimes used but declining practice of in-situ manuring. Although there were slight differences between the four areas, manures were regarded as the best source of soil fertility, chemical fertilisers ranked second, composts third and legumes fourth (Table 1). Further detail is shown in Annex 3

Table 1: Summary matrix ranking of the main soil fertility management practices

Inputs	Chambas	Lower Pakuwa	Upper Pakuwa	Bhakimli	Overall
Manures Organic matter added to manure	1=	2	1	1	1
In-situ manuring	Nu	Nu	Nu	5	5
Composts Primarily leaf litter	3=	3		3	3
Legumes Beans, black gram, soya-beans, cowpeas, pea, interplanted or relay cropped	3=	4	3	4	4
Chemical fertilisers Primarily DAP and Urea	1=	1	2	2	2

Nu=not used

In Chambas and Lower Pakuwa, chemical fertiliser was given as high or higher priorities than manures, as a result of more intensive cropping systems and greater availability of *khet* land. Where *bari* land predominated, manures were seen as the best. The use of composts was seen as necessary to supplement when manure and chemical fertiliser were unavailable or unaffordable.

Focus group and individual farmer discussions in the case study areas provided more details with farmer descriptions of higher and lower soil fertility and productivity against each indicator (Annex 3.1). We were able to confirm that farmers use a variety of criteria to characterise soils with soil colour being dominant. Other factors included texture, depth consistency, internal drainage and moisture retention capacity, temperature regime, slope, aspect and elevation and management implications (such as source of water, labour requirement, compost and/or chemical fertiliser required and yield). In fact farmers consider that with sufficient water, manure, labour and a suitable climate and appropriate management, any soil can be made fertile and productive.

Pair wise ranking of these criteria by farmers provided detail on the priorities for each indicator. This differed slightly from area to area but overall highest ranking was given to indicators associated with crop productivity, especially crop growth, followed by soil characteristics, especially soil colour and hardness, management requirements then pests and manure requirements (Table 2).

Table 2: Indicators and ranking identified through pairwise ranking in farmer discussion groups

	Indicator	Lower Pakuwa	Upper Pakuwa	Chambas	Bhakimli	Average	Overall rank
Crop productivity	Crop yield	2	6=	3=	3=	3=	1
	Crop growth and colour	4=	1=	1=	1	2=	
	Grain fill	1	3=			2=	
	Late rice/early maize	8				8=	
	Taste of grain		3=			3=	
Soil characteristics	Soil colour	3	6=	3=	3=	4=	2
	Soil depth		8			8=	
	Soil hardness	10=	5	6	3=	6=	
	Soil moisture	8	1=	7	6	5	
Management requirements	Ease of work	4=				4=	3
	Labour requirement	6=	10=			8=	
	Ploughing time			1=		1	
Indicator species	Weeds	10=	9	3=	2	6=	4
	Disease and pests		10=	9	7	8=	
	Termites			8		8=	
Manure needs	Manure requirement	6=				6	5

Productivity trends observed by farmers

Historical trends observed by farmers included: a) increasing intensification over the last 30 years; b) decreasing livestock numbers and therefore insufficient manure for all crops, c) increasing use of chemical fertilisers with increasing problems of soil hardness and ploughing difficulties; d) reduced labour availability due to children being at school with young people not wanting to work on farm, increasing migration and an ageing rural population; e) an increase in pests due to intensification and e) a change in the climate with rain no longer falling at the most optimal time, resulting in increased soil erosion. (Annex 3.3)

Reasons for declining productivity

Scored causal diagrams derived from focus group discussions held in each area (Annex 3.4 indicate that the primary causes of declining productivity and soil fertility were a decrease in manure availability (ranging from 50-75% depending on area), increased cropping intensities (30%), low use of chemical fertilisers (10-25%), and a change in climate (more erratic rainfall). Other primary reasons included an increase in cropping intensity with reduced fallows, lack of irrigation (at Chambas) and low use of improved technologies.

The reasons for lack of manure included lack of labour (18-50%), due to migrancy, children being at school and young people not wanting to work on farms, insufficient livestock (due to inadequate fodder, cash and labour to look after the livestock. The reasons for low use of chemical fertiliser (10-25%) included high cost, non-availability, transport problems, increased soil hardness when used, the need to apply increasing quantities as well as inadequate knowledge of their use.

We were not able to distinguish the views of men and women or the three categories of household separately, as those participating in the group discussions wished to participate and contribute as a community rather than subdivisions of their communities. However contributions from each area (Annex 3) attended by different participants did show considerable similarities.

Household survey
A household survey was undertaken in the four AEZs to confirm and quantify information provided by farmers during the group discussions. It was informed by earlier base-line studies in each area (Nepali *et al*., 1998, 1999a and 1999b), as well as the focus group discussions. It provided detailed information on livelihoods, farming systems and confirmed aspects of soil fertility management including the indicators used by communities. A draft survey was field tested in June 2001, modified and applied in September and October 2001 using a survey analysis package (SNAP6) for both survey design and analysis. Households were classified into three Food Security Groups (FSGs) defined by farmers during discussions (Annex 3.5). Some important points included:

- The low incomes derived from crop production (10%, 5% and 15% from FSG1-most secure, FSG2 and FSG 3-least secure respectively) with pensions, remittances and local work being as important.
- The use of green manures and mulches were very rare, largely confined nurseries and seed beds
- 96% of farmers used manures, purchase was rare and confined to FSG1 and FSG3 groups
- 95% of farmers used inorganic fertilisers to supplement manures. Those with smaller areas and without livestock tended to use higher quantities, largely FSG3s.
- Soil fertility indicators derived through participatory methods were confirmed.

A summary of results is shown in Annex 4.

Participatory development of simple field soil fertility indicators (Activity 1.3)

This activity represented a continuation of Activity 1.3 and comprised a 3 month study in Upper and Lower Pakuwa (Desbiez *et al*., 2002). Semi-structured interviews were conducted in 68 households to gain more detailed insight into farmers' soil fertility management practices, local methods used to assess the fertility status of a field, and perceived trends in soil fertility. In addition 33 farmers were then asked to identify fertile and infertile fields. Characteristics of these fields in terms of the indicators mentioned in the interviews were recorded. Soil samples were collected from each field and analysed at the NARC-Lumle soil laboratory. Soil colour was quantified with a Munsell Colour Chart. Weeds in the field were identified, and weed cover and height assessed. Data were stratified according to agro-ecological zone and type of field, *Khet* or *Bari*. Key household characteristics included gender and number of years farming experience were also recorded

<u>Soil classification</u>
Results indicate again that farmers use soil colour as their main classification system, with each having different characteristics in terms of soil fertility, manure requirement, erosivity and soil moisture retention (Table 3 and 4)

Table 3: Farmers' classifications of soil types and their properties in *Khet* and *Bari* fields

Soil types	Occurrence	Colour	Fertility	Manure demand	Erosivity	Moisture retention
Kalo mato	upland *Bari* and *Khet*; lowland *Bari* and *Khet*	Black	High	low	Medium	High
Seto mato	upland *Khet*; lowland *Khet*	White[1]	High	low	Medium / High	Medium / High
Khairo mato	upland *Bari* and *Khet*; lowland *Bari* and *Khet*	Brown	Medium	medium	Medium	Medium
Pahelo mato	upland *Khet*; lowland *Bari* and *Khet*	Yellow	Medium/low	high	High	Medium / Low
Rato mato	upland *Bari* and *Khet*; lowland *Bari* and *Khet*	Red	Low	high	Medium / high	Low

[1] These soils are called white because of shiny mica particles that become apparent when the soil is moist, giving the soils a shiny grey appearance. The soils tend to be very dark in colour.

The relevance of each indicator was found to vary according to whether the farmer was referring to *Khet* or *Bari* land, particularly water indicators. Farmers focused as much on the practice or condition they believed generates or destroys soil fertility as on the properties themselves. It is interesting to note that environmental factors were widely mentioned. Results show that short-term indicators (44% of the total number) were used more frequently than medium-term indicators (28%), and long-term indicators (28%). But interestingly, the numbers of medium-term and long-term indicators together were more than the number of short-term indicators. This high diversity of indicators demonstrates the intimate knowledge farmers have of their soils and the use of medium and long-term indicators a concern for the longer term.

<u>Use of soil fertility indicators by farmers</u>

It became clear from discussions that farmers use soil fertility indicators to make soil management decisions and for subsequent monitoring and assessment. However, rather than using just a single indicator to make a decision or assessment, they use at least five, with some even mentioning up to 15 (Table 4). Each indicator is interpreted separately, but their significance is combined when making an assessment.

Indicators were found to be used for:

- Assessing soil fertility.
- Planning fertiliser (organic and inorganic) applications.
- Monitoring soil fertility.
    - Short term: over the growing season
    - Medium term: over several cropping seasons
    - Long term: over several years
- Assessing the effectiveness of management actions
- Providing warning of necessary changes to be made
- Setting out goals and crop potential
- Predicting crop yields of the current crop
- Assessing crop suitability

Table 4 Classification of indicators used by farmers to assess soil fertility

Perspective	**Soil Characteristics**	**100%**	**Crop performance**	**97%**	**Environmental factors**	**87%**	**Agricultural management**	**99%**	**Biological indicators**	**32%**
Short	Cracks forming in the sun	1%	Yield/amount of crops	76%			Quantity of FYM applied	75%	Pest outbreaks	16%
			Colour of crop	51%			Quantity of inorganic fertiliser applied	29%	Presence of weeds	15%
			Crop size	35%			Quality of ploughing	10%	Invertebrates beneath the soil	15%
			Growth rate	32%			Number of ploughings	3%	Invertebrates above the soil	13%
			Crop suitability	26%					Weed species	10%
			Crop Height	25%					Weed cover	7%
			Disease	10%					Weed height	7%
			Density of plant	9%					Rats	4%
			Size of fruit seed	9%					Weed colour	1%
			Crop appearance	7%						
			Crop roots	4%						
			Germination	4%						
			Crops wilting early	4%						
Medium	Colour of soil	87%			Shade From Trees	28%	Water availability/irrigation	66%		
	Hardness to touch	49%					Difficulty to plough	56%		
	Response to manure	46%					Number crops planted	21%		
	Moisture	37%					Quantity of FYM needed	19%		
	Water holding capacity	31%					Quantity of chemicals needed	12%		
	Infiltration	12%								
	Top soil depth	10%								
	Emergence of rocks	7%								
	Heaviness of soil	4%								
	Soil compactness	3%								
	Response to chemicals	1%								
Long	Stoniness	57%			Quality of water source	32%				
	Soil texture	19%			Distance from water source	28%				
	Erosivity	12%			Distance from house	24%				
	Soil temperature	10%			Landslide potential	19%				
					Size of plot	17%				
					Terrace heights	16%				
					Potential of destruction by monkeys	13%				
					Slope	13%				
					Southern exposition	7%				
					Water temperature	6%				
					Altitude	6%				
					Position within fields	4%				
					Roots of trees in field	3%				

Farmers assessment vs. scientists' evaluation of soil fertility

There was close agreement between farmers' assessment of the soil fertility status of a field using these indicators, particularly soil colour (Table 5), and weed abundance (Table 6), which were examined in more detail.

Although weeds were not spontaneously mentioned by farmers as indicators of soil fertility, most of them recognised that there were more present in the fertile then infertile fields. This view is supported by both visual observations and from quadrat sampling. In *Bari* fields, where management practices are relatively uniform, weeds (in particular *Ageratum conyzoides*) can be used as an indicator of soil fertility. In *Khet* fields, with much more varied management practices, no clear results were obtained, and irrigation regime and water levels are probably more important in influencing weed distribution and abundance than soil fertility.

Table 5: Numbers of farmers using specified colour descriptions of their 'fertile' and 'infertile' *Khet* and *Bari* fields (n=33)

Colour description	***Khet***		***Bari***	
	Fertile	**Infertile**	**Fertile**	**Infertile**
White	7	1		
Black	7		6	
Light black/white	1			
Light black				1
Mixed brown/black	1	1	2	
Brown	1	3	5	3
Mixed brown/red		2		
Red		9	2	11
Light yellow/brown				1
Yellow		1	1	
TOTAL	17		16	

Table 6: Principal weeds collected in *Bari* fields and their preferred field fertility.

Local Name	**Botanical name**	**Family**	**More abundant in:**
Boke (white)	*Ageratum conyzoides*	Compositae	Fertile fields
Boke (blue)	*Ageratum houstonianum*	Compositae	Fertile fields
Avijalo	*Drymaria cordata*	Caryophyllaceae	Fertile fields
Rotnaulo	*Polygonum nepalense*	Polygonaceae	Fertile fields
Adikari	*Galinsoga parviflora*	Compositae	Fertile fields
Chitre bonsu	*Oplismenus sp.*	Graminae	Infertile fields
Bonsu	*Digitaria sp.*	Graminae	Infertile fields
Davile	*Brachiaria ramosa*	Graminae	Infertile fields
Suire	*Imperata sp.*	Graminae	Infertile fields
Kaney	*Commelina diffusa*	Graminae	Infertile fields
Sama	*Echinochola sp.*	Graminae	Infertile fields
Gorre dubo	*Cynodon dactylon*	Graminae	Infertile fields
Rote	*Cynodon dactylon*	Graminae	Infertile fields
Kuro	*Brachiaria ramosa*	Compositae	Unknown

Soil nutrient analysis corresponded well with farmers' assessment of soil fertility (Table 7)

Table 7: Soil nutrient characteristics of farmer defined fertile (F) and infertile (I) *Khet* and *Bari*

	Lower Pakuwa				**Upper Pakuwa**				
	Khet		***Bari***		***Khet***		***Bari***		
	F	I	F	I	F	I	F	I	$LSD_{0.05}$
%OM	2.07	1.30	3.02	2.76	2.61	1.36	2.91	2.04	0.55
N	0.199	0.157	0.183	0.145	0.201	0.172	0.216	0.153	0.034
P	38.2	25.1	37.5	19.8	36.9	16.2	37.4	15.6	9.08
K	89	51	179	90	114	84	204	109	29
pH	4.809	4.489	4.905	4.387	4.458	4.453	4.876	4.261	0.234
n	8	8	8	8	9	9	8	8	

$LSD_{0.05}$ indicates the Least Significant Different at the 5% level of significance for comparisons between fertile/infertile means.

Development of a systems framework (Activity 1.4)

From Activity 1.1, a systems framework in the form of a whole-farm computer household simulation model is being developed. The model makes use as much as possible of existing models of crop (e.g. maize, millet), tree and weed growth, and is coupled with a soil carbon and nutrient model and a livestock model. It also tracks labour and economic flows within the household, and includes simple household decision-making. Work so far has focused on validating and linking the various components, further details of which are given below:

The DSSAT models (Tsuji and Balas, 1993) were used as a basis for the crop models, but needed to be restructured substantially to link with the other components of the system. This was completed at the end of 2001, and subsequently an MSc project at Cranfield University over the summer of 2002 has focused on validating the maize and soil sub-models, using experimental data from a previous DFID-funded project (R6757). Problems were identified with the soil drainage routines which were not draining water fast enough under the high daily rainfall in Nepal during the wet season (>90 mm d^{-1} on occasions) so that the model was predicting that the soil remained saturated for most of the season, causing depressed N uptake by the roots due to anaerobic conditions, despite N being present in the soil. The drainage subroutine was modified to allow the water to drain faster, which matched soil water conditions more closely and gave better overall predictions of crop yield and N uptake. Work is now underway (not within the current R7536 project) to use the maize, millet and soil modules to evaluate the sustainability of maize/millet cropping systems in Nepal. Other crops (e.g. rice, wheat, and legumes) will also be included in due course. The crop and soil modules have also been linked into the rest of the household model, with harvested grain entering the household store, which can then be either consumed by the household members or sold to generate cash. Crop residues can either be incorporated into the field or fed to livestock (as indicated below).

A trees' growth module has been developed, based on the forest model of Kirschbaum & Paul (2002). As the trees grow, they produce litter (wood and leaf litter), which can be collected by the household for fuel and fodder for the animals (see below), respectively. Flows of carbon and nitrogen through the forest stand are tracked. A prototype version of this sub-model has been completed, but has not yet been validated, neither has it been linked fully to the rest of the household model. Data for validation of tree growth has been obtained from ARC Lumle..

A weed module has also been developed, which simulates weed competition with the crop if they are allowed to grow. Frequent weeding by the farmer will control weed growth and allow the crop to achieve better yields at the cost of increased labour. This has been linked with the overall household model, but has not yet been validated.

A suitable livestock model with the desired characteristics could not be found, so a new model was developed using an energy balance approach to determine growth and production of the animal, based on equations given in AFRC (1993). The model describes the consumption of fodder by the animal, production of produce (e.g. milk, eggs), and production of manure. Although the model is generic and is capable of describing a number of species (e.g. buffalo, cows, goats, sheep, pigs and chickens), so far it has only been parameterised for cows. It has also been linked to the rest of the household model so that fodder can be transferred from crop residues after harvest or from the forest, and manure can be returned to the fields. Daily milk production is added to the household store and can be sold to generate cash.

The model currently uses the soil module employed by the DSSAT family of crop simulation models, which is based on the PAPRAN model (Seligman and van Keulen, 1981). However, effort is currently underway to replace this module with one based on the CENTURY soil organic matter model (Parton *et al.*, 1988) which has enhanced capacity to simulate soil dynamics over long periods of time and has been well validated. This is almost completed at the time of writing.

The overall household model operates on a daily time-step, with the household carrying out various activities each day (e.g. feeding and milking livestock) or at particular times of the year (e.g. sowing, harvesting crops). The labour and economic flows between the various components are tracked by the model, and are summarised at the end of each year. At present, household decision-making is rather rudimentary (i.e. based only on time of year), but it is intended that it will be based on an analysis of the performance of the various enterprises of the farm in terms of returns, labour required, and the costs of inputs. If a particular enterprise (e.g. growing a particular crop) is not economic or requires too much labour, the household may choose to invest more in other enterprises (e.g. livestock).

Weather and soils data for the model were obtained from ARC Lumle. It was also intended that use be made of the Organic Resource Database System (ORDS) developed at Wye College, which contains nutrient content data for a large number of organic materials used in agriculture, but time has not allowed this so far.

Ideally there should have been more interaction between model developers and potential model users (i.e. Nepali researchers), but the budget for modelling activities did not allow this. It should be emphasised that the amount of time and effort that has been put into development of the household model to date has exceeded the time available in the project. This difference has been met by (a) time budgeted for on other projects, (b) by MSc student projects, and (c) providing additional time at no cost to the project.

It was planned to have a working prototype of the model available by December 2002 to meet the project target, but due to early cessation of the project in September 2002, this will not be achieved.

Means developed for evaluating SFTs (Output 2)

Quantification and validation of soil fertility enhancing technologies (Activity 2.1)

Year 1 (2000-2001)
Farmers from each of four agro-ecological outreach research sites were invited to participate in testing of soil fertility enhancing management practices of their choice. To this end farmers from each area were invited to Lumle to view and discuss those options that they felt could be tested by themselves. Ten from each area opted to test improving manure management through covering the manure with plastic and ten from Bhakimli and Chambas selected incorporation of grain legumes roots residues in farmers' fields and their effect on crop yields. This included pea and blackgram roots residue management respectively prior to planting a maize crop (Table 8)

Table 8: Farmer testing of technologies (2001)

Area	Agro-ecological zone	Land type	Improved manure management	Legume crop residue management
Chambas[1]	River basin 600 m	*Bari*	Upland rice	Upland rice (following blackgram)
Lower Pakuw	Low hills 600-1000m	*Khet*	Maize	--
Upper Pakuwa	Mid hills 1000-1600m	*Bari*	Maize	-
Bhakimli	High hills Above 1600m	*Bari*	Maize	Maize following peas

Evaluations were carried out from both farmers' and scientists' perspectives.

Farmers' evaluations
This involved continuous assessment during the season both individually and as groups with discussions centred on establishing farmer perceived differences between treatments at key stages.

- During manure decomposition, farmers were encouraged to note differences between covered and uncovered manure. The different criteria noted were: colour, smell, moisture content, rate of decomposition, uniformity of the manure, temperature, texture (hard or soft), weight of the manure and some indicator of quality as the manure was moved to the field.
- During transport from the heap or pit to the field, and while spreading and incorporating the manure, farmers noted any increase or decrease in labour required.
- During the growth of the crop, differences in crop condition were noted, 1) at crop emergence, colour and crop stand ; 2) at first weeding, plant stand, 3) at tasselling, stem thickness, colour and size of ear were compared together with any differences in termite damage and 4) at harvest, the weight of grain and straw was established.
- Mid season evaluations were also undertaken during field days, during which researchers facilitated discussions between farmers to capture their evaluation criteria and views.
- At the end of the season soon after harvest earlier information was confirmed and a participatory gross-margin budgeting exercise (Doorwod and Galpin, 1998) undertaken with farmers to compare the different treatments and draw conclusions that could be used in future planning activities by farmers (Table). A

format was developed with farmers and the information worked through with those farmers who had undertaken the testing exercise.

For crop residue management similar criteria applied but also included
- Cutting legume crop: work involved
- Land preparation: ease of operation

Differences between treatments are shown in Annexes 5.1 and 5.2

Scientists' evaluation
Comparative nutrient analysis of covered and uncovered manure was made at the time of manure application in the field. At the same time soil samples were analysed for each farmer test plot before manure spreading to ensure that there were no major differences in soil fertility between treatment plots. Grain and straw yields were sampled and yields per ha determined at 12% moisture content. Further comparative soil analysis was undertaken after harvest to determine any residual soil fertility differences in farmer plots.

Manure analyses indicated that nitrogen and potassium content tended to be higher in covered manure, confirming that covering manure did enhance the nutrient content of the manure, most probably through gaseous and moisture losses being reduced. Soil analysis before manure spreading showed no significant differences in nutrient status of the testing plots. Soil analysis after harvest showed an increase in organic carbon, available P and exchangeable K, both where improved manure was used and where legume residues were left in the soil, indicating some increase in soil fertility available for the next crop in both sets of trials (Annexes 6.1-6.5). Paired two sample t tests were used for assessing statistical significance.

Covered manure produced significantly high yields (7.01 t/ha) than uncovered manure (6.05 t/ha) at Bhakimli. Similarly, significantly higher yields of maize were recorded with covered manure at Upper Pakuwa (1.44 t/ha compared with 1.06 t/ha for uncovered manure). However, spring maize grain yields at Lower Pakuwa were not significantly increased although covered manure overall gave on average a greater yield (2.99 t/ha vs. 2.65 t/ha). At Chambas upland rice grain using covered manure gave significantly higher yields (3.34 t/ha vs. 2.77 t/ha). An increase in straw yields, important was also noted

No significant effect of blackgram or pea root residues at Chambas and Bhakimli was obtained in the following crop

Year 2 (2002)
This is now being undertaken for a second season in conjunction with expanded activities detailed under Activity 4.1. Farmer testing of community selected SFTs has again included improved manure management again using plastics, crop legume post harvest management and this year introduction of a grain legume (locat bean). Farmers with support from Lumle staff have established simple split plots for experimentation that is being evaluated by farmers. Follow up to build on and confirm/test already established farmer evaluation criteria and work with new partners was due to take place in June and July and then rescheduled for October, as security consideration prevented this happening earlier.

Activity 4.1 has resulted in a substantial (but unverified as yet) increase in farmer testing of technologies, both as a result of other NGOs now participating in the programme and being involved with inter-farmer and inter area visits. A wealth of valuable information to confirm which farmers are now testing which technologies, how they may have modified the making of manure, where this takes place, on which crops it is being used and how farmers are evaluating the results.

Assessment of different methods for evaluating SFTs (Activity 2.2)

A number of different economic evaluation approaches have been used to assess the viability of the alternative soil fertility enhancing technologies. These comprised

i) Using a participatory budgeting approach with those groups of farmers who had tested soil fertility enhancing technologies during 2001. This was undertaken in the four agro-ecological zones soon after harvest, offering potential for use as a tool for assessing the costs and benefits of each technology
ii) Applying a partial budget approach to the same manure and crop residue management soil fertility trials but based on yields determined by researchers. Inputs used by farmers as determined in the participatory budgets were used to establish any cost differences
iii) Undertaking an economic analysis of four years of soil fertility trials undertaken in the mid hills areas (Tripathi *et al*., 2001), based on an annual partial budget approach and then discounting future benefits to Year 1 net present values.

Participatory budgeting approach
Group discussions were facilitated by Lumle staff and aimed to compare inputs and outputs for each treatment. This required estimation of the quantities of purchased and household supplied inputs used and their valuation for each treatment. Local units of measurement were used throughout. The methodology follows that of Dorwood and Galpin (1998) with a format for this being developed with farmers (Annex 5.4). Results showed that in all cases an increase in gross output was achieved. Purchased inputs increased by the cost of the plastic material. Household supplied inputs remained the same, though in some cases farmers indicated that they were able to use less improved manure to obtain the same yield. Some indicated that the value of the covered manure was now more should they wish to sell it. Labour differences centred on an increase in time required for transport, reduced time for spreading manure and increased time for weeding. All other inputs remained the same.

Interestingly in all cases when labour and manure costs were included a negative gross-margin resulted. If these were excluded a positive margin (over purchased inputs) was achieved. In all cases an increase in productivity between treatments was achieved (Annex 5.4).

Table 11: Summary of participatory budgets shown as differences between treatments (units per ropani[1])

	Increases						Increase in gross margin	
Area	Grain yield	Straw yield	Total Output	Cash needed	Labour required		Inc. household inputs	exc. household inputs
	muri	bundles	Rs	Rs	days	Rs	Rs	Rs
Manure management								
Bhakimli	0.5	1	412	100	0	0	312	312
Chambas	1	2	550	100	0.5	25	475	450
Lower Pakuwa	0.5	3	475	100	-1	-60	415	475
Upper Pakuwa	0.5	1	480	100	-1	-70	310	480
Legume residues								
Bhakimli	0.5	1	412	0	-1	-60	472	532
Chambas	0	0	0	0	-1	-60	60	60

[1] 20 ropani=1 hectare

Applying a partial budget to assess the farmer trials
A partial budget approach to establish the value of increased benefits less increased costs was used, based on researcher measured average yields for each agro-

ecological zone (Annex 6.4). Inputs used by farmers, determined in the participatory budgets were used to complete the partial budgets. Prices were those identified by farmers in the participatory budgeting activities. Only those costs that vary as a result of the treatments were considered. This allowed net benefit, a benefit: cost ratio, the marginal rate of return (to cash expenditure) expressed as a percentage and the returns to any increase in labour to be established (Table 11).

Table 11: Summary of partial budgets

	Increase in								Return to	
	Grain Yield	**Straw yield**	**Total output**	**Cash needed**	**Labour needed**	**Labour cost**	**Net benefit**	**B:C ratio**	**Cash**	**Labour**
Area	**kg**	**kg**	**Rs**	**Rs**	**days**	**Rs**	**Rs**		**%**	**Rs per day**
Maruei management										
Bhakimli	988	na	12546	800	30	1500	10246	5.5	1281%	342
Chambas	582	511	4225	800			3425	2.9	428%	-
Lower Pakuwa	377	2340	6659	800	20	1000	4859	3.7	607%	213
Upper Pakuwa	346	1914	5925	800	20	1000	4125	3.3	516%	206
Legume residues										
Bhakimli	1793	101	22849	0	0	0	22849	23.8	-	-
Chambas	0	0	0	0	-20	-1000	1000	-	-	-

Na=not available

Results indicate a net benefit in all cases ranging from Rs 3500-over 10000 per ha, with a benefit: cost ratio ranging from 2.9:1 to 5:1. Marginal returns to cash investment in the case of use of plastic ranged from 500% to over 1200% and returns to increased labour ranged from Rs 200-over 3000 per ha per day where increased labour was required.

Undertaking an economic analysis of four years of soil fertility trials

In both the participatory budgeting and partial budgets, evaluations had centred on a single crop. Yet past work in the mid hills areas (Tripathi *et al*., 2001) has shown that soil fertility trials based on the use of inorganic fertilisers, manure and various mixes of the two are likely to have long term implications for productivity. In fact farmers had been stating that continued use of inorganic fertiliser led to increased soil hardness with a need to apply increasing amounts of inorganic fertilisers in order to maintain yields. It was therefore decided to re-evaluate these results over the four years of the trials using farmers' 2001/02 prices. These researcher-managed trials had been undertaken in four locations (Table 12) including two of the areas of the farmer led experiments of this project and were known to many of the communities with which this project was working

Table 12: Location of trials (1997-2000)

Area	**Agro-ecological zone**	**Land type**	**Crop rotation in trial**
Chambas[1]	River basin	*Khet*	Rice-wheat
Pakuwa[1]	Low hills	*Khet*	Rice-wheat
Dordor Tar		*Bari*	Upland rice-blackgram
Dordor Gaun		*Bari*	Maize-finger millet

[1] Areas coinciding with farmer manged trials of this project

The trials were based on two levels of nutrient application (high and low) of inorganic fertiliser, organic fertiliser (manure) and a mix of the two (Annex 7.1)

Key to the analysis in all the trials has been the prices attributed by each commodity (Annex 5.3). Those that are regularly bought and sold were valued at market price on the farm either at the time of use in the case of inputs or at time of harvest in the case of outputs. Although buying earlier or selling later could result in price benefits, it is rare that farmers are able to make use of such facilities (Ellis-Jones *et al*., 2002).

Valuing manure at the cost of purchasing similar nutrients as inorganic fertiliser
In order to compare the value placed on manure by farmers with a value based on its nutrient content, manure from three locations were used to assess nutrient quality. Although as expected the analysis proved to be highly variable, farmers did not differentiate between the value of different qualities of manure. The mean nutrient value was therefore used to determine nutrient content and hence value (Table13). The value of the manure, determined on this basis, is lower than cost of N, P, and K purchased in inorganic form by 41%, 39% and 40% respectively. This indicates that better quality manure such as that sampled in Bhakimli is further undervalued and poorer quality manure as sampled in Pakuwa is more appropriately valued. However if the market value increased to Rs0.6 due to shortages, it would be higher than the cost of N, P, and K in inorganic form by 19%, 23% and 19% respectively.

Table 13: Value of N. P, K for the main nutrient sources used

Fertiliser type	Nutrient Content	Fertiliser application required per 1 kg of nutrient (kgs)			Market price per kg	Value per kg of nutrient (Rs)		
		N	P	K		N	P	K
Urea		2.2	0	0	14	30	0	0
N content	*46%*							
DAP		12.6	4.9	0	22	278	109	0
N content	*18%*							
$P_2 0_5$	*46%*							
MOP		0	0	2.0	14	0	0	28
$K_2 0$	*60%*							
Manure		60	222	56	0.3	36	133	34
N	*1.66%*							
P	*0.45%*							
K	*1.77%*							
% Decrease in value of manure over N, P and K in inorganic form						*-41%*	*-39%*	*-40%*

1kg P_2O_5 = 0.44 kg P, 1 kg $K_2 0$ = 0.82 kg K

Manure would need to be valued at between Rs 0.45 and Rs 0.5 per kg to equate with the nutrient value of N, P, and K in inorganic fertiliser

Five scenarios were examined.

a. Manure valued at the value indicated by farmers (Rs 0.3 per kg) and labour at the opportunity cost of hiring in labour (Rs 60-80 per day for men and Rs 50-60 per day for women, depending on area). This reflects the situation where there are some constraints on both manure and labour availability.
b. Manure and labour given no value, on the basis that these were household supplied and that no cash was involved in their acquisition. This reflects the situation where there are no constraints on either manure or labour availability
c. Valuing manure at zero and labour as in scenario a. This reflects the situation where there are no constraints on manure, but some on labour availability.
d. Valuing manure at zero and labour twice that of scenario a, representing the situation when labour becomes scarce or increases in value relative to outputs. This reflects the situation where there are no constraints on manure, but increasing constraints on labour availability.
e. Valuing manure and labour at double that in scenario a.

All four sites were evaluated and found to give a similar pattern of results (Annex 7). Only results from Pakuwa are reported here.

In Scenario a (Annex 7.2, Figure 1), over the four years (eight crops) of the trials, the highest returns were achieved from use of inorganic fertiliser (high and low inputs), and high levels of mixed inorganic and organic fertiliser. Worst returns were derived from use of manure.

There was however a noticeable trend that over the four-year trial period productivity declined when only inorganic fertiliser was applied. This was particularly apparent under scenario b, (Annex 7.2, Figure 2), where no value was placed on either manure or labour. In this scenario highest productivity was achieved using high mixed inorganic and organic fertiliser and high organic fertiliser. In this scenario productivity increases over the four years were most apparent where inorganic and organic fertilisers are mixed and productivity declines most noticeable where only inorganic fertiliser was used. However scenario b is only realistic when household labour for manure management is freely available and no alternative source of income or livelihood are available.

In scenario c, where no value was placed on the manure, and labour was valued at its opportunity cost (Annex 7.2, Figure 3), highest productivity was achieved with mixed inorganic and organic fertiliser followed by totally organic fertiliser. This scenario is most representative of the situation at present but remains largely dependent on continuing availability of low cost female labour.

In scenario d, as opportunity increases for off-farm employment and labour becomes increasingly scarce or expensive (Annex 7.2, Figure 4), productivity using organic fertilisers declines dramatically with high inorganic and high mixed becoming the most productive.

In scenario e, where manure and labour opportunity costs increase, use of inorganic fertilisers becomes increasingly attractive.

Similar trends were seen for Chambas, Dordor Tar and Dordor Gaun.

Net Present Values (NPVs) of future benefits

When the net benefits over the four-year period were discounted to Year 1 values, these trends become even more apparent (Annex 7.3, Figures 1-4). Two discount rates were used: - 20% reflecting greater interest in short-term returns (Gittinger 1994), and 5% reflecting greater concern for long-term sustainability as indicated in this project (Desbiez *et al.*, 2002). The resulting NPVs have been ranked (Table 14). :

Table 14: Rankings of NPVs of future net benefits of soil fertility options (1=best, 7=worst)

		Scenario									
		a		b		c		d		e	
		20%	5%	20%	5%	20%	5%	20%	5%	20%	5%
T1	Nil	5	5	7	7	7	7	7	7	3	6
T2	High Inorganic	1	1	1	1	1	1	1	1	1	1
T3	High Organic	7	7	3	3	3	3	6	6	7	7
T4	High mixed	3	2	2	2	2	2	2	2	4	4
T5	Low Inorganic	2	3	5	6	4	4	3	3	2	2
T6	Low Organic	6	6	4	4	5	5	4	4	6	5
T7	Low mixed	4	4	6	5	6	6	5	5	5	3

The results were not sensitive to change in discount rate. In all scenarios best returns were achieved using high levels of inorganic fertiliser with high mixed being a close second.

In Scenario a (some manure constraints, some labour constraints) use of organic fertiliser ranks lower than the nil treatment. In Scenarios b and c (no manure constraint, no labour constraint for b and increasing labour constraint for c) use of organic fertiliser comes third in the rankings. In Scenarios d and e (no manure constraint in d and severe manure constraint in e, with increasing labour constraints in both),_organic fertiliser again ranks lower than no nutrients.

Such results do need to be interpreted with caution as the trials were carried out for only a short-medium term period (4 years) and do not demonstrate possible further declines in productivity in the medium to long term (5-10 years) associated with the use of only inorganic fertilisers. However they do indicate the critical importance of labour, the value farmers place on this and the opportunities to earn incomes outside of agriculture. The results are however relevant when considering each FSG and their opportunities cost of labour and manure.

A new approach developed (Activity 2.3)

This new approach embodied two related sets of tools, one participatory set aimed at empowering farmers to undertake their own evaluations of SFTs with increasingly less involvement of researchers or extension workers, and the other use of the systems framework household model aimed primarily at researchers

<u>Participatory tools</u>
Essentially a four phase PLAR approach each with a set of tools, being those which have been used during the project . This includes a

- Diagnostic phase (pairwise ranking, scored causal diagrams, community mapping, resource ranking transect walks and key informant interviews
- Planning phase (inter farmer, inter area and experimental station visits and discussions)
- Experimental phase (use of farmer soil fitness indicators)
- Evaluation phase (pairwise ranking, participatory budgeting)

<u>Use of the household model</u>
As mentioned previously, it was originally intended that the development of the model as a systems framework, would provide a tool for analysing potential soil fertility enhancing techniques in terms of their contribution to overall household livelihoods. This activity would have taken place following the development of the prototype model by December 2002 (Activity 1.4) and be available for use by June 2003. This has now been suspended.

Research findings promoted (Activity 2.4)

<u>Research activities have been promoted through:</u>

- Involvement of stakeholders at two project workshops (Ellis-Jones and Tripathi, 2000 and 2002)
- The use of PLAR with farmers, Lumle Outreach workers and more recently District Agriculture Officers and NGOs.
- Field days organised by farmers, involving District Agriculture extension workers, NGOs working in agriculture development, local level politicians, media people and researchers of ARS Lumle during farmers' field days in each site during the crop maturity period. Three to four groups evaluated the soil fertility technologies separately presenting the results to a plenary session. The media (local magazine and Radio Nepal) further disseminated the field day activities.

- Research activities have been presented to other researches, extensions workers, representatives of NGOs, and policy makers of NARC and the Department of Agriculture during Annual Review and Planning Meetings of the Research Extension Coordination Meetings (RECOM).
- Results from the research activities have been used in training sessions for lead farmer trainees of the Sustainable Soil Management Project (SSMP), Seed Sector Support Project (SSSP) as well as local training for Lumle technicians working in different districts of the western hills.
- More recently local level NGOs of Parbat district: MADE-Nepal, PCDS, NCCDC and SWYC were invited to participate in the research. This led to a one-day workshop at Parbat district headquarters. This was followed by visits to Lumle to view soil fertility management activities at Lumle and Lumle Outreach research site at Hemja and Kaski for discussions with lead farmers and groups who had been testing the soil fertility enhancing technologies.

Capability of local professionals improved (Output 3)

Stakeholder workshops (Activity 3.1)

Although the project officially started in March 2000, delays were experienced in starting field activities until October 2000, as a result of negotiations with NARC. An initial stakeholder workshop involving farmers, NGOs and Government extension staff and researchers took place in October resulting in a detailed workplan being agreed with stakeholders (Ellis-Jones and Tripathi, 2000). This formed the basis of activities, which were reported and discussed at a second stakeholder workshop in February 2002, which was used as a forum for a mid term review (MTR) of the project (Stocking 2002). The February MTR was reasonably positive about achievement of the project and progress towards outputs. Much of Output 1 had been completed, and the groundwork laid for Outputs 2,3 and 4. This second workshop and MTR gave opportunity to reconsider the Outputs and Activities of the project, with the MTR concluding with a need to:

- Revise the logframe giving emphasis given to integrating the modelling work into contributing toward Output OVIs and a strengthening of Outputs 3 and 4.
- Ensure an effective 3-year duration of the project to end of September 2003, in order to undertake the uptake and promotion activities against the revised Outputs 3 and 4.
- Consider the modelling work in terms of its structure, provisions, potential users and integration with both the written database (Activity 1.4) and "a new approach for integrating biophysical and socio-economic evaluations" (Activity 2.3)
- Give attention to farmer-to-farmer linkages and communication.
- Keep the Purpose narrative and OVI clearly in mind – that the project is about improved methods to bridge research and development.

Subsequent to the MTR security conditions in Nepal and the region deteriorated and both DFID and the Foreign and Commonwealth Office placed an embargo on travel to Nepal. This meant that detailed interchange and monitoring of project activities has been severely hampered by planned visits to Nepal during May-June-July having to be cancelled at short notice. The project logframe was revised substantially as a result of the MTR and it is this logframe against which this FTR is reported. A number of the activities that related to Outputs 4 in particular did require detailed discussion in Nepal with other stakeholders to ensure they were practical and feasible. This remains to be undertaken.

Dr Tripathi can be congratulated on the progress he has made despite inability of UK-based researchers to visit Nepal.

Farmer/community interactions encouraged (Activity 3.2)

The project is concerned with building capability for farmers to prioritise, experiment and innovate their own as well as introduced technologies, with the assistance of local professionals as and when needed. Some farmers themselves, the 'leader-farmers', are regarded as local professionals in their own right as in the Helvetas-SSMP.

In keeping with this vision the project has aimed to promote empowerment, encourage innovation and farmer adaptation of either new or existing technologies. It worked in the first year largely within the existing ARC-Lumle Outreach sites, due to budgetary and security considerations. It worked with existing contact groups and lead farmers, learning from them and providing opportunity for them to test soil fertility options they considered suitable for their conditions. Much of the work has encompassed participatory learning and research principles providing opportunity for researchers to work alongside farmers learning from them and at the same time being able to verify trial results from a scientific perspective. This process and the results from it are reported under Activities 1.2, 1.3 and 2.1

In the second year, responding to the need for increased farmer to farmer linkages community based NGOs (MADE-Nepal, PCDS, NCCDC and SWYC) of Parbat district, the Mothers' Group of Bhakimli, the Goat Keeping Group of Lower Pakuwa and Women's Group of Chambas have been encouraged to establish work groups concerned with improving soil fertility management and farmer testing of SFTs. Lead farmers have been involved in inter community and Lumle visits.

Monitoring the process of farmer testing and uptake of SFTs (Activity 3.3)

There are now a growing number of groups working through a system of lead farmers on soil fertility improvement. Group discussions are being facilitated by ARC-Lumle, DAO and NGOs and farmer evaluation days have been arranged. Lumle site co-ordinators have undertaken day to day monitoring of farmer testing and uptake of SFTs in Lumle Outreach sites. The researchers and technicians of ARS Lumle have provided regular visit and are obtaining feedback from farmers[1]. NGOs are providing similar support in their areas of operation. <u>There remains a need to detail these activities and learn from them.</u>

Project workshop at completion (Activity 3.4)

Not undertaken

Distribution of research reports and other published outputs (Activity 3.5)

Relevant research reports have been circulated to target institutions, including District Agriculture Development Offices, SSMP target hill districts (11 districts of Nepal), Community based NGOs working with SSMP, Regional Directors of all regions,

[1] The soil fertility options being tested by farmers are reported by Lumle socio-economists as being adopted and modified by neighbouring farmers in all four sites. It was intended to follow this up to ascertain which farmers were using the technologies, how these had been modified as a result of farmer testing and what benefits they were receiving.

Research Stations and Commodity programmes of NARC, NARC Divisions, AER/OR sites of ARS Lumle.

Two papers have been drawn up for publication. One (Desbiez *et al*., 2002) looks at farmers perceptions of soil fertility and the indicators they use, the other (Matthews *et al*., 2003) describes the computer model currently in preparation (~70% completed). Both are intended for publication in peer-reviewed international journals such as Agriculture, Ecosystems & Environment or similar.

A paper (Tripathi and Ellis-Jones, 2002) was presented to the 17th World Soil Science Congress held at Bangkok, Thailand from 14-21 August 2002.

Two M.Sc. students from Cranfield University, UK did their Masters thesis under the guidance of project partners (Desbiez., 2002; Welsh 2002).

Farmer access to useful NR management improved (Output 4)

Farmer experimentation encouraged (Activity 4.1)

Identification of lead farmers by farmer groups
Priority was given to encourage farmer testing of farmer selected technologies, undertaken by lead farmers' in their fields within existing Lumle outreach sites. Lead farmers were selected by the community, in which they were working and were expected to provide feedback to the community facilitated by Lumle Outreach workers and research staff during both group discussion and local field days. This was intended to encourage further farmer testing by both neighbours and farmers from adjoining areas as well as providing feed back to researchers on farmer indicators and evaluation criteria. Security problems, lead farmers not always communicating within the community and local staff changes necessitating re-training in the necessary facilitation skills have hampered such activities. However recent feed back has indicated that neighbouring farmers have visited and learnt from the trial plots and relevant messages have been passed to the other farmers of their area. There remains a need to learn from these interactions and how they can be encouraged.

These issues were discussed at the February workshop and actions taken to ensure that community involvement in the activities was further encouraged through training and communication for Outreach workers, lead farmers and the groups/community they represented. Most of the agreed actions have been implemented but there does remain a need to support Lumle staff in these activities.

Exchange visits from lead farmers to AEZ sites
Exchange visits by lead farmers to other AER sites for discussion with existing farmer groups have been initiated although this has been limited by security problems. It is intended that this part of the programme be further encouraged this coming winter season.

Report backs to other group members
Lead farmers visited Lumle Outreach research sites at Hemja and Kaski, have reported back to their groups and neighbours. As a result other farmers have started to test soil fertility options in their fields.

Encouragement of farmers to experiment
Those farmers, who did not directly participate in the SFT experiments in the first year of the project have now started their own testing on quality manure preparation, its use in the crops, as well as using legumes root residues in the following crops.

Development and use of extension materials (Activity 4.2)

Early drafts of extension material SFT have been discussed with Sustainable Soil Management Project (SSMP). This now requires additional input to ensure it meets the needs of SSMP and other NGOs, incorporating the findings of the project to date on how local professionals can facilitate the testing and evaluation process.

Use of local radio programmes for knowledge dissemination (Activity 4.3)

This activity has not been planned in detail, awaits further discussion with Nepali collaborators on its feasibility and was proposed to start in the next financial year.

OUTPUTS

The research results and products achieved by the project. Were all the anticipated outputs achieved and if not what were the reasons? Research results should be presented as tables graphs or sketches rather than lengthy writing and provided in as quantitative a form as far as is possible.

Improved understanding of factors affecting the adoption of soil management technologies

This Output has been partly achieved through: i) a substantial Word-based database, ii) a review of farmer perspectives, iii) development of soil fertility indicators and iv) a systems framework household model.

i) Word based database report

The report identified and classified soil management practices based on their primary functions. These included controlling run-off and nutrient leaching, increasing organic matter and nutrient availability and managing internal flows of nutrients and increasing nutrient uptake. It further classified each according to type (structural or vegetative measure, whether they required low or high external input and whether they were effective in the long or short term. It identified the variations on the main type, where it could be used, resource requirements of each including labour, skills level, input costs and potential for negative environmental impact. Farmers are faced with a bewildering choice of soil management technologies. However, in many cases it is population density and market availability or orientation determines the prices of inputs and outputs and hence which practices are used. Proximity to market provides the opportunity for growing high value crops, as well as purchasing inputs. Under such conditions there is likely to be a wider variety of income and livelihood sources, which in turn can provide both incentive and cash for investment in productivity increasing technologies. Where markets are limited or households have limited market orientation, there is likely to be limited cash crop production, with few opportunities for off farm income, limited purchase of inputs and often labour migration. The report also provided a review of the use by farmers of soil fertility indicators confirming that farmers have a good knowledge of their soils and are often aware when soil fertility is declining and that finding ways to use this knowledge in interaction with science is necessary.

The review provides a conceptual framework that inter relates biophysical and socio-economic factors effecting soil nutrient processes and management practices, the consequence to the soil and how these impact on crop productivity (Figure 1). This conceptual framework forms the basis of bringing biophysical and socio-economic factors into a household model described under section (iv).

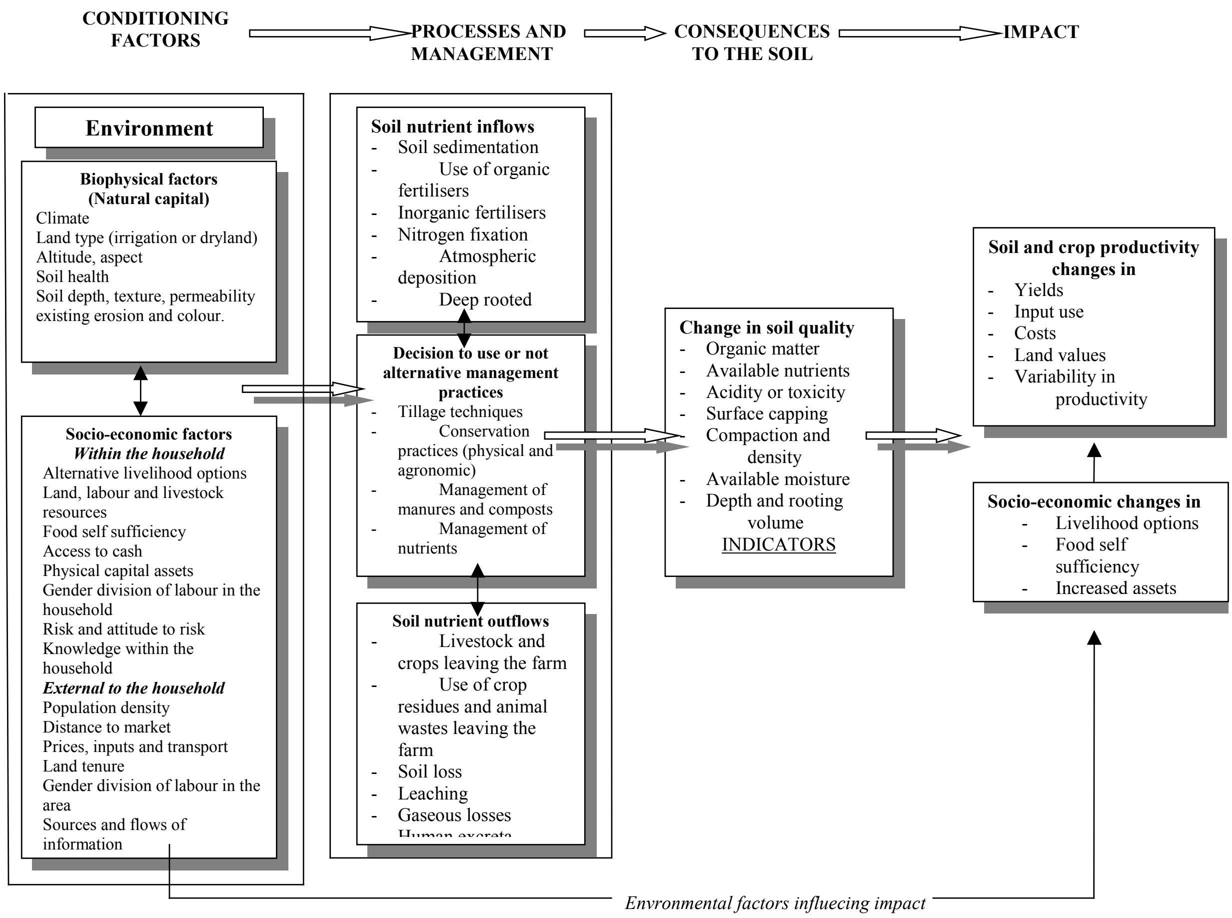

Figure 1: Biophysical and socio-economic conditioning factors, processes, management, consequences to the soil quality and impact on soil productivity

ii) Review of local farmer perspectives

The process of local literature review, participatory discussions with farmers and the household survey were important in providing researchers with essential background information. The participatory tools used in discussions were essential in building relationships as part of a PLAR process that provided opportunity to work closely with farmers on a priority problem (improving soil health to produce) and develop the tools for Output 2. This included scored causal diagrams, matrix ranking, historical trend analysis and resource ranking and identification of soil fertility indicators and their validation.

iii) Development of soil fertility indicators

Farmers identified a total of 62 indicators that they used to evaluate and monitor soil fertility. Each indicators was categorised according in one of the following (Table 15)

- Soil characteristic indicators: being soil properties, which farmers felt characterised fertile or infertile soils
- Agricultural management indicators: reflecting decisions in soil management.
- Crop performance indicators: being crop characteristics reflecting soil fertility status
- Environmental indicators: being external factors which farmers felt influenced soil fertility
- Biological indicators: plants (other than crops) or animals whose density or growth reflected soil fertility status.

Table 15 Key indicators and percentage of times mentioned by farmers (n=66)

Soil characteristics	**100**	**Crop performance**	**97**	**Management**	**99**	**Environmental factors**	**87**	**Biological factors**	**32**
Soil colour	87	Crop yield	76	Quantity of FYM applied	75	Water quality	32	Presence of weeds, weed cover, colour and height	29
Stoniness	57	Colour of crop	51	Water availability	66	Shade	28	Pest outbreaks	16
Soil hardness	49	Response to manure	46	Difficulty to plough	56	Distance from water source	28		
Moisture content	37	Crop height and growth rate	35						
Water holding capacity	31								

Examples of how, and which indicators farmers use for considering key questions are shown in Table 16.

Table 16: Use of indicators for considering key questions

Decision/assessment	**Indicators used**
What is the current soil fertility?	Soil colour, crop colour and yield, soil hardness, presence of weeds
What potential does this field have?	Soil colour, quality of water source, stoniness, moisture holding capacity
Are changes in soil management needed?	Crop colour, crop germination
Is it worth investing in fertiliser or manure?	Water availability, landslide potential, response to manure, crop type
Is the soil management strategy in this field working?	
Shorter-term	Crop colour, crop size, invertebrates beneath the soil
Longer-term	Difficulty in ploughing, moisture, weeds
What crop should be grown?	Soil colour, number of crops planted (rotations), water availability
How is the current crop performing?	Crop colour, growth rate, crop size, density of crops

This work confirmed that farmers have a well-defined and comprehensive set of indicators that they use to classify and assess soil fertility. Generally, these are characteristics they can see, feel, or smell, and are based on their own experiences in cultivating their fields. Farmers' perceptions of soil fertility were found to be more 'holistic' than those of researchers, as they included factors that influenced both soils and crop growth. Farmers see soil fertility as a dynamic process integrating the soils' chemical and physical characteristics, its cropping requirements, as well as factors from the surrounding environment. More importantly, farmers see themselves as active participants in this process. Researchers, on the other hand, are often more interested in the way the soil was formed, and things that they can measure and which are not always visible (e.g. soil N content). In addition, they tend to rely on methods and techniques conceived in the context of the developed world, which are not necessarily wholly appropriate in a developing country context (Pawluk *et al.*, 1992).

The term 'field fitness' is used for assessing soil productivity, as it conveys farmers' perceptions more accurately than 'soil fertility' alone. This requires that researchers should take into account more fully the diversity, interpretation and use of indicators employed by farmers to assess soil fitness. This will encourage and facilitate improved dialogue between farmers, researchers and extension staff providing greater insight into appropriate research and at the same time provide a rapid inexpensive method for rapidly assessing the soil fitness of individual fields and technologies.

iv) Systems framework household Model

The household model is not complete and is not yet available for general use. However, even the development to its present stage has helped to understand the integrated nature of the many components that make up a mid-hills farming system. This is particularly so in relation to the flows of inputs and outputs within the farm at different times of year. This represents a genuinely innovative attempt to bring together in one dynamic simulation model both the biophysical and socio-economic characteristics of an agricultural system. The use of such an approach is novel, as most household models traditionally use a linear programming approach, which determines an optimum mix of resources to meet specified objectives (e.g. maximising income or minimising risk, etc.). The limitation to this approach is that it presupposes a 'goal' of the household, and does not adequately consider the day-to-day decisions being made by householders. Also, such models are structured to represent equilibrium, and represent a time when production has stabilised. Climate conditions, for example, are assumed to be average every year. They, therefore, are not able to simulate processes leading from one equilibrium to another particularly well. We were incorporating processes of household decision-making into a dynamic simulation framework, which could be used to scale up from farm to a community or regional level. The assumption was that by understanding the socio-economic and biophysical processes of the system better, it would be easier to design pathways out of poverty. This assumed a household wanted to enhance its livelihood through food security, cash generation, and quality of life, and that ways can be found or policies devised whereby this be achieved without degrading the environment?

Means developed for evaluating soil management technologies (Output 2)

During the first year emphasis was given to developing the process of developing tools for local professionals. It developed a PLAR approach to involve individual communities (existing Lumle-Outreach sites) and farmers in a four phases (Figure 2)

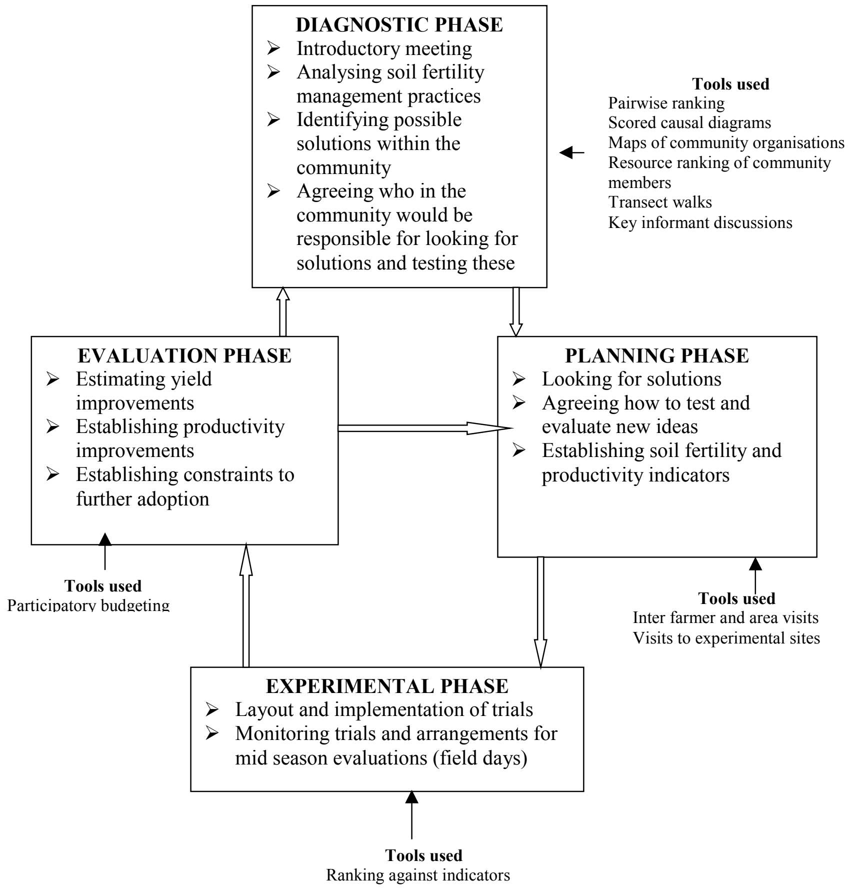

Figure 2: Four-phase PLAR approach to encourage farmer testing of soil management practices

In each phase a number of different tools were used to facilitate the discussions. This led to farmer led participatory trials being undertaken in the four mid hill AEZs where Lumle has Outreach sites. At the same time as facilitating farmer evaluation, Lumle researches used a more traditional scientific approach to evaluate the same technologies (Table 17).

Table 17: Key differences between farmers' and scientists' evaluations

Farmers evaluation	Scientists evaluation
Manure assessments	
Ongoing assessments of manure and crop performance using farmers' indicators	Comparative nutrient analysis of manures (NPK)
Mid season evaluations	
Opportunity to involve others Emphasis on confirming/identifying farmers' criteria with others	Soil nutrient analysis before manure application Soil nutrient analysis after harvest Mid season monitoring
End of season evaluation	
Recap on ongoing assessments Visual yield estimations Participatory budgets with consideration for non literate farmers	Comparative yield assessments based on sampling and statistical analysis Partial budget analysis comparing treatments

The conclusions reached after one season of close collaboration with farmers were that farmer' evaluation criteria:

- Can be used as a basis for discussion between farmers, scientists and extension personnel
- Allow evaluation, using criteria considered important by farmers.
- Add value to scientific evaluation.
- Are easier to comprehend for non-scientists
- Can be used to facilitate discussion between development professionals and farmers
- Indicate that covering manure and leaving legume root residues gave better results than traditional practices
- Indicate that further adoption will take place.

At the same time scientists' evaluation criteria allows evaluation of criteria considered important by scientists and facilitates scientific validation of technologies under farmer management conditions, if required. However such criteria can usually only be understood by scientists and can be difficult to use in dialogue with farmers. Although results indicate that improved manure management enhanced farmer yields on an economic basis, crop residue management was not shown to be statistically better for improving yields.

The PLAR process is an essential component of empowering farmers. It facilitates farmer interaction, farmer identification of problems, consideration of options for improvement, identifying potential improvements as well as monitoring and evaluation of the trials. Farmers' indicators are an ideal measure of soil fitness to produce and participatory budgeting techniques allow assessment from farmers' perspectives. Above all the process empowers farmers giving them the confidence to continue the process without outside facilitationWith the success achieved during year 1, new effort has been made to link with DAO and NGOs to promote farmer to farmer linkages.

There are now a growing number of farmers groups who are testing soil-improving innovations using components of the PLAR process wholly or in part. There remains a need to detail and learn from these activities so the tools can be improved and promoted to research and development professionals in Nepal.

Capability of local professionals strengthened (Output3)

In many ways this is the most important of the four Outputs that builds on the information base and tools being developed in Outputs 1 and 2. This output deliver the toolkit of methods together with the facilitating skills that allow improved extension and farmer to farmer contact.

This process has been initiated with collaborating development institution including the DAO, Helvetas-SSMP and lead farmers from Lumle Outreach sites. As a result of these interactions a number of other community based NGOs, linked to SSMP, (MADE-Nepal, PCDS, NCCDC and SWYC) and community groups have initiated work and are using the PLAR process to encourage farmer testing of improved soil management technologies. They have undertaken the diagnostic phase themselves. ARS-Lumle researchers and technicians have facilitated the planning phase through inter area and experimental farm visits and have assisted in some cases with the experimental phase. There now remains a need to monitor, assist with and develop this process, as was programmed during the remaining twelve months of this project.

The development of the systems model as a tool for use primarily by other researchers is well advanced and needs to be taken through to the stage where researchers can interact with it and use it for planning and evaluation.

Reports of project activities have been disseminated and two papers jointly prepared by UK and Nepali scientists are nearing the point where they can be submitted to refereed journals.

Access to useful NR management improved
The project has been working through a three-stage process in which

- Researchers work with farmers to identify and evaluate potential SFTs-(Year 1 activities)
- Farmers carry out their own evaluation trials with researchers monitoring and learning from the process, encouraging, and supplying modest support if required (Year 2 activities).
- Farmers establish their own trials calling on local professionals when required (Year 3 and beyond activities)

The first stage has been successfully completed. The second stage has been embarked upon, but now requires support. The third stage would have started as the project was completed and continues in to the future.

By the end of the first year, over 60 farmers in four AEZ, Lumle Outreach sites were participating in testing of soil fertility enhancing technology options. During the second year this had expanded significantly to include two additional Outreach sites, one DAO site and a number of NGO areas. Lumle researchers have been involved in providing training to lead farmer trainees from the SSMP and SSSP programmes. However communication difficulties, security considerations and an inability to travel in many rural areas has hampered the obtaining of valuable information that will help to validate and improve the methodologies being developed.

Early drafts of suitable extension material have been discussed. There remains an urgent need to follow up on this so that appropriate material can be developed, tested and improved with local professionals before being widely disseminated.

CONTRIBUTION OF OUTPUTS TO DEVELOPMENTAL IMPACT

Include how the outputs will contribute towards DFID's developmental goals. The identified promotion pathways to target institutions and beneficiaries. What follow up action/research is necessary to promote the findings of the work to achieve their development benefit? This should include a list of publications, plans for further dissemination, as appropriate. For projects aimed at developing a device, material or process specify:

The expected Outputs of the project have only been partly achieved, due to early termination. This particularly affects the systems framework analysis (computer model) and the further development of the participatory tools. Notwithstanding the project has provided useful data and perspectives from both farmers and scientists viewpoints that is being used for evaluating soil fertility management options.

A range of organisations is now using the PLAR approach either wholly or in part. The concept of farmer empowerment to identify and solve their own problems is finding favour. A range of soil fitness indicators has been developed with farmers, and is being used in training, trial monitoring and evaluations. A participatory budgeting process for assessing soil productivity has been developed. Both are presently being validated and improved with farmers. There is active involvement of Government extension and NGO agencies in helping to develop these methodologies and a solid platform has been set for using the methodologies on a wider scale.

Lumle staff has been involved in providing to NGO staff and facilitating discussion with farmer groups. Again there is a need to build on this demand through development of appropriate extension material.

<u>Key activities that remain to be undertaken include</u>

- Completion of the systems framework
- Monitoring, evaluation and improvement of the four Phase PLAR process
- Monitoring its use by institutions using the approach
- Monitoring farmer testing of SFTs to learn from the process, in particular:
    - which technologies are being tested
    - the source of the innovation
    - modifications and further adaptation that may have occurred since the innovation was identified
    - what indicators farmers are using and
    - who is benefiting form the results

The Outputs can be delivered when these activities have been successfully completed.

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* Indicates project publications

R7536: Biophysical and socio-economic tools for assessing soil fertility Logframe revised 8 August 2002

Narrative summary	Objectively verifiable indicators (OVIs)	Means of verification MOVs	Important assumptions
GOAL			
Improved hillside farming strategies relevant to the needs of marginal farmers developed and promoted	**By 2002**, new approaches to the maintenance and improvement of soil fertility validated in two target areas. **By 2003,** this new knowledge incorporated into strategies to increase the local availability of food and/or fodder supplies and adopted by target institutions in two target countries	Reviews by Programme manager Reports of research team and collaborating /target institutions Dissemination of products Local and international statistical data Data collected and collated by programme manager	Target beneficiaries promote systems and approaches. Enabling environment exists. Budgets and programmes of target institutions are sufficient and well managed.
PURPOSE			
Improved methods for research and development organisations to identify cost-effective and appropriate soil fertility enhancing technologies and management strategies developed and promoted	By 2003, local professionals in NGOs and NARC - Routinely make technology assessments according to resources of the household, production benefits and consequences for the environment - Use the methods developed in training courses - Integrate these into policy decisions	Project FTR Review reports of Programme Manager For both collaborating and target institutions, evidence of use and promotion of analytical tools in: - Organisational plans - Training materials and training programmes - Annual and other reports Funding requests	Target beneficiaries adopt methods and approaches. Budgets and programmes of target institutions are sufficient and well managed.
OUTPUTS			
1 Improved understanding of the biophysical and socio-economic factors (and their inter-relationships) affecting the adoptability of sustainable soil management strategies in hillside systems	**By Dec 2002,** a database of information that presents farmers' and scientists' perspectives for evaluating the factors affecting soil fertility enhancing technologies developed in contrasting environments in the mid-hills of Nepal.	Quarterly and annual project reports Database on NR management options Dissemination material (leaflets, posters, booklets and information for radio programmes) Systems framework analysis (computer model) Annual and other reports of collaborating institutions Annual and other reports of target institutions	Enabling environment for adoption of analytical tools exists Target institutions integrate new methods into research, development and training programmes.
2 Means developed for evaluating alternative SFTs for different resource users in different farming systems with the assessment reflecting farmers' wishes and practices	**By June 2003**, means disseminated and promoted to research and development professionals in target institutions within Nepal, specifically - leaflets, posters and booklets used in training for extension workers[i] - exchange visits for farmers[ii]: - radio programmes aimed at farmers and extension workers[iii] **By October 2003**, at least 2 papers submitted to referred journals[iv].		
3 Capability of local professionals, including leader farmers and extension in collaborating institutions to provide useful information to farmers strengthened	**By end project (Sept 2003)**, approaches, methodologies and processes for the identification of appropriate soil fertility enhancing technology validated and used by at least two collaborating institutions **By December 2002**, evaluation techniques are being used by at least by half the participating leader farmers in each of the outreach sites of the project		
4 Access to useful NR management information by farmers as a result of better SFT evaluations in project target and other sites improved	**By Dec 2002**, farmers in at least 3 target sites actively seek further provision of NR management information from at least one collaborating institution. **By end project (Sept 2003**, findings disseminated to and used by research and development professionals in at least 5 other sites by NARC, DoA and NGOs, as a result of workshops held specifically for this purpose [v]		
ACTIVITIES	**Milestones**	**Means of verification MOVs**	**Important assumptions**

1 Improved understanding of biophysical and socio-economic factors 1.1 Development of a data-base of - soil fertility enhancing options - the biophysical constraints to their adoption - the socio-economic constraints to their adoption	**By September 2001** database completed	Data-base t report	Politically stable environment for undertaking field activities. Collaborating institutions and farmers participate in the research activities. Local conditions and logistics allow frequent travel and communication between project sites Farmers willing to experiment Adequate data obtained from validation experiments
1.2 Review of local farmer perspectives at household and landscape levels through participatory appraisal and formal survey	**By September 2001**, participatory review in three contrasting areas completed By January 2002, formal survey analysed	Review document Survey report	
1.3 Participatory development of simple field soil fertility indicators that incorporate farmer perspectives, effect yields and have scientific validity.	**By October 2001**, indicators developed with farmers and validated through scientific testing	Survey report	
1.4 Development of a systems framework (a new approach) for linking livelihood strategies and socio-economic constraints for different farming systems to SFTs (building on 1.1-1.3).	**By September 2001**, initial framework developed **By December 2002**, computer model prototype completed [vi]	Project reports Computer model prototype	
2 Evaluation of SFTs 2.1 Quantification and validation of the major biophysical effects of soil fertility enhancing technologies through participatory research and monitoring of farmers in different socio-economic and agro-ecological environments.	**By October 2001**, preliminary validations completed **By February 2003**, further validation completed.	Project reports Computer model	
2.2 Assessment of the different methods for valuing the costs and benefits of SFTs	**By October 2002**, assessment of alternative methods completed	Project reports	
2.3 A new approach developed for integrating biophysical and socio-economic evaluations for evaluating SFTs.	**By June 2003,** computer model completed and available for use.	Computer model	
2.4 Research findings from Activities 1.1-1.4 and 2.1-2.3 promoted	**From March 2003,** dissemination materials for use in Nepal and beyond, jointly prepared by UK and Nepalese partners in the project	Dissemination materials	

3 Capability of local professionals improved 3.1 Initial stakeholder workshop involving farmers, NGOs, Govt extension and research professionals	**By October 2000,** detailed work plan agreed with stakeholders for Outputs 1 and 2 **By April 2002,** detailed work plan for Outputs 3 and 4 agreed and adjustments changes made to other plans as required	Project proceedings Inception report Revised activities	
3.2 Farmer/community interactions encouraged by local professionals through farmer participation and evaluation of trials, group discussion and field days at key stages during the project.	**From August 2001**, the process of development and evaluation of SFTS given publicity through existing extension channels during the main cropping season.	Project reports	
3.3 Monitoring the process of farmer testing and uptake of SFTs by local professionals	**By March 2003**, an evaluation made of the extent of farmer testing.	Project reports	
3.4 Project workshop at completion.	**By October 2003** , proceedings distributed	Workshop proceedings	
3.5 Distribution of research reports and other published outputs to Hillsides target institutions.	**By October 2003**, at least two papers submitted to refereed journals with copies to HPS stakeholders.	Project reports Papers	
4 Farmer access to useful NR management improved 4.1 Farmer experimentation encouraged through - Identification of lead farmers by farmer groups in communities in target outreach sites - Exchange visits from lead farmers to AEZ sites for discussions with existing farmer groups - Report backs to other group members - Encouragement of farmers to experiment	**By July 2001**, farmers in 4 AEZs participating with the programme **By July 2002**, farmer groups in 4 NARC (Lumle Outreach sites), one NGO (SSMP site) and one DoA site, participating in and evaluating their own research activities.	Project reports	
4.2 Development and use of extension materials by farmers and extension staff during and after exchange visits	**By July 2002**, extension material available and in use by Outreach workers and collaborating institutions' extension staff	Extension material	
4.3. Radio programmes broadcast indicating how farmers can access information with case study examples of farmer experimentation and knowledge sharing.	**By March 2003**, radio programmes broadcast[vii]	Radio programmes	

Notes to expand on logframe summary

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[i] For wider promotion of the research findings, 50 participants from government organisations (Department of Agriculture, Nepal Agricultural Research Council, Department of Soil and Watershed Management), and NGOs will be invited for a 3 day- workshop to Lumle. Feed back on farmer testing of alternative soil fertility management technologies and farmers' participation in the technology testing will be emphasised to the participants..

This will also be promoted at regularly held (twice per year) “Research - Extension Co-ordination Meetings” held at Lumle.

[ii] Dissemination will undertaken through training of extension workers, exchange visits between farmers of the target environments and promoting interaction within farmer groups as well as providing booklets, leaflets and posters of soil management options.

[iii] The programmes will fit with on-going broadcasts aimed at farmers organised by the Nepal Broadcasting Corporation and Department of Agriculture. . Further interaction will be required with the broadcasters in order to meet both their and the Project requirements. In keeping with new policy all programmes are expected to contribute to costs of broadcasting.

[iv] Some overlap with Output 3, activity 3.5 is apparent

[v] See notes 1 and 2 above

[vi] This will be a computer model prototype intended to improve understanding by researchers, but not suitable for routine downstream use

[vii] See note 3