HANDING OVER REPORT

FOR THE POST

OF

SOIL & WATER CONSERVATION ENGINEER

Simon C. White

May, 1985

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I would like to thank the following for their assistance over the past two and a half years. The staff of the Provincial Director of Agriculture's Office, the District Agricultural Staff in Embu and Meru, especially those in Siakago, Gachoka and Tharaka divisions: ODA and Kenyan EMI Project Staff.

It is only the cooperation with the above mentioned that has made the laying of a foundation for an effective soil and water conservation programme within Embu and Meru possible.

While acknowledging the assistance of others, the views expressed in this report are my own and not necessarily those of other EMI or MALD staff.

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1. INTRODUCTION

This handing-over report aims to give the background to and the current status of soil and water conservation within the EMI Soil and Water Conservation Project (EMI/SWCP).

Details which are available from the quarterly and other reports are not in general included but rather the report concentrates on the reasons for the current direction of the work and on the major issues underlying planning and implementation of conservation work in the field. The report should therefore be read in conjunction with the project proposal, the brief prepared for the project review of March 1984 as well as the routine reports prepared since the inception of the project in 1982. This report is divided into three main sections. The first deals with organisational and institutional questions, while the other two concentrate on the technicalities of soil and water conservation. The section on sand weir construction is detailed in anticipation of those carrying on the work not being fully conversant with this method of water conservation. The land use planning work of the project has been the responsibility of the Team Leader and so is only mentioned in passing in the report.

1.0 INTRODUCTION

This hand-over report aims to give the background to and the current status of soil and water conservation within the Soil and Water Conservation Project (MMI/SWCP).

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2. INSTITUTIONAL ASPECTS

2.1 The role of the administration in soil conservation

(The Administration = P.C., D.C., D.O., Chief, Assistant Chief).

Due to the emphasis placed on soil conservation by the President, the Administration, which falls directly under his authority, has become directly involved with the implementation of soil conservation work.

In the first place, this applies to aspects of soil conservation which require intervention by the authorities, for example, the prevention of cultivation over 35% slope, as per the Agricultural Act and more recently, the prevention of stream bank erosion. However, the involvement of the chiefs and sub chiefs goes much further. Each year a soil conservation week is organised during which the chief is expected to organise one or more soil conservation events with the aid of the local agricultural staff.

It is the observation of the SWCE that the involvement of chiefs in soil conservation is not particularly productive despite the efforts of the Ministry of Agriculture to put Administration staff through relevant short training courses and also in spite of the increasing emphasis being placed by the Government on the Administration to implement soil conservation policy. The reasons for the failure of the Administration to make any real impact has many causes but must importantly it arises from the nature of the Chief's role within the community.

When the chief calls a 'baraza',(public meeting) every household within the location is supposed to be represented at the meeting by law and disciplinary action can (though rarely is) taken against the head of any household who fails to comply. As a result,at any soil conservation event called by the chief, the local people are required to attend whether they have any interest in soil conservation or not. The chief is regarded, in any case, as a playing a policing role on behalf of the government and so soil conservation comes, unfortunately, to be thought of as a government requirement, although in general there are no preconditions

to cultivation such as installation of soil conservation works within the Agricultural Act (the relevant section can be found in 'Soil Conservation in Kenya' pages 123-136).

This is not to say that events organised by the Chief are failures. By no means. In areas where farmers are more aware of the need for soil conservation and the chief is respected as a local leader these events can be very successf in terms of attendance and work completed on the sites. On the other hand these events should be treated as training opportunities, a chance for extension which is not usually taken. The main purpose should be to allow the agricultural staff to explain in detail why the work was necessary and why the methods used were chosen for that particular site.

The Administration's part should be to assemble the people and organise the work but then to step back and let the Ministry of Agriculture and Livestock Development staff use the event as an extension exercise. After all, the chief is never going to be able to organise more than a tiny fraction of the conservation work required in his location.

The powers of the Administration are very wide and there is a worrying and growing tendency for the exercise of these powers to spill over into the realm of extension where any kind of force is counterproductive. There is a role for the chief to play but his powers should be used as a last resort rather than the first line of attack. The disturbing thing is the attitude taken by some District Officers and Chiefs that the problem of soil conservation is so enormous that we cannot wait for the people to do it voluntarily, they have to be 'forced'. This approach is doomed to failure for the following reasons:.

1. Soil conservation measures which are going to be maintained and have lasting effect will only be undertaken by farmers who decide of their own volition to do so, even if this is after having been persuaded by extension staff of the need for conservation.

2. The chiefs are often frustrated by a lack of coordination between government ministries. How do you prevent a farmer cultivating a plot of 50% slope when it has been designated as his only shamba by the Land Adjudication department? The farmer has no alternative even though he is contravening the Agricultural Act.

3. The Chief, despite his wide powers, also has to keep the respect of his community. Occasional orders to individuals to stop poor practices will be tolerated but orders covering a large enough proportion of farms to have any impact on soil erosion would be hard to implement and in any case politically unacceptable.

4. The laws governing the use of degraded land or land which is under threat of erosion are in any case vague. If the Administration is to order closure of eroded lands in any scale what criteria are they to use (e.g. the presence of gullies of a certain depth, ground cover of less than 5%)?

Soil Conservation Harambee

During the period May to October 1984 the project organised and fielded 12 location soil conservation events with the assistance of chiefs and agricultural staff. The list of events and comments on each can be found in the report for 3rd Quarter 1984. The soil conservation days themselves were held between August 16th and October 9th, the first 3 months being required for preparation. This included visiting possible sites within each location, then selecting one and planning for the measures required. In all cases hand tools were supplied by the project for the days in question. These were supplemented by local M.A.L.D. stocks where available.

The main lessons to be learned from the exercise were:

1. Most chiefs and T.A.'s appreciated the project's approach which is to concentrate on still viable but threatened farmland rather than concentrating on spectacular gullies which are of low

productive value except where they threaten a road, homestead, fertile plot etc.

2. There was often resentment at being forced to attend which was reflected in the way many avoided any prolonged working.

3. Rates of work were low, between 20 - 25% of that expected from a casual labourer.

4. T.A.'s seemed unable to adapt soil conservation methods to semi-arid areas.

The use of 'Soil Conservation Harambee' should be dropped and a substitute such as 'Chief's Soil Conservation event' used. Harambee, which means roughly 'let's pull together' is degraded in this case because of the compulsory attendance and should only be used for truly self-help exercises.

The purpose of the project's organising these events was, in part, to assess the assumption that the Administration can be used effectively in soil conservation. In conclusion, these events if properly planned can be useful demonstrations of soil conservation techniques and a good opportunity for education but let no one pretend that the chief can, by use of his powers and in the present political climate, have any significant effect on soil erosion.

Does this mean that the Administration can be passed over? The chief is responsible for all projects and activities in his location. Therefore he must be kept informed of all developments, although he does not necessarily have to be directly involved. If he involves himself in say, public meetings with womens' groups on soil conservation, his blessing on the meeting is an advantage as long as it is made plain that the authority of the chief or the 'government' is not being involved in routine conservation matters.

2.2 Counterpart staff

2.2.1 Deficiencies of the counterpart concept

It has been common practice within aid projects in Kenya to provide expatriate personnel with 'counterparts'. The idea is to provide on the job training for the counterpart so that he will be able to carry on the work after the departure of his expatriate colleague. The counterpart concept is weak for the following reasons:-

1. Government of Kenya Ministry staff are often transferred at short notice and not necessarily to a new post which takes account of the experience gained as a counterpart officer. His experience in the project is then of little use and leaves the project without the required staff. The frequency of transfers is decreasing because of the allowances which the government has to pay to an officer who is instructed to transfer. For the same reason the use of transfers as a disciplinary measure is also becoming less frequent.
2. Counterpart staff have often been supplied at the insistence of the donor agency. It may not be easy for Government of Kenya to find the right staff for the posts concerned and unsuitable staff may be sent to fill the post because of donor insistence on the placements.
3. The greatest weakness lies in the fact that posts created for counterparts usually cease to exist when the project ends and therefore the counterpart officer himself finds that he is reabsorbed into an unrelated but existing establishment post.

2.2.2 Two alternatives

The two following approaches are suggested as realistic alternatives:-

1. The fact that the counterpart will not carry on the work of the project after the funding stops is accepted. The counterpart is then viewed as a 'right - hand man' to the expatriate officer for the life of the project and that he will merely carry his experience back to the ministry when the project ends.

2. The expatriate officer is appointed as counterpart to a GOK officer in an existing ministry post. In this way the expertise passed over will carry on after the end of the project. This approach requires, however, that the role of the expatriate is tailored to fit in with the duties of his counterpart.

The second of these approaches seems the optimal one but has a strong bearing on the nature of a project such as EMI/SWCP. When the EMI/SWCP was drawn up the project proposal envisaged the SWCE as counterpart to the Provincial Soil Conservation Officer, in accordance with the second approach above. However, the SWCP area of operation had already been defined so that the PSCO would have found himself counterpart to an expatriate officer concerned with only two parts of two of the six districts in Eastern Province for which the PSCO is responsible.

If an expatriate officer is to have a counterpart officer who is an established ministry post their spheres of influence must coincide. (either province or district).

2.2.3 Counterparts in EMI/SWCP

The appointement of counterparts within EMI/SWCP can be summarised as follows:-

TCO	Date of Arrival	Counterpart	Date Appointed	Delay in Appointment
Jim Mansfield (Land Use Planner)	Feb.'82	Mr. Mwaniki Project Manager	July '83	17 months
Simon White (Soil and Water Conservation Engineer)	Oct.'82	Mr.Mwarasomba (Soil and Water Conservation Officer)	Feb. '84	17 months

The late appointment of Mr. Ireri Mwarasomba was disadvantageous for two reasons. Firstly he missed out on all the early planning stages of the project including

discussions on the approach to soil conservation to be taken by the project. In Mr. Mwarasomba's case, his missing the planning stages was especially unfortunate. He is a very capable officer when it comes to organising field operations, dealing with junior staff and farmers, addressing public meetings and so on but his capabilities as a planner and report writer are still weak after 5 years of government service. It would also have been an asset to have had him in the project during the early stages of implementation (January to June 1983) when mistakes were made which could have been avoided with the assistance of a capable counterpart. Having formerly been Embu District Land Development Officer he was, unlike the expatriate staff, already versed in how to deal with chiefs, committees and the local farmers themselves.

Mr. Mwarasomba should be recommended for further training as much to increase his planning abilities as to better his technical knowledge. He presently has a diploma from Egerton College which could be upgraded to post graduate diploma or degree level. Mr. Mwarasomba is actively looking for further training opportunities.

His training at Egerton was in farm management and so he is not in a position to handle construction work. However there are other Technical Officers in the AMS Stations who look after this aspect and Mr. Karani of AMS Chiakariga is well suited to the work. Mr. Chiyonzo from AMS Machang'a, presently in charge of EMI/SWCP sponsored work is less well suited having been trained in Farm Power and Machinery.

2.3 Funding

When funds were first made available to the project in July, 1982, all expenditure had to pass through the GOK system. GOK was responsible for claiming back from ODA the costs incurred under the votes allocated to the project.

Although sound in theory, the reimbursement system is clumsy because of the procedures which have to be followed. For instance to reclaim 200/= spent on fuel entails preparation of a payment voucher which has then to be inspected and authorised. The voucher details are then

entered in the vote book and having ensured that funds are still available in that vote, payment is made by the cashier. Although this does not sound complex in practice it may take 1 to 2 weeks and may never happen at all unless the officer concerned 'chases' the voucher through the various stages.

In addition to the time taken to obtain repayment there is the question of procurement procedure. Unfortunately ceilings for expenditure categories have not been raised for several years and are as follows:

Under 200/=	pay cash and reclaim
200/= to 1000/=	use Local Purchase Order (LPO)
1000/= to 4000/=	obtain 3 quotations on form S 10. Then District Supplies Officer adjudicates.
4000/= to 2, million	District Tender Board awards to competitive quotation.

(The District Tender Board is chaired by the District Commissioner. The District Supplies Officer is secretary and at least 3 district heads must be in attendance to form a quorum).

In late 1982 the situation was becoming untenable. The P.C.'s office was often short of cash for disbursement to other departments who in turn were often unable to pay suppliers. It was becoming increasingly common for suppliers to refuse to accept LPO's because of the slow payment.

Eventually on March 8th 1983 the government declared that there was to be no expenditure under development heads (e.g. D.10, Agriculture) and so the project then found itself having to look for another system of financing.

Before this date Steve Wiggins* had been issued with an imprest of Ksh. 40,000/= to cover the three main projects for essential supplies such as spare parts, office equipment and tools of the trade, but from March 1983 all the project finances had to be by direct funding.

From April, 1983 project funds were received directly into EMI Projects bank account with Barclays Bank, Embu. The team leaders were then responsible for ensuring that funds disbursed to their projects were correctly accounted for.

* then Assistant to the Provincial Planning Officer

The EMI Coordinator had overall control. This system still operates for the SWCP and GASP but the EMI Forestry Project went back to the reimbursement system in July, 1984. By all reports. 'things take longer' but nevertheless the system does work in that instance.

A further and fundamental change came about in July,1983 when District Focus was implemented. The D.C. then became the controller of all funds for the District rather than the departmental heads receiving funds from head offices in Nairobi. The new system seems to be functioning now but initially was chaotic.

The direct funding principle has advantages:

1. Money can be drawn and used quickly.
2. There are few delays in receiving funds from source.
3. An independant accounting system prevents interference from outside and diversion of funds to non EMI uses.

and Disadvantages:

1. The project can act as a separate entity to the related government department.
2. An accounting burden is placed on the EMI Coordinator and other officers directly handling funds.

Overall, direct funding has been a good thing for the EMI/SWCP. The ease of cash flow has made construction work and purchasing of tools at short notice possible and has all in all, allowed the project to progress faster than it would have done under reimbursement. The present P.D.A. is aware of this and for this reason wishes the project to continue being directly financed.

The first disadvantage noted above however is a serious drawback. Without the control of funds the PDA/DAO's will never have full control of and responsibility for the project as they theoretically should. In the second phase of the project ODA is currently insisting that reimbursement must be used for all operating expenses and so control will shift back to the D.A.O's. No doubt there will have to be a system of joint authorisation of directly used funds between the offices of the EMI Coordinator and the D.A.O.'s Embu and Meru.

Whatever the exact arrangements for authorisation and accounting, reimbursement is bound to slow the project down considerably.

One advantage of the reimbursement system is that it would take the accounting load off the project staff who are technical people unaccustomed to and untrained in accountancy. Unfortunately since direct funding was introduced in March 1983 there have been no procedural guidelines from ODA on accounting. Without such and regular outside checking mistakes are likely. The recent review of the accounting system by a Nairobi based accounting firm has done little to help this although advice on a few specifics, for instance the need for fixed imprests, has been useful.

During the last two years the SWCE has handled in excess of £17,000 in cash and out of this sum there is presently a discrepancy of some £250. The SWCE, the Team Leader and the EMI Coordinator have all tried to find the cause of the shortfall but without success. The most probable explanation for the loss is one or more missing vouchers submitted by the AMS which never got into the project accounts. The High Commission although aware of the problem has not reacted and so the SWCE will be leaving the post without this matter being resolved.

There is an urgent need for a strict monitoring procedure to be instigated to prevent officers who have no accounting background running into similar difficulties.

2.4 Relationships with Government of Kenya Staff

The progress made by the project over the last 18 months has been made possible only by the good relations enjoyed between Kenyan and British project staff and between the project staff as a whole and the P.D.A.'s and D.A.O.'s offices.

When the project began in 1982/83 this situation was very different. The D.A.O.'s andthe P.D.A. of the time did not agree with the aims of the project as laid down in the project proposal, a document which most provincial and District Agricultural staff claimed never even to have seen. (Their approval would have been essential before the document ever proceeded to the final inter government agreement stage). However, as often happens, staff were changed at the crucial time so that the individuals concerned were unaware of the aims and origins of the project.

The two main complaints during the early days were:

1. Lack of integration. The most common complaint was that the project was 'not within the Ministry'. At one level this was a justified criticism in so far as district, divisional and locational agricultural staff were not being properly involved in what the project was doing. At another level this only reflected the frustration of some officers that they did not have access to the project funds.
2. The 'pilot' nature of the project. The Steering Committee which was formed in early 1983 could not reconcile itself with the trial and investigational nature of the project aims and pressed for action - 'the project is doing nothing'. Doing something meant the provision of tangible benefits to the project area. Because of this the soil conservation work became more implementation rather than trial oriented and the sand weir construction programme became a high priority.

Relations sunk to a low ebb in mid 1983 with one Steering Committee Meeting portraying a clear 'give us the money and we'll do the job ourselves' attitude, although this is not recorded in the minutes!

With the appointment of a new P.D.A., Mr. Muasya and a new D.A.O. Embu (Mrs. Mucai) relations began to improve immediately and the D.A.O. Meru (Mr. Sese) also now seems to be taking a more active interest in the project. This has led now to a position where it is possible to envisage the project officers being merely advisors to the D.A.O.'s staff and implementing the stated aims of phase 2 using only established ministry staff. This kind of close cooperation and intergration is obviously advantageous. One benefit is that when the project ends the funds available to the D.A.O.'s decline rather than a whole separate operational unit collapsing at the same time.

2.5 Some related institutions in Kenya

2.5.1. Survey of Kenya. Box 30046, Nairobi Contact.Mr. Chabeda, Chief Lithographer. The survey department is situated on the Northern side of the Thika road behind the Benedictine Monastery.

The negatives for the D.O.S contract 194 aerial photographs of the project area are held by SOK and prints can be ordered. When a whole new set of prints was required for issuing to the A.M.S. stations for dam site location photographic paper had to be ordered by the project from the UK.

SOK have produced photolaydowns of the aerial photos for Evurore and Marimanti catchments and are currently involved in the same exercise for the proposed new catchment at Kiritiri.

2.5.2. National Agricultural Laboratories

The N.A.L. is situated on Waiyaki way about 1½ km. from westlands roundabout. The Soil Survey of Kenya is located in the same grounds.

The N.A.L. offers mechanical and chemical soil analyses.

2.5.3. University of Nairobi. (Agricultural Engineering, Department).

Contact Dan Thomas (Chairman of Dept.).
or Henk Debbits

Located at the Kabete campus of the University. Some contact with Dan Thomas, now chairman of the Department. Also Hank Debbits has cooperated with Bob Watson and Ken Proud on ox Cultivation. The Project Manager, Mr. Mwaniki holds a post graduate diploma in Soil Conservation from the University. Mr. Karani (A.M.S. Chiakariga) has recently made an unsuccessful bid to get into the B.Sc. Ag. Eng. Course.

2.5. 4. Katumani Research Station Machakos

Has small soil and water conservation section previously under Marete Styczen, Danish FAO Associate Expert. There was a proposed joint effort with them at one of their pre-extension trial forms at Kamanyaki (east of Ishiara) with a farmer called Njugu Nyaga but this came to nothing.

2.5.5 Kitale FAO Seed Project

Contact; Mr. Ebrahim.

Source of seed for distribution during draught under Nutrition Project based in Embu. Has also provided seeds for the project. Visited by Jim Mansfield, late 1984.

2.5.6 Agricultural Machinery Testing Unit (AMTU)

Contact; Barney Muckle (Nakuru) or officer in-charge Siakago.

Headquarters in Nakuru but substation at Siakago, Embu district. Collaborated with the project in ox-training around Ishiara with some success. Seems to be rather inactive at present.

2.5.7 Embu Institute of Agriculture, Box 6 Embu

Contact Principal; Mr. Kamau Muniu.

Some lectures given by SWCE in conservation to 2nd year students. Organised by Mr. Sillah, head of the department. Good place for training seminars. College exists to train technical assistants. Now only 2 colleges of this type, the other being Bukura. The Eldoret college has been taken over for teacher training so that there is presently no T.A. Agricultural Engineering Course.

2.5.8 Kremu (Kenya Rangeland Ecological Monitoring Unit)

Contact Mr. E.K. Wahome.

Mr. Wahome was at one time a possible counterpart to LUP but was not released from KREMU. Most recently Wahome has been involved in farming surveys including parts of lower Meru and has some recent 1:10,000 aerial photographs which could be of use.

In general, collaboration with other bodies in Kenya has been insufficient, partly due to the unwillingness of Nairobi based personnel to visit the project area.

2.5.9 British High Commission (BHC)

In general the Aid department does a good job in servicing the EMI/SWCP particularly in routine administration matters such as clearance and delivery of project supplies from customs, reimbursement of personal expenses, subsistence claims and like. A quick and sympathetic service is the norm.

The High Commission Aid department is responsible for all British aided projects within Kenya. As such all administrative matters relating to the projects and which require interactions between ODA and GOK pass through the aid department.

Unfortunately visits by High Commission aid staff to EMI/SWCP have been too infrequent for them to have any real grasp of what is happening in the projects. This perhaps is unavoidable due to pressure of work.

The department should involve itself more in getting the right papers and letters pushed between government departments. In this way delays could be avoided by a few well time visits to the right offices in, e.g. the Ministry of Agriculture. At present the TCO finds himself involved in chasing from one office to the next to get the right papers signed being, seemingly, the only one with sufficient interest in the outcome to put in the necessary effort.

This underlines the need for a 'Mr. Fixit' in the BHC.* This person should preferably be an educated Kenyan (or failing that a Briton) whose task would be to follow up paperwork of all kinds and act as a high class messenger.

The appointment of such a person is a priority and would save weeks of administrative delay not to mention frustration at the project implementation level.

.5.10 British Development Division in Eastern Africa (BDDEA)

Located on the 14th floor of Bruce house, the BDDEA is ODA's wing in East Africa. As such they are responsible for liaison between ODA headquarters and the High Commission in Kenya, Tanzania, Uganda, Sudan,Somalia, Mauritius and Seychelles.

Unfortunately, the advisors who staff BDDEA seems to be perpetually rushed off their feet and have difficulty focussing

*(Aid Department)

down on EMI for more than a few hours at a time. Their frequent absence from the country causes long delays in decision making.

2.5.11 Crown Agents

The reputation of Crown Agents in Nairobi seems in general to be good but their performance in regard to the EMI/SWCP has been nothing short of appalling and, despite some realisation of this, things do not seem to have improved much.

The example of the second indent EMI/SWC/2/84-85 is pertinent. The indent was forwarded to the Crown Agent by the project in early August, 1984. The documents were sent to central Tender Board in an incomplete form and so were returned, in all, 3 times to the MALD. The items in this indent have still not been ordered. Perhaps the blame for the delay can be laid at the door of the Ministries concerned but it is in the interest of the client, in this case ODA, that the Crown Agents follow up such cases, something which they seem until recently reluctant to do.

Crown Agents' monopoly on British Government supplies is unfortunate. Competition would undoubtedly improve the service offered.

2.6 Contracts With Other Ministries

There has been some contact between the EMI/SWCP and other ministries. The project's having a somewhat separate identity from the MALD, although negative in some ways, helps to break down the normal suspicion between different ministries, making cooperation easier.

2.6.1. Culture and Social Services (MOCSS)

The potential importance of women's groups for soil conservation has only been fully realised late in the current phase of the project. All these groups have to register with the MOCSS and interact with the government at the local level through the Locational Social Development assistant. When Jane Lawry undertook her survey in Evurore/Kiangombe in lower Embu she used the LSDA as an intermediary as did Mr. Mwarasomba (SWCO) when organising group soil conservation (LSDA in Ishiara is Mrs. Asenath Njiru). In future better

links should be made with MOCSS at the District and Locational level.

2.6 2. Water Development (MOWD)

Chris Mackintosh (PTAS) worked on the exact location of pipelines and offtakes for the Ishiara piped water scheme and mapped the existing network. (Rural water offtakes are metered to check consumption but are charged 15/= flat rate per month).

Both officers from the AMS who were trained in dam construction obtained information on water supplies, present and future, in the EMI/SWCP area from the provincial water office.

In February/March 1983 Embu district was toured by Provincial Hydrologist and Hydrogeologist plus SWCE to check possible dam sites and to see existing wells and boreholes.

Maji House (MOWD HQ) staff were consulted on sand weir design and an unsuccessful attempt was made to get flow data on the Ena river. The plan was to have gauging stations at two drifts on the Ena (Kamumu and Karerema) in order to assess the runoff from the catchment area in between. A small amount of money (500/=) was given to MOWD to help with establishing the second gauge but this did not materialise.

The Uvariri Spring in Kiangombe hill (above Ngunyumu) was visited with an officer of MOWD Provincial HQ. and a report on the possible development of the spring helped the project towards implementation by the Embu water office with assistance from Nigel Crowe, Embu District Water Engineer (VSO).

2.6 3. Works, Housing and Physical Planning (MOW)

The MOW assisted greatly with the preparation of the dam construction contract documents. The then Provincial Quantity Surveyor scrutinised the draft contract, the chief structural Engineer, Mr. Skiba gave comments and the Provincial Works Officer (Mr. Muya) is now acting as Arbitrator for the contract.

2.6 4. Environment and Natural Resources (MENR)

Here contact has been through the EMI Forestry Project

The EMI/FP has advised on suitable tree varieties for rehabilitation and, recently, gully control (at Karaba where Atriplex semi-bacatta is being tried on gulleys in black cotton soil). The SWCE has visited both Marang'a hill (Embu) and Kuani (Meru) plus Isiolo trial site to advise on soil conservation methods.

2.7 Training

The project was originally conceived as a planning and training exercise. As explained in the section on 'History of the Project' the pressure for implementation led to EMI/SWCP existing as a separate entity from the Ministry and having a limited role in training the ministry staff. This, with a few exceptions has continued to the present.

The SWCE's role in training has been limited and so is easily summarised.

1. Teaching during one term at the Embu Institute of Agriculture on S C in semi-arid areas.
2. One lecture with Jim Mansfield at the DDC during a teachers and local leaders soil conservation short course.
3. 5 lectures at national level 'in-service' soil conservation training course for MALD staff and foreign students from Tanzania, Ethiopia and Zambia. Subject soil conservation in Semi-Arid Areas (2 hours).
4. One session at a fortnightly 'T & V' workshop at Gachoka divisional office.
5. Two meetings with administration staff of lower Embu and Meru giving illustrated simple talk on sand weirs, their purpose and location.
6. Tour of EMI/SWCP project area with University of Nairobi postgraduate SWC students to explain the projects aims and activities.

The subject of training within the MALD has been dominated over the last two years by 'Training and Visits', an extension technique introduced to the country recently and developed by Israeli extension workers. It was first tried in India and then Thailand in both cases with considerable success.

The influence of 'T & V' on the extension service is so all pervading that it merits some explanation.

• Section 3.3

In summary the system works as follows: . The technical Assistant, the 'front line extension worker' identifies 'contact' farmers within his area of operation who are supposed to be representative of the farming population. He then draws up routes whereby he is to visit 6 to 8 farmers per day and there are eight such routes which repeat over a two week cycle, the remaining 2 working days being for training and 'extra activities'. During his fortnightly training workshops he is given messages to pass on the 'contact' farmers whose farms in turn, are supposed to act as training grounds for the surrounding 'follow-up' farmers. The messages are agreed between district agricultural staff and researchers during the monthly workshop for 'subject matter specialists' (SMS) held at the District level.

'T & V' has been operating for two years in Meru and one year in Embu and so far the SWCE has not been invited to attend or to speak at any monthly workshop in either district. This shows the failure of the EMI/SWCP to integrate with or to be absorbed by the DAO's. Opportunity has been wasted here to bring to the attention of both senior and junior MALD staff alike the special conservation problems of the semi-arid areas of Embu and Meru.

The degree to which the SWCE can be involved in training depends on how well married the DAO's office and the project are. There is plenty of scope for training opportunities in workshops held at Siakago, Gachoka and Mitunguu and at Embu and Meru towns. Also at the Embu Institute and the DDC.

There has been considerable debate about the compatability of soil conservation work and the 'T & V' system. The main problems are that the contact farmer concept cannot work with soil conservation where contour layouts have to be done. Good farming practices, tree planting, maintenance of terraces and so can all be handled within the system because they are 'messages' but where the TA must involve himself with several hours of work on any one farm the visiting format cannot be applied, and this is the second main snag.

This debate has not yet been resolved and the ministry has up to now adopted the concept of peak periods, usually during the short dry season in February and two months in August/September when the T & V timetable is abandoned and T.A's concentrate on soil conservation alone.

The paper in Appendix 2 refers to this debate but implies the need for full time conservation technical assistants, something which the ministry is presently unwilling to contemplate.

2.8 Project Amendments

In the course of a project it may become apparent that resources allocated are insufficient to fulfil the projects aims. This may relate to an activity e.g. gully control or equipment e.g. vehicles.

Project amendments are not popular with BHC or BDDEA and so any requests for further equipment and funds should be put forward in one package.

A project amendment is prepared by the project management and is then put forward for approval. The process is long and requires considerable 'pushing', as with all bureaucratic processes, to see it through.

The prescribed route for approval is as follows:-

1. Informal discussion with BHC/BDDEA/MALD on the need for and form of the amendment.
2. Formal application for amendment from MALD goes to Treasury.
3. Treasury forwards to BHC.
4. BHC obtains advice from BDDEA.
5. If BDDEA approves, amendment submitted to High Commissioner for approval and signature.
6. Project Memorandum amended and amendment signed by ODA and GOK.
7. If equipment required, Crown Agents instructed to obtain quotations from UK suppliers.
8. Quotations forward to project management for comments.
9. Indents prepared by Crown Agents and forwarded to Central Tender Board.
10. Orders placed with approved suppliers.

This process takes 9-18 months!

2.9 Equipment

A large amount of office camping and other equipment was ordered for the project by Jim Mansfield in early 1982. The equipment arrived in dribs and drabs for the next 18 months and has been stored in the project office store and in a temporary sheet-iron store next to the Provincial Irrigation Unit Offices.

All the equipment from the original indent from UK is provided under 'TC' (Technical Cooperation) and is British government property until it is disbursed to GOK at the end of or during the life of the project.

Items provided under capital aid however, e.g. the two '110' Land Rovers become GOK property on arrival in the country as they are purchased out of the aid grant to GOK agreed between the two governments as set out in the project 'Memorandum of Understanding'.

The method of purchase under reimbursements is given in the Appendices. The expenditure ceilings have now been entered under District Focus so that all contracts and quotations (4000 - 2,000,000/=) can be handled through the District Supplies Officer. The method of procurement through supplies Branch for government contracted items remains the same.

Under direct funding these procedures have not been closely followed. Quotations have been obtained for major purchases but the only project expenditure to pass the District Tender Board has been the contract for dam construction. The procedure followed to date has been on informal one, allowing quick purchases and vehicles repairs and greatly speeding progress as a result. If the next phase of the project reverts to direct funding this advantage will be lost.

Some suppliers worthy of mention:-

In Embu: Eastern Emporium for hardware and just about anything else. Not the cheapest but they have a wide range of stock and offer a good service plus giving credit. Kindaruma Ltd. also hardware stockists. Cheap but unreliable.

For spare parts, Embu Motor Services (previously Auto Fancy Emporium) and Wingkim Technical Agencies.

In Nairobi: For scientific and drawing equipment, Sciex and Sciencescope, both in Mfangano Street: For hardware, Doshi Hardware Stores Ltd., Funzi Road: Photographic work Expo Ltd. Mama Ngina Street or Africolor Labs., Koinange Street: For repairs to canvas bags, chairs, tents, Kenya Tents on the Thika Road.

Some items of equipment delivered to the project need comment:

Stereoscopes. The Cassella scopes sent from UK are useless. Two excellent Topcan S-scopes were borrowed from the University of Nairobi (Ag. Engineering Dept.) for a few months. After these were returned others were sent to the project through the SCB in Nairobi from Nakuru after being released from the now defunct Farm Management Unit. To add to the four now in stock available more have been ordered under the EMI/SWCP project amendment 1984/85 No.1 (of the 4 only 1 came with binocular attachments).

Quickset Levels

Of the 6 originally supplied most have been distributed to the AMS for survey work. Their condition should be checked on, especially as they have not been carefully checked for accuracy and the quickset device has a way of deteriorating over time and/or with rough handling.

Bicycles

These are an essential part of the projects equipment without which field work would be hampered. Unfortunately the locally assembled bicycles are of poor quality and the project has spent several thousand shillings over the last two years maintaining a dozen or so cycles. (The 'Hamilton' make should be avoided particularly).

12 new cycles from the UK arrived in February 1985 and these are proving satisfactory although the tyres supplied were ridiculously flimsly and had to be replaced with the local heavy duty type. The new bicycles have car

type valves in the tubes and the correct adaptors have yet to be found.

Tractor, Trailer and Lorry (not yet received)

These items have been required by the project for a long time but have been slow in arriving (see under Crown Agents). There main role will be to assist with gully control, dam construction, movement of planting material and hand tools.

3. SOIL CONSERVATION

3.1 General Approach to Soil Conservation

3.1.1 Least Cost Approach

During the period October to December, 1983 the approach of the project to execution of soil conservation had to be formulated before field work could begin. The Project was not established with the aim of transferring familiar technology from the high potential to the low potential lands but rather was drawn up with the development and demonstration of appropriate methods for semi-arid conditions as found in lower Meru and Embu.

The first requirement, therefore, was a review of the approach already adopted by the MALD. Soil conservation work has been concentrated mostly in the highlands under the sponsorship of SIDA, who have staff in the soil conservation branch headquarters to advise on implementation within their programme. Their approach is largely an expansion of work carried out by Dr. Carl Wenner, who produced a handbook called 'Soil Conservation in Kenya' which is now the standard text within the SCB. The manual concentrates on techniques for small scale farming in high potential areas.

Implementation is the responsibility of the DAO's staff, the DAO being the AIE holder for the funds from SIDA. These funds are used in tree nursery running costs, gully control and most importantly in the payment of casual labour for the installation of "cut-off drains" (diversion

ditches). The rationale behind this payment is that as a cut-off drain may cross land belonging to several farmers it is not the responsibility of any individual and therefore farmers should be paid for its construction. Before employment the farmer is supposed to sign a maintenance contract whereby the drain will be cleaned out when necessary on the farmer's own initiative. Furthermore, as any terracing work would be confined within an individual's farm boundaries, it is his own responsibility and he should undertake that work without payment.

In practice this approach seldom works and the reason is not hard to find. If a farmer is paid for one type of work why should he not wait for the rest? The subtleties of the distinction between throwing the excavated soil downhill (COD) and uphill (fanya-juu terrace) don't have much impact on farmers. Also the structures are often not maintained. It is even possible to find the situation whereby the farmer digs CODs all through his shamba so that he can be paid for all the work he had done.

The question of payment for soil conservation works is a vexed one but it was decided within EMI/SWCP at an early stage that no payment would be made to farmers for any kind of on-farm soil conservation works for three important reasons. These are:

1. The Government of Kenya, even where supported by aid programs, will never be able to carry the financial burden of paying for conservation works if sufficient work is to be undertaken to sensibly reduce soil erosion. This is not to say that conservation under the SIDA project has not brought about erosion control in certain areas. More importantly, however

2. The wrong attitude is engendered in the thinking of the average farmer when payment is introduced. He feels that he is working for government and the benefit to himself is the cash he receives rather than the future improvement of his farm.
3. This type of expenditure cannot be justified within the semi-arid lands because of their low potential for production, either in terms of crops or livestock. A recent analysis of the economic benefits of the proposed phase 2 of the project, although hardly rigorous, found that the benefits in terms of production were marginal when compared to the input and operating costs even assuming that on-farm works were not paid for.

The other ASAL soil conservation projects are also taking the non-payment line. In general, no other approach other than that arising for the least-cost while remaining effective can be taken in the low-potential semi-arid areas.

The SIDA programme also provides for the cost of large numbers of handtools to be provided to the DAO's offices. The DAO in turn passes them on to farmers where necessary. This is a valuable and necessary input. The tools, in theory, are to be used within the higher potential divisions of the district (at least in case of Embu and Meru) because there is no other source of handtools for distribution within the drier regions.

The EMI/SWCP has also taken the line that provision of handtools is an essential input, especially within the project area where tools for excavation or for transport (e.g. wheelbarrows) are almost entirely lacking. Where conservation works are paid for it is necessary to provide tools even if the farmer has his own because he will not be prepared to wear out his tools doing what he regards as someone else's work. In the semi-arid areas, where farmers do not have the tools this does not arise. Tools such as jembes and mattocks are not seen because, either the farmer cannot afford them or, in the case of the jembe, the soil conditions do not allow. The soils are often thin, hard and stoney, especially around hill complexes. In the flatter areas soils tend to be deeper.

The tool most commonly found is the digging stick, which may be just a sharpened stick, or, more normally, a blade fixed to the end of a stick. This is used for both planting and weeding. To plant, a hole is jabbed in the soil and the seed dropped in. Where farm labour is very

short this is one way of cutting down on the labour required for planting.

3.1.2 Public Works

There will always be exceptions to the rule that the farmer himself should take responsibility for conserving soil in his shamba. In cases of serious denudation the problem may be beyond the resources of the farmer to cope with. In extreme cases he may not be able to control denudation even where assisted by his neighbours or a labour group to which he might belong. In these situations, the government, or a project acting alongside the government may decide to intervene and provide inputs of labour, materials and supervision sufficient to cope with the erosion problem and to put the land on the road to recovery.

It is one thing to realise that conservation of a plot of land is beyond the owner's capabilities. It is another to decide that it is worth the investment to rehabilitate that land. In other words the solution has to be linked to the potential value of the land.

For example, a bare eroded plot may already have been stripped of its top soil and may have been abandoned as useless by its owner. In the project area land is not yet so scarce that such a plot must be kept under continuous cultivation or even grazing (although in practice there is little grazing control). The bare plot may have

developing gullies. If the plot presents no immediate hazard to its surrounding, the only appropriate action is to fence with thorn and/or live fencing, a task which could probably be handled by the owner. The prevention of grazing would be in many cases allow ground cover to re-establish. If not, grass or tree planting could be considered. These operations also would normally be within the farmer's labour capacity.

However, if the runoff from the plot or the headward erosion in the gullies prevents a hazard to a road, a building or homestead then more intensive efforts are needed to control the erosion processes.

3.1.3 Two tier approach

In the formulation of a future soil conservation programme a two tier approach is required.

A. On-farm soil conservation undertaken voluntarily by individuals or groups with technical advice and tools (on loan) from the MALD.

B. Public works undertaken by the government with paid labour.

In part B, the term 'Public Works' would have a particular meaning. As almost all land has (in the case of Embu) or will (in Meru) be adjudicated there will eventually be little true public land remaining. Public works here then, would not refer to public land but to works

undertaken on an individual's land for the public good (i.e. stopping the rot in one place before it spreads to others)

This two tier structure was recommended in a recent report by Atkins. Land and Water Development (Cambridge, England) in a study of the Masinga catchment undertaken for the EEC and the Tana River Development Authority.

The report suggested that a public works programme should go hand in hand with the use of self help groups to combat soil erosion. Despite the ambitious targets set within the proposal, this approach seems sound. (Unfortunately, copies of the report, which is in 3 volumes, were not available from the EEC office, Nairobi but an effort should be made to get a copy for the EMI Library as it has good general information, some of which refers to Mwea, which lies within the proposed phase 2 area).

Within the EMI/SWCP work under category A has been carried out and a foundation laid for working with individuals and groups in limited areas. However, category B has hardly been addressed at all except for conservation of 5 gullies within the Ciamithu sub-cathment, a task undertaken mainly as an on-the-job training exercise for the field assistants in May/June 1983.

To mount a public works conservation programme funds are required for hire of labour and purchase of materials.

Before starting work however there are two crucial requirements:

1. A survey, using local agricultural staff to pinpoint serious erosion hazards within their locations together with air photo interpretation and mapping;
2. Adequate transport, particularly a lorry and one or more tractor and trailer for moving materials to site.

These two requirements have been lacking in the first phase of the project. Time has been lacking to undertake a thorough survey of the lower parts of Embu and Meru Districts. Although this is a priority, once the implementation phase of the project started (under strong pressure from the then PDA) there was no time for such surveys. If undertaken by the SWCE with assistance from the counterpart and a cartographer, and with the local TA's well primed as to the information required, this exercise could be completed in the equivalent of 2 months full time.

The transport situation has been unsatisfactory from the beginning. A proposal for the supply of a lorry and tractor and trailer was first put forward by the SWCE in January '84 but after the preparation of a project amendment which was approved in mid-'84, the machinery has still not yet been ordered! The need for such equipment arises from the inadequacy and poor condition of the existing plant in the AMS.

3.1.4 Rehabilitation

The other main area which has not been addressed is that of rehabilitation and protection of eroded grazing lands. A small start has been made through the rehabilitation trials in the Evurori catchment and within the GASP ranch at Marimanti.

In these, a variety of techniques have been tried. Fencing, fencing plus seeding, fencing, seeding and tree planting have all been tried in various combinations with various cultivation techniques. Conclusions to be drawn from these plots are few, the full details being with Ken Proud who is presently supervising these trials.

No attempt at rehabilitating large areas has been made largely due to a lack of expertise within the SWCP project staff (both British and Kenyan) in pasture agronomy or range rehabilitation. Also concrete recommendations on rehabilitation, management, carrying capacities and so on for grazing land (which is really only fallow land) within a mixed cultivation-grazing system are absent.

It has been frustrating to realise at a fairly early stage in the project that the most serious and extensive erosion problem could not be addressed due to lack of time and expertise. The nub of the problem is how to break the practice of abandoned cultivated land not being protected from grazing which prevents re-establishment of cover and consequent risk of erosion.

It is hoped that the problem of not only the rehabilitation of eroded grazing land, but also the management of pasture will be handled by a pasture agronomist within the EMI/GASP project.

3.2 Extension Targets

3.2.1 Individuals/Labour Groups

For the first 12 months of the implementation stage of the project only individual farmers were contacted.

From April, 1984 onwards the project began to work with groups in the Marimanti catchment (men and women) and later, from February '85 with groups (women only) near Ishiara. Hopefully it will be possible to continue with both types of client. This might be necessary in future in order to reach all interested parties. The head of the household is usually male and has or wants to be seen to have the decision making role with regard to major farm decisions of which undertaking to install conservation works is one, because of the labour input required. There is no strict division of labour between men and women. Men and women both dig but many are not members of women's or men's groups. A proportion of farmers therefore will never be reached through the channel of groups, even though, as an extension medium, groups are far more efficient.

The land holding situation, especially in lower Embu is a complex one. Mwea is more or less a settlement scheme

where supposedly landless farmers were given 10 acre plots (this does not include the irrigation scheme which is managed by the NIB). In other parts of lower Embu adjudication is more or less complete but many plots are cultivated by someone other than the owner who may be either an absentee landlord (those from the highlands who have bought plots as insurance against a shortage of land in the future) or local inhabitants who have permanent employment elsewhere. (Plots are normally lent freely without payment of rent).

In such cases, there is little incentive to conserve the soil since the user may have to leave the plot at any time and in any case the absent landowner is not available for consultation on whether he sees the need for conservation. Such farms are therefore not good targets.

The other category of farmers who do not produce good results*are those with outside interests such as honey, butchery, etc. No simplistic assumption should be drawn about outside employment however because those with permanent employment are often in the forefront of conservation e.g. teachers, nurses. This is because some of them can afford to pay casual labourers to make the conservation structures and are also more aware of the need for conservation.

* in soil conservation

3.2.2 Land Productivity

A key but ill-defined indicator of the farmers who are likely to respond to soil conservation extension messages seems to be the productivity of the farms in questions.

This is seen within both catchments but is most clearly demonstrated in the Marimanti catchment. This catchment covers 2 sublocations, Marimanti Sl and Turima Sl. It also straddles the boundary between ecological zones 4 and 5 (as defined in the Farm Management Handbook prepared by the German Agricultural Team). The boundary between zones 4 and 5 coincides roughly with the boundary between the upper, flatter, deeper soils area and the lower more incised, eroded, and stoney portion although there is a portion with low slope angles and deep soils within the N.E. part of the catchment (zone 5) The sublocation boundary runs slightly to the east, i.e. lower side of the 4/5 boundary).

The response and activity of farmers in the upper area is far better than those of the lower portion of the catchment. Although there is no marked break point between the two halves of the catchment. Certainly the situation is affected by a concentration of labour groups in the upper catchment but even neglecting this, the difference is clear. There are at least four possible explanations for the contrast.

1. Soils in the lower section are hard to work and farmers cannot face the prospect of digging in the hard ground.
2. The better soils and slightly more reliable rainfall in the upper portion means that the farms are more productive. Therefore, farmers seeing the obvious value of their soils take more interest in conserving them.
3. The economic status of those in the lower section is poorer and they cannot therefore either afford to pay labour to install conservation works nor are they willing to spare their labour which might otherwise be used in finding outside employment to supplement the family income.
4. Those in the higher area are basically settled cultivators who keep livestock whereas those in zone 5 are pastoralists who cultivate.

As such the 'pastoralists' have little interest in the value of any individual plot because they are still practising shifting cultivation whereas those in the upper area have become settled cultivators who do not shift. (Some of the most active farmers in the Evurore catchment are those with only a small plot and no chance shifting.)

All these points have some truth but the two key elements seem to be soil depth and workability (and therefore, generally, fertility) and the degree to which shifting cultivation is practised.

In the Evurore catchment it was discovered in the extreme South east of the catchment (Mang'ote - Kamukanya) that there were several interested farmers whose plots were on good soils. They receive the least reliable rainfall of the whole catchment but an awareness of the productivity of the land presumably provided the incentive for conservation. More recently the work which has just started with apparent success in Kamutu (just to the east of the catchment) is also amongst farmers whose farms have good workable soils.

To provide an exception to the rule, the field assistants discovered that in the small portion of the Evurore catchment to the south of the Ena River there was considerable demand for assistance. Many of the farms here are rocky and suitable only for construction of stone terraces.

The only hard and fast rule in the Evurore catchment seems to be 'the further from Ishiara market, the better the response'.

3.2.3 Adjudication

The process of land adjudication is very slow but in the present political climate, will continue until the whole of the project area has been parcelled off to individual owners. Adjudication affects the question of the target group for extension in so far as it affects the farming system.

Thére is a strong contrast between the tenure system in the two pilot catchments. In the Evurore catchment all land has been demarcated but shifting cultivation and free movement of livestock still goes on. So far the farming system has not been seriously affected, although there is some evidence from JEM's* survey work that the situation is changing. In the upper part of the Marimanti catchment, however, there has been no adjudication but the farmers have practised 'self-demarcation' and know their farm boundaries. The response to offers of assistance in soil conservation from these farmers is far higher. The way in which land is used, therefore, is not correlated with the completion of the adjudication process. The simplistic assumption that where there is demarcation farmers will take interest in conservation and vice-versa has to be taken with a pinch of salt.

To conclude, the farmer most likely to take up soil conservation activities within the project area is settled, has workable soils in his farm, has few off-farm interests (unless he is permanently employed) and lives on or near the shamba.

3.2.5 Labour Groups

One reason for mens' and womens' groups not being made better use of by the MALD is that their contact point to the government is through another ministry. In order for a group to meet regularly, collect subscriptions and

* Jim Mansfield

appoint officials it must be registered with the Ministry of Culture and Social Services.

All the groups surveyed in the preliminary socio-economic survey by Janey Lawry of Evurore/Kiang'ombe were women's groups and the existence of men's groups were formed under the guidance of Mr. David Njeru, the JTA for the sub-location. These groups were formed specifically for soil conservation activities. No other such groups have yet been found in the project area.

Women's groups in Embu and Meru are not normally involved in soil conservation. To quote from the preliminary survey report "women's groups in these two locations appear to act primarily as cash raising groups. The money is used on building projects such as canteens, buying household utensils for members, communal goat rearing and harambee contributions. They are often involved in entertaining visiting dignitaries by dancing. They may also hire themselves out as farm labourers."

In general the groups have no background in soil conservation unlike those in Kitui and Machakos where the conservation efforts of such groups are well known throughout the country. The scepticism of the agricultural staff about the possible role of women's groups in Mbere was off putting. No approach was made to groups in the Evurore catchment in the first instance because the acting chief and local agricultural staff

were sure that they would not respond. 'Women don't dig". In August '84 Susan Kamuru the T.O. at Siakago responsible for Home Economics (which falls within MALD) was asked to bring forward the names of two interested women's groups but so far she has taken no action on this.

An example of an active group is Kagumo Women's Group in South Tharaka, centred some 1.5 kms. south of Materi Mission. The organisation of the group is the same as that followed by several others in that they have the three offices of chairwomen, secretary and treasurer but also have a male spokesman, in this case called the Coordinator. His role is to help them make contacts with government officers or with other organisations who might be willing to assist the group. In the strongly sexist Mbere/Tharaka society these contacts can be hard for a village woman to make.

In the case of Kagumo, the coordinator is a Mr. Gerald Nthumbi an energetic and persistent advocate of the group's virtues and needs. His group was responsible for the self-help work during the construction of Mbachacha sand weir (the first to be built in Meru by EMI/SWCP). They have also been involved in goat rearing, soil conservation (Mr. Gichane, PSCO, arranged for them to be lent tools by AMS Chiakariga) and have built a store for a food reserve in time of famine.

Groups such as this form an excellent focus for extension.

Convincing the group of the need to undertake conservation work means that 20-30 people will be mobilised rather than just one individual. If, for example, stone terraces are to be built the group will rotate around the members' farms until the work is complete. Although the rate of work per person per day is lower than for an individual (there is a good deal of chatting and socialising to be done) the weekly commitment to group work provides a momentum which carries the work forward.

During times of drought or disease the group structure breaks down. Members go elsewhere in search of food (i.e. work to buy food) and, in the case of the cholera outbreak in Tharaka (October '84 - February '85) group meetings were banned by the authorities.

Women's groups may have a few male members, for example, "Vinya wa Kamutu" (Strength of Kamutu , Evurore sub-location). This has a plus and a minus. The plus is that male field staff have a better point of contact to the group but the minus is that the field staff concentrate their extension messages on these male members. This has already happened with the Kamutu group.

If the project is to concentrate on women's groups in the future then it should consider the employment of female works paid field assistants, or, if WPS are no longer used, should concentrate on the use of the locational home economic officers, who are always women. Cooperation with

the Ministry of Culture and Social Services will be through the locational Social Development Assistant and if these groups are to be used on a large scale the District Community Development Officers should be informed.

3.2.6 Erosion Hazard/Client Priority

There will always be a conflict of interest as to allocation of resources. Should they be concentrated on farmers who are responsive, whether their farms are seriously eroded or not, or should conservation work concentrate on the most serious erosion hazards, which may be in farms belonging to individuals with no interest or even resistance to conservation measures?

The Ishiara catchment turns out to be one of the worst eroded parts of the whole project area. The initial altitude of 'if we can make it work here, we can make it work anywhere' was over ambitious. The extension work has had only a limited success in this catchment. Would it not have been better to have concentrated resources on an area where more enthusiasm was shown?

One main reason for the relative failure of conservation in Evurore compared to Marimanti is that the wrong problems are being addressed in the Evurore catchment. Here conservation is not firstly about terraces, cut off drains and check dams but it is to do with grazing control, rehabilitation of overgrazed, overcultivated land, pasture improvement and the like. Farmers know that

cultivation, as farming practices stand at the moment, will always take second place to livestock.

What is required then is a physical soil conservation programme for cultivation dominated farming area and another type of programme for livestock dominated areas.

However, even if the right techniques are offered the client (i.e. the farmer) will always call the tune and should be allowed to do so. Only in extreme cases of irresponsible farming practice (e.g. extensive destruction of tree cover on vulnerable slopes) should the chief step in to prohibit such practices by law. Otherwise extension work should be geared to the "interested farmer". (The constant assertion by the former Embu DAO that there were no disinterested farmers was plainly ridiculous).

The workshop on 'soil conservation in grazing lands' held recently in Nairobi took as one of its resolutions

that it is the responsive farmer who should receive attention before a disinterested farmer with eroded land.

Only where a programme of public conservation works is undertaken by the government is the farmer's cooperation desired but notessential. Even then riding roughshod over a farmer's wishes should obviously be a last resort.

3.3 History of Soil Conservation within EMI/SWCP

Jim Mansfield and Chris Mackintosh (PTAS) arrived in February 1982 to start the Project. Howver, no funds were

available until July of that year. The SWCE arrived in October of the same year and spent three months in orientation before beginning field work. In the planning stages of the Project, two pilot catchments were selected in accordance with the Project Proposal for concentration on soil conservation and land use planning. They were selected on the basis of high cultivation density and hence likelihood of soil erosion problems, and secondly, on the basis of having all year round access.

In January 1983 two soil conservation committees were formed in the Evurori catchment, the first area of concentration. At that stage the Project Officers had no counterpart staff and therefore had to rely on the locational agricultural staff and the administration for advice on the best way to proceed at the locational level. Two committees were required because, unfortunately, the catchment is divided by a locational boundary, with Evurori location in the north and Kiang'ombe in the south. Each chief set up his own soil conservation committee and two initial meetings were held with each of the committees to explain the aims of the Project.

The committees were asked to select possible sites for trial conservation and rehabilitation plots. The committee members selected themselves as the plot owners in the hope of receiving some assistance from the Project. As it has turned out most of the committee members are not full time farmers, and have no interest in maintaining

these plots. As such the trial plots have not been a success and this type of arrangement should be avoided in future.

The on-farm soil conservation work started in March 1983. The first step was to employ four works paid field assistants and to bring in a technical assistant, Mr. Simon Wachira, to supervise them. They were based at Kamuthigo camp site, being housed in sheet iron mobile huts which were purchased from East African Metal Works under Technical Cooperation funds. One of the houses was used as a store. The field assistants were all form 4 leavers and so had no background in soil conservation at that time. They were therefore given a basic classroom training in concepts of soil erosion and conservation and were also given field training in basic survey techniques, including the use of prismatic compass, clinometer and line level. They then became involved with finding farmers around the sub-catchment of the Ciamithu stream who were interested in putting in their own conservation works. They also undertook an erosion survey of the sub-catchment whereby they made east-west traverses at 1 km. intervals recording details of surface conditions and evidence of erosion. (This data has never been analysed.)

In general the response in the Evurori catchment has been poor. During the year from April 1983 - March 1984 only 80 farmers had undertaken any substantial soil conservation work. The trial plots initially served as

an advertisement to local farmers, and therefore were of some use in the early stages. However many farmers wanted to know why the Project would not put in conservation works for them in all of the fields where it was required. The response has been best in the south and south-east of the catchment, i.e. at the furthest points from Ishiara market. The reason for this is now clear in that the influence of the market is such that farming is a secondary activity for families which live nearby and have trading interests in the market place.

The initial catchment selection criteria did not, of course, pick up the difficulty that the proximity to the market would cause. Before field work began there was no sociological survey of the project area to identify places where farmer response would be best. This type of survey has still not been undertaken, to the detriment of the project.

During the initial meetings with the two soil conservation committees, (which have incidentally not been used since those first meetings) it was said that group conservation work could not succeed because cooperation between families was very limited, and cooperation within womens' groups could not be used for conservation because 'Women don't dig'. Here again the lack of counterpart staff was a disadvantage. If it had been clear to the Project Staff in the initial stages that conservation works would be the best approach, it would have saved a lot of wasted effort

and conservation in the area would now be further forward. However, at the time there was no option but to follow the advice of the local staff which we now know to have been wrong.

In March 1984 three more works paid staff were employed. This made the total up to 6, one of the original four having resigned the previous December. For the purposes of training all the field assistants were then moved to Marimanti catchment in Tharaka. A new campsite was established at Kibung'a market, the field assistants operating beteen Kibung'a and Marimanti markets. The situation in this catchment was found to be quite different to that in Evurori. Before the Project moved to the area, soil conservation groups had already been formed in Kibunga under the influence of Mr. David Njeru, the JTA for the sublocation, and these groups had already tried to obtain hand tools from Chiakariga AMS to start their own conservation work, but without success. This meant that the local farmers were already keen to undertake conservation on a group basis and were eager to be given tools and advice by the project field staff. Up to March 1985 more than 200 farmers have been involved, the majority through five men's groups and 2 womens' groups who are cooperating closely with the project. Here again, the catchment has imposed an artifical boundary sometimes even dividing members within the same group. There is a sound reason for pursuing conservation on a catchment

basis because of the 'knock on' benefits of reducing run-off throughout the catchment, but this is overridden by the importance of finding interested parties, and also the restrictions imposed by administration boundaries.

The field assistants are presently operating on a fortnightly cycle whereby two weeks is spent in each of the centres. This allows them to be paid for approx. 15 nights out per month, putting their total emoluments in line with those of the land use team. The original arrangement of being based in one campsite such as Kamuthigo in the Evurori catchment meant that the field staff received only field allowance, and the discrepancy between their earnings and those of the land use team eventually led to a change to the present system which has eliminated friction over the pay differential.

In August 1984 two of the field assistants moved back to the Evurori catchment to continue the work. As it turned out it was a mistake to have moved all the field assistants to Marimanti, because this gave the impression that the project had stopped working completely in the first area. The number of farmers who were active during the period August-February 1984 was very low. The reasons for this are unclear, but undoubtedly the severe drought meant that most farmers were concerned with survival and not with improving their farms. A new technical assistant Mr. Joseph Muthike, had taken over supervision of the field assistants by that time, Mr. Wachira having been

transferred for health reasons to Runyenjes Division. One of the failings was undoubtedly the poor cooperation between Muthike and the other two assistants.

In February 1984, Mr. Mwarasomba and the SWCE jointly decided that a different approach would have to be tried if conservation extension was to succeed in the Evurori catchment. The approach was changed to concentrate on groups and at present there are 3 womens' groups working with the project, two of which are not within the catchment boundary. This is obviously the right approach for the future. Finding the right groups is best done through the social development assistant and in the case of Evurori and Kiangombe locations Mrs. Njiru, SDA, has been of great assistance to Mr. Mwarasomba in finding interested groups.

It has been suggested that in Phase 2 of the project, two more catchments, one in each district will be added. However, it remains to be seen whether the high concentration of field staff required to operate on a catchment basis will still be possible under Phase 2. The future of the works paid staff is uncertain because senior agricultural staff feel that the technical assistants themselves would be used for soil conservation work. In any case, the catchment concept should be adhered to loosely in that while catchment areas at risk can be identified this has been combined with an assessment of

the level of interest of the farmers concerned before moving staff and equipment to the area. The Kiritiri area in Gachoka division of Embu district was toured with Mr. Mwarasomba in February 1985. The locational chief for Mavuria showed interest and the local agricultural staff seemed confident that there would be considerable interest amongst farmers, but this has still to be established.

This might be a good area to try formation of conservation groups by only agreeing to give tools and advice to those farmers who are prepared to group themselves together.

3.4 Physical Soil Conservation Measures

The general aim of soil conservation works in semi-arid areas is to 'retain not drain' where this is practical. This is in order to retain water and soil on the field where they can be of use to the crop. Lack of water is the major limiting factor in crop growth and so conservation should aim at holding back both water and soil.

3.4.1 Trash Lines

The collection and piling of stover across the field is a traditional conservation measure in common use since the 1950s or before. Their attraction is that there is a low labour input required, 2-3 man days per hectare for a reasonably good crop of maize, sorghum or millet.

Unfortunately, trash lines have many disadvantages. These are as follows:

1. The trash is eaten by termites;
2. The trash has to be replaced every season. It may be simply washed away by run-off or eaten by animals allowed in to graze the cultivated plot during the dry season.
3. Trash lines can only be made after a good harvest when there is sufficient material and when there is enough grazing outside the farm to avoid competition between fodder requirements and making trash lines.

In general trash from maize stalks are bulkier than either sorghum or millet and therefore make a better barrier. Maize is not usually harvested in the semi-arid areas.

The practice of the 'shifting trash line' should be avoided. Here the breakdown of the trash puts organic matter back into the soil and makes a fertile strip. It is tempting for a farmer to plant in this line, where crops do well, and to shift the trash line to a slightly lower position. This makes sense for crop growth but means that no accumulation of soil takes place and the overall conservation effect is minimal or nil.

If trash lines are maintained and built up every season they do conserve soil. The best examples of trash lines are found in zone 4 where higher and more consistent crop yields are found. If farm management is at a high enough

level to ensure the seasonal maintenance of the trash lines they can work well. However, they should not be recommended in zone 5 where crop yields are so variable and where there would probably be more benefit from the mulching effect of the trash left on the ground surface.

The farmer's alignment of trash lines is often quite close to the contour, the line having been put in by eye. Obviously where straight lines have been used (for neatness) advice has to be given on the correct alignment. Where ox ploughing is practiced trash lines are sometimes made purely as a convenience. Removing the trash lines and piling it along the contour so as not to interrupt the line of the plough produces trash lines.

3.4.2 Stone Terraces

(Also called stone bunds)

These structures have been in common use for at least 30 years. There is evidence, especially in the Evurore catchment of old, degrade, stone terraces which were put in during 'Ukoloni' when terracing had to be done before cultivation was allowed. Most of these structures were abandoned when the land was left fallow.

Farmers today continue the practice of stone terracing. The technique has an advantage, therefore, in that all farmers have seen these structures at some time. For the extension worker then it is more a question of 'how and where' to construct rather than 'why'.

It is rare to find stone terraces in the project area more than 30cm. high, and this is the minimum height recommended by the field assistants to farmers. Although terraces of a greater height are reported from elsewhere the terraces do not seem to be very stable and stones 'roll off' easily as run off passes. The type of stones may also make a difference. The coarse quartz gravel commonly found (a derivative of the quartz veins formed within the metamorphosed pre-Cambian basement system) has hard smooth surfaces which do not bind together well. The more basic rocks form into more angular stones with a rougher surface and probably better stability when piled up.

Whatever the material used it may be that the runoff passing over a stone terrace of more than 30cm has enough energy to disrupt it. Alternatively it has simply not been the practice to enlarge stone terraces over the years. In some farms stones are insufficient to make up terraces to 30 cms. height in which case the height limitation has nothing to do with management.

As to the terrace itself, the project has recommended a terrace of at least one foot height (30 cm.) and made up of a mixture of large and small stones. If only small stones are used the terrace will be unstable and if only large stones are used the voids will not trap water or soil. In theory terraces constructed on slopes of over 10-12% should have a small level bench (about 50cm. wide)

constructed underneath it. Although this is supposed to help in stabilising the structure, no farmers dealing with EMI/SWCP have done this. One of the advantages of the stone terrace is that no digging is required and if digging is then introduced it means issuing digging tools.

The minimum terrace height idea has been emphasised because of the practice of lining up stones across the contour one by one, as if single stones can be effective erosion checks. This practice should be discouraged. The individual stones left in their original places probably do more good in terms of water conservation and rainsplash prevention.

The tools normally issued for the construction of stone terraces are a wheelbarrow and a garden rake. The wheelbarrows are expensive (K.Shs.450-500 each) but are very popular with farmers because they can also be used for transport of boma manure and even water jerricans. It costs K.Shs.550 to equip a farmer for stone terrace work as compared to K.Shs.150 for digging work.

One great advantage of stone terraces is that they can be built by all members of the family. Even small children can help with carrying small stones. In the Evurore catchment where the soils are generally shallow, stone terraces have proved very popular. During the lifetime of the project over 9 kilometres of stone terrace have been constructed compared to 3 km. of fanya juu terrace.

The main limitation on the use of stone terraces is the availability of material. It is impractical to expect stones to be moved more than 100-200 metres even with the aid of a wheelbarrow. Does this then mean that all farms with inadequate surface stone should resort to dug terraces? Perhaps, but unfortunately there are a few farms where neither type of terrace is suitable.

There is a temptation for the field assistants to recommend construction of stone terraces where there is a lot of exposed rock. However what is required are loose surface stones. A crowbar is sometimes issued to a farmer to assist him with loosening stones but this should only be from rock mounds which cannot be cultivated. One case was found in the Marimanti catchment where the farmer had dug rocks up from his field to make the terraces. The result was that more soil was loosened up ready for transport by runoff than the rain itself would have been able to detach in several seasons.

One question which the project tried to address itself to was, 'what is the relative merits of leaving surface stone in place, where it may aid infiltration and removing it to make semi-permanent stone terraces?'

To look at this question some of the runoff plots at trial site T1 were cleared of surface stone in order to assess the difference in runoff between a stoney and non-stoney surface. This turned out to be a moot point because the

cleared plots have now been eroded to the point where more surface stone have appeared. If there is a depth of stoney soil, therefore, the surface conditions will return to their original state quite quickly even if the stone is removed for terracing.

3.4.3 Developed Terraces

The best known and most popular on-farm conservation structure in Kenya is the developed or 'fanya-juu' terrace. Fanya-juu'= Make-up'. This refers to soil from the dug trench being thrown uphill to form an embankment which stops and holds runoff or disposes it along the terrace at a safe velocity.

This structure has proved popular and successful in high potential, high rainfall areas where soils are typically deep and mechanically stable and where grasses can be planted along the bank for further stabilisation of the lower side of the terrace bank.

The principal of the FJT is to allow nature to gradually deposit soil eroded from the upper portion of the terrace on the lower portion so that the interbund area gradually flattens out leading to better inflitration, less runoff and less erosion. Erosion is also reduced by cutting the length of slope so that the LS factors in the USLE is reduced.

A note should be included on nomenclature. The term 'terrace' refers to the area between the trench and bank lines which run either along or close to the contour. In practice the term is used to refer to the trench and bank itself.

The construction of fanya-juu terraces requires a high labour input. A farmer might be expected to dig 5 to 7 metres of trench in a day. Supposing he has a farm of a hectare on a 7% slope, roughly 80-100 man days are needed to complete the digging required for terracing of that shamba, in reasonably workable soils. By any standard this is a heavy investment and the areas in Kenya where most terracing is done are where labour groups are active and the individual does not shoulder the work load alone.

Although dug terraces can be applied to semi-arid areas there are certain limitations which should be considered before blanket recommendation of FJT and diversion ditches.

1. Labour The main constraint on agricultural production is shortage of farm labour. The heavy labour input required for fanya-juu structures may be beyond a farm family's resources.
2. Soils Where soils are shallow, hard or stoney the work required for digging may be double that of easily worked soils and in some places digging deeper than a few inches may prove impossible.

3. Terrace Development Where erosion is allowed to continue until the terrace is flattened off and soils are shallow, the subsoil will be further exposed in the upper section leading to infertility while the lower portion remains relatively fertile.

4. Tools The right kind of digging tools are not normally available because farmers may not be able to afford them or find them unsuitable.

5. Grasses It is not clear whether suitable grasses for protection of terrace banks are available for low rainfall areas.

Some accommodation of the design can be made, however, to make FJT more suited to semi-arid areas, as follows:

Depth of Excavation and Vertical Interval

Typically, terrace trenches are dug 3 foot wide and two feet deep or two feet wide or two feet deep. In practice, field staff and farmers find these simple rule of thumb measurements easier to deal with than the theoretical considerations of variable terrace bank size which only confuse everyone at the field level.

By reducing the depth of excavation to one foot the problem of penetrating the hard subsoil is partially removed. Clearly, with only half the cross sectional area of excavation the terrace bank will be smaller (theoretically 0.7 times the height assuming a rest angle of 30° on the sides of the bank). The capacity of the

bank to hold back runoff is correspondingly reduced and so the vertical interval has to be reduced (VI=height difference between successive lines of trench + bank).

A greater length of digging is then required but only half as much excavation in any one spot. This has been proved in practice to work well although there has been some confusion amongst field assistants about the reduction of the vertical interval. Originally the following guidelines were given:-

Slope %	VI Normal	VI for Small Bank
0 - 7	1.0m	0.5m
7 - 15	1.5m	0.75m
15 and above	2.0m	1.0m

The smaller VI has been proved to give terraces which are too narrow and therefore it is recommended that the following schedule be adopted.

Slope %	VI Normal	VI for Small Terraces	VI SB/TL
0 - 7	1.0m	0.75m	0.5
7 - 15	1.5m	1.0m	0.75
15 and above	2.0m	1.5m	1.0

(SB/TL = Stone terraces or trash lines).

If this is adopted it will have to be gone over carefully with all the field staff involved who are in any case not following the original guidelines properly.

The reduced excavation depth and VI is a soil condition modification not a change made because of rainfall. Even though there is an advantage because of better

distribution of trapped water over the field with a reduced VI, there is no need from a soil conservation point of view to change from the standard VI figures where soils are deep (A Horizon, 0.75m plus).

On the question of grasses for terrace establishment an unexpected factor has turned up where dug terracing has been used in the two pilot catchments. All farmers have found that whatever is planted on the terrace bank grows well because of the deeper, looser soil and probably because of higher moisture contact within the bank itself.

The practice of cultivating these banks has to be discouraged or else the banks will degrade. It may not be easy to stop this cultivation unless the material planted on the bank as a replacement is productive.

Mr. Mwarasomba has recently collected and planted grasses for bulking at Kangaru nursery including bana grass, bajia grass and a local thatching grass called Kiutha (a variety of Hyperrenia) which is of value. Both bana and bajia are fodder grasses but bana, which is the more productive, may not do well in drier seasons. Some bana planted in October '84 has already died out during the short Jan/Feb '85 drought.

The question of grasses for terrace bank stabilisation is one which should continue to be a priority in the next phase of the project.

3.4.4 Gulley Control

The general principle to be followed in gulley control is to stop the run off which gives rise to the gullying and to protect the gulley to allow vegetation to re-establish. This is far more important than check structures within the gulley. Structures may be required but they should be vegetative where possible, otherwise stone. Gabion gaskets are very expensive (700/- approx.) and are almost always unnecessary. Unfortunately, they have become fashionable but the Presidential Commission on Soil Conservation and Afforestation is now becoming aware of their unsuitability.

The technicalities of gulley control are discussed fully in 'Soil Conservation in Kenya'.

The project proposal allowed for a programme of gulley control which has never been implemented for the following reasons:

1. The priority of establishing sound soil conservation methods for the semi arid areas in Phase 1 of the project;
2. Lack of detailed knowledge on gulley sides where good farmland or roads are under threat;
3. Lack of equipment especially a lorry and tractor and trailer.

If an expanded gulley control programme is to be introduced the cost of casual labour should be budgeted for as well as fuel and materials. In the proposed

project for SY85/86 4,000 has been requested.

Before starting this work a survey should be undertaken to assess the areas of greatest need. This could take the SWCE up to two months full time. Information should be collected from locational agricultural staff and 2 technical officers should be assigned, one by each DAO, to supervise the work when it starts. As in the case of the water conservation work, the gulley control exercise would not be confined to the pilot catchments.

3.5 AN ALTERNATIVE TERRACING SYSTEM

Farm labour is the overriding limitation in cultivation. If an effective low labour system can be found for the semi-arid areas it would be a great advantage. Dug terraces have the advantage of permanence (if they are maintained) but have a heavy initial labour input. A one hectare plot with a slope of 7% might require about 500 metres of terrace and cut off drain. This is the equivalent of 80 - 100 man days in workable soils and 150 man days in hard soils (assuming a standard size of terrace, see discussion under fanya-juu terrace). Trash lines require a small fraction of this labour (about 5%) but have to be placed every season. It would clearly be an advantage to have a low labour input permanent terracing system with a moderate labour need. In the high potential areas the technique which is often applied is the grass strip.

Under semi-arid conditions it is hard to find

creeping grasses which are suitable. There is a local cultivar of Cynodan dactylon (star grass) known as Rugoka found commonly in the Marimanti catchment which has grown very well along one terrace bank and is commonly found near streams.

Star grasses are excellent for terrace protection but to put in a strip say 1m. wide across a field would leave the farmer with the constant task of weeding to stop it creeping. It also might not establish well away from the relatively moist terrace banks. It already is not popular with local farmers because it is seen as a weed.

A better solution might be to use a live closely planted barrier to stabilise trash lines. The live barrier might consist of bana grass, bajia grass (a napier - miller cross), closely planted leucaena bushes, or pigeon peas (in zone 4). Once these had established trash would then be piled up against the barrier to act as a strainer for soil and moisture retainer. A trial of this type of terracing using leucena can be seen at Katumani Research Station, near to the run off plots on the left hand side of the road when approaching the turning into the station. The extra moisture collected along the line and organic matter produced from trash break down would feed the grass/bushes forming the barrier. As the barrier would allow some run off to pass nd the vertical interval should be half that for fanya-juu terraces, as with stone terraces and or trash lines.

The advantage of using leucena, pigeon pea or bana grass is that they would in themselves be productive. The pigeon pea would not be productive for more than few seasons however, whereas the other two would go on producing fodder. However, there would certainly be problems of establishment of both Leucena and bana grass in the drier parts of the project area or on poor soils. The bajia grass although not good fodder is a better bet for establishment in less favourable areas. Closely planted thatching grass (locally known as Kiutha) could also be used for the live barrier.

It would probably be best to allow the grass/bush to develop for at least two seasons before trash is piled on them so as not to encourage termite activity before the young shoots/seedlings were well established. Gapping up could be done after one season.

If such a system could be established soil would be collected above the vegetative barrier but the decomposing trash and the barrier themselves might not trap run off effectively and might after soil build up and in case of a heavy run off event be liable to erosion. The live barrier could not be planted with stems closer than 15-20 cm. and so water would still be able to pass over the top.

To stabilise the developing terrace creeping grasses such as Panicum Makarikariensis could be planted around the base of the bushes or fodder grasses. Makarikari grass

does not present a weed problem. The creeping grass would then stabilise the downslope side of the terrace as it built up. In the case of banaor bajia grass the need for the creeping grass could be avoided by regular cutting of the grass and replanting in between existing plants to thicken the barrier. When regularly cut both these grasses spread leaves sideways and provide a good cover. Once the grass has established well this would reduce the need for piling of trash along the vegetative strip.

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There would certainly be some competition for moisture between the plant and the crop. However with fanya-juu terracing a 1 - 1.5 metre wide strip is lost in any case. With the vegetative strip perhaps one metre on either side would be left without crop.

The difficulty with using any kind of vegetation for conservation is the transport and the availability of the planting material. Of these two the lack of planting material is the more restrictive. In this respect bana and bajia grass have a relative advantage. They are being bulked in Kangaru nursery and at the Embu Research Station and bana can also be obtained at Ishiara nursery. What is more when planted out it quickly reproduces, each stem producing enough for 3 or more lengths for replanting.*

In the case of constructed terraces tools can be delivered to and used by the farmer at any time whereas live material has to be delivered to the planting site within a 10-14 day period at the beginning of the rainy season when roads are wet and transportation difficult.

The use of Leucena on any scale might prove difficult logistically. Given the same example of one hectare of land with 7% slope as cited above, perhaps 1000m. of terrace would be required. With leucaena planted at, say, 30 cm. spacing this requires upwards of 3000 seedlings for that one plot assuming 100% survival rate. Even if the forest department were up to providing the number of

* in one season

seedlings required there is then the question of transport.

Also this technique might be of limited application in poor soils because the grasses and seedlings will not establish well in very shallow soils even when rain is adequate, as has been well shown at the rehabilitation plot R1, and trial plot T4 where a few seedlings are surviving even after good rains in October-December '84.

The labour requirement of such a system would be somewhere between that of the trash line and the dug terrace. Assuming that planting material has to be collected from elsewhere, allow 5 man days for collection of material, another 5 man days for preparation of planting sites and a further five days for planting this gives a total of 15 man days. In the case of fodder bushes this might increase to 25 man days when hole digging is considered (contour marking is neglected as it is common to all techniques). This would mean 30% or less of the labour input for a constructed terrace even allowing time for collection of trash. Unlike the constructed terrace, however, the live barrier terrace would need protection from grazing during its first two years.

This system and variants are recommended for extensive investigation in phase 2 of the project.

A similar approach could be tried with stone terraces. A start was made on this at T1, where stone bunds had Panicum maximum (bulked at Ishiara nursery) planted out just above the terrace. The establishment of the grasses in this unfertile plot has been poor.

It might be better to plant grasses in amongst the stones of the terrace where slightly moister soil conditions are found as evidenced by the weed growth in and around the stones.

3.6 HANDTOOLS

The following hand tools used within the soil conservation work. All the digging tools except the shovel came without handles.

3.6.1 Mattock

Description: 5 lb. head, two sided, 1.Axe, 2.Hoe

Origin: China or Hungary. Both inferior quality.

Use: In fairly hard or gravel soils.

Cost: Best 70/-, average 90/-

3.6.2 Pick Axe

Description: 7 lb. head, two sided, 1.point 2.Narrow Chisel

Origin: India or China. Indian fair quality.

Use: Hard and stoney ground. Too heavy for women to use.

Cost: Best 70/-, average 95/-

3.6.3 Shovel

Description: Wooden handle, best type carbon steel round nose.

Origin — Handles all local. Best blades either local or various imported steel plate e.g. Polish.

Use — Moving loosened soil or wet soil.

Cost — Best 35/-, average 40/- for good type with properly moulded handle. Cheaper with poor handle.

3.6.4 Wheelbarrow

Description: Standard size, 3 cu. ft. with solid rubber wheel

Origin — Several local makes. 'Datini' best.

Use — Moving loose soil and especially stones and manure. General purpose (and therefore popular).

Cost — Datini best 450/-, average 500/-.

3.6.5 Rake

Description: Normally 14 pronge

Origin — Local, fair quality.

Use — Raking small stones for stone terraces or manure distribution.

Cost — Best 30/-, average 35/-.

3.6.6 Forked Jembe

Description: 3 lb. 3 pronge

Origin — UK (Crocodile) sometimes available from old stock, otherwise Indian (fair) or Local (poor)

Use — Digging in any soil type without stones.

Cost — Crocodile Best 84/-, average 100/-, Local 65/-.

3.6.7 Plain Jembe - Not normally suited for semi-arid areas.

3.6.8 Long Jembe
Locally made tool popular especially in Kitui.

Description: 12" blade made of old springs fixed at right angle to handle by a collar.

Origin Local.
Cost 30/- ? (those with project received via SIDA through soil conservation branch, Nairobi).

3.6.9 Panga (Machete)

Description: 16" curved or straight.

Origin UK (9368) if available or local.

Use Bush clearing, cutting roots, etc.

Cost Best 35/-, average 38/- (UK)
Best 28/-, average 35/- (Local)

3.6.10 Crow Bar

Description: 3/4" or 1" diameter 5' or 6' length

Origin Local.

Use Removing rocks from hillocks for stone terraces

Cost 50/-

3.6.11 COMMENTS

Many locally made tools are of such poor quality that and frequent replacements are required/should be budgeted for. In the areas of better soil forked jembes are favoured whereas mattocks are the most popular in the harder stonier soils. Pickaxes are only required in the most severe conditions and are generally unpopular because they are too heavy. This tool was developed for road and building excavation work and is not really suited to the farm. The Indian pick axe although durable is too curved and so does not penetrate the soil properly.

The 'long jembes' have proved popular especially in the softer soils but the heavier and shorter the tool, the better. The longer and lighter types do not penetrate well and tend to vibrate on impact with the ground.

A copy of the tools requested under project Amendment 1/85 No. 2 is in the Appendices. The Amendment has recently been approved but no quotations have yet been obtained from UK suppliers. These tools, when delivered, (in, say, mid 1986) should provide the majority of the hand tools required for the next phase of the project (up to mid 1988). Tools to be included in the annual budgets should be for replacements only and for those required as a carry over until the ex UK stock arrives.

Further comments on handtools are available in the report for 1984, last quarter. Tools are also received by the DAO's offices in Embu and Meru from MALD HQ via the SIDA project. By pooling resources shortages can be alleviated and there has been good cooperation with the DAO Embu in lending and borrowing handtools.

The simplest way of issuing handtools is to an individual who is responsible for tools used by a group e.g. a chief or chairman of a women's group. In practice however the tools are most secure when issued to each individual farmer. Whatever the distribution system all the tools should be signed for. There has been little abuse of the loan of handtools to date although some farmers have assumed that the tools are theirs to keep. The ownership

position should be clearly explained before issuing.

Handles were originally shop bought for 8/- (pick axe, mattock) and 18/- (jembe handle). They are now made under local contract at Kibung'a in the Marimanti catchment for 7/- (short) and 10/- (long) from local hardwoods.

3.7 CONTOUR MARKING

The most time consuming of the field assistants duties is marking out contour lines (or graded lines) along which either vegetative or constructed conservation measures are to be placed.

The MALD has opted the line level as the standard piece of equipment for this and all Technical Assistants are trained in its use (although at first their practical knowledge is often shaky). The SWC field assistants have also been using the line level.

The line level consists of two graduated sticks about 1.25 m. in length which are held upright and connected by a taut string on which is suspended a small spirit level. The level tells the reader whether the line is horizontal and hence whether the base of the two sticks is at the same level.

If the string is moved up and down

the graduations on the sticks a certain gradient can be marked out provided the ratio between the graduations and the length of the string is known.

On gently undulating ground the string can be kept at a length of 7 to 8 metres. On uneven or dissected terrain the string has to be shortened to 3 to 4 metres to ensure that ups and downs are not overlooked which might cause the structures to be aligned off the contour.

The line level has been widely adopted but does have some disadvantages.

1. The cost of a decent spirit level is increasing and they may soon become unavailable as import restrictions tighten up. One level is now 35/- to 40/- not including the string and the levelling 'boards'. The total cost then is approximately 45/- to 50/-.
2. Three people are required for the levelling operation. Most TAs work alone and therefore have to enlist the help of the farmers family to hold the levelling boards. Line levelling for one plot may take 1/2 to 1 day.

A simple modification is to fix a length of small bore transparent plastic pipe to the levelling boards, sealed at one end and filled with water. This acts as a very accurate levelling device and cuts out one person as the level is now being checked at one end of the pipe rather

than in the centre of the string. However, there is no cost advantage as plastic piping is expensive in Kenya.

Another alternative is the A frame used as in other sub-Saharan countries. Three pieces of wood in the form of an A are fixed together with a simple plumb line swinging freely from the apex. A central mark on the cross piece of the A coincides with the plumb line when the two 'feet' are on the same level.

This is a simple and cheap device which can be operated by one person with, for convenience, another placing marker pegs. Only 2 to 2 1/2 metres can be covered in each measurement but errors can be reduced by rotating the frame so that the user faces in the opposite direction when taking successive readings. When using the frame it soon becomes obvious that a guide is needed for the plumb line to damp down its oscillations and reduce the time for each reading.

The advantages of the A frame are simplicity and cheapness. If the frame is produced in numbers, it should not exceed 20 - 25/- per piece.

3.8 TRIAL PLOTS

As noted earlier in Section 3.3, the trial plots established in the Evurore catchment were sited on the farms of members of the two soil conservation committees formed in the very early stages of the project. As it

has turned out none of the owners has shown much interest in these plots and so they have been neglected.

T1. Existing stone terraces realigned and built up. 4 run off plots installed. Owner took interest at first then moved to Kiambere for business.

T2. Fanya juu terraces in very stoney ground to be flooded by road run off. No effect on crop growth seen but crops grew well on the terrace banks. Banks planted with grass.

T3. Terraces + fanya juu plus ridge cultivation. Neglected by farmer who is now using the plot for brick making.

T4. Trees planted on bare site. Small fanya chini terraces (1' x 1' excavation).

First planting Leucaena 300. Atriplex 230, Acacia albida (50), Prosopis Juliflora (20) Atriplex was overgrown before planting. All trees died except a few Prosopis and Acacia albida. Very slow growth rates even then.

Impressive reestablishment of ground cover after closure of plot. (All plots thorn fenced at project expense to prevent grazing).

The only other trial plot put in was to the northern side of the Marimanti - Mitunguu road about 3 km. from Marimanti. This plot cost approx. K.Shs.4,000/- to install and is comprised entirely of terraces plus cut off drains and was designed as an eye catcher. It is now also functioning as a good bulking plot for terrace grasses while the owners continue to cultivate in the normal way.

In future trial plots should be on the farms of those who are actively involved in soil conservation and who are willing to undertake the work themselves. What a farmer can achieve by his own efforts is a far more effective extension tool than anything the project with, all its resources, can provide as a demonstration The concept of off farm trials has proved a failure. All future trials should be conducted by and with the farmer on his own land.

4 WATER CONSERVATION

4.1 Rationale for Use of Sand Weir

The rationale for the construction of sand weirs is based on the overriding concern of local officials and farmers for adequate water supplies. Sand Weirs (or subsurface dams) were mentioned in SWCE's job description and, on investigation, seemed to be the only suitable method of providing water in the project area, albeit in small quantities. Other types of supply were considered *viz.*

4.1.1 Piped Water

Only possible where permanent water sources can be found or where catchments (with adequate storage) can be constructed from e.g. hills. High cost and limited in application but piped water is still seen as the only 'proper' type of water supply. A good example of the unsuitability of a piped water supply is Kathigaceru, near Kamumu (locational centre, Kiang'ombe location). Here, pipes have been laid up to Kamumu but no water is flowing because it is a pumped supply and there is a technical snag with the intake and/or pump. Even if this is solved the availability of fuel, spares and maintenance will remain in doubt.

4.1.2 Roof or Ground Catchment Tanks

Required in each homestead. Can be effective but cost per head high and heavy organisational input required to cover a large number of households. The low percentage of Mabati (tin) roofs in the driest areas is a disadvantage

but for the more wealthy this is a good alternative for clean drinking water. Storage by this means is not adequate for livestock watering.

4.1.3 Wells

Shallow wells are few and far between in the SWCP area. Ground water has not been fully investigated but the water table seems to be too deep for shallow wells in most places except for the edges of large hills e.g. Kiang'ombe and Kiambere in Embu District and e.g. Kijege, Kiagu, Kikingo in Meru District. However, further investigation into shallow wells could be made.

Boreholes, whatever the cost of development, involve the use of diesel or electric pumps which have a way of breaking down and staying that way!

4.1.4 Water Furrows

In Tharaka division water furrows are and have been used extensively for water supply. There are several permanent rivers running through the division. From South to North these are as follows:

1. Thuchi - bordering Embu District
2. Ruguti
3. Mara
4. Mutonga
5. Thingithu
6. Kathita

1 - 6 From Mt. Kenya

7. Thanantu)
)
8. Thangatha) 7 - 9
) From Nyambeni Hills
9. Ura)

The potential for the use of water furrows where permanent rivers are available and where these rivers are not too deeply incised is considerable and should be exploited in the next phase of the EMI Programme (and in any future small scale irrigation project). See also section on 'Potential for Water Furrow Development'.

4.1.5 Earth Dams

Although the soils of the area are often high enough in clay content that construction of earth dam walls is feasible this method suffers from several disadvantages.

1. The dissected terrain and drainage lines of the project area give rise to relatively small storage compared to the volume of the dam wall.
2. The high rates of erosion common from catchments in grazing or cultivated lands means that rapid sedimentation of the reservoir is probable and indeed has occurred at many such sites. (Ask Machang'a AMS for details).
3. The unregulated movement of livestock means that pollution of the reservoir is also likely. The erection of fencing to preclude this is costly.
4. Evaporation rates from open water are high due to high day time temperatures and low humidity. Open pan

evaporation ranges from 1800 mm per year to 2200 mm/yr within the project area.

The topography in the western part of Gachoka Division (including Mwea area) is flatter and more suited to earth dams as regards storage potential but rapid sedimentation would still be a hazard.

It is often assumed by agricultural and administration staff that the soil conservation works required to prevent siltation of open reservoirs can be carried out with self-help efforts by the community concerned. In practice this rarely happens and there is no guarantee as to the efficiency of the conservation works in any case. If such works are deemed suitable they should be adequate and allowed for in the dam construction budget.

The dissected terrain and incised flow lines also mitigate against the use of be side river storage as has been successfully used in northern Kenya where a storage pond is dug beside a seasonal stream (lugga) and in time of flood is filled via a channel led off the main channel. This provides water mostly for cattle watering but there are few sites in the SWCP area where this method could be used.

In conclusion the potential for future water development in Lower Embu centres mainly on the use of sand weirs and open dams and in Lower Meru on the use of water furrows.

4.2 NOMENCLATURE

Sand weirs have been used in Kenya since the 1930's and have proved their worth. In theory, they should be maintenance free and have a life of at least 20 to 30 years if properly constructed.

Given the drawbacks of many of the above mentioned techniques and having reviewed the alternatives it was decided that the most practical alternative for the semi-arid areas of Embu and Meru would be construction of concrete barriers across seasonal streams with the aim of collecting coarse sediment above the barrier which would then act as a reservoir in which water would be stored. These structures are known as 'sand weirs'.

Unfortunately there is a great deal of confusion over the names of different types of dams. Most people and especially the chiefs tend to refer to everything as "earth dams" or even "surface dams". For clarity the following distinctions can be made.

1. Earth dam. A structure with an earth wall designed to collect and store open water.

2. Masonary/Concrete Dam. As above but with different wall material. May be used where suitable fill is unavailable or where there are fears of flood damage to an earth structure.

3. Sand Weir. May be a concrete or masonary built across a seasonal stream normally on a solid rock foundation. The river flood is allowed to deposit coarse sand above the dam wall which then acts as a reservoir for water protecting it from evaporation and pollution.

4. Sub-Surface Dams. As sand weir but, where wall top level is at or below original sand bed level.

NB. Whatever the project decides to call the structures everyone else will call them dams. What matters is not what they are called but to improve the understanding of how they work.

4.3 Acceptability and 'Evolution'

In the SWCP project area the geology has conspired with the rejuvenation of most streams within the area to produce incised channels where rock bars, generally of and sometimes basalt, are exposed. In Mbere/Tharaka however the stream channels are normally cut deep and relatively narrow with bed slopes commonly 3% or more. This gives a poor storage potential compared to the flatter areas of Machakos and Kitui, both districts having a history of sand weir construction.

Sand dams have not been used in the SWCP area before and there have been difficulties in introducing the concept. It is not initially easy to take on board the idea that a reservior is supposed to be filled with sediment when everyone knows that sediment is the blight of other types of dams. However, extraction of water from sand river beds is the traditional method of obtaining water during the dry seasons and so once the concept has been explained it is readily understood. 2 meetings were held in February 1985 with all the chiefs and DO's from locations and divisions where structure had been completed or planned for to discuss sand weir management and all were appreciative of an explanation of how the structures were supposed to store water. This was a good example of where the local leaders had in some cases been resistant to the EMI/SWCP work because the work had not been fully explained to them. Once this explanation was provided however (it should have been given much earlier), this resistance turned to support.

Over the last two years it has become clear that there is an evolution process for sand weirs. This evolution has two sides.

4.3.1 Physical.

It takes time for sedimentation to take place in the reservoir until the river bed level reaches the wall top level. If the first rains after completion of the wall are poor then the correct sedimentation will not take

place. If the surge of water over the wall during flood is insufficient then manure, twigs and leaves will be left together with silt. This was clearly seen at Ciamithu during the April-May '84 rains. The end result was foul water due to anaerobic decomposition of the vegetable matter. It is essential that the river flows at least twice during the rainy season so that the vegetable matter is washed down. As far as the sedimentation process is concerned the heavier the storm the better and the higher the stream velocity the coarser the sediment brought into the reservoir.

If the rains are good the reservoir of a 2-3 metre high structure could be filled in 1 or 2 seasons, i.e 1 year. In any case an improvement in water quantity and quality would be expected over the first 1-2 years.

The original approach was to avoid large rivers because of danger of flood damage to the weirs. It now seems that this was wrong. It is the small streams which should be avoided because of inadequate flood flow and fine sediment. It is easier to overdesign a weir where flood damage is a danger than to arrange for correct sedimentation in a small stream.

4.3.2 Social

In the first few months after completion of a dam it may be unused for at least three reasons. It may simply be the case that only a few people know it exists. Secondly,

there may be doubts about water quality (sometimes with good reason) and the old trusted watering points may be used in preference. Thirdly, such a construction project may be thought of as 'Government' and there is a fear of interfering unless express permission is given.

These attitudes can only be overcome with time through discussions with the community leaders. The structure will come into its own when there is no other water source availabe as the long dry season draws on (August-September). If after first use the weir seems to provide better water (cleaner, less salty or more conveniently accessible) then that water will continue to be used, presumably, in preference to the old supply. This subject needs further investigation during phase 2.

The main point here is that if an assesment is to be made of either the physical characteristics or the acceptability of the supply at least two years should be given after construction before a fair judgement can be made.

4.4 MANAGEMENT OF SAND WEIRS

The design and construction of sand weirs are straight forward. They are simple both to design and install apart, perhaps, from the question of the method of water extraction. Difficulties may start after the construction work has been completed. A number of questions then arise:-

1. Is the water for domestic use or also for livestock?
2. How is the use of the water to be regulated?
3. How are the extraction point and the structure itself to be protectd?
4. What happens in case of breakages? Who pays?

4.4.1 Domestic/Livestock Use

This question has to be answered by the community itself. If the storage capacity of the structure is small and there are other water-sources within reasonable distance then perhaps livestock can be excluded by order of a committee set up to regulate the use of the structure. (Which would probably include the subchief and a few elders from the immediate locality of the dam).

In most cases however the reality is that the water will be given to animals to avoid trekking long distances with the livestock. This being the case the dam will have to be managed accordingly and in the case of dams with a small storage (say 500 cu.m. of water) the community should be made to understand that the water cannot possibly last the dry season. Even if water is adequate for both purposes livestock and humans should be segregated at the site.

Traditionally this is either done by allowing animals to drink from a dug river bed well and then rescooping before drawing for human consumption or by having separate wells, some of which are surrounded by thorn fencing to keep animals out.

In the case of sand weirs the best solution is to allow for water to be discharged somehow downstream of the wall, either to a trough or, if available, to a natural depression in the stream bed from which animals can drink.

4.4.2 Regulation of Water

The ideal solution for water regulation is that the community oversees the use of water itself. In the case of Mubura (pronounced Moo-Vu-Ra) east of Gatunga in Tharaka families dig their own wells in the stream bed, fence them and have rights of use over them. (They have to be dug after each rains, of course). This arrangement is best and the Ministry should avoid interfering unless there is clear evidence that some needy potental users are being deliberately excluded.

If the weir has a tap below or a well then these can be made lockable and a nearby local resident made responsible for unlocking the supply at certain times every day. (The operator would be appointed by the management committee. Such a system is used at some sites under MIDP,with mixed results). The problems which arise with this arrangement show that the need for policing should minimised.

Whatever management system is used some kind of controlling body or committee will be required. In the two meetings mentioned above on management the chiefs were asked to set up a committee for every dam. The SWCE

promised to visit the committees which were to be formed by March '85. Unfortunately lack of time has precluded this but the matter should be dealt with in order to ensure that some local body will take responsibility for the use of the dam.

In the meeting with DO Siakago and representatives of chiefs Kiang'ombe, Nthawa and Kiambere held in the EMI/SWCP office it was agreed that:

1. Live fencing could be placed around the lower section of the reservior to stop animals entering. This would be done on a self-help basis. The portion of fence crossing the river bed itself would have to be temporary thorn fencing which would be swept away and replaced each season.

2. Water would be drawn from dug wells within this fenced area (say the 100m strip of the river bed above the wall) and, for livestock, put into a cattle trough outside the fenced area.

On reflection this second alternative sounds highly impractical. It would be easier to keep the fenced area for domestic water extraction only and supply the animals in another way.

The Tharaka meeting took a more pragmatic approach and agreed that livestock owners are not going to carry water

any distance if the animals can reach the water themselves.

4.4.3 Protection

If the foundation for the weir is solid rock beneath and on the sides to a height exceeding that of the wall by 2 metres or more the wall should need protection works. If but there is a complete rock foundation it does not exceed the height of the wall then elevated side walls should be placed to keep the flood away from the sides. Periodic checks are required to ensure the side walls are not being undercut.

If one side is of soft material it should be protected by an elevated side wall extending into the earth bank say 2-3 metres and then gabion boxes running up the bank as far as the flood water is likely to reach. Also two rows of 2m x 1m x 0.5m gabion boxes should be placed on the bank down stream of the wall to prevent scouring under the downstream side of the wall. (AMS Chiakariga has some gabion boxes in stock).

The best way to protect extraction points is not to provide any! However if for some reason a tap is necessary, any, galvanised piping below the wall should be strapped down to rock or fixed on to concrete pillars for support. The pipes at Ciamithu dam were left unprotected and were all ripped up during the first flood. The tap itself should also be supported (and high enough off the

ground for a 20 litre container to be placed under it).

4.4.4 Maintenance

It would be wise to include in the budget for say £100 per year per site in order to allow for small repairs which may be needed.

It might be possible to arrange a levy from users of the dam for repairs but this would have to be arranged by and on the initiative of the management committee. In any event the project should not pay for damage arising due to abuse of the facilities.

4.5 SITE SELECTION

The criteria for site selection are a combination of development priorities, office mapping work, local preferences, and ground checking.

4.5.1 Development Priorities

Since July, 1983 the process of approval for development projects of all types follows (in theory) the following procedure. The Development Committees are formed at the locational, divisional and district development committees. The Chief, District Officer and District Commissioner act as the Chairmen of the respective committees. Requests for assistance from the locational level are passed through the divisional committee (also called sub-DDC) and, if passed, up to the DDC. If the DDC gives approval funds are then sought from, for example, the Rural Development Fund (funded by a number of

donors including NORAD who also now have 2 engineering advisers at the provincial level to help with project implementation). If funds are available then the relevant ministry is instructed to implement.

Before embarking on any water supply project it is first essential to ascertain whether there are any priority areas to be considered and whether there are specific projects which should be funded and/or implemented by the Ministry through the project. Also it may turn out that another similar project has been approved for the same locality as one under consideration by the project.

The key officer in dealings with the DDC is the DDO (District Development Officer) who coordinates all projects within the District. It is essential, in any case, that the DDO should be fully informed of what is taking place within the project. It is not sufficient in such cases to merely send reports to his office. The filing systems and registries of most GOK offices are highly inefficient and reports may never reach their destination. The officer concerned may be too busy to read them. It is better to call personally and explain what is happening in the field. Invite the DDO to tour the work.

Unfortunately projects may be passed by the DDC before proper technical appraisal has been made of the

feasibility of the scheme, especially in remote areas which are seldom visited by officers qualified to judge. As a result not all projects passed by the DDC are technically feasible. In this way the expectations of the local community can be raised unfairly.

4.5.2 Identifying Areas in Need

It is possible to establish in broad terms the water short areas of lower Embu and Meru by studying the distribution of perennial streams and supplementing this with information on piped water supplies and boreholes (for e.g. Kiambere, and Kerie recently fitted with 'Kijito' windmill, manufactured near Thika). There may also be locally dug on or off stream wells which provide an adequate water supply but these cannot be located until the ground checking stage as they may not appear on SOK maps.

It is also valuable to check the status of present and future supplies. An existing piped supply might be very unreliable and a future piped supply may not be built for many years, if at all. In both cases the area may still be deserving of assistance.

It would be a useful exercise to draw up a map of the expanded project area (under the proposed new phase of the project both agro-ecological zones 4 and 5 would be covered) showing all the information listed above and also

existing sand weirs. In this way a current assessment of the priority areas can be made. This should be incorporated into the planned review of the dam construction program in the second half of 1985.

4.5.3 Mapping

By using the aerial photos from DOS contract 194 with nominal scale 1:12,500, maps can be drawn up of the target area. The first step is to find the actual average scale of the relevant photos and this can be done by comparing the average topo height from the 1:50,000 survey of Kenya sheets to the flying height and the focal length of the camera. Then by using a pantograph the 1:50,000 sheet can be enlarged to the required scale and the aerial photos used to correct the drainage lines where necessary and to plot roads, crest lines, schools and all homesteads. (Care should be taken when an area is chosen which straddles different aerial photo flying heights).

The 1:50,000 sheets often have errors in road alignment, place names and portions. However, with a corrected map, population clusters can be found. The crest lines are useful because in due course the area of the catchment and hence some idea of the flood flow can be estimated for sites with er-odible banks or where for some reasons elevated side walls are required to keep the flood away from the banks.

At this stage the ideal spots for sand weir construction can be plotted on the map along seasonal streams. It is always worth looking for a site at a confluence where storage will be greater as the contour line corresponding to the top height of the wall will run around both streams and enclose a larger area on the upstream side of the wall.

By using a stereoscope the relevant sections of stream can be studied. The slope of the river bed can be assessed if not actually measured. The general slope can be gauged from contour lines crossing the river but this does not generally give enough detail. Unfortunately the 1:12,500 scale does not normally allow rock bars crossing the stream to be spotted although rock outcrops on either side of the river may give a clue. The photos give only a general indication that a site may well be found within a given reach of the river.

4.5.4 Field Checking

Location of specific possible sites is best done in the field by trained personnel walking up and down the relevant sections of stream. Time can be saved by asking the local residents who can guide you to the right places if the required conditions are explained.

The site itself should ideally have the following characteristics:

a. There should be a solid rock crossing the river with the banks also of solid rock.

b. The river should have a low slope, 2% or less (in Machakos IDP, the water section uses 1% or less) except if there is no other available site in an acutely water short area.

c. Dug wells or surface water upstream (or down stream) of the site indicates impeded drainage under the sand in that section of the stream. Most sites so far selected had this characteristic and it is an important indicator of a barrier under the stream bed.

d. The rock on either side of the river should not be shattered as this may lead to excessive seepage around the dam wall. A few exposed cracks however is not a serious drawback. These can normally be grouted over before the wall is placed.

e. The type of sand in the river bed should be fairly free of silt and for construction the particles should be regular and with a range of particle sizes from fine to coarse sand. The centre of the stream bed should have coarse sand. If there is an appreciable amount of silt in the bed load where the main flow has passed then the sediment is suspect as a storage medium.

4.5.5 Water Quality

Salty water is often found in the seasonal streams of Mbere/Tharaka and local information should be gathered on this. This is normally quite sufficient to tell if the

water is suitable for human consumption. Measurements of electroconductivity are not normally required. The tongue is a good enough indicator. If a very favourable site is found on such a river a structure might be put but only on the understanding that the water would be of use to livestock and that water for domestic use would still be sought elsewhere unless there was no alternative (in contrast to many of the seasonal streams the perennial rivers off Mt. Kenya tend to be very low in dissolved salts).

4.6 DESIGN

4.6.1 Wall Configuration

The shape of the wall should be as straightforward as possible. A straight wall with upstream face of 3:1 slope downstream face of 2:1 slope and top width of 0.5m has been adopted as standard. A vertical front face and 3:2 downstream slope has the same x-sectional area but is slightly less stable. With an overburden of 2 metres of water (neglecting velocity of flow) this keeps the resultant force acting on the dam wall from the centre of gravity within the centre third of the wall, as required by standard design procedure. Dams over 4 metres require a chartered engineer's design by law and would, in any case, require a larger top width to maintain stability. Taking cost considerations into account, 4m. should be considered the practical maximum height.

4.6.2 Concrete/Masonary Work

Concrete mixture 1:3:6 or mortar with heavy slabs fractured along parallel cleavage planes and mortared with 1:4 cement; sand mortar. In the concrete structure plumbs (large rocks) may also be used provided that they do not touch one another and that they do not constitute more than 10% of the wall volume. The use of plumbs obviously gives a saving in the amount of cement used.

4.6.3 Shuttering

Where concrete is poured between shutters, the shuttering is normally made of 3"x2" vertical frame work with 10" (or 12") x 1" horizontal planks. Ideally the vertical frames should be placed on the outside of the boards so that the boards form the concrete to a completely smooth surface. In practice the most convenient arrangement is to put the 3" x 2" uprights on the inside of the boards so that after the first pouring of concrete the uprights are held firmly in place by the concrete and boards can simply be moved up to the now fixed uprights for the next pouring. In the end the slots occupied by the uprights have to be fixed in the upstream face after the 3" x 2"'s have been removed and before plastering.

4.6.4 Prevention of Sliding

Where the foundation is smooth plain rock surface, dowel bars 3/4" reinforcing bar) should be set into the rock along the length of the wall base, along the centre line

of the wall and in two rows 0.5m apart. These bars are to prevent sliding. Where the dam straddles the rock bar these dowel bars are not required. The artisans of both the AMS stations believe that wrapping barbed wire between the bars greatly improves the efficiency of this technique. Although this seems unlikely the practice has been allowed to continue because of the lack of confidence in the structure brought on by the idea of leaving it out!

4.6.5 Prevention of Siltation

In theory the structures should be built up in successive layers of 0.5 or 0.75 metres in order to allow collection of only coarse sediment above the wall. The project approach has not been to set up its own construction teams (as at Mutomo SWCP) but rather to strengthen and improve the service of the AMS. Given this constraint the logistics of moving the AMS team plus their staff, equipment and camping gear to one site and then moving on to another site is sufficiently difficult without adding the difficulties of returning to the same site several times.

Due to this constraint the wall is built in one go. As found at the first site (Ciamithu), when the rains are insufficient the reservoir fills up with unwanted detritus causing foul water and effectively preventing storage of water which can flow to the outlet.

Because of this the design was changed to incorporate a notch into the wall. The notch is merely a gap left in the wall 0.5m wide which will allow all the suspended load to pass but would be easily filled in 1/2 metre stages as the correct coarse sediment accumulates*. The refilling could be done by an artisan and a couple of helpers brought to the site with a few tools, a wheelbarrow and a few bags of cement all transportable in a small vehicle.

In practice, however, it has turned out that the notch is too small and that twigs and branches are washed down and block up the notch thus defeating its object. In future therefore a V-shaped notch is recommended 0.5m wide at the bottom and widening to 1.5m at the top (i.e. side slopes approx 3:1).

The use of a notch has caused misunderstanding and has to be explained along with the sand weir principle. The initial reaction is 'what is the point of building a dam and then leaving a hole in it?' which is a fair question if no explanation has been given.

4.6.6 Extraction of Water

There is still uncertainty over the best method of water extraction. However, the simplest, quickest, and therefore most cost effective method is to provide no well or piped outlet in the wall. The water can then be extracted by using hand dug wells in the sand, something

* The base of the notch is set 0.5m above existing bed level

which is well understood by tradition. This approach also means that there cannot be any wastage of water. The absence of taps, handpumps and other paraphenalia may lead to criticisms from 'high ups' who think this is not real development. At a recent Steering Committee it was decided that wells with handpumps are to be installed at existing and future sites. The committee felt that better quality water would be obtained in this way.

The most extreme example so far of the time and money used in providing an extraction point in Kirigo on Maribwe river in Iriatune sublocation (Embu). The weir itself was constructed in two months at a cost of some K.Shs.80,000. The 'walk in' well took another two months and cost a further K.Shs.50,000. There was a deal of time wasted here by having the AMS undertake an unfamiliar item of construction. The well is working well at present, however.

It has been the practice to place 2" GI pipe with puddle flanges through each of the walls to act as a drain or take off point if required. The pipe is then connected on the upstream side to a concrete collection box which in turn is connected to 2" PVC slotted (usually cutting a herringbone pattern with a hacksaw) pipes radiating from the box. These act as a primitive filtration system when surrounded by small stones and sand. Refer to 'Standard Details Drawing Dam Contract'. (The slots in the pipes should face downwards). This method of filtration has not

been fully proven. In some cases, e.g. Gakurungu in Embu it has failed.

Improvements for the future could be made as follows:

1. Replace concrete collection box with pipe fittings. This would save time. The first site had a 1" outlet pipe and 3" collectors and the cost of the pipe fittings and reducers required to connect them is prohibitive. However by keeping the same size of inlet and outlet pipe (2") the coupling becomes much simpler. With 3 radiating plastic pipes the requirements would be only one 2" GI cross (or 2, 2" Tees if cross unavailable) plus 3, 2" PVC valve sockets screwed into the cross. Given the time saving in not having to construct a box this would be cheaper than the collection box. (The end of the 2" GI pipe should have a plug, not a valve).

2. The laying of the filtration material around the PVC 'drain' pipes has not been correctly done in the past. The AMS supervisors have tended just to pile a few stones and sand over the pipes and hope for the best. This is quite inadequate. Once small stones (preferably gravel) have been placed around the pipes (on all sides) then sand should be brought to completely cover all the pipes and the area between them. In fact the investment required to fill the reservoir sump with sand in the 10m above the wall

would be well worthwhile to ensure that the correct sediment fills the area around the filtration system.

4.7 CONSTRUCTION COSTS

4.7.1 Finance

Under an amendment to EMI/SWCP an additional sum of slightly over K.Shs.2 million was allocated for the construction of 15 sand weirs in UK FY '84-'85. Some of these funds were to go to dams constructed under contract while the remainder was for the AMS to continue their construction programme with.

4.7.2 Cost per Structure

It has not been possible to ascertain the exact cost for any structure because some labour and transport costs are always shared between jobs running concurrently. The best guess cost breakdown for work undertaken so far is given below:

Site		% Complete	Cost (K.Shs), to April '85
1.	Ciamithu	100	142,000
2.	Kirigo	100	152,000
3.	Gakarungu	100	70,000
4.	Ngoce	100	70,000
5.	Karumba	100	80,000
6.	Mbita	100	140,000
7.	Muguambiti	100	60,300
8.	Gwakamwangi	90	70,300
9.	Karumire (EI)	5	23,700

10.	Mwakiri (E2)	60	33,900
11.	Rienu (E3)	50	36,100
12.	Thura (E4)	5	2,000
13.	Mugumoni (M1)	90	90,000
14.	Munyari (M2)	Postponed to FY 85-86	5,000
15.	Mbachacha	100	125,900
16.	Muthangacwe	100	98,200
17.	Mubura	100	130,000
18.	Upper Gakauni	100	50,000
19.	Ruguti	100	114,800
20.	Kariee Ka Mburi (M3)	100	97,500
21.	Maragwa (M4)	50	?
22.	Kamwathu (M5)	Postponed to FY 85-86	0
23.	Tunyai furrow	70	156,000

1-8, 13, 14 - Machang'a AMS

9 - 12 - Sema Building Company

15 - 23 - Chiakariga AMS

Cost breakdown Tunyai furrow: (Approx)

	K.Shs.
- intake repair	80,000
- redigging furrow	45,000
- road culvert	25,000
- minor structures	5,000

Up to now a guide price of K.Shs.125,000 has been used with the breakdown of costs roughly as follows:

Salaries, wages, allowances	50%
Materials	20%
Machinery Hire	30%

Note:

1. Salaries are those for 'workspaid' staff only. The cost of GOK staff time can be ignored as their salaries are paid by the Ministry Headquarters but their allowances, lunches, etc. are included.
2. Material costs include temporary housing units, cement, timber, nails and pipes.
3. Machinery hire includes costs of fuel, spares and repairs which are deducted from the invoice for hire before payment to the D.C.

In the materials the main item is cement, say 15% of the total cost of the structure. The price of cement was raised in Feb. '85 by 20% from approx. K.Shs.70/- per bag to K.Shs.84/- per bag. This means an overall rise of only 3% or roughly K.Shs. 4000/- per structure. The % cost of materials is low because sand and aggregate are normally available near or on the site (the river channels belong to the state so that no land owner can claim for the cost of sand). The cost of water is the cost of hauling so this is incorporated under transport.

More importantly a salary review is currently being undertaken by the Directorate of Personnel Management. As a result it is likely that casual labourers' wages and allowances might rise by 30%* and salaries of establishment staff by rather less. This could increase the overall cost by as much as 15%.

* stop press - salaries raised by 20% on 2/5/85

By July 1985 therefore a more realistic guide price for budgeting would be K.Shs.150,000.

4.7.2 Efficiency of AMS teams

There is no doubt that over the last two years the construction teams have become more efficient and as efficiency improves costs come down. The first dam at Ciamithu took 5 months and cost K.Shs.140,000 plus. There is no reason why today this could not be done in 3 months at a cost of K.Shs. 120,000 (even allowing for inflation).

The key constraints for efficiency are:

1. Supply of materials to site, especially cement;
2. Supply of water to site and arrangements for temporary storage;
3. Supply of fuel for tractor or lorry.

The obvious difficulties then arise due to a lack of transport, especially lorries in good conditions as well as management by the officer in charge. (Breakdowns and punctures especially in worn out tractors, trailers and lorries are the biggest time wasters). The project should consider deployment of the tractor and trailer and lorry to be supplied to the project as a part time basis to ease these problems.

With regard to machinery the next 3 year phase of the project could aid the situation as follows:

A comprehensive list of spare parts could be drawn up for the machinery and vehicles required for completion of the sand weir and furrow construction work over the next 3 years. A project amendment would then be prepared to obtain these parts tax free from the U.K. After the supply of these parts (which on current form would take about 1 year) these would be passed to the two stations on the strict understanding that the machinery was to be used for EMI Project work only for a defined period, an undertaking which should be made by the PDA or the DAO's before the amendment is submitted.

The following equipment ideally be made available by each station to the project for a fixed period after the necessary repairs.

1 7 ton lorry
2 Small vehicles (Land Rover/Pick up)
1 Compressor
1 Concrete vibrator
2 Tractors (with functional tachometers!)
1 Tipping trailer
1 Tractor drawn water tanker.

The tractor and trailer and lorry already ordered under EMI/SWCP should be available at least part time for construction work and should therefore be reckoned amongst the available machinery.

4.8 AGRICULTURAL MECHANISATION SERVICES

4.8.1 General

In Embu and Meru districts the AMS has established one station per district. In Embu a station was established at Machang'a in 1978 (originally sited north of Kiritiri but later moved to the present site near Kamburu). The station was set up under the sponsorship of an FAO soil and water conservation project which only lasted for two years but which made the initial input of offices, workshops, etc. In Meru, the station at Chiakariga began in 1979 as an off-short of Machang'a.

The AMS offers 4 services. 1. Tractor Hire (THS) 2. Farm Survey; 3. Industrial Machinery; 4. Soil and Water Conservation. In the early years funds were available for all sections including SWC (which in Embu was interpreted as water conservation only). Several dams were constructed notably the three at Kerua, North of Kiritiri and close to the original EAO project base. These dams are concrete and still provide an important source of water for the area.

From '81/'82 onwards however funds for public works were no longer available. From that time the stations have functioned on a revenue earning basis only. The public works such as dam construction then ceased. In Meru, the Chiakariga station also constructed dams including the sequence of 7 small sand weirs on the first dry stream crossed on the road Chiakariga - Marimanti. They also

built the water furrow to Kamwimbi (north west of Ishiara).

4.8.2 Role of EMI/SWCP

The EMI/SWCP hoped to be able to revitalise the dam construction work of the AMS in the two districts. Originally it was assumed that the project would act as a client to the AMS who would invoice the project for services rendered. This would include hire of personnel, machinery, the rates which are set out in form LRDD/April/1982, and charges for material used. The SWCE would supervise periodically to check on progress.

This did not work out because the stations:

1. Have insufficient funds to operate and maintain their machinery;
2. Funds for fuel are insufficient and purchasing procedure can be lengthy.
3. Earnings go back directly to the Treasury so that there is no incentive to operate efficiently and plough back th funds into the upkeep of the station.

Two officers were given training in dam siting in the EMI/SWCP offices for 6 weeks in April and May 1983, Mr. K.B. Chiyonzo (from Machang'a) and Mr. J. M. Karani - (called Macharia) from Chiakariga . These two officers were trained by Chris Mackintosh and SCW in basic photo interpretation and mapping plus field checking for

selecting good dam sites. (see also 'dam site selection').

They grasped the methodology fairly well and were subsequently issued with a Casella stereoscope and a set of DOS contract 194 1:12,500 reprints, each station receiving prints covering its district so that the mapping and site selection could continue. They were also issued with pantographs for mapping within the stations. (Chiakariga has made good use of the photos, but Machang'a has made almost none). Unfortunately soon after Mr. Chiyonzo had completed his training he was transferred back to the station by the Station Manager to be put in charge of the workshop. Chiyonzo's training is in farm machinery but there was no soil and water conservation officer in the station at the time of selection for training by EMI. The work was then given to Mr. S N Karaga, a new diplomat from Egerton College who had the right background but had not been given the specific training required by EMI staff. (This is indicative of the management style of the then Station Manager). Mr.Karaga stayed with the project for nine months and did a fair job technically. His handling of staff and relations with the manager were poor and after much acrimony Mr. Karaga went to THS and Mr. Chiyonzo was eventually returned to the project in June '84.

4.8.3 Implementation

The first construction was undertaken 1 km from Kiguambiti on the Ciamithu Stream and about 5 km. south of Ishiara. The construction team of 6 works paid staff from Machang'a was left to set up a camp site with their tents but beyond this was provided with no construction equipment or tools whatsoever, apart from a few shovels. The then manager, Mr. Maina, claimed that the EMI project said it would provide all necessary tools. This was partly a misunderstanding but also reflects the lack of tools available in the station and the low level of management. The team was left in this condition for 3 weeks. The project then supplied what was necessary for the work to continue.

A list of all tools supplied is available from Mr. Kareru, the office clerk responsible for store keeping (there is no trained storekeeper in the project) at the project offices, Embu.

The method of payment was originally to be by invoice from the station, the manager asking the project to provide 'up front' the fuel required for operating the lorry, tractor, compressor and concrete vibrator (the cost of the fuel then being deducted from the invoice before payment). Private clients are also asked to do this. (Before July 1983 when District Focus came into effect, payments went

to the Accounts Controller, Ministry of Agriculture but now payments go to the District Commissioner).

The stations are supposed to create more funds for the ministry. Rotating funds are not normally allowed within the government. The small amount of funds available in the votes (now held by the DC) means that by mid year (Jan./Feb.) the votes are exhausted and work comes to a halt.

Due to the stations having difficulties with funds the project eventually found itself paying directly for materials and also paying salaries and allowances for the field staff. This left only the machinery hire less cost of fuel, spares and repairs to be paid by invoice.

This situation has continued up to date. The SWCE found himself involved in handling large cash sums as imprest to officers from AMS Stations and dealing directly in purchase of materials and fuel. The result was that during the period January to June, 1984, 60% of the SWCE's time was used on dam construction matters. This was deemed to be unsatisfactory and in September, 1984, the PDA and DAO's agreed to a new financing system.

In September, 1984 two bank accounts were opened at Barclays Bank (Embu and Meru branches) one titled EMI Dam Construction (Embu) and the other ditto (Meru). These were given an initial float of K.Shs.10,000 which was made up to the present level of K.Shs. 50,000 as a

rotating fund for each station, with the relevant DAO and officer 1/C of the construction as signatories. (The BDDEA was initially unhappy that no TCO was a signatory but it was pointed out that it would be cumbersome for SWCE or Tony Moody to be signing cheques for the Meru Account and in any case the idea was to ease the administrative burden on the SWCE).

In this way all the routine payments for materials, fuel, salaries, allowances can be made through the DAO's office. Only the machinery hire is paid directly from the EMI Co-ordinators office as sums may be too large for the 50,000/- float to cover easily.

Reimbursement is then made from the EMI project account. A covering voucher is prepared for the receipts/vouchers from the officer I/C construction. The SWCE's office then checks the entries, addition and correct use of the funds. This voucher is then certified by the SWCE and passed to the coordinator so that the dam construction accounts can be reimbursed. So far the system has operated successfully.

In theory there is up to 100,000/- which could be 'lost' in so far as misuse of the imprest is always a possibility. This has to be accepted as a reasonable risk. To the time of writing only one such case has been found. In the case of vehicle repairs the SWCE has asked the stations to clear the expenditure before commencing

the repair. In the case of one vehicle for Chiakariga approx. 4000/- were spent on repairs which were not authorised (because the vehicle is not used for EMI work) and this money has not been reimbursed. The sum is still outstanding and the DAO Meru has to solve the situation.

4.8.4 Dams Constructed under AMS Machang'a

Dams constructed under Machang'a AMS, in order of completion are;

1. Ciamithu — July - Dec. '83
2. Kirigo — Dec. '83 - April '84
3. Ngoce) Close together Iriatune/K atheru sub-
4. Karumba) location. Constructed simultaneously - supervised by Karaga.
5. Gakurungu) Feb. '84 - June '84.
6. Mbita Rock Catchment — Jan. - August '84 (No construction July - Sept. '84)
7. Muguambiti — (October '84 - June '85)
8. Gwakamwangi — (Dec. '84 - June '85) to be completed by June '85.
9. Mugumoni — Marimanti location, Tharaka
10. Munyari — " " ".

For exact details of construction it would be best to visit each site with the AMS Officer concerned but a few comments can be made as follows:-

1. Ciamithu dam suffered from poor rains during 1984 which meant that proper sand deposition in the reservoir did not take place but rather vegetation was left rotting

in the reservoir which caused the water to become foul and scared the local people off using the downstream well connected by a 1" GI pipe through the dam wall to the reservoir and in which the water was particularly rank. A harambee effort was organised in August '84 by the chief Kiangombe for digging out the black rotten vegetative matter from the reservoir but only a little material was moved. However after the good rains of October/November'84, the reservoir is properly sedimented with coarse sand and the water quality should improve. How much of the rotten vegetative matter remains at the bottom of the reservoir is not known.

The 1" GI pipe was broken during the single flood of April '84 and has never been properly closed off despite repeated requests to Mr. Chiyonzo to take care of this. During the dry season Feb./March '85 a temporary wooden bung in the outlet pipe was removed and the reservior ran dry.

2. Kirigo. An ideal site apart from some leakage below the wall which is acceptable because livestock can get water below the well. The site was selected after walking the stream with the local elders in late 1983 (it was the last of 4 alternatives suggested by the community).

The well constructed on the upsteam side was expensive and not be be recommended. It has been recently repaired, the walls having been built too high with no cross supports and having collasped into the well. The storage should be good at this site.

The only problem is the large rock in the river some 30 yards upstream of the wall. This should be removed in the dry season either by compressor and drill than breaking, or by fire and water (build a large acacia wood fire over the rock for a week, then pour on cold water to cause heat differentials and cracking - then smash). The rock is preventing sedimentation just at the point where water feeds in to the well and there will continue to be evaporation losses if the rock is not removed.

3. Ngoce/Karumba/Gakurungu. Sites all have small storage. Gakarungu has foul water and blocked pipe as of December '84. Ngoce needs repair below the wall where flood is cutting back into the softer rock under the wall. These structures were built in double quick time, an average of one month each and at a time when due to a shortage of funds the works paid staff were receiving no field allowances and feared that their jobs would soon end.

4. Mbita Mbita rock catchment was a project initiated in 1982 by the Hon. J.J. Nyagah, M.P. for Embu south and Minister for Water Development.

The catchment is on the western side of Mbita Hill, northwest of Kiritiri. The site having been selected, the job of construction was left to AMS Machang'a, the Ministry of Water Development providing no input until very near completion. (This provides a good example of the political pressures that the station is under). However AMS Machang'a managed only to dig the trench and place concrete a few inches thick at the bottom. Unknown to the SWCE at the time of first inspection the foundation was not properly excavated down to bedrock and the wall, after completion now suffers from leakage. The thin layer of concrete masked the improper excavation. In January '84, the station manager asked the Project for assistance which was originally granted in the form of 3000 litres of diesel to fuel a D6 for excavation of the catchment reservior. At least half of this fuel was diverted by the manager to other uses. As a result the soil was not pushed properly out of the catchment and may now be washed back in.

The project eventually paid for all the requirements to finish the structure despite the fact that it was obviously not an ideal site, the wall being very large compared to water storage volume. In sand weir

construction the ratio should never fall below 1:30 and preferable 1:50 or more should be sought. (Ratio of concrete to water, not to total volume).

In March '84 however, it became clear that EMI funds for construction were also becoming short and therafter the MOWD paid one month's salary (April) and provided 100 or more bags of cement. The project provided 300 bags of cement and invested a total of K.Shs. 140,000 approx. at the site. The job was finally finished in August '84. The plan is to send water to a nearby school but funds will now have to be sought for the pipe work to do this.

All the previous dams, apart from Mbita rock catchment lie in Siakago division and there was same pressure from local councillors and agricultur-al staff to see that Gachoka division was not excluded despite the fact that Foster Parents Plan International is concentrating on that division and has since become involved with the construction of earth dams.

However, Kiambere being a target area as far as water supply is concerned it was decided that AMS Machang'a would be given three sites at Kiambere. Only two sites have been started (one is complete and the second is almost complete at time of writing). 3 sites were selected, one of which has originally been found in the training exercise of April/May '83 (Muguambiti) and the

second, Gwkamwangi having been a site approved by the sub-DDC (Divisional level) and subsequently the DDC some 2 or 3 years previously.

A third site after inspection by SWCE was found to be unsuitable.

7. Muguambiti. This weir lies just off the tarmac linking Gitaru and Kiambere HEP site and 6 km from Kiambere market. A small storage site but no better site was available. This is a case where a guide height for dam walls is not a good idea. If the cross section profile has a sharp cut in it then a low wall results from using a fixed maximum height. However in order to increase the storage 30 cm was added after the wall had been built.

8. Gwakamwangi. Lies only 2 km from Kiambere market and even closer to the Kiambere borehole (which gives salty water). This site was originally passed by the DDC as an earth dam but after seeing the broken rock foundation it was clear that only a concrete wall would give a good seal and be safe from flooding. The reservoir has a good configuration (and incidentally is covered in star grass, at least before flooding). The storage should be excellent. Water drawn from the sand above the site is said not be be salty and therefore favoured by the community.

There have been delays in construction because the officer in charge, Mr Chiyonzo moved in January '85 to Meru to cope with two of the dam sites not given out to contract in that district. The AMS Machang'a team are currently at work on M1 (Mugumoni) and M2 (Munyari) leaving the other 3 sites from the Meru contract to Chiakariga.

During a meeting with the DAO, (Embu) SW CE, Mr. Kemboy, the new Manager at Machang'a and Chiyonzo in the DAO's office it was agreed that Gwakamwangi site would be supplied with water twice a week from the station by a lorry carrying oil drums filled with water. This arrangement failed causing at least one month's delay. Construction is continuing at present because water has collected at the site after the recent rains. The structure will be expensive due to idle time. The site should still be complete haever by June '85.

4.8.5 Dams Cosntructed Under Chiakariga AMS

In order of completion

1. Mbachacha	Oct. - Dec. '83
2. Muthangacwe	Oct. - Jan. '83
3. Mubura	Jan. - April '84
4. Upper Gakauni	May - June '84
5. Ruguti	Oct. '84 - Jan. '85
6. Karie ka Mbûri	Feb. '85 - April '85

To be completed by June '85 . . . . .

7. Kamwathu

8. Maragwa

1. Mbachacha. 'Sponsored' by Kagumo women's group who gave free labour from time to time throughout the construction period. This is the only site where there has been a real unprompted self-help contribution mostly in collection of small stones for use as ballast and in the filtration gallery. Casual labourers were also employed for the main construction work. The community was very pleased with the dam (see letter 'congratulations' in Chiakariga AMS file).

   The 'downstream well' was not realistically sited in that people have to climb up to the well to draw water. The best way of drawing the water has still to be decided with the chief and leader of the women's group.

2. Muthangacwe The original site was located in February 1983. visited by SWCE, Mr Karani and Chris Mackintosh. The site was later changed by the AMS because of fears of leakage through the shattered rock in the valley sides. The dam was relocated about 300 metres downstream on a hard but porous partially weathered rock which is common in the project area (and commonly found to be water bearing - the same rock is found at Karie Ka Mburi (M3), east of Gatunga). The wall was to act a recharge for a stream bed well some 150 metres

below the site which although fairly reliable always dried up in the June-September dry period.

As such the dam wall is supposed to allow water to seep under it. Water is normally found just below the wall where stones have been excavated during flood. If this acts as a watering place for animals it is well and good as long as the original well is kept for domestic use.

A well in the river bank was supposed to have been dug just on the eastern bank slightly above the wall position. Mr Karani decided for some reason to move the well downstream 100 metres or so to a site where it has never been used.

Both sites 1 and 2 are in South Tharaka and in January '84 the emphasis shifted to the area between Gatunga and Kathangachini in North Tharaka location (in future this very large location may be subdivided) which is an area with acute water shortage and although it has a low population density due to past trouble with "shifta" livestock are walked for long distances, either to Thanantu river (on which Gatunga market lies) or Thangatha (just to the east of Kathangachini) or to the Tana River. A large AMS camp was established with some 8 or 9 temporary living units being provided by the project. This camp is still in use and is at the Chief's camp, just beyond Gatunga market.

3. Mubura. This dam site, although remote has prompted more controversy than any other. The site is near to Mubura Primary School (120 pupils). The site had many wells within the sand indicating that rock barriers below the sand were holding back water and these wells were clearly visible on the 1:12,500 aerial photographs.

This dam is the only truly subsurface structure of the 21 built or to be completed by June '85. i.e. the wall was built up to the height of the sand bed but not higher. The construction was delayed for several weeks by the presence of a large volume of water at the site and the AMS having an old, malfunctional pump. (A new small 1 1/2" pump was supplied to Chiakariga AMS in March '85).

The controversy over the dam arose from two factors. The first was local politics. During a meeting at the school, which took place when the construction was drawing to a close, the Chief (Kanake) and the local councillor promised that this dam would have pipes from it leading to a storage tank and a distribution system to taps (piped water is often seen as the only 'proper' sort of water supply).

No such idea had ever been mentioned and it was, in any case, an impossibility. The local populous were disgruntled therefore to find merely a concrete wall.

After a meeting to explain subsurface dams in February '85 at Chiakariga, Chief Kanake expressed his complete satisfaction and said how much higher the water level in the river sand above the wall was now compared to the level before the wall was built.

A second curiosity was found in that after the rains immediately following completion most wells upstream of the wall had a boosted water level but the prime site directly in front of the wall was as dry as a bone! There seems no clear explanation for this but in general everyone accepts that the dam 'works'.

4. Upper Gakauni. This is the smallest of the dams to be built in terms of volume of concrete. The site is near to another similar structure at lower Gakauni built with the assistance of the Catholic father at Gatunga Mission with advice from Brother Ajese from Meru, (an experienced technician who seems to have had a hand in most of the construction work of the Catholic Diocese of Meru). Both these structures were made using large flat stones mortared together and plastered on all sides. This technique seems a good one where stones with clean roughly parallel cleavage planes are available. (same method used at Ruguti.) The masonary wall is not as strong as ordinary 1:3:6 concrete but should be cheaper, saving on cement and eliminating the need for shuttering.

In the case of U. Gakauni, the dam wall had weak mortar placed at the southern end which may have to be replaced if eroded by floods.

5. Ruguti. South Tharaka (Kamarandi sub-location). The site was not favourable but no better could be found. The foundation is good but the storage poor due to the steep slope of the stream. This structure took 4 months to complete. Again the delays were due to lack of materials and transport problems. The DC 'borrowed' the only functional lorry from Chiakariga for 2 weeks and the tractor had constant punctures which kept it off the road most of the time. It has yet to be seen how this dam performs.

6. Karie Ka Mburi. One of the sites to be within the Meru contract is now half complete. Built on rock similar to Muthangacwe with water found when excavating.

   If water is easily pumped away to storage, either in drums, or another hole dug for the purpose then transport of water for concrete mixing can be reduced.

7,8 Maragwa, Kamwathu. Maragwa built on solid rock foundation. Storage won't be great but site should be safe. In constrast Kamwathu is not a very good site and care will have to be taken to provide side walls to keep flood flow well away from the erodible banks.

4.8.6 Tunyai Water Furrow

From October '84 to March '85 Chiakariga AMS also involved itself in the rehabilitation of the Mitunguu-Tunyai water furrow (sketch map of the alignment is provided with this report).

The furrow was originally constructed during the 1940's and ran from the intake above Mitunguu on the Thingithu river through Tunyai and finished up by discharging at the source of the Muthangacwe stream. As such it provided 30 kms. of flow line from which water for human and livestock consumption was drawn. As the years passed however the performance of the furrow deteriorated because:

1. The demand for irrigation water at Mitunguu increased as settlement of farmers from high potential areas continued. An increasing number of small furrows was drawn off from the original furrow so that flow to Tunyai decreased.
2. Some parts of the furrow silted up due to bad alignment.
3. Some sections suffered from seepage and seepage caused collapse of the bed and walls in isolated places.

Previous attempts to repair the furrow have brought only short term improvements. A section just above Tunyai was concreted (50 metres) to protect the furrow from water coming down from above which was excavating out the furrow but this again is slumping and may have to be repaired.

The rehabilitation of the furrow has been a DDC priority for some years. In October '84 the Tunyai area was suffering from famine and despite the high local priority it was felt that to call self-help labour to undertake the work was unfair and unrealistic.

Labourers were hired to re-dig the furrow at 3.15 per metre and some 5 km. were excavated. The section of furrow below Tunyai is still uncorrected but this will have to be completed in FY '85-'86. The project has already spent K.Shs.140,000 + on this work.

The main change that has been made to the furrow is that about 2 km above Tunyai a new section of furrow (about 800 metres) has been dug to supply water to another dry stream called Gakurungu which leads eastwards through a very dry area and Thingithu river again just above Marimanti; GASP ranch. The water is to be divided 50:50 using a division box (which will have to be managed so that rival groups don't block each other's furrow) which means that the furrow must be able to carry enough water to satisfy both areas, or rather to maintain a reasonable flow in the Tunyai section. Water will be drawn by bucket or karai only - not by blocking the channel.

The furrow has a licence for extraction of only 150 ? litres per second. This could be checked with water Bailiff of the MOWD, Meru who has the responsibility for extraction licences and could be revised if possible up to

200 litres/second. The furrow should be able to cope with this flow, and should be designed to so in the new upper section which will act as a diversion around the new irrigation area (under German aided Mitunguu irrigation scheme).

The first 150 metres of the furrow has been partially lined to prevent water going back to the river and to protect 2 other points in the upper section where the furrow runs along a steep section of the river bank. Taken together these spots were causing an estimated loss of 10% of the flow before the repair.

A new road culvert has been installed just below the point where water is diverted from Kireria stream in Ngoce's swamp (Mzee Ngoce is the father of Chief S. Tharaka). Here the old culvert has sunk over the years due to the overburden of heavy trucks.

The furrow has been re-opened from Ngoce's swamp up to just beyond Tunyai but only drawing water from the swamp and with no recharge from Thingithu. Flow from the swamp will be inadequate during the dry season. Irrigation at the new scheme should begin early 1986 and this should remove all objections about diverting the furrow. Chief Mitunguu has already said that the furrow can be diverted on a new alignment around the town and this section should be completed at the earliest opportunity.

Unfortunately, for the management and maintenance aspects, this furrow flows through two divisions. The border between S. Imenti and Tharaka crosses the Mate Road (main road, Ena-Ishiara-Mitunguu-Gaitu-Meru) just above Tunyai at the junction to Materi Girls School (and dispensary) which is run by American Catholic Brother John.

There is already bad feeling amongst the Tunyai (Tharaka) people who feel that Mitunguu (S. Imenti) has taken 'their water' as described in 1. above. The only way of managing the furrow is to get the two chiefs to co-operate in maintenance, desilting, clearing the channel through Ngoce's swamp) and management (making sure no one blocks the furrow etc.). If it is proven that the diversion to Gakurungu functions, then Chief Marimanti will also have to be involved as his location will be the main beneficiary.

At a meeting in February '85 to explain the purpose of sand weir's and to discuss ways of managing them the Chiefs of Mitunguu and S. Tharaka were told * to give self-help labour to complete the furrow under the direction of AMS Chiakariga. So far nothing has been organised.

4.9 POTENTIAL FOR FURTHER WATER DEVELOPMENT

In Lower Meru, local leaders are aware that the perennial rivers running through the area are not being fully utilised either in terms of water supply or irrigation.

* by the D.O., Tharaka

In Tharaka division there is very little irrigation taking place apart from, 1. Materi Girls Schools - Brother John has a pumped water irrigation plot. 2. Tharaka Secondary School - pumped water to sprinkler irrigation to about 5 ha. 3. Church elder Stephen Njeru at Ruungu. 4. Irrigation from Nkondi furrow has always been limited and has now been stopped completely by the Chief.

There is a good deal of undeveloped potential for water furrows for drinking water and irrigation. If the furrow is designed for irrigation it should be elevated but if it is for water supply only then it should be below ground level so that water has to be lifted from the furrow and cannot be extracted in large volumes (as with the Tunyai furrow). The practice of blocking such furrows for diversion of water to fields is highly anti social and should be discouraged as strongly as possible. In the case of the Tunyai furrow, where water has to travel over a long distance, 15 km. or so, to Tunyai market there should be minimal interference from upstream users. If water is to be extracted it should be by bucket or jerrican only.

To irrigate from a furrow more specialised conditions are required than those for conveyance of water by the furrow itself. A furrow can be constructed for water conveyance through soil which may be infertile or otherwise unsuitable for irrigation and across terrain which is too steep for irrigation (normally 2% or less for furrow

irrigation). During the planning stage the District Water Office should be consulted as all water extraction requires a licence from the water bailiff.

Areas where furrow development should be explored are those where the rivers are not deeply incised and where the topography is not too severe. In Meru these are as follows:

Existing furrows include

1. Kithenu
2. Tunyai
3. Gachongo

Possible future developments:

1. Area between Mutonga and Kithenu river.
2. Area between Kithenu river and Mate road bordered by Mitunguu to the north and Materi to the south.
3. Ruungu on the east bank of Thingithu
4. Kibunga area between Manyari (dry stream) and Kathita
5. Nkondi and Mukothima (from Thanantu).

There is a large area between Kathita and Thingithu rivers which has no permanent water source. In conjunction with Mr. Karani of Chiakariga AMS the possibility of supplying water to the dry stream which runs from 642959 to 838897* over a distance of some 20 kms. was explored. The dry stream (Munyari) concerned could only be fed from Njue or Mariara streams. Njue is too small to give sufficient flow all the year round (it dries to almost nothing in the

* Grid references, 1:50,000 Sheet

long drought) but Mariara on the other hand is a large river with a fairly constant flow - during the 1984 drought it was seen to be carrying as much water as Thingithu, probably in excess of 1.5 cu.m/s

No convenient site was found however for diverting the water from Mariara. A two stage diversion from Mariara-Njue-Mun-yari was also considered and there is a possible Njue-Munyari diversion at 640963 but still none from Mariara-Njue. The idea was dropped when there was no immediate obvious diversion site but it could be explored again because of the potentital benefits to the dry area concerned. If a low maintenance solution could be found which would fit a budget of K.Shs.200-300,000 installation cost it would be well worth while.

Existing Furrows Include:

1. Mitunguu-Tunyai - Discussed in detail page
2. Kithenu. This is a short furrow running from the east bank for some 2 kms. whereupon it divides. The eastern branch could be taken a lot further but was stopped due to objections raised by a farmer that his field had been turned into a swamp by water seeping from the furrow.

   The furrow was dug in 1976 by Harambee effort organised by the now Chief Mitunguu. There is no permanent diversion structure on the Kithenu river but trash, stones etc. are placed across the river each dry season

to act as a weir and raise the water level sufficiently to get a suitable flow into the furrow. The Chief has asked for assistance to construct a proper weir and this should be followed up by the project. If a weir was constructed in the first few metres of the furrow to allow flood flow to go back to the river (as at Tunyai furrow intake).

A committee has been formed in order to look into possibilities of a furrow running from the western bank of the river but so far no action has been taken. Chief South Tharaka should be contacted about this.* Possibly the same formula of self-help furrow digging plus project assistance with hand tools plus materials and artisans for construction of a weir.

As mentioned above it would first have to be decided whether the furrow would be elevated or not depending on the use to which the water is to be put.

Although, in general, Embu district has less potential for furrows, in colonial times at least three existed in Embu, leading water from upper Runyenjes Division to the lower areas of Siakago division. There is only one furrow which still functions. This runs through Embu town and is under the jurisdiction of the D.C.

The old furrows in Embu could usefully be rehabilitated for water supply and possibly small scale irrigation.

* Ask chief about Ngu'uru-Gakirwe Project

There are also proposals for new furrows e.g. from the junction of Rubingazi/Thiba confluence to Maki ma. Interest in water furrows in both lower Embu and Meru is at a peak because of the recent drought. Furrows tend to be neglected in times of plenty if maintenance is not properly organised from inception.

One pre-independence furrow feeds water from Thambana stream to Kapingazi* which is then tapped and water led to a small stream, Ngerwe which leads to Kiamuringa in Siakago Division, Embu District.

4.10 CONTRACTS FOR DAM CONSTRUCTION

After the intial unfavourable experience with the AMS in dam construction it was agreed by the project Steering Committee that some work would also be given to contractors to see if their performance would be superior to that of the AMS.

Initial contacts with Nairobi based contractors in September '83 indicated that costs would not be much higher than those for the AMS. It was decided however that the AMS stations would also be given the chance to tender although they in fact never did.

The AMS were given the task of identifying and surveying contract dam sites while continuing with their construction work. It took the two stations 7 months to complete the survey of 9 sites (5 in Meru and 4 in Embu)

* Thambana and Kapingazi are tributaries of the Rupingazi

whereas they were supposed to survey a total of 15.

The contract documents were prepared over 3 months from March to June '84. The contract is based on the Standard Conditions of Contract for Civil Works from I.C.E., London, parts I and II and modified to fit the contract. Advice was sought from the Provincial Engineer, the Provincial Works Officer, the Chief Structural Engineer and EADD Engineering Advisors. (Despite all the checking of the documents a serious error slipped in. The amount of surety should read 15% on the Tender Surety Form, not 7 1/2%).

Separate tenders for the two districts were advertised in the national press in July '84 and tenders adjudicated in August by the District Tender Boards. Embu awarded the contract to Sema Building Contractors (282,000/-) and Meru to Wama Works Ltd. (311,000/-). Both were given orders to commence work but Wama was unable to produce a tender surety and so the funds were passed back to AMS for the completion of the 5 sites in Meru. (Under District Focus, the tenders had to be adjudicated separately in each District).

There was a strong preference in Embu board for a local contract. Sema B. C. had no relevant experience but offered a reasonable price and they are Embu based. It has since transpired that the contractor is technically incompetent and is far behind with the work. In the

Steering Committee of April '85 it was decided that his contract be extended to end not on the original 6 month deadline of May 18th but at the end of June. From there he would be required to withdraw from the work and the balance of the funds would go to the AMS to complete any work left undone at the 4 sites.

The major problem with the contract, apart from the incompetence of the contractor has been the lack of supervision by AMS Machang'a who were charged with the responsibility of supervising the contractor. This they simply have not done and mistakes and delays could have been avoided if supervision had been adequate. It would be unfair to conclude that the use of contractors is disadvantageous. If the work had been better supervised it could have been successfully completed by this time with minimal administrative burden on the DAO and EMI/SWCP. Furthermore, in future, all the groundwork for the relevant documents would not have to be done again.

4.11 WATER JARS

It was agreed in a discussion of the work plan for the second half of 1983 with the then PDA and DAO Embu that the construction of water jars would be tried out on a pilot basis within the Evurori catchment as an alternative method of water conservation for homesteads. At the Embu Agricultural Institute a casual labourer, Mr. Patrick Njue, was found to have been trained at the Village Technology Unit at Karen, near Nairobi in the

construction of such water jars, and subsequent to his training had helped to set up the small alternative technology demonstration within the grounds of the Institute Mr. Njue was then seconded to the project for a period of 6 months from Sept. 1983 to February 1984 and during this time he was housed at the Kamuthigo camp site and was provided with a bicycle by which to travel to the homes of farmers who had registered themselves for the provision of a water jar.

In the end only 13 such water jars were constructed by the project, 3 of them being at schools within the catchment. The precondition for provision of a tank was that the home owners would pay the cost of the outlet pipe and tap and also the cost of the guttering on the house which runs rain water into the tank. The cost of the pipe and the tap was approx. 100/- and this had to be paid in advance. The tank construction programme was not a success for the following reasons:

1. Only about 10% of houses have iron roofs which means that only the better off can use roof collected water. This meant that the projectwas favouring the more wealthy who were better able to cope with the water transport problem than others.
2. Approximately 4 drums (800 litres) of water were required to construct a single tank and the long distances to permanent water meant that there was a

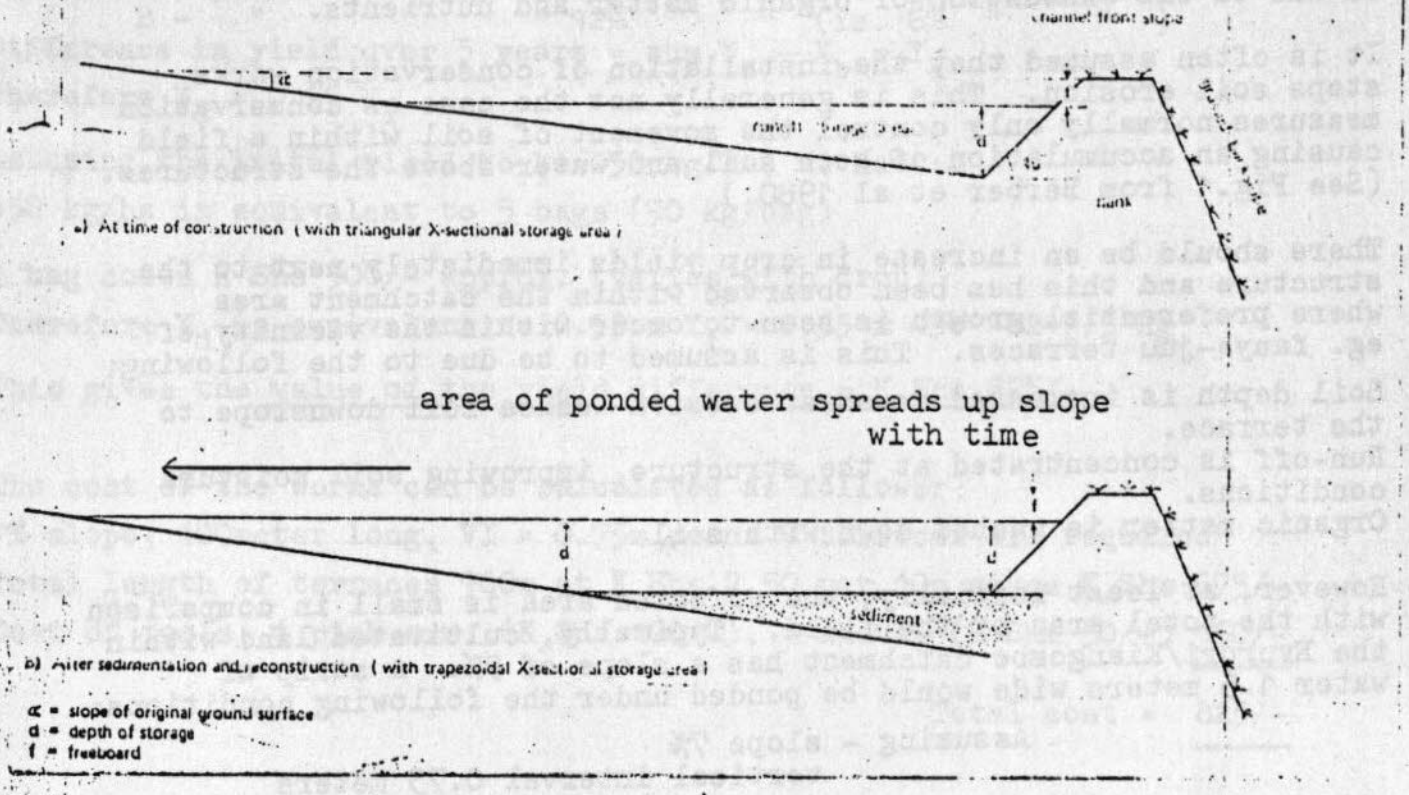
heavy transport burden on the project in order to provide sufficient water for construction. Not all of this water was used for cement mixing of course, much of it was used for washing and for curing. Eventually the project resorted to hiring an ox cart to transport the water and this was regarded as an unacceptably high level of subsidy.

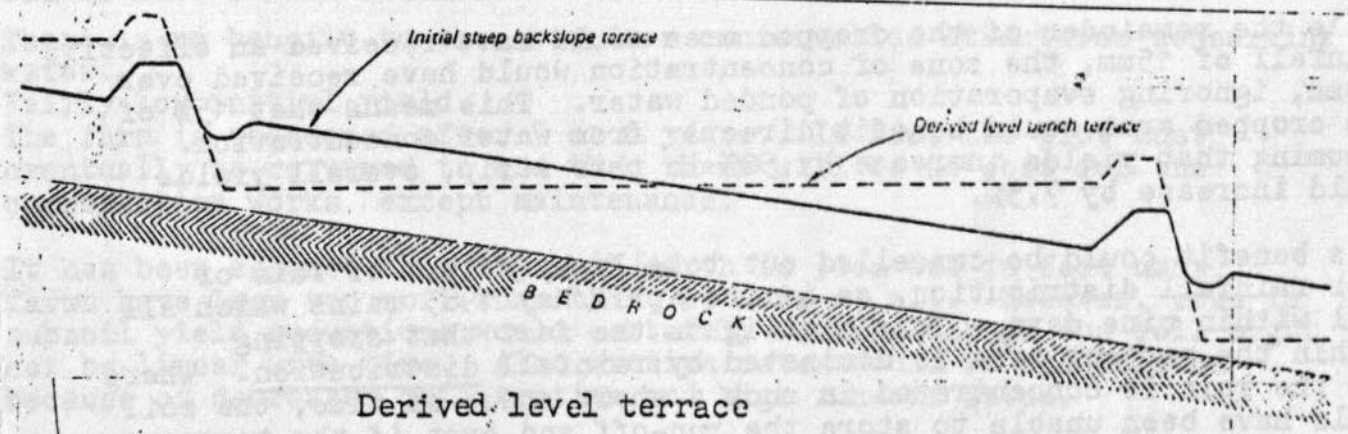
The fact that the programme was not a success in this particualr area does not mean that it does not have application. It would be well suited to alleviation of the water supply problems of remote schools, where children often waste time in bringing water to the school. Also it could be widely applied in slightly more prosperous areas where tin roofs are common and where home owners would be able to afford the full costs of the water jar. It would be worth looking into this again during phase 2 of the project.

The overall cost of each jar was approx. K.Shs.1200. This included the fundi's time and wages for one assistant and the cost of cement, piping and guttering. The sticks for weaving the basket which formed the frame for the water jar and the sand and gravel for the mortar were assumed to have no cost as they were collected by the house owner himself.

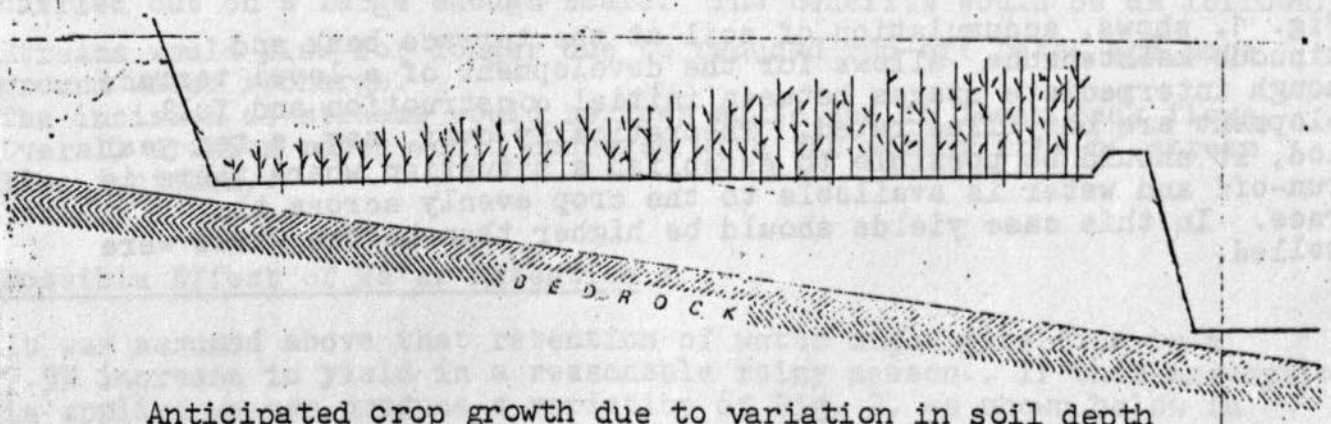
Figure 1

modified ex Barber et al(1980)





Derived level terrace



Anticipated crop growth due to variation in soil depth

matter is generally not compensated for by application of boma manure. It is here assumed that on any one plot yields will decrease naturally over time even where there is no loss of top soil. This is due to the exhaustion of organic matter and nutrients.

It is often assumed that the installation of conservation works stops soil erosion. This is generally not the case as conservation measures normally only control the movement of soil within a field causing an accumulation of both soil and water above the structures. (See Fig.1 from Barber et al 1980.)

There should be an increase in crop yields immediately next to the structure and this has been observed within the catchment area where preferential growth is seen to occur within the vicinity of eg. fanya-juu terraces. This is assumed to be due to the following:

1. Soil depth is increased as sheet erosion washes soil downslope to the terrace.
2. Run-off is concentrated at the structure, improving soil moisture conditions.
3. Organic matter is washed down with soil.

However, at least initially, the affected area is small in comparison with the total area of the field. Typically, cultivated land within the Evurori/Kiangombe catchment has a slope of 7%. A strip of water 1.5 meters wide would be ponded under the following conditions:

Assuming - slope 7%
vertical interval 0.75 meters
distance between terraces 10 meters approx.
30mm storm, 40% run-off giving 18mm storage.

While the remainder of the cropped area would have received an effective rainfall of 15mm, the zone of concentration would have received over 100mm, ignoring evaporation of ponded water. This means that 15% of the cropped area would benefit directly from water concentration. Assuming that yields increase by 50% in this strip, overall yields would increase by 7.5%.

This benefit could be cancelled out totally by a lack of rain or poor rainfall distribution, as in the April/May 1983 rains which all fell within nine days. This highlights the fact that cropping within the project area is dominated by rainfall distribution. Where all the rain is concentrated in such a short space of time, the soil would have been unable to store the run-off and even if the terrace were not overtopped, most would be lost to deep percolation. Soil conservation works only show a benefit with good rainfall distribution.

As Fig. 1. shows, accumulation of soil at the terrace bank and continuous maintenance allows for the development of a level terrace although intermediate stages between initial construction and full development are not illustrated. Theoretically over, say, a ten year period, it should be possible to establish a situation where there is no run-off and water is available to the crop evenly across the terrace. In this case yields should be higher than before works were installed.

From Fig. 2. we see that:

On line A - yield reduction is 10% per year (ie. 5% per season)
B - " " " 12% " " (ie. 6% " ")

Difference in yield over 5 years = sum $Y_a - Y_b = Y_d$

Therefore $Y_d = 0.55\ Y_i$

Assuming the inital yield to be 450 kg/ha, we have:

450 kg/ha is equivalent to 5 bags (90 kg/bag)

1 bag costs K Shs 300/- approx. (varies with crop)

Therefore Y_d is equivalent to $0.55 \times Y_i = 0.55 \times 450 = 247.5$ kg

This gives the value of the yield difference = K Shs 825/-

The cost of the works can be calculated as follows:

7% slope, 100meter long, VI = 0.75m means 9 terraces are required

Total length of terraces 900m at K Shs 7.50 per 10m gives K Shs 675/-

Cost of tools, 1 pick axe. (K Shs 100/-), 1 shovel (K Shs 50/-) 150/-

Total cost = 825/-

The costs are now balanced with the value of the yield difference but we have so far assumed:

There is no benefit to the crop from conservation structures conserving water.
Fairly low initial yield.
The farm is abandoned after 5 or 6 years.. In fact the plot must eventually be returned to and then there will be no cost for the conservation works except maintenance.

It has been assumed that top soil depth is 30cm but in fact many farms have less top soil than this, or none at all. However, even in subsoil yield reductions would certainly occur although the fall might not be linear with time. Also erosion rates would be accelerated because of decreased infiltration and high run-off rates.

A side effect of the soil conservation work which would be hard to cost is the improvment of the catchment hydrology if works could be carried out on a large enough scale. The benefits would be as follows:

Streams would flow for longer due to reduced run-off rates and more ground water recharge.
The incision of streams would be less acute due to lower peak flows.
Overall erosion rates would decrease with the slower rate of stream line incision..

Possible Effect of Water Retention

It was assumed above that retention of water might give rise to a 7.5% increase in yield in a reasonable rainy season.. If this assumption is applied we can produce a variation of Fig. 2. as shown below in Fig. 3. As the yield declines over the 6 year period the actual amount of yield increase due to water retention should also decline.

Costs/Benefits

To examine cost benefits, however, it would be safest not to assume any increase in yield due to the structures. A high level of management is required to achieve level developed terraces, and it has so far only been established that farmers within the catchment area are willing to install the relevant works. Maintenance is another question altogether and without it no assumptions can be made about terrace development.

For the sake of a simple model therefore, it is assumed:

1. There are no changes in crop husbandry practices.
2. Installation of conservation measures means that there is no soil loss from within the plot.
3. With soil conservation measures yield reduction occurs due to natural exhaustion of soil nutrients and organic matter only.
4. Top soil is 30cm in depth on a plot of 7% slope, 100m square = 1 hectare.
5. Soil erosion causes accelerated decline in yields due to loss of top soil.
6. Top soil is exhausted in 6 years with yields falling to 40% of initial yield.
7. Yields decline linearly over 6 years.
8. Soil erosion rate 1cm / year ie. 100t/ha/yr.
9. Exhausted top soil is equivalent to subsoil ie. exhaustion by cultivation has equivalent effect to erosion of top soil.

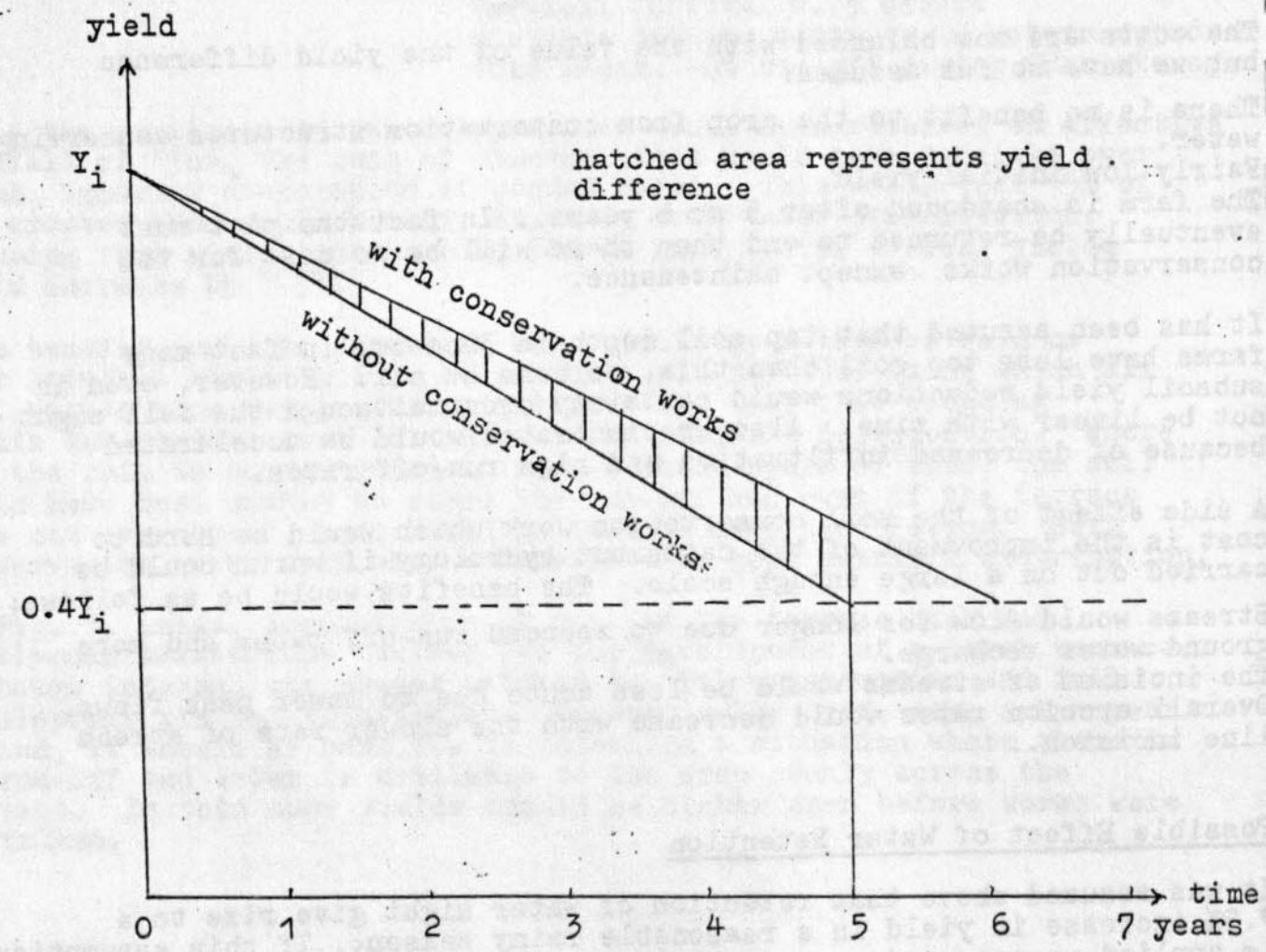


Figure 2

other ways of rehabilitating eroded land, but there is little chance of establishing cost benefits for these methods at this stage.

What must be emphasised is the need for water conservation methods to trap rain water between the major structures. The labour costs and benefits in terms of crop yields are even less well understood than those for the structures discussed above.

References

R G Barber et al (1980) 'Studies in Soil Erosion and Run-off, and Proposed Design Procedures for Terraces in Cultivated Semi-arid areas of Machakos District, Kenya'

S L Wiggins (1980) 'The Economics of Soil Conservation in the Acelhuata River Basin, El Salvador'

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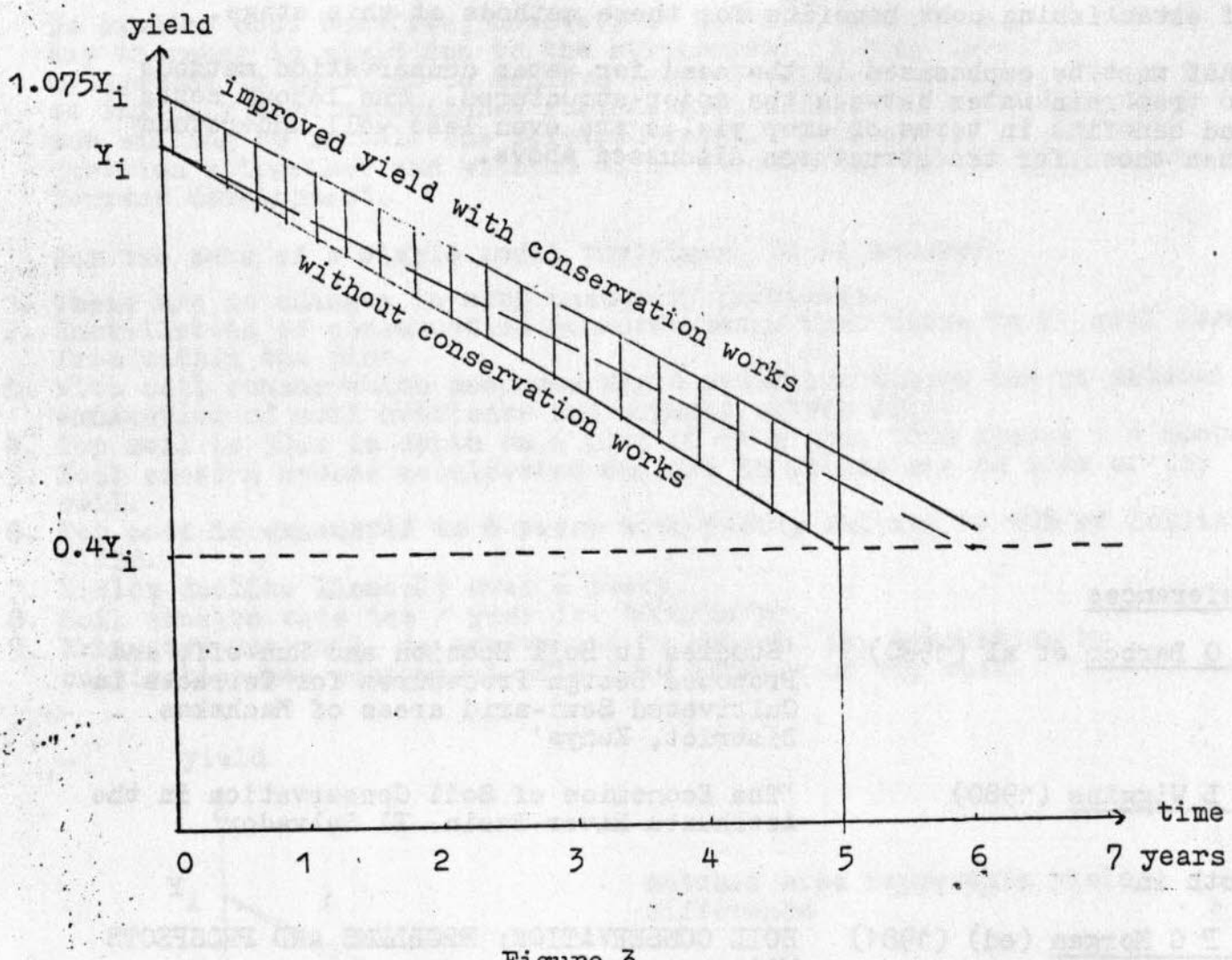

Figure 3

Difference in yields, Y_d now = 1.13 Y_i
or, as in the previous example:
Increase in total yield = 1.13 x 450 = 509 kg
Value of total yield increase = 509/90 x 300 = K Shs 1696/-

Less cost of installation	825/-
	871/-

In this example the benefit to the farmer would be, say, K Shs 870/- over a 5 year period.

Conclusion

By making gross assumptions on yield responses an examination of the cost benefits of soil conservation measures shows that at worst a farmer is unlikely to loose out by installing these works unless drought prevents crop growth over an extended period. The types of measures looked at here represent only one aspect of soil conservation which must include tree planting, grass planting, and

APPENDIX I

NB Lines in Figures 2 and 3 should be concave not straight

ECONOMIC BENEFITS OF SOIL CONSERVATION WITHIN EMI/SWCP

Introduction

Soil conservation within the EMI/SWCP area is presently being undertaken in three ways:

1. Individual farmers undertaking the work within their farms on an unpaid basis.
2. Voluntary community action, normally organised by chiefs and assistant chiefs.
3. Work undertaken with paid labour.

What follows below is a first attempt to examine no. 1. To establish a connection between the adoption and installation of soil conservation measures and resulting economic benefit can only be gauged from the value of crop yields. It is not possible to establish that overall yields can be increased by normal conservation measures (ie where these are spaced at wide intervals to impede run-off). However, theoretical considerations can give a guide as to the magnitude of costs and possible benefits involved.

Even experimentally it would be hard to isolate the effects of soil conservation on yield in the project area because of extreme local variation in soil type, depth, and fertility. However, under research station conditions and over, say, a five to ten year period this might be achieved. To try to draw conclusions from field trials on farmers' plots would be impossible.

Shadow Labour Costs

Most farmers within the project area cannot afford to employ labour to install or maintain conservation works. A few people, usually government employees or teachers, have paid for the installation of such works in the sub-catchment, the SWC field staff handling the organisation and payment of labour on behalf of the farmers.

The majority, however, must provide their own labour which costs the project nothing but must be assumed to have a shadow cost. As most soil conservation work takes place in the dry season, spending time on conservation measures would normally be at the expense of herding animals, for men, and water collection, in the case of women. It is here assumed that 50% of the daily wage for digging (K Shs 15/2 = K Shs 7.50 per day) would be the shadow cost, ie for half of the time the farmer would have been otherwise beneficially occupied.

Effect of Soil Conservation Measures on Yield

Some have claimed (eg Wiggins 1980) that installation of works gives an immediate increase in yield because of:

1. Increased infiltration
2. Retention of organic matter within the field eg manure, crop residues.

It is also assumed that a subsequent steady increase of yield will take place because, as the top soil is no longer being removed, pedogenesis at depth is gradually increasing the amount of nutrient rich material available. These assumptions seem to be wildly over-optimistic when applied to the semi-arid area covered by the project, especially as fertilizer is normally uneconomic, and loss of organic

(1)

MINISTRY OF AGRICULTURE

E.M.I. SOIL & WATER CONSERVATION PROJECT
PROVINCIAL AGRICULTURAL HEADQUARTERS
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P.O. Box 4, EMBU.

APPENDIX II This paper was prepared in December 1983.

DISCUSSION PAPER

ROLE OF EMI SOIL AND WATER CONSERVATION ASSISTANTS WITHIN T & V SCHEME

Introduction

Since March, 1983 the Field Assistants employed by the EMI/SWCP exclusively for soil conservation work have been based at a camp site within the Evurore-Kiang'ombe catchment, lower Embu. They have achieved a degree of success by living close to farmers about 50 of whom have adopted some soil conservation methods on their farms within the last eight months. The way in which the work is presently organised does not fit with the introduction of the T and V work plan and so has to be reassessed.

Future role of Field Assistants

There are strong arguments for not including the field assistants (soon to be 6 in number plus one TA supervising) within the normal extension service, however desirable it may seem for consistency within T and V..
These are:-

1. The concept within T + V of the 'contact farmer' is not applicable to soil conservation work. Every farm differs and so does the advice and structures required. Obviously, the work of laying out structures has to be done on each farm where the farmer is willing to cooperate. This makes the approach quite differen t from eg crop husbandry where information can be passed from one farmer to another.

2. The two week cycle of visiting within T + V cannot easily be applied to soil conservation work. Time required per farm visit varies with the season. A visit to encourage a farmer to maintain works might take twenty minutes while a visit to lay out contour lines might take 3 hours. Also for this work, the field assistants should work in pairs , not individually.

3. The dry marginal areas do not presently have enough TA's and JTA's to effectively cover the area considering that the distance between farms is large and also that most of the staff do not have bicycles for work. It cannot be said therefore that the EMI staff are going to be duplicating the work of other field staff. Indeed they might be a very necessary supplement in soil conservation work which requires a high input of

sup ervision at certain times with which the extension staff might not be able to cope.

4. The field assistants are not presently trained in any other field of agriculture and would therefore be unable to cope with general extension duties.

Annual Schedule

*in semi-arid zones

Unlike the high potential areas, soil conservation activities* are not limited to the dry seasons. It is true that works cannot be installed while the crop is still on the field but, as only 20% of the area is cropped there is plenty of scope for rehabilitation work to go on during the growing season. This work includes reseeding and grass-planting. Also in areas where access is poor, opputunities could be taken for constructing access tracks or for realigning paths that have been incorrectly sited and are causing erosion.

The suggested program below would cover the same catchment of 78km2 using 6 field assistants (2 new ones in training) and one TA. These would work closely in collaboration with the TA's responsible for the area (presently 3, but this may be increased).

The year can be divided broadly into two six month periods, the dry season (Feb. - March and July - October) and the cropping season (April - June and Nov. - January). During the dry season activities would be as follows:-

* 1st Phase. 3 weeks moving from one farm to another marking out structures, instructing farmers on how to put in works and issuing tools. A rate of two farms per day should be possible and a pair of local farmers trained in laying out contours would also be helpful.

2nd Phase. Visiting farmers for 6-7 weeks using the two week cycle of visits as per T + V to encourage and monitor the farmers' progress in construction of works.

DURING THE CROPPING SEASON:-

*1st Phase Onset of rains. Grass and tree planting and reseeding all undertaken by the farmer but with inputs by the project.

2nd Phase Main rainy period (3-4 weeks). Pointing out to the farmer erosion as it takes place. Monitoring the performance of the works, checking for breaks and making observations with a view to any modification in design required.

3rd Phase End of rainy period. Getting to the farmer as soon as possible after breakages or dangerous concentrations of water have occurred so as to persuade him to take action while the issue is still fresh in his mind.

4th Phase Preharvest. Finding new interested farmers immediately prior to harvest and reworking the visiting schedule where necessary.

Special Activities Day

One day per fortnight is set aside for other activities and this is the ideal opportunity for the field assistants to plan and supervise group activities such as gully control. One day per fortnight may not be sufficient however and it might be better to modify the schedule to allow for two days.

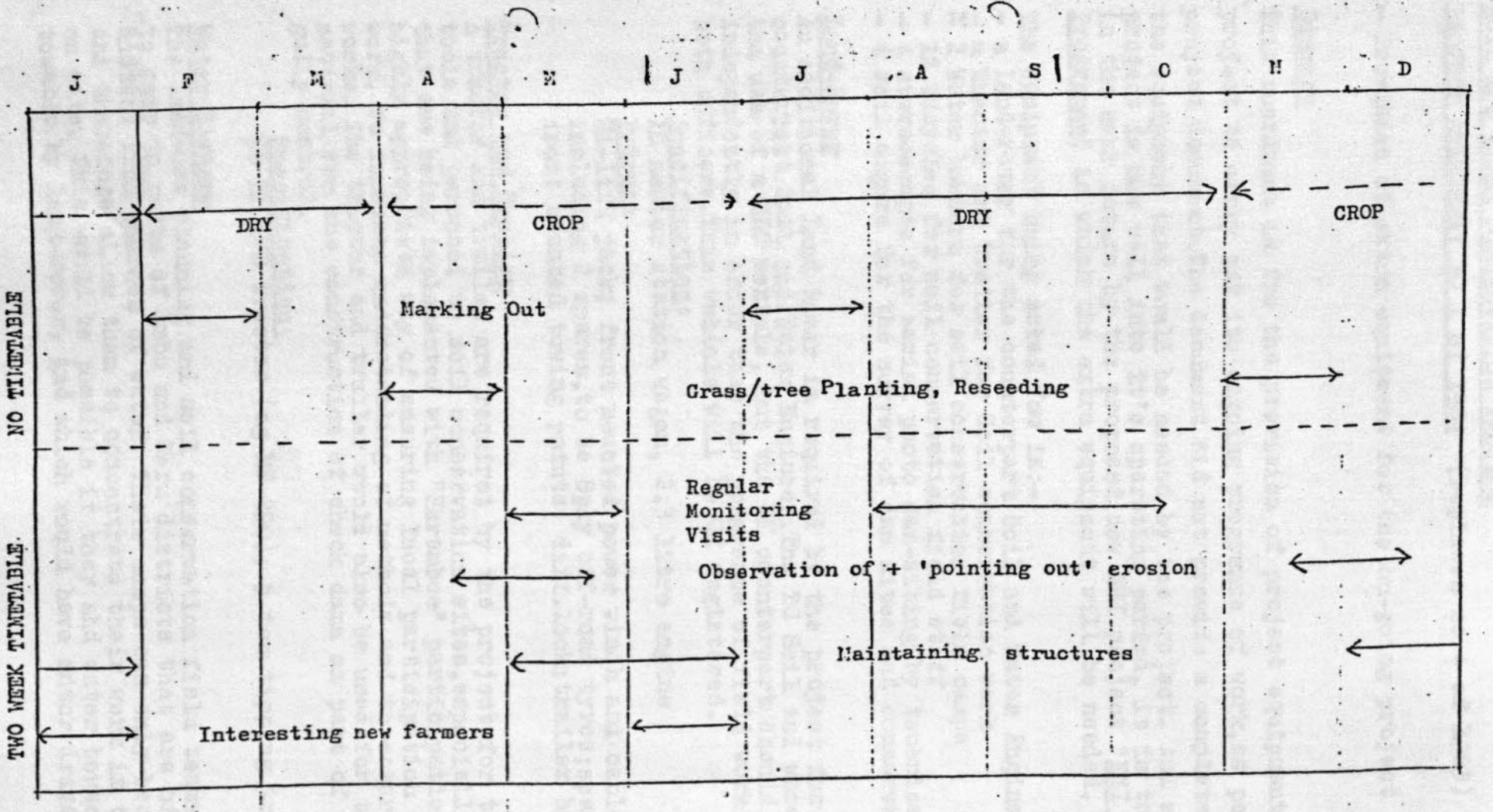
Training

The T + V schedule allows for one day's training per fortnight for field staff. Whether the EMI Field Assistants should be included should be discussed and this opens up the question of whether they are ultimately to be included in the government service and, therefore, whether further training for them can be justified.

[All activities on the two week visi ting schedule except*]

S.C. White
SOIL & WATER CONSERVATION ENGINEER

December, 1983.



Proposed annual schedule for Soil conservation Field Assistants

APPENDIX III Extract from Project Amendment EMI/SWC/1/84-85

SOIL AND WATER CONSERVATION PROJECT

PROJECT AMENDMENT NO 1 of 1984 (replaces no 4 of 1983) (Total cost £ 28940.00)

- Provision of extra equipment for the on-going project

Summary

This amendment is fro the provision of project equipment to enable the project to carry out its ongoing programme of work,as per the original project document.The document did not provide a complete assessment of the equipment that would be needed by the project. And although the project is now well into it's operating period, it is to be absorbed in the near future by the proposed new EMI project "EMI Dryland Farming Programme", in which the extra equipment will be needed.

The equipment being asked for is:-
- a Land-rover for the counterpart Soil and Water Engineer
- a Tractor and Trailer for Soil conservation work
- 2 Water bowsers for soil conservation field camps
- 12 bicycles for soil conservation field staff
- 4 stereoscopes for aerial photo dam-siting by technical assistants
- 4 soil augers for the survey of dam sites and conservation plots

Land-Rover

An additional Land Rover is required by the project for the use of the counterpart Soil and Water Engineer.The TC Soil and water engineer has the use of a BHC vehicle, but the GK counterpart should be able to work independently in order that the programme of field work can be covered by both officers.This vehicle will be GK registered.

Specification:
10 seater station wagon, 2.3 litre engine

Extras:
Hi-lift jack; front mounted power winch and cable;all tyres, including 2 spares,to be 8ply off-road tyres;spares kit; roofrack; front mounted towing points; diff.lock;trailer hitch and electrics

Tractor and Trailer

A tractor and trailer are required by the project for the transport of tools and personel to soil conservation sites,especially those sites that are being implemented with "Harambee" participation,which is a highly appropriate way of ensuring local participation in soil conservati work, to increase understanding of methods and to ensure future upkeep o works. The tractor and trailer would also be used for the transport of material for the construction of check dams as part of the programme of gully control.

Specification:
90 HP 4WD Tractor (eg MF 290); 5 ton tipping trailer

Water Bowsers

The land-use planning and soil conservation field teams both are required to camp in parts of Embu and Meru districts that are often 10 miles distant from sources of water. Their camps can only become self-cotained and therefore allow them to concentrate their work if they can keep wate on site. This would be possible if they ahd water bowsers that would be towable by land-rover, and which would have motor driven filter pumps.

(Water Bowsers, continued)

Specification:
Two units. 1 - 1½ tons capacity; 2 wheel; inertia brakes; spare wheel; trailer lights and electrics compatible with Land Rover; reflector plates; 3 hp petrol driven centrifugal pump (with filter) 4m suction hose and foot valve; rear mounted 1" outlet with gate valve; drain plug.

Bicycles
More field staff are being employed on the project who will require to be fully mobile within that part of the project area where they work. Twelve additional bicycles will fulfil this function.

Specification:
12 Raleigh single speed HD touring cycles; 24" frame, 28" wheels; 24 spare HD tyres; 12 sets spare pedals; carrier frame.

Stereoscopes
The project was originally supplied with 6 Cassella stereoscopes, but have proved both unusable, and of poor design. Consequently the project has borrowed Topcon stereoscopes from the University of Nairobi, but these are now wanted back. 4 stereoscopes are therefore still required for the project - 1 for the Land Use Planner, 1 for the Soil & Water Engineer, and 1 for each of the Technical Assistants. The stereoscopes are for aerial photo interpretation of dam sites etc. within the project area.

Specification:
4 x Topcon or Wild Stereoscopes
-suppied with 4 binocular attachments, parallax bars, hard carrying cases, and desk top photo-holding frames.
In addition 3 extra biocular attachments for Wild stereoscopes and 4 carrying cases.

Soil Augers
4 soil augers are required for the survey of dam sites in dry sand river beds in order to adcertain the rock level for foundations. This task is achieved much faster when soil augers are availabe.

Specifications:
4 x Dutch Augers each with 1 metre rod.
In addition 2 1 metre extension rods and 2 gravel heads.

Summary Estimated Costs	Kenya £
1. Land Rover with spares (c.i.f.)	10000.00
2. Tractor and Trailer (c.i.f.).....	10700.00
3. Water Bowsers (c.i.f.)	4000.00
4. Bicycles (c.i.f.).....	1440.00
5. Stereoscopes.....	2500.00
6. Soil Augers.....	300.00
OVERALL TOTAL COST OF ABOVE AMENDMENT.....	£28940.00

EMI SOIL AND WATER CONSERVATION PROJECT

SUPPLEMENT TO PROJECT AMENDMENT NO 2 of 1983

Revisions of costs and implementation procedures (Total cost £ 109,535)

Time period

The project amendment of 1983, which has already been submitted, endorsed by the GK Ministry of Agriculture, and Treasury, called for the construction of 20 small dams a year for an unspecified time period, in the lower drier areas of Embu and Meru districts, with the aim of improving domestic and livestock water supplies.

It has now been estimated that in a period of a little over 2 years, a programme of building approximately 40 small dams would fulfil the water supply requirements of the project area, and thereby remove a considerable constraint on the agricultural development of those areas, using the soil conservation and agronomic measures that the EMI programme hopes to encourage.

However, the existing Soil and Water Conservation project runs only, under existing budget agreements, until March 1985. By that time a new EMI project, or programme should have become operational in the area of agriculture, which will absorb the work of the existing project:- " EMI Dryland Farming Programme" (final proposal under preparation).

Therefore, the existing project amendment that is now being tabled should only cover the period until March 1985.
The terms of reference for the new project will then incorporate a provision for the extension of the dam-building programme, on condition that an evaluation of the programme implementation and impact is made at that stage.

From experience in dam construction to date, it is now proposed that 15 small dams be built in the period up until March 1985.

Implementation - Use of Contractors

The original amendment document envisaged the sole use of the staff and equipment of the M o A Agricultural Mechanisation stations. It has now become apparent that the stations do not have the capacity to carry out the envisaged level of dam construction activity. The use of contractors has now been considered and approved by the Provincial Director of Agriculture, Eastern Province, and it would seem to be a suitable means of implementation, provided that the contracts specify the use of local artisans and the employment of local labour.

The Technical Officers of the Ag.Mech. Stations would act as supervisors to the work of contractors. The Ag. Mech. Stations would continue to be involved with the dam construction work, and would be able to construct about 4 of the dams. Experience so far suggests that the cost of construction by the Ag.Mech. Stations would be similar to that of the contractors, and no distinction is made in the estimates.

Costing

In view of the experience gained to date in the trial construction of 3 dams between June and November 1983, the costs tabled in the original amendment now appear to be quite inadequate. And if the work is to be carried out by contractors, then the estimates should be made by rate, including labour, transport and fuel costs.

Taking a typical dam of 2.5 metres height and 15 mtres width, the quantiti required can be listed, as below, with the contractor's rates, as at September 1983. The total cost of each structure is then estimated as follows:-

	Rate(Sh)	Quantity	Cost(Sh)
Concrete(1:3:6)m^3	1100.00	45	49500.00
Shuttering, m^2	120.00	40	4800.00
Tractor & Trailer hire per hour	300.00	100	30000.00
Tractor & Tanker hire, " "	300.00	100	30000.00
Cement Blocks per 100	1200.00	1.5	1800.00
Lengths of 75mm slotted PVC pipe	400.00	3	1200.00
" " 39mm GI pipe	600.00	5	3000.00
Waterproof plaster, m^2	60.00	20	1200.00
Cement per tonne	2000.00	0.5	1000.00
Running metres of 20mm RI bar(prov)	30.00	30	900.00
Excavation, m^3	50.00	5	500.00
		Total	123900.00

In addition to the unit costs per dam, the following costs would be incurred for supervision and surveying of the sites:-

Repairs for 2 supervisors vehicles (10000.00 per annum)	20000.00
Fuel for 2 supervisors vehicles (16000 km. per annum each)	28800.00
Subsistence for 2 supervisors (200 nights at 75.00 p.d.)	15000.00
Subsistence for survey teams (300 nights at 50.00 p.d.)	15000.00
Stationery, ammonium paper etc. for plans	5000.00
Preparation of contract documents (12 sites at 750.00)	9000.00
Total	92800.00

Summary costs

1. Dam construction, 15 dams at 123900.00Sh.....	1858500.00
2. Supervision and survey costs.....	92800.00
3. Other costs(maps, air photos, drawing equipment.....	40250.00
4. Contingencies(calculated at 10%).....	199155.00
OVERALL TOTAL COST OF PROPOSED AMENDMENT.....	2190705.00Sh
	(K£ 109.535)

APPENDIX IV

MINISTRY OF AGRICULTURE

Telegrams: "MINAG", Embu
Telephone: Embu 20196
When replying please quote
Ref. No. .....

E.M.I. SOIL & WATER CONSERVATION PROJECT
PROVINCIAL AGRICULTURAL HEADQUARTERS
EASTERN PROVINCE
P.O. Box 4, EMBU.

Date 3rd September, 1984

EMI SOIL & WATER CONSERVATION PROJECT

PROJECT AMENDMENT NO. 2/84

SUMMARY

This project amendment allows for the provision of hand tools to facilitate expansion of soil conservation activities within the present project and the Dryland Farming Programme to begin in April, 1985. Funds allocated for tools in financial year '83-'84 have proved insufficient and with the increasing demand for tools, a new allocation of funds is required for purchase of the required implements. The total cost of the amendment is approximately sterling £ 42,500.

The hand tools required are:

	NO
Pick axe heads	800
Mattock heads	900
Forked jembe (Hoe)	1200
Crowbars	130
Wheelbarrows	400
Shovels	2200
Sledge hammers	60
Metal tape measures	22
Land measure wheel	8

ACTIVITIES REQUIRING HAND TOOLS

a. On farm Soil Conservation

The project presently works in two catchments (one in Embu District, one in Meru) where interested farmers are loaned tools in order to undertake conservation work within their own farms.
The excellent response of farmers in the Meru catchment has meant that the years allocation of tools is proving insufficient.
If two more catchments are incorporated in 1985, the project will need a good stock of tools in advance for equiping responsive farmers.

b. Harambee Soil Conservation

Evey location and sub location within the project area is

supposed to undertake soil conservation projects during the two dry seasons i.e. August/September and February/March. However, the locational chiefs are hamstrung by the lack of hand tools in the district stores.
These activities which are primarily educational, would be more successful with the seasonal loan of tools. These projects are usually started on a day when the whole location is called and a set of tools able to equip 500 people at a time is required fo rotation between the 10 locations in the project area.

c. Group Soil Conservation

Men's and women's groups registered with Ministry of Social Serv undertake a range of activities, soil conservation being one. These groups are sometimes discouraged from doing this work by t lack of tools available within the Ministry of Agriculture for t Semi-arid areas. The project could help by having sufficient t for, say, 10 groups of 30 people per group.

d. Replacement of MOA Handtools

In order to cope with the existing demand for tools, the project has borrowed tools from the District Agricultural Officer (Embu) which are to be replaced by 1.10.84. The remainder of the project allocation for tools in '83-84 will be used in replacing these items.

USE OF HAND TOOLS

Fork jembes, mattocks and Pick axes for digging work(for group in order of increasing hardness). Shovels are used to move the loos material.

Crowbars - for dislodging large rocks and digging holes for treeplanting.

Wheelbarrows - for carrying stones for construction of check dams and stone teracces and for transport of manure.

Sledge hammer - for stone breaking.

Tape measure & Land wheel - for use by field staff in marking out and survey of farmers' fields.

...../ 3

Details of Hand Tools

Pick axe head	7 pound
Mattock head	5 pound
Fork Jembe	Large, 3 pronged
Shovels	Round nose
Crowbars	5 foot length, I" diameter.
Wheelbarrows(in knock down form)	Standard 3 cu. ft., solid rubber tyre body bo ted not welded to frame
Sledge Hammer(large)	14 Ib head
Sledge Hammer(small)	8 Ib head
Hand measuring wheel-	Large diameter wheel with solid rubber tyre.
Tape Measure	20 metre, steel tape

Storage

To accommodate these tools, two stores should be erected, one at Ishiara(Embu) and one at Marimanti (Meru) to ensure that a large Quantity of tools can be stored without the inconvenience of shuttling stores to and from Embu.

The two stores should be approximately 20 feet by 30 feet, have a concrete base, basic wooden walls and windows, and galvanised iron roof.

...../ 4

SCHEDULE OF TOOLS REQUIRED

£ Sterling

		A	B	C	D	TOTAL	UNIT PRICE	COST	NOTES
1.	Pick axe Head	600	100	100	-	800	4.10	3,280	7 pound head
2.	Mattock Head	600	100	100	100	900	6.00	5,400	5 pound head
3.	Fork Jembe	900	100	200	-	1200	3.20	3,840	3 prong large size
4.	Shovels	1500	200	300	200	2200	3.90	8,580	Round nose type
5.	Crowbars(5ft)	60	20	50	-	130	6.50	845	
6.	Wheelbarrows	300	50	50	-	400	20.00	8,000	3 cubic feet
7.	Sledge Hammer(14 Ib)	15	5	10	-	30	9.20	276	complete with handle
8.	Sledge Hammer(8 Ib)	15	5	10	-	30	6.00	180	"
9.	Metal tape Measure	12	-	-	10	22	8.00	176	20 meter length
10.	Land Measuring wheel	8	-	-	-	8	40	320	Large diameter wheel
11.	Wooden Store	2	-	-	-	2	4,000	8,000	20'x30', Funds used locally
12.	Handle for 1,2,3	2100	300	400	100	2100	1	2,900	Purchased locally.

TOTAL £. 42,297

NB. All prices (excluding items 11 and 12 are for UK Manufactured items and are C.I.F. Mombasa)

After discussion with EADD this letter was written for clarification.

3/8/3

MINISTRY OF AGRICULTURE

Telegrams: "MINAG", Embu
Telephone: Embu 20196
When replying please quote
Ref. No. .....

E.M.I. SOIL & WATER CONSERVATION PROJECT
PROVINCIAL AGRICULTURAL HEADQUARTERS
EASTERN PROVINCE
P.O. Box 4, EMBU.

Date 20th September, 1984.

Mr. P. Weare,
Senior Advisor,
E.A.D.D.,
P.O. Box 30465,
NAIROBI.

RE: EMI/SWCP PROJECT AMENDMENT 2/84- HANDTOOLS.

Further to our discussion of yesterday please find below clarification of proposed usage of tools within the Project amendment.

1. On - Farm Soil Conservation:

All tools remain the property of GOK and are issued to farmers on a rotational basis. An accurate log of the whereabouts of tools will be kept. Every farmer signs for the tools when they are issued and is informed of the date for their return. This system is already in operation in our Ishiara and Marimanti catchments.

It is also proposed, however, that farmers who complete all their assignments over a twelve months period should be given a set of tools as reward and as an incentive to those not yet participating. We have made one such set of awards in the Ishiara Catchment. 10 farmers received a pick axe plus shovel each (value Kshs. 150) and the best 3 farmers in the catchment received wheelbarrows (value Kshs. 500 each). The increased response from farmers following this is already discernible.

The result is that there will be a "loss" of say 30% of these handtools used in on farm Soil Conservation. Adding to this another 20% for breakages and wear this means that there will be an annual wastage of 50%.

2. HARAMBEE/GROUP ACTIVITIES.

The usage of tools here is simpler. All tools remain the property of G.O.K., while groups or Chiefs are issued the tools for a discerete period, say 3 or 6 months. Again tools will be signed for.

Again breakage and wear and tear will be inevitable. 20% replacement annually should be expected.

Referring to the schedule on page 4 of the amendment, replacement costs (annual) would be as follows:-

		(£ sterling) Total value of tools	Annual Replacement.
(i)	On-Farm Soil Conservation	18 108	9 054 (50%)
(ii)	Harambee/Group Soil Conservation	6 113	1 222 (20%)
	Annual Replacement Total		£ 10 276

These figures do not appear in the Project amendment as it stands as the EMI/SWCP will come to an end before the first replacement of tools is required in January 1986. It should be born in mind that another Project amendment will

Mr. P. Weare,

20th September, 1984.

Yours sincerely,

(SIMON C. WHITE)
SOIL AND WATER CONSERVATION ENGINEER.

SCW/lwm

Copy to:-

Mr. J. Drummond,
EADD,
P.O. BOX 30462,
NAIROBI.

Mr. T. Moody,
EMI CO-ORDINATOR,
P.O. Box 137,
EMBU.

Miss L. Penny,
BHC,
P.O. Box 30465,
NAIROBI.

P/S
The Project amendment to cover replacement of tools would come under the Dryland Farming Proposal or the continuation of this project, whichever is applicable.

APPENDIX V These instructions will only apply if the project reverts to the reimbursement financing system.

NOTES ON OBTAINING SUPPLIES

All government departments are required to obtain their supplies, where possible, through Supplies Branch. The items available from SB are listed in their catalogue which is revised each year.

Unfortunately, about half of the items classified are not in stock at any one time but those items listed and out of stock can only be obtained from another source if authority to buy has been GRANTED by SB. Once authority has been given then cash limits and methods of purchase apply as normal. (See chart).

At Supplies Branch — Take with you -
- IRV (Issue and Receipt Voucher) book with carbon paper, signed and stamped but otherwise blank.
- ID (Passport, Driving Licence or TCO ID)
- Patience

Before arrival list all your requirements by class and item. Take the numbers from the most recent catalogue you can get hold of (get a new one while there if available). Some offices are still working on the 1962 copy (!) so that many items have now been declassified. Take with you an IRV (Issue and Receipt Voucher, Form 12 Rev.) book which has been signed by an approved officer and stamped (vital) but with the date, items and account number left blank. Have as many IRV's stamped as there are classes of goods required plus . sevcral spares.

SB is located on Likoni Road, Industrial area. On entering, make sure that you declare whatever you have in your vehicle as you will be security checked on departure, if you have collected goods.

Present yourself at the stock checking section in the first cream coloured building on the right as you enter SB. Enter the central door, pass the counter, and take the left hand corridor to the large room at the end. Here, a room-full of people looks after the records of stocks, each person being responsible for a group of classes. By doing the rounds the listed items can now be divided into:-

Unclassified - forget these and use normal purchase methods
Classified and in stock
Classified and out of stock

The IRV's can now be filled in. All classified items must be entered but the trick is to write the in and out of stock items on SEPARATE IRV's. In this way out of stock items can start straight away on the procedurefor authority. Otherwise, this process has to wait until all the other items on the IRV have been collected and left the SB compound.

Once the vouchers have been written (ask if you have filled them correctly, as you won't be told otherwise until later), they then go for registration, signature checking, return to the various desks for entering and finally go to the warehouse. This all

---------/2

takes half to one day unless you take them round, so it is probably best to go away at this stage as there will be plenty of waiting to do at a later stage!

Having checked that all the IRV's have gone to the warehouse (but only those for items in stock) go to the main door of the warehouse with the numbers of the IRV's listed on Scraps of paper, this time by section, eg. Household and Sanitary, Stationery etc. These will then disappear to the relevant sections and a wait of half to two hours will ensue - worse if there are a lot of others waiting. They stop receiving requests at 3.30 pm and not at all on Saturdays. The main office doesn't close till 5 pm by contrast.

When the goods arrive, various books have to be signed and eventually you will have to produce ID and you will be issued with a gate pass to be given in at the security check. By this stage you will only be left with copy 2 of the IRV with the price of the items supplied filled in. When leaving with the goods, get yourself security checked. Even if there are askaris standing around don't expect to be stopped. If you leave without being checked all hell may break loose. The goods in your car are checked against the copy 2's and other things have to be accounted for - which is why you declared them on entry.

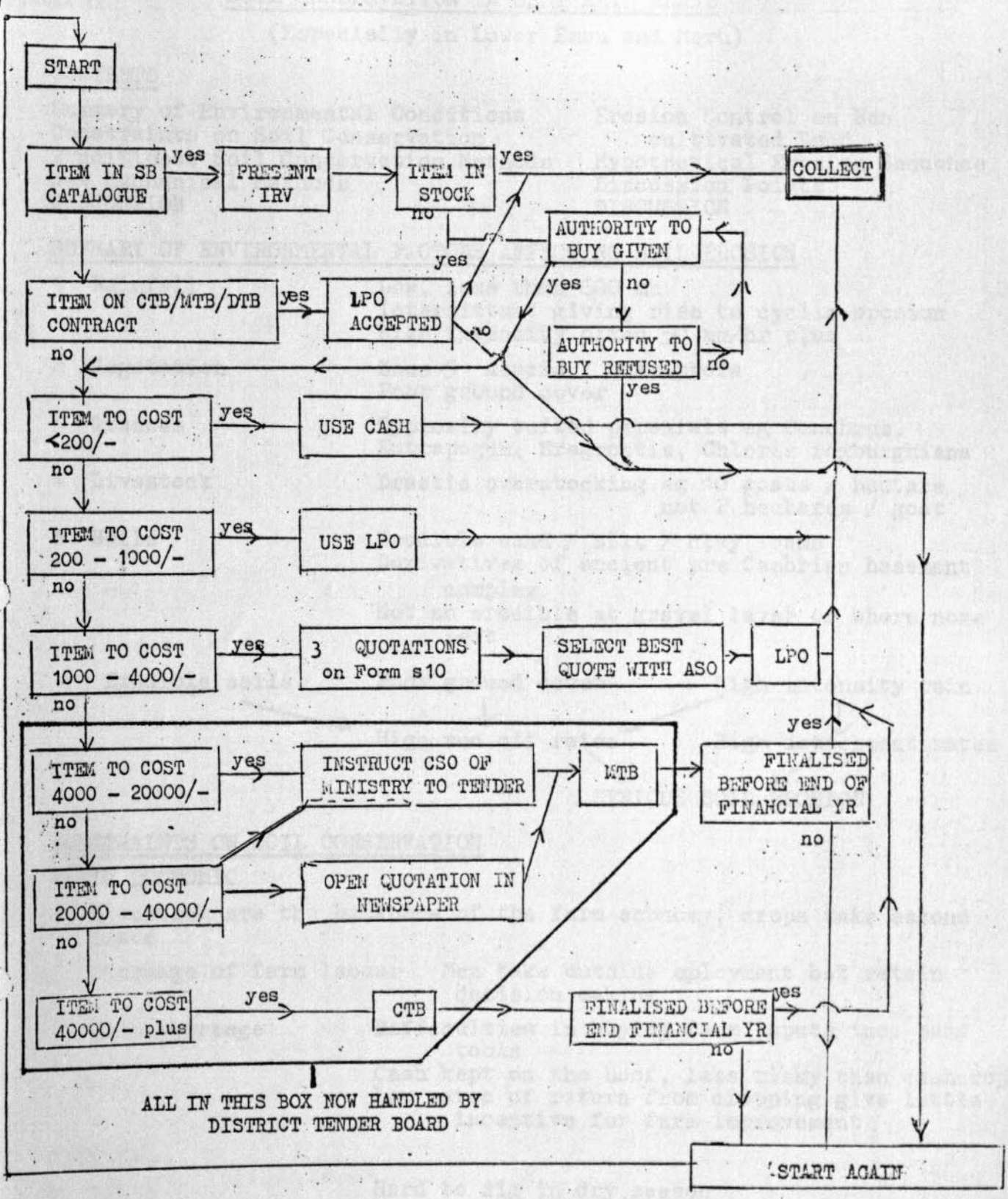
Authority to Buy to get this the IRV must pass through seven stages. If you are prepared to carry the forms around this can be done in a day but otherwise it is best to leave it for a week before trying again. Unfortunately getting the authority is not a passport to quick purchases as you now have to start all over again on purchase procedures.

If you want an item costing less than 4,000/=, (an item is any number of the same thing) then finding that it is not in the SB catalogue is good news because it can then be bought more simply using an LPO. Lets say that a few jembes are required. There are classified as 04-236 Jembes, (Hoes), 1½ Kg. If for some reason (which should be vaguely plausible) you need a 2½ Kg jembe, the PO, they don't stock it and you can use an LPO instead. However, this also works the other way. They may have some old 3lb Jembes hanging around. If you fill in the exact description including the 1½ kg, you won't get the 3 Lb ones even if they are the only ones available, since they don't fit the description!

For purchases above 4000/=, SB can be very useful because it saves the months of hassle involved in Central and Ministerial Tender Boards. Set against the delays involved, SB can provide almost immediate access to supplies, if they are in stock, of course!

Examples of items stocked by supplies Branch

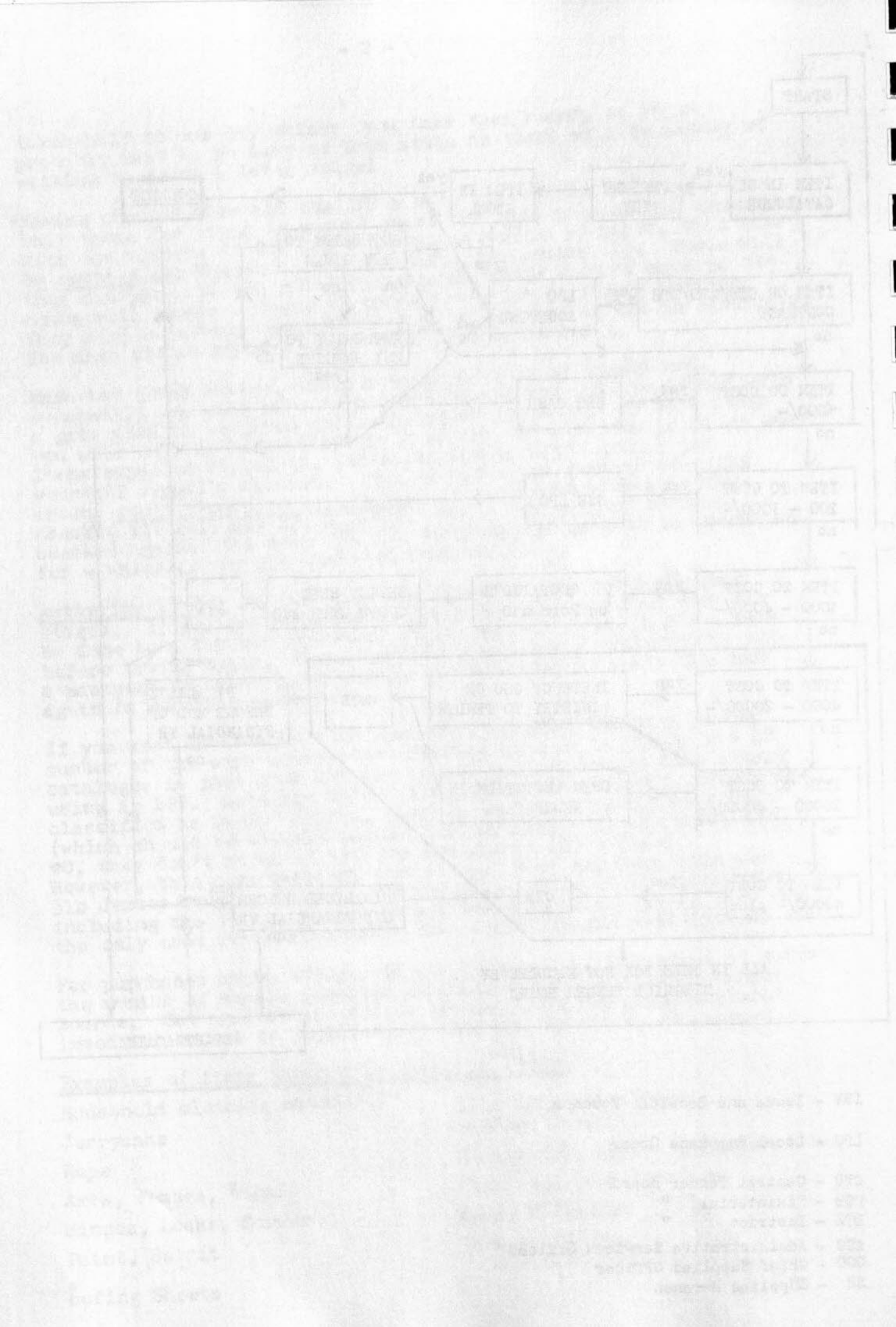
Household cleaning materials
Jerrycans
Rope
Axes, Jembes, Karais
Hinges, Locks, Screws
Paint, Spirit
Roofing Sheets
Iron bars and plates
Uniform material
Stationery, Office furniture
Pipes and pipe fittings
Beds, Matresses
Tables, Chairs.



IRV - Issue and Receipt Voucher

LPO - Local Purchase Order

CTB - Central Tender Board
MTB - Ministerial "
DTB - District "
ASO - Administrative Services Officer
CSO - Chief Supplies Officer
SB - SUpplies Branch



APPENDIX VI

SOIL CONSERVATION IN SEMI ARID AREAS

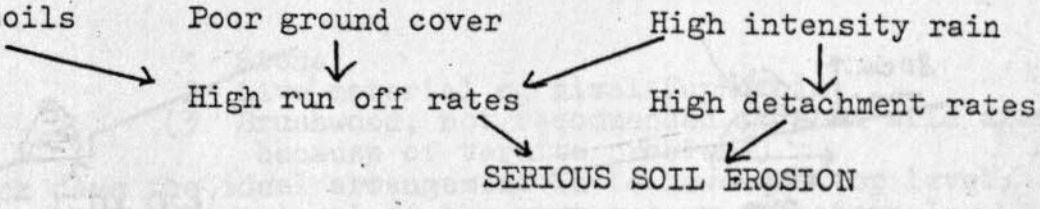
(Especially in Lower Embu and Meru)

CONTENTS

Summary of Environmental Conditions
Constraints on Soil Conservation
Traditional Soil Conservation Methods
New Mechanical Methods
DISCUSSION
Erosion Control on Non cultivated Land
Hypothetical Erosion Sequence
Discussion Points
DISCUSSION

SUMMARY OF ENVIRONMENTAL FACTORS AFFECTING SOIL EROSION

1	Rainfall	Low, less than 600 mm Intermittant giving rise to cyclic erosion High intensity often 50 mm/hr plus
2	Vegetation	Zone 5 Acacia / Commiphora Poor ground cover
3	Grasses	Typically tufted perenials eg Cenchrus, Entrapogum, Eragrostis, Chloris roxburghiana
4	Livestock	Drastic overstocking eg 10 goats / hectare not 2 hectares / goat
5	Soils	Erodible sand / silt / clay loams Derivatives of ancient pre Cambrian basement complex Not so erodible at gravel layer or where none left



CONSTRAINTS ON SOIL CONSERVATION

SOCIO ECONOMIC

1	Livestock are the backbone of the farm economy, crops take second place	
2	Shortage of farm labour	Men take outside eployment but retain decision making
3	Cash shortage	Difficulties in buying farm inputs inc. hand tools Cash kept on the hoof, less risky than cashcrops Low rates of return from cropping give little incentive for farm improvement

PHYSICAL

4	Soils	Hard to dig in dry season Infertile
5	Climate	High day time temperatures for working on the shamba
6	Nutrician	Reduced physical strength at times of low food intake
	IN GENERAL	High cash inputs to soil conservation cannot be justified Simple, low cost technology only Machinery inappropriate for conservation works

MECHANICAL SOIL CONSERVATION METHODS

A TRADITIONAL

1 Trash Lines

Advantages — Very low labour demand

Disadvantages — Attacked by termites
Have to be replaced each season
Competition for grazing when green or after harvest
Can only be made after good harvests

BUT If, due to labour shortage nothing else is possible then trash lines can be recommended

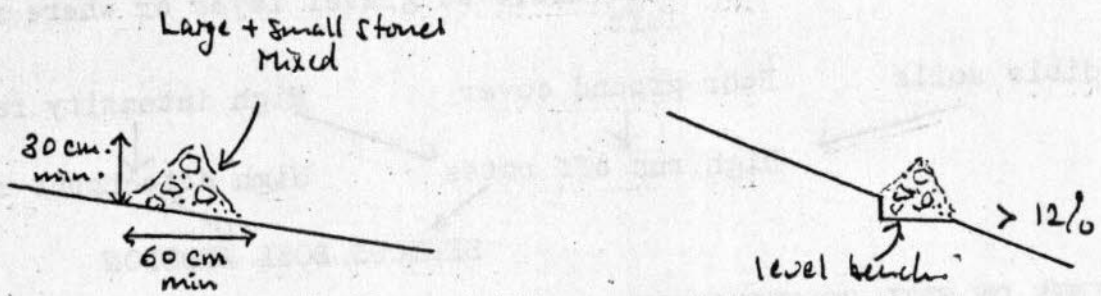
terraces up to 30 cm height can be built up over time

NB The 'shifting trash line' is probably a waste of time, more valuable if crop residue is left as a mulch?

2 Stone Terraces / Bunds

Advantages — Semi permanent
Errors in contouring not critical
Can be done by women and children

Disadvantages — Fairly high labour input
Terraces allow water to pass
Only possible where large amounts of surface stone available on or nearby shamba



If the slope exceeds 10 12% the ground beneath the terrace can be levelled but this means more work is then required
hand tools are needed

Stone terraces can be successful if maintained and built up over time

One good stone terrace of height 30 cm plus is worth more than several smaller ones

B 'NEW MECHANICAL METHODS'

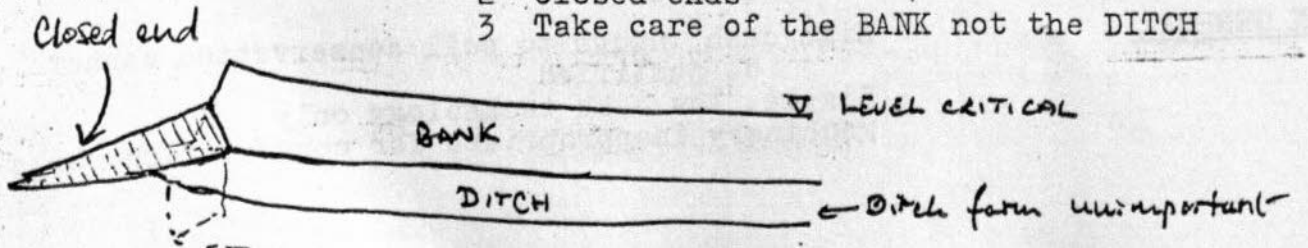
1 Cut off drain/diversion ditch

LOTS OF HARD WORK! REMEMBER, WOULD YOU DO IT YOURSELF?

There may be two problems in construction of a cut off drain
Ground is too hard
There is no safe discharge point

In the dissected terrain of many semi arid regions waterways are already at or beyond their safe water carrying limit
Therefore RETAIN not DRAIN

Modify cut off drain to become a retention ditch as follows:
1 Zero grade
2 Closed ends
3 Take care of the BANK not the DITCH



Cut off drains continued

If the catchment for the cut off drain is too large then a graded channel should be used together with protection works for the water course into which it drains. There is no particular limit for the size of catchment, but a guide figure is that water should not run down from more than 200 m above the cut off drain.

NB FORGET ARTIFICIAL WATERWAYS

2 Fanya juu Terrace

EVEN MORE HARD WORK!

Design can be modified to fit conditions ie

1 Low rainfall: zero grade for water retention
2 Shallow soils: reduce depth of excavation

Excavation normally 3' x 2'. If we reduce depth to 1' terraces will be reduced in size, therefore more terraces are required.

Build more smaller terraces while halving the Vertical Interval

Advantages of small terraces

Easier to dig, higher rates of work
Better water conservation (ie better distributn)

Features of small terraces

Zero grade
Closed ends
Half normal Vertical Interval

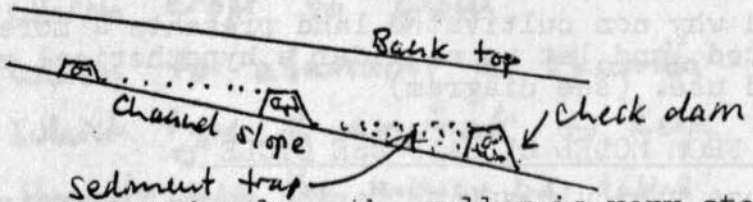
NB If soil is not too hard nor shallow no need to change design

3 Check Dams

Materials

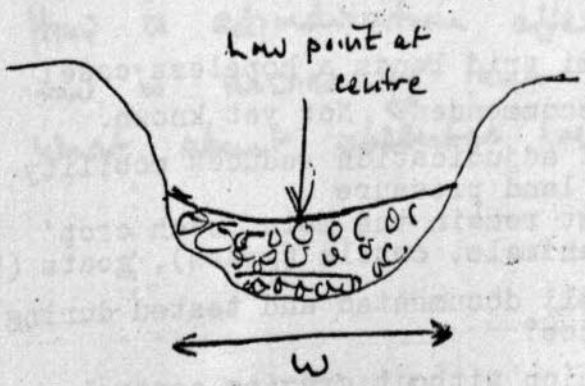
1 Stone
2 Live material eg sisal/Euphorbia
(3 Brushwood, not recommended in semi arid areas because of termite problems)

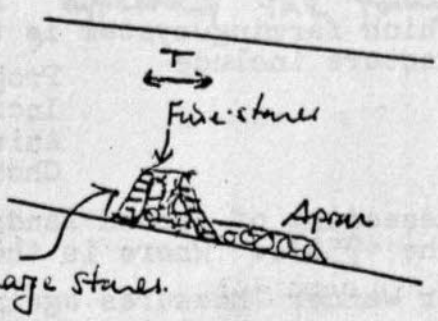
With stone check dams the ideal arrangement is to have the top level of one structure as the base level of the next one up the channel.



This rule can be followed unless the gulley is very steep (15% plus) in which a constant spacing should be selected or check dams can be alternated with say sisal to reduce labour input.

Design





Rules for Check Dam Construction

1 Top level of check dam must be minimum 30 cm lower than bank.
2 Centre of check dam must be lower than sides.
3 Downstream apron essential to prevent scour erosion and subsequent collapse of structure. Apron length minimum 2 T.
4 T = 1/10 W, minimum
5 Large stones form the protective outer edge while fine stones fill the centre to act as a soil filter.

NB Hard core alone is <u>not</u> the most suitable material. Small stones should be mixed in or some of the hard core broken up.

Gabion baskets are very expensive (K Shs 600/- approx. each) and should only be used in extreme circumstances.

Cutting off run off before it enters the gulley is more effective than using check dams.

EROSION CONTROL ON NON CULTIVATED LAND

Non cultivated land — fallow
grazing land
<u>not</u> range land

Points to note

1 The importance of physical soil conservation works is now accepted most MALB and Administration staff.
2 Rehabilitation of abandoned, bare, once cultivated land, is not regarded as important by many agricultural officers and is also not well understood.
3 Possible solutions
a) Fencing off abandoned areas to allow ground cover to re establish
b) Fencing and re-seeding
c) Fencing and chisel ploughing and re-seeding
d) Control of livestock movement without fencing
e) Use of agro-forestry to provide fodder

AIM to raise the productivity of fallow land

To understand why non cultivated land presents a more serious problem than cultivated land let us consider a hypothetical model of the cycle of land use. (see diagram)

OBSERVATIONS FROM MODEL OF LAND USE CYCLE

1 If we assume the cultivation period to be two years and the fallow period 10 years then only 20% of the land is under cultivation at any one time.
2 The most serious erosion occurs on unprotected fallow land.
3 Concentrating conservation efforts on cultivated land doesnot addre the real erosion problem of semi arid areas.

DISCUSSION POINTS

1 WHY BOTHER? Are the semi arid lands a hopeless case?

2 Which farming system is to be recommended? Not yet known.
Factors include
Progress of adjudication reduces mobility
Increasing land pressure
Animals must remain the main 'cash crop'
Choice of animals, cattle (grass), goats (brow

3 Reseeding of eroded lands was well documented and tested during the 1950's. Where is the evidence?

4 Dr Wenner 'Measures against erosion without grazing control are useless'. BUT WHERE ARE THE GOVT POLICIES?

5 Does the MALD have the resources to investigate further?

TACKLING THE EROSION PROBLEM ON FALLOW LAND

For any government / aid body to be effective it requires the following information.

1. An understanding of the existing land use system.
2. Proven improved land management methods
3. Realistic government policy for farmer cooperation in destocking.

Without these three, environmental degradation will continue, however concerned the government is to reverse the situation.

1. Existing Land Use System.

We need to know how the farmer makes decisions about:

- Which crops to grow
- When to abandon a shamba
- Which type of animals to keep
- How to use the money he earns
- When to sell animals
- Other sources of income.

How is adjudication affecting the farming system?
How is increasing land pressure affecting the farming system
What about absentee landlords?

⋮

Improved Methods of Land Management

We need information on

- Land carrying capacity
- Rehabilitation of eroded lands
- Suitable crop varieties
- Ways of improving stock
- Fodder trees / grasses

} All these still in investigational stage only.

For erosion prevention, the overriding consideration is establishment and maintenance of cover :-
(bush or grass, depending on grazing / browse preference).

Reseeding - tried with some success in 'Ukaloni' eg Machakos, Kitui, Baringo,

a. Exclusion of animals by 'order'
Good cover reestablished 6-10 years
who gives the order?
owner / Committee / Clan / Chief / L.E.O ?

b. Exclusion by fencing
Thorn fence - decay due to termites + rot
Live fencing - e.g. commiphora
Barbed wire - effective but who pays?

c. Ripping + reseeding (+ deep ploughing) (3-5 yrs)
Local grasses should have best chance of establishment
eg Cenchrus ciliaris, Eragrostis superba, Eragrostis macilenta
Chloris roxburghiana

REHABILITATION WITHOUT DESTOCKING INCREASES LAND PRESSURE

GOVERMENT POLICY ON CONSERVATION OF SEMI-ARID LANDS

Has the ASAL programme produced a national policy on semi-arid land management?

Various projects: Turkwel Gorge R. P.
MIDP
Kitui ASAL
Machakos SWCP
BEAAF
EMI / SWCP
+ NDFRS / ICRAF + other NGO project

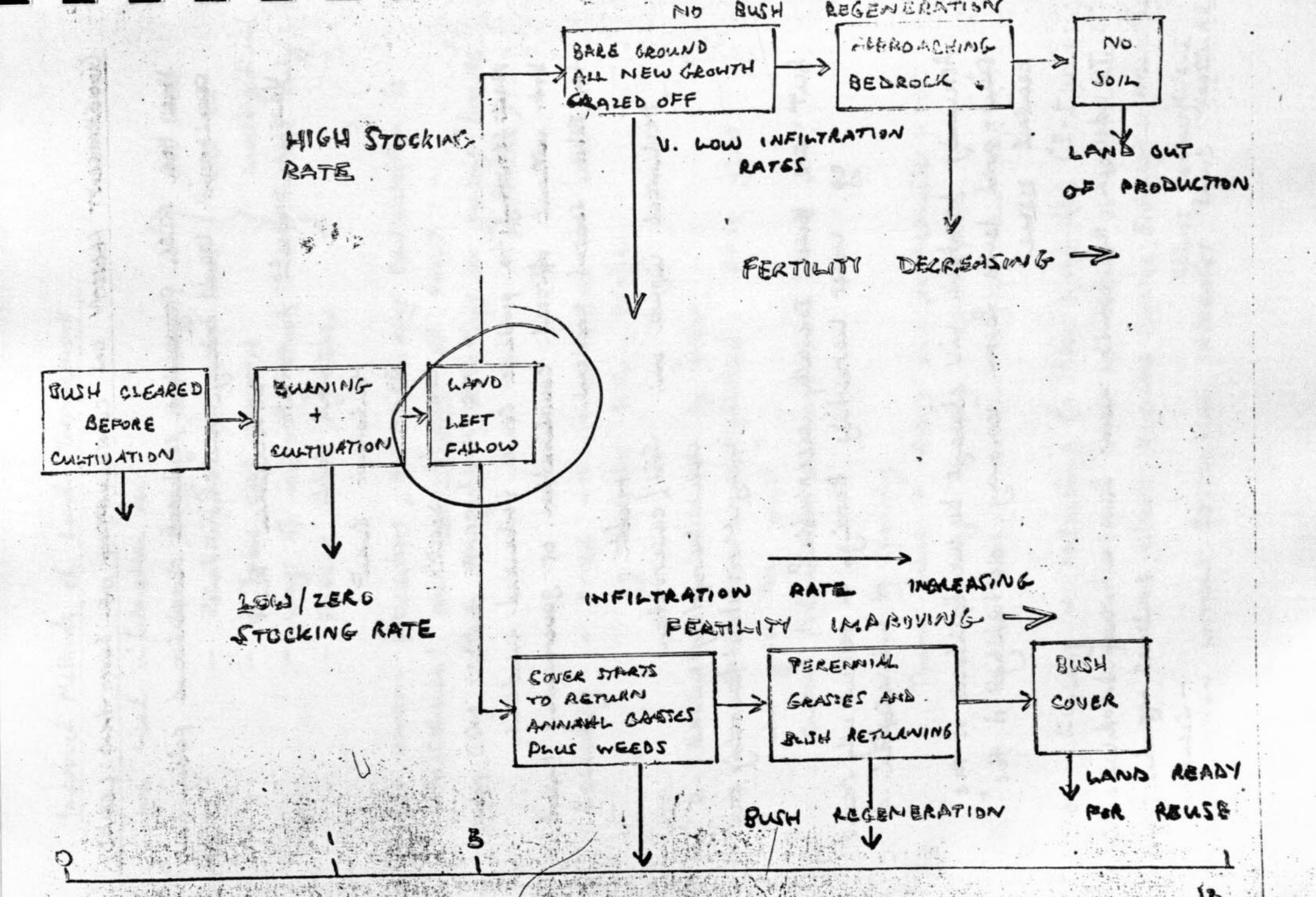
Now starting to produce some technical solutions but without official coordination or government input to solve social problems.

Technical inputs on: + water
Soil / conservation
water harvesting
Drought resistant / quickly crops

BUT are these socially acceptable?
eg. water harvesting dams. - technically sound
- not adopted.

Assuming livestock will always be the backbone of the semi-arid land farm economy, destocking is the central issue.

To destock the farmer must have alternative - income source
- status symbols
- security.


NO BUSH REGENERATION
BARE GROUND ALL NEW GROWTH GRAZED OFF
APPROACHING BEDROCK
NO SOIL
HIGH STOCKING RATE
V. LOW INFILTRATION RATES
LAND OUT OF PRODUCTION
FERTILITY DECREASING
BUSH CLEARED BEFORE CULTIVATION
BURNING + CULTIVATION
LAND LEFT FALLOW
2 Sh / ZERO STOCKING RATE
INFILTRATION RATE INCREASING
FERTILITY IMPROVING
COVER STARTS TO RETURN ANNUAL GRASSES PLUS WEEDS
PERENNIAL GRASSES AND BUSH RETURNING
BUSH COVER
LAND READY FOR REUSE
BUSH REGENERATION
0
1
5
1

APPENDIX VII Recommendations from the Workshop On Soil conservation on Grazing Lands

April 9-12, Utalii Hotel, Nairobi

For clarity recommendations have been grouped under five headings.

4.1. Planning and Implementation

4.1.1. Project planning and investigation should begin with unhurried discussion and investigation at the grass roots level.

The former tendency of planners to impose projects from 'above' should be resisted and replaced by consultations with community leaders and groups of both men and women. The local technical and administration staff should be brought in to facilitate a two way exchange of ideas leading to a concensus on which local and district leaders can agree.

4.1.2. The Ministry of Agriculture and Livestock Development should act as the coordinator of all Soil Conservation efforts at the national, district and locational level.

MALD should bring together the Administration, Ministry of Culture and Social Services, Missions and other NGO's at the District Agricultural Committee and in the locational Soil Conservation Committee.

4.1.3. A pilot project should be established in a mixed grazing - cropping area to train extension staff in the social skills required to identify and communicate with the semi-pastoralist, especially on conservation and grazing management issues. This project should be closely monitored and give feedback on the relevance and acceptability of the extension approach and recommendations being tried out.

4.1.4. Locally organised seed collection should be expanded so as to provide tree and grass seeds for distribution to those attempting rehabilitation and pasture improvement.

The seeds could be collected by school children or others on a contract basis (payment per kilogramme).

Seed bulking of promising crop varieties should also be expanded on a contract basis. Seeds of promising exotic tree/grass varieties might have to be collected from research institutions but should be introduced into the local bulking network at the earliest opportunities.

4.1.5. Micro-catchments should be used to aid the establishment of tree seedlings and grass, especially in eroded areas.

4.1.6. Water points for livestock should not be increased in number before livestock population control is carried out.

4.2. Extension and Training

4.2.1. The Range Management Division should be brought more fully into the "T & V" system and should be given the responsibility of putting forward recommendation for grazing land conservation.

4.2.2. Technical Range Assistants should have a deeper level of training in Soil Conservation and TAs should be exposed to Range Management concepts : such as grass seeding and carrying capacity.

4.2.3. Soil Conservation training for technical staff should include the following

Cultural and biological conservation methods
Water harvesting and spreading
Agroforestry
Forage
Rehabilitation
Policy issues in grazing land conservation

4.2.4. School teachers, adminstration staff and all local leaders should be made more aware of the dangers and causes of soil erosion on grazing land as an extension of the existing training programmes

for these people.

4.2.5. Some group leaders and selected farmers should receive a basic soil conservation training so that they can assist their own communities

4.2.6. The use of demonstration plots should be emphasised to show proven techniques for example live fencing, rotational grazing, rehabilitation.

4.2.7. The proposal to start an MSC course in soil and water conservation at the University of Nairobi is supported, provided that the course involves placements for on-the-job training.

4.3. Research

4.3.1. Physical conservation structures should be adapted to suit semi-arid and arid zones

4.3.2. Studies should be undertaken on the productivity and nutritional value of fodder and multi purpose species, especially trees and shrubs.

4.3.3. The potential for livestock and wildlife production in arid land should be compared and measurement taken of erosion rates under the different management systems

4.3.4. Semi-arid grazing lands should be zoned on the basis of the best ways of improving water infiltration and the cost/benefit ratio of conservation measures designed to raise productivity.

4.3.5. Further investigation is required into stocking rates and carrying capacity and how different animals compete for forage.

4.3.6. More detailed maps should be prepared showing

- existing land use patterns
- vegetation cover and type
- soil types

4.3.7. Having identified conservation techniques with a good chance of success, on - farm trials should be continued to test research recommendations in, for example

seed variety and seeding techniques
live fencing
cultivation techniques
fodder trees

4.4. Information

4.4.1. A simple hand book for extension workers should be prepared to provide information referring specifically to grazing land on

use of agricultural by-products as fodder or for compost
live fence establishment and maintenance
the role of trees and shrubs in conservation
deferred, rotational and zero grazing

4.4.2. Projects and research institutions in ASAL should exchange lists of seeds available specifying crop, tree and grass varieties, the amounts of seeds currently available and estimating future production.

4.4.3. A semi-annual technical news bulletin should be created for distribution to all concerned in ASAL Soil Conservation. This bulletin should be prepared at the Soil and Water Conservation Division and, in the first instance, by the Technical Evaluation and Monitoring Officer.

4.4.4. Projects should undertake to collect information from livestock owners on the best local fodder species with varying soils, slopes, rainfall and altitude.

4.4.5. An annual technical workshop should be held to compare notes on field operations, extension approach and progress in the development of simple technologies.

4.5. Policy

4.5.1. The overall policy of increasing and maintaining production should be applied to the grazing lands but attention should also be focussed on the socio-economic changes taking place especially in the mixed cropping-grazing lands as they affect long term policy.

4.5.2. The sections of the Agricultural Act pertaining to land conservation should be enforced although only as a last resort where all forms of persuasion have failed.

The front line extension worker should not act as a policeman but should be responsible for informing the land user of the relevant regulations. Any order to prohibit should be signed by the District Commissioner or the District Agricultural Officer acting on behalf of the District Agricultural Committee.

4.5.3. A team, under a coordinator of soil conservation in ASAL, should be formed within the Soil and Water Conservation Division to coordinate policy and activities between ASAL conservation projects of all types and sizes, whatever their source of finance.

4.5.4. Soil conservation activities should be concentrated in areas where communities show willingness to cooperate or have requested assistance rather than those areas with the greatest erosion hazards. Where conservation is a priority but the community is disinterested, motivation, preferably through the organisation of mens and womens groups, must precede implementation.

4.5.5. The Government should develop a cogent policy for the management of communally used grazing land especially the formalisation of land and tree use rights to promote responsible use and development of the fodder resource. The cutting of trees by outsiders and especially by charcoal burners should be properly regulated.

4.5.6. Where large farms are sub-divided and portions given to small holders the government should specify and dictate to the Districts Agricultural Committee the minimum economic holding size.

This is necessary to avoid overexploitation of a small holding which has, in some cases, already led to land degradation and erosion.

4.5.7. Land which is unsuitable for cultivation according to the Agricultural Act should not be demarcated but set aside for afforestation for other appropriate use. The present users of such land should be informed well in advance that in the event of land adjudication they will not be given ownership of that land.

4.5.8. - Marketing system should be developed to make the sale of stock more attractive to the livestock owner.

APPENDIX VIII

Cultural DO's and Dont's

A few guidelines, which don't always apply especially in more 'modern' circles. However the principles still hold good.

1. DO shake hands when meeting and saying goodbye.
   Take your time over saying hello without rushing straight into business.
2. DONT lose your temper. Whereas temper may occasionally be a useful disciplinary tool in European society, in Kenya it is only an embarrasing loss of self-control which will lose you respect.
3. DONT discipline anyone in front of others.
4. DONT press anyone for an admission of guilt.
   eg. 'you took it, didn't you? You will never get anywhere because of the loss of 'face' involved and you will be resented later.
5. DONT get frazzled by others' lateness. For instance everyone knows that a public meeting in rural areas starts 1 to 3 hours after the designated time.
6. DO give respect to old people, as age is still venerated.
7. DONT call anyone 'stupid' or 'Silly'. These carry the force of e.g. Cretin!
8. DONT ask anyone to count his animals or his children. The old belief that they die if numbered still lingers on.
9. DO speak clearly and avoid idioms. If you try to speak a local language you will be accomodated so return the compliment when speaking English.

10. DONT invite visitors to pass through your kitchen.

11. DO accept food when offered (if you have just eaten you can decline politely) and offer a drink or bite to eat when visited.

Not so. Eat it & suffer!

APPENDIX IX

PERSONNEL

Embu	Name of Officer in post at May 1985
DC	Mr. Chalang'a
DDO	Mr. Kigen
DAO	Mrs. Mucai
DLDO	Mr. Machogu
DACO	Mr. Kangesa
DEC	Miss Mwangi

Meru	
DC	Mr. Yagan
DDO	Mr. Malova
DAO	Mr. Sese
DACO	Mr. Kirui
DEC	Mrs. Muthuri

Eastern Province	
PC	Mr. Etemesi
DPC	Mr. Njuguna
PPO	Mr. Mwinamo
PDA	Mr. Mwasya
PLDO	Mr. Mburu
PSCO	Mr. Gichane

EMI/SWCP	
Team Leader/Land Use Planner	Jim Mansfield
PTAS Student	Ken Proud
Project Manager	Mr. Mwaniki

Assistant to LUP	Mr. Nyongesa
SWCO	Mr. Mwarasomba
Accounts Clerk	Mr. Njoka
Storekeeper	Mr. Kareru
Typist	Miss Njagi
Other PTAS Staff	Chris Mackintosh (Feb '82 to Aug '83)
	Bob Watson (Oct. '83 to Nov. '84)

APPENDIX X

Notes on Land rover KTY939

1. Fuel consumption: Petrol, 16 miles per gallon
   Oil, 1 litre per 200 miles

2. Mechanical Defects: Presently in good condition but gearbox has had several problems. Transmission whine is now a permanent feature. Reverse gear jumps out when reversing up a slope.

3. Wiring: This vehicle is the only one of the KTY or KTH collection to have wiring for a trailer.

   The front tank petrol gauge stops working when it is interfered with during gearbox repairs.

4. Suspension: Rear shocks recently replaced. New front shocks in EMI/SWCP store. Has 1 tonne springs.

5. Servicing: Cooper Motors does a good general service but are weak on solving out of the ordinary difficulties.

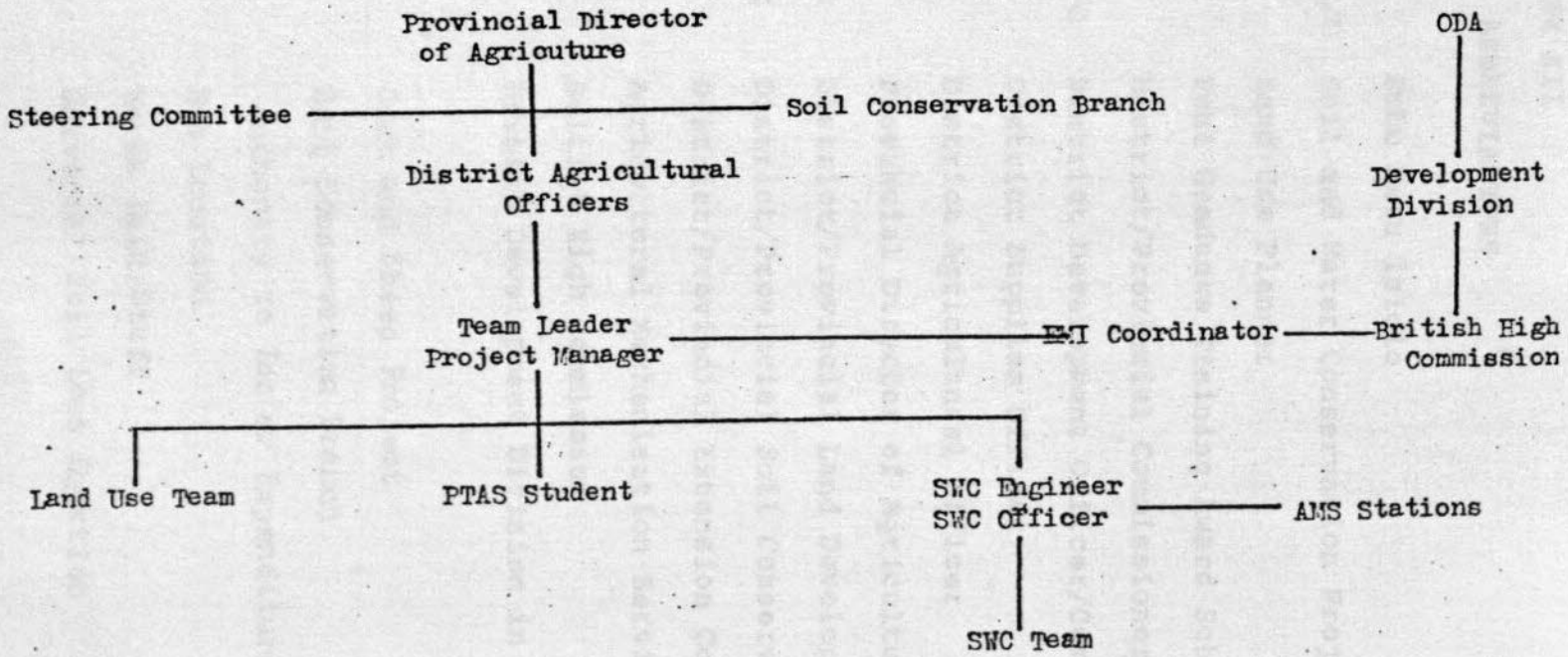
   PC's workshop in Embu has deteriorated recently. New Embu Uhuru garage gives a good service. Good for welding jobs.

   Needs full service every 5,000 miles.

6. Work Tickets: It is worth keeping a log of vehicle mileage, running expenses and repairs so that there are no queries about the way the vehicle itself or operating funds have been used.

EMI SOIL AND WATER CONSERVATION PROJECT

PRESENT ORGANISATIONAL STRUCTURE



APPENDIX XII

USEFUL ABBREVIATIONS

EMI	Embu Meru Isiolo
SWCP/E/O	Soil and Water Conservation Project/Engineer/Officer
LUP	Land Use Planner
PTAS	Post Graduate Training Award Scheme
D/PC	District/Provincial Commissioner
DDO/C/C	District Development Officer/Committee/Centre
DSO	District Supplies Officer
DAO	District Agricultural Officer
PDA	Provincial Director of Agriculture
D/PLDO	District/Provincial Land Development Officer
D/PSCO	District/Provincial Soil Conservation Officer
D/PEC	District/Provincial Extension Coordinator
AMS	Agricultural Mechanisation Services
BHC	British High Commission
BDDEA	British Development Division in Eastern Africa
GASP	Goat and Sheep Project
SCB	Soil Conservation Branch
AIE	Authority to Inc ur Expenditure
SL	Sub Location
WPS	Works Paid Staff
USLE	Universal Soil Loss Equation

APPENDIX XIII

TELEPHONE NUMBERS - EMBU

Provincial HQ (in P.C.'s W/shop)	20020
District Water Office	20140
District HQ	20010
District Commisioner	20062
DAO, Embu	20270
Ministry of Works	20261
Ministry Of Transport	20254
EmI Coodinator	20542
EmI Forestry	20540
EmI SWCP	20676
Embu Institute of Agriculture	20117
Eastern Emporium	20168
Kindaruma	20272
Kenya Material Trading Corporation	20662
Embu Timber Industry	20752
Automac	20314
New Embu Uhuru Garage	20234
Labour Office	20169
Church of the Province of Kenya	20618
Foster Parents Plan International	20393
Kenya Power & Lighting	20037
Kenya Posts & Telecom.	20500
Isaak Walton Inn	20128
Barclays Bank	20066
Mt Kenya Business Machines (Olivetti)	20621
P.D.A. (Direct)	20194
Kangaru High School	20511
Runyenjes Drapers	20666

TELEPHONE NUMBERS - NAIROBI

British High Commissioner	335944
Ministry of Agriculture Livestock Development (Kilimo)	720030
Land Development Division	721689
Paul Njoroge (Home)	501193
Chief Supplies Officer - Supplies Branch	330970
Don Thomas (Chairman, Ag. Eng.) Home	60965
Dept. of Agricultural Engineering, University of Nairobi	592141
Dept. of Civil Engineering	334244
Gill House	746613
F.A.O.	27642
Wildlife Conservation and Management	891601

Ministry of Water Development (Maji House)	723103
Cooper Motors	554211
Hughes Ltd.	559822
Kate Ltd. "	333074
Mombasa Peugeot Service "	334431
Car and General	540860
Kenya National Trading Corporation	29141
National Agriculture Labs.	48211
Ministry of Finance and Planning	338111
USAID	331160
DANIDA	331088
Survey of Kenya (Ruaraka)	802241
Ministry of Works	"26441
Mr. Skiba - Chief Structural Engineer	721022
UNICEF	520671
TARDA	332455
Nile Investiments	333230
Economic Housing Group	556999
British Council	334855
Sciex	331424

Fairview Hotel	723211
Intercontinental Hotel	335550
Duduvile Conference Centre	802744
Panafric Hotel	720760
ICRAF	29867
Customs and Excise	722095
Rentokil	20701
Davis & Shirtliff	557617
Machinery Services	558335
Wigglesworth	557022
Lets Go Travel	29539
Doshi Hardware	554733
Airoquip	64742
Alexander Gibb	22543
Haward Humphreys	332360
World Bank	24391
Rural Access Roads (MOTC)	722149
SIDA	29042
Kenya Electronics	24907
Crash Agents	335783

TELEPHONE NUMBERS - OTHERS

DC Meru	0164	20700
DAO Meru	"	20755
County Hotel Meru	"	20427
Catholic Diocess of Meru	"	20317
Rural Afforestation Meru	"	20206
MOWD, Meru	"	20453
Kaguru FTC	Nkubu	30
DAO Machakos Office	0145	21706
DAO Machakos Direct	0145	21766
Katumani Research Station		21506
AmS Chiakariga	Chiakariga	2
AmS Makueni	Makueni	16
Divisional Extention Officer	Runyenjes	59
"	Gachoka	4
"	Siakago	5
"	Tharaka, Chiakariga	5
Chief Nthawa Location	Siakago	8
" Karaba " (via)	Wang'uru	19112
" Evurori "	Ishiara	5