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# ENGINEERING & MANAGEMENT STUDY

Agricultural Mechanisation Services Branch,  
Ministry of Agriculture,  
Kenya.

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JUNE 1983

OVERSEAS DIVISION  
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# **ENGINEERING & MANAGEMENT STUDY**

**Agricultural Mechanisation Services Branch,  
Ministry of Agriculture,  
Kenya.**

*by T.J. Willcocks, J. Scott, J.R. Parkinson, R.M. Doake and R.S. Fieldson*

**JUNE 1983**

*Report No. OD/83/10*

**OVERSEAS DIVISION**

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SHORT TERM STUDY OF AGRICULTURAL MECHANISATION SERVICES BRANCH (AMSB)  
MINISTRY OF AGRICULTURE, KENYA (Apr/May 1983)

The findings and recommendations of a review conducted by a multi-disciplinary team consisting of an Agricultural Engineer, Management Consultant, Agricultural Planner, Civil Engineer and Agricultural Economist

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## ABBREVIATIONS USED IN THE TEXT

<u>Abbreviations/Acronyms</u>	<u>Position/Organisation</u>
<u>A</u>	
AEZ	Agro-Ecological Zone
AO	Agricultural Officer
ADC	Agricultural Development Corporation
AEIP	Agricultural Equipment Improvement Project
ADAS	Australian Development Aid Service
AMSB	Agricultural Mechanisation Services Branch LRDD
AMS	Agricultural Mechanisation Station LRDD
ASALDB	Arid & Semi-Arid Land Development Branch, MOA
AFC	Agricultural Finance Corporation
AEU	Agricultural Economics Unit, LRDD
AMTU	Agricultural machinery Testing Unit
ATE	Authority to Incur Expenditure
A-M	Aveling Marshall (now Track Marshall)
<u>C</u>	
CLRDD	Chief LRDD
CLSMB	Cotton, Lint and Seed Marketing Board
CWS	Central Workshop
CIDA	Canadian International Development Agency
CBS	Central Bureau of Statistics
CEBECO	Dutch Co-operative for Agricultural and Horticultural Items
<u>D</u>	
DAO	District Agricultural Officer
DLRDO	District Land Resources Development Officer
DEO	District Extension Officer
DANIDA	Danish International Development Agency
DPC	District Programme Co-ordinator
<u>E</u>	
EADD	East African Development Division, (ODA)
ETS	Extension and training Section, SWCB
EDF	European Development Fund
EMI	ODA Embu, Meru and Isiolo Regional Development Proj.
<u>F</u>	
FAO	Food and Agricultural Organisation
FTC	Farmer Training Centre
FYDP	Five Year Development Plan
FMB	Farm Management Branch, MOA
FMHB	Farm Management Handbook
FFS	Family Farming Sector

Abbreviations/AcronoymsPosition/OrganisationG

GAT  
GOK  
GDP

German (FDR) Agricultural Team  
Government of Kenya  
Gross Domestic Product

H

HTS

Hunting Technical Services

I

IDB  
IBRD  
IADP  
IMF  
IH

Irrigation and Drainage Branch, LRDD  
International Bank for Reconstruction & Development  
Integrated Agricultural Development Project  
International Monetary Fund  
International Harvesters

K

KSS  
KRSMU  
KFA  
KARI

Kenya Soil Survey  
Kenya Remote Sensing and Monitoring Unit  
Kenya Farmers Association  
Kenya Agricultural Research Institute

L

LRDD

Land Resources Development Division

M

MoA  
MENR  
MWD  
MF  
MLD  
MMP

Ministry of Agriculture  
Ministry of Environment and Natural Resources  
Ministry of Water Development  
Massey Ferguson  
Ministry of Livestock Development  
Sir M MacDonald & Partners Ltd

N

NIAE  
NCPB  
NU

National Institute of Agricultural Engineering  
National Cereals and Produce Board  
Nairobi University

O

ODA  
OD/NIAE

Overseas Development Administration (UK)  
Overseas Division, National Institute of Agricultural  
Engineering, UK

P

PO  
PPO  
PCO  
PDA  
PLRDO  
PHS  
PPCSCA

Planning Officer  
Provincial Planning Officer  
Provincial Crops Officer  
Provincial Director of Agriculture  
Provincial Land Resources Development Officer  
Plant Hire Section, AMSB  
Permanent Presidential Commission on Soil  
Conservation and Afforestation  
Permanent Secretary

PS

S

SWCB  
SIDA  
SP

Soil and Water Conservation Branch, LRDD  
Swedish International Development Agency  
Sessional Paper

T

THS  
TO  
TA  
TCO

Tractor Hire Section, AMSB  
Technical Officer  
Technical Assistant  
Technical Cooperation Officer

U

USAID

United States Agency for International Development



SHORT-TERM STUDY OF AGRICULTURAL MECHANISATION SERVICES BRANCH (AMSB)  
MINISTRY OF AGRICULTURE, KENYA (April/May 1983)

INTRODUCTION

1) Preface

The purpose of this report is to:

- Outline the findings of the Agricultural Mechanisation Services Branch Review Team
- Provide workable solutions to the management of technical problems that currently face the Plant and Tractor Hire Services (PHS and THS)
- Recommend a work programme for the improvement in future development of the Mechanisation Services Branch

Details concerning the request for this short-term study, the Draft Terms of Reference and Approach taken can be seen at Appendix A. Details of itineraries and contacts made are at Appendices B and C.

The multidisciplinary team comprised:

Agricultural Engineer	Theo J Willcocks, Overseas Division, National Institute of Agricultural Engineering (NIAE)
Management Consultant	Janol Scott, Peat, Marwick, Mitchell & Co.
Agriculturalist	John R. Parkinson, Hunting Technical Services
Civil Engineer	Richard M Doake, Sir M MacDonald & Partners Ltd.
Agricultural Economist	Robert S Fieldson Overseas Division, NIAE



The study was designed to assess the aspirations of AMSB and to give a first hand appreciation of the constraints under which the Branch operates. This was only possible by working alongside AMSB staff and by visiting most of the nineteen stations and the Central Workshop (CW) at Nakuru.

The investigation was based on four key questions:

- i What type of plant and tractor hire service does Kenya need in the 80's?
- ii What can the private sector provide?
- iii What should a Government-run service provide?
- iv What alternative technologies and management strategies are available to satisfy the needs identified?

For convenience the report is presented in two main sections:

- A) Summary Report, outlining the main findings and recommendations of the review team; and
- B) Main Report, with details of the findings, calculations and discussion of ideas that provide the basis upon which the recommendations have been made. Detailed technical, management and background information can be found in the supporting appendices.

Before leaving Kenya in early May a four page Summary Note of the findings and recommendations was produced. This document (copy at App D) was used as a basis for discussion with the Permanent Secretary of the Ministry of Agriculture, the LRDD/AMSB HQ staff and the EADD/BHC. Major issues were discussed in detail at those meetings. Agreement in principle was reached on the overall recommendations that the team would put forward.

## 2) General Background

At the time of the study AMSB was responsible for about 110 units of PHS plant and 200 THS agricultural tractors (see section 3.3).

At today's prices the value of the fleet is equivalent to about £12million



worth of plant and £3 million worth of agricultural equipment. The plant and equipment is distributed over 19 agricultural machinery stations throughout the country. (See map at rear ; Kitali and Mariakani stations are about 850 km apart).

Internal reports of the AMSB clearly reveal the severe difficulties that for some years have been experienced in operating the services. In 1981 and 1982 requests were made for further aid (British Commodity Aid in 1981 and Sector Aid in 1982) amounting to K£12.6 million for machinery and development costs and K£0.19 million for overseas training (App E). It was considered, however, that the supply of yet more hardware was unlikely to provide a workable solution to the operational problems and a request for a multidisciplinary short-term study of AMSB was made (see App A).

Early in the study period it was evident that advice which had been given on previous missions, regarding the technical aspects of running large plant and tractor hire services in Kenya, (eg Willcocks 1974, Spooner and Gota 1976, CEBECO - Handelstraat 1977, McRota, Oud, Pesse and Sovee 1981), had not been followed. Much of that advice is based on sound engineering practices but most of the estimates of machine outputs and operating costs bear little relationship to what was actually being achieved (Section 3.5). It was considered important, therefore, that this study should base its recommendations on the actual outputs and costs of PHS and THS so that realistic targets could be established for the future.

In parallel with the three objectives(p 1), and from the four questions highlighted in the preface above, it was also considered necessary to establish:-

- I current Government policies and objectives for soil and water conservation and mechanisation;
- II achievements of AMSB towards these objectives
- III whether the initial objectives remained valid for AMSB;
- IV what practical options were available for the future.

The above four points are reported on in the Summary Report below.



A SUMMARY REPORT OF THE REVIEW TEAM ASSIGNED TO THE  
AGRICULTURAL MECHANISATION SERVICES BRANCH (AMSB)  
MINISTRY OF AGRICULTURE, KENYA

\* BACKGROUND, FINDINGS AND DISCUSSION

I GOVERNMENT POLICY AND OBJECTIVES

i) Agriculture

The aim is to integrate the Family Farming Sector (FFS) into the cash economy by the year 2000. At the same time, encouragement is being given to the policy of increasing access to land. This is being done by sub-dividing suitable large land units into individual small farm units, (4FYDP and Presidential Decree 15 April 1983); the development of semi-arid lands, [Sessional Paper (SP) No 4, 1980]; swamp drainage and the development of valley bottoms (4FYDP).

In the Fourth Five Year Development Plan (4FYDP 1979-83), and the initial recommendations for the Fifth FYDP emphasis was placed on the need for major development efforts to be concentrated on the FFS (MoA, 1983).

ii) Agricultural Mechanisation

It is acknowledged that the future development of agriculture will necessitate the wider use of more appropriate technology that will increase labour productivity and decrease the present emphasis on imported capital intensive equipment (SP No 4, 1981 - National Food Policy). This paper also states that the Government of Kenya (GoK) will give encouragement to development programmes which supply mechanised, ox-drawn and hand equipment. Support will also be given to the long-term development of effective farm machinery manufacturing, extension, distribution and servicing systems.

iii) Soil and Water Conservation

The GoK is commendably aware of the pressing need for a national appreciation of, and mass effort towards, the conservation of the country's limited natural resources.

'Resource conservation is the base on which Kenya's agriculture is built. Soil ... is an asset which must be maintained for future generations.' [Permanent Presidential Commission on Soil Conservation and Afforestation (PPCSCA) Office of the President, Conservation Week Booklet, 1982].

The commitment by the Nation's leaders towards conserving these resources is evident through the publicity given by the mass media to the various campaigns conducted throughout the country.

The President himself has stated that 'All past ... appeals have not yet resulted in a countrywide popular understanding of this peril (of soil erosion)' and '... valuable topsoil has been eroded and lost at an alarming rate'. (PPCSCA Booklet, 1982).

This drive to create an awareness of the fragile nature of the ecology



is focused each year on efforts made during National Conservation Week, the third of which took place from 11 to 16 April 1983 (see Agricultural Annex).

The Permanent Commission on Soil Conservation and Afforestation (PPCSCA), which is directly attached to the President's office, is charged with co-ordinating the Government's efforts in the drive towards a better understanding of, and commitment towards, practical conservation of the country's natural resources (Cabinet Memorandum on the Establishment of the PPCSCA).

The GoK's main objective in resource conservation activities is 'to conserve the natural resource base of the country' (Personal communication Chief Executive, PPCSCA.) The Government has further expressed its commitment towards intensifying its popular campaign in which '... daily efforts must be made by Kenyans ... (in) all soil conservation.' 'The main task of the PPCSCA is to define an integrated national soil and water conservation and afforestation programme' (Cabinet Memorandum).

#### iv) Plant Hire Service

The specific objectives of the PHS have not been clearly identified. However, the main aims of what was previously known as the Soil Conservation Service (SCS) were outlined in the SCS Equipment Project Phase II (1976) as follows:

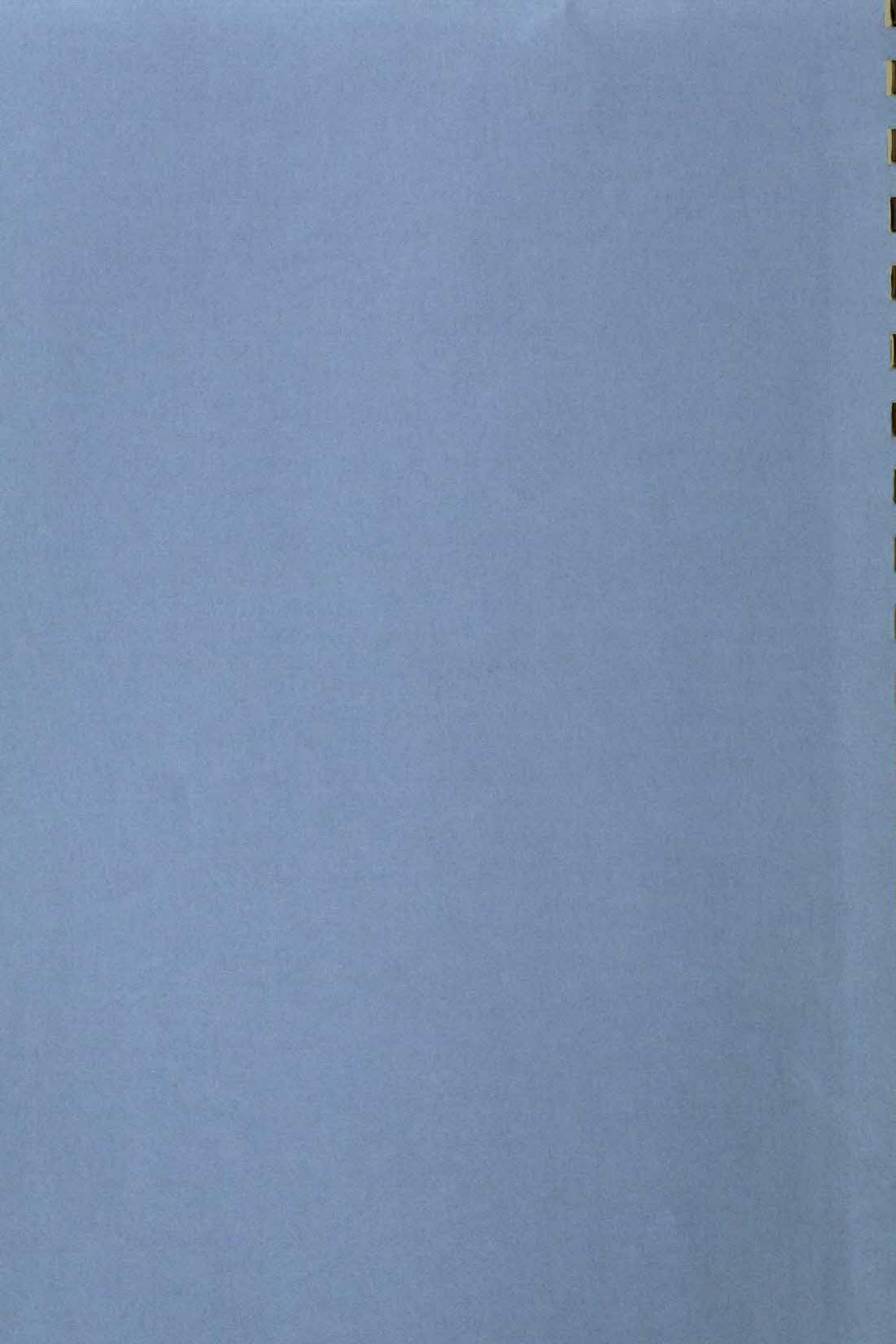
- "1) To ensure that every acre of cultivated agricultural land is maintained at its maximum level of production, consistent with the use of appropriate soil and water conservation measures.
- 2) To bring more land into agricultural production by:
  - applying appropriate conservation treatments;
  - implementing drainage measures;
  - providing dams and waterholes in marginal areas;
  - planning minor irrigation projects in irrigation potential areas.
- 3) To be responsible for informing farmers and agriculturalists on the appropriate conservation techniques and requirements and to carry out services in accordance with approved plans and conservation principles."

Minor irrigation projects are now the responsibility of the Irrigation and Drainage Branch (IDB) of the LRDD while the Soil and Water Conservation Branch (SWCB) of LRDD is responsible for the information and servicing role explicit in paragraph 3) (see App F for organograph of LRDD).

#### v) Tractor Hire Service (THS)

The original main objectives of the THS were:

- "1) To open new areas for agricultural production
- 2) To introduce modern agricultural techniques to farmers and to stimulate private ownership of farm machinery.
- 3) To supplement land preparation (especially in Family Farm areas) where private contractors are not sufficiently operative.



- 4) To increase agricultural productivity, especially cash crops such as cotton which are important to the Kenyan economy".

A confirmation of the above aims was spelt out in January 1971 when the Head of the Land and Farm Management Division stated in an interim policy statement that the THS should not compete with local contractors and that it should be 'self-supporting'. The policy statement also stressed that the service should become more efficient and detailed how this could be done. Guidelines were given on specific tasks to be carried out by DAO's and Tractor Unit Supervisors on: preliminary investigations, prior collection of hire charges, plot size and dispersion, supervision and maintenance of equipment and other duties. A further aim of the THS was to 'encourage mechanisation in areas other than the Masai Wheat Scheme.'

Since 1971 no 'final policy statement', although anticipated at the time, of the above directive has been made.

Sessional Paper No 4 - 1981 is critical of the THS. In the paper the efficiency of the Service is stated 'to be extremely low ... very few farmers actually benefit'. However, it is stated that 'the service will be improved and the role of farming groups and the private sector expanded. The service will be broadened to include the use of tractors for soil conservation and land improvement.' And that '... the enlargement of the THS will be conditional on the increase in its efficiency.'

The Policy Paper states that credit facilities will be made available to co-operatives and farmers for buying tractors, particularly in areas where the services provided by the private sector are considered to be inadequate. The paper adds that 'animal traction equipment usage will be encouraged' and this has been the main activity of the Agricultural Machinery Testing Unit (AMTU) of the LRDD in recent years.

## II ORGANISATION, PERFORMANCE AND ACHIEVEMENTS OF THE AGRICULTURAL MECHANISATION SERVICES BRANCH (AMSB)

### i) Organisation

The Agricultural Mechanisation Services Branch (AMSB) is a component activity of the Land Resources Development Division (LRDD) of the Ministry of Agriculture, which also contains the Soil and Water Conservation Branch (SWCB) and the Irrigation and Drainage Branch (IDB). See MoA and LRDD organographs at Appendix F.

AMSB combines the previously discrete functions of the Plant Hire Service (PHS) [formerly known as the Soil Conservation Service (SCS)] and the Tractor Hire Service (THS). In addition to the hire of plant and agricultural equipment with operators, some surveying services are also offered to farmers on a hire basis. Hire charges are published from time to time in the Kenya Gazette, (App G).

In 1981 a Government policy decision to 'decentralised' effectively placed responsibility for the administration of AMSB in the hands of the Provincial Directors of Agriculture (PDA). The responsibility for "technical and professional" matters was left with the Head of AMSB and his two (PHS and THS) co-ordinators.



From the original seven stations in the 1970s AMSB has now expanded and dispersed to 19 locations. Few stations have adequately equipped workshop facilities. Machanga, Mariakani and Migori stations now have upgraded regional workshop facilities (eg Photo 3) but these new workshops have been designed specifically for THS equipment. Central workshops at Nakuru have discrete PHS and THS buildings but again the PHS facilities remain unsuitable (Willcocks 1974) for the efficient repair of large plant (Photo 4, 5, 6, & 7 pp 62 and 63).

Statistics concerning each station are summarised at Appendix H and a map of Kenya, with the station locations marked, is included at the end of the Study Report.

## ii) Performance and achievements of AMSB

In this study it was decided that the PHS and THS should be considered separately. This was done because conservation works uPHS tend to be once-off constructional projects, whereas tillage for crop production is needed each season.

### 1 Survey and planning unit (SPU)

Agricultural mechanisation stations generally lack the facilities needed for surveying and planning for soil and water conservation.

Some staff have long experience in surveying but AMSB lacks an appropriately qualified Soil and Water Conservation Engineer for farm layout, earth structure design and implementation.

### 2 The Plant Hire Service (PHS)

During this review it became evident that there were no clearly defined objectives for the PHS staff to work to. Most stations had no planned work programme for 1983 since the service was essentially operating passively on an ad hoc basis. Anticipated annual work loads were usually based on theoretical potentials of plant work hours that were never possible to achieve in practice. The annual reports from the AMSB stations (summaries at App H) record a very low utilisation of plant in 1982, viz. an average of only 210 h/unit/year based on a reported fleet size of 106 units. The cost per unit of plant during 1982 was K.Sh 2580/- per hour (Kf129/h). (see Section 3.8 and App. I for details).

Most of the stations visited identified their problems with finance, eg:

- inadequate funds;
- inflexible and extended payment procedures that led to serious delays;
- lack of fuel;
- lack of spare parts and maintenance/repair facilities;
- low work incentives for staff and delays in payment of field allowances.

Managers also made the point that it was difficult to know who was their real boss. Technical advice was available from AMSB headquarters but difficulties had been experienced with directives from provincial or district staff because they did not understand the disciplines necessary to run mechanical units. Earlier studies of the



SCS (Willcocks 1974, Spooner and Gota 1976) have highlighted the needs for efficient technical support facilities with regard to equipment utilisation, operation, maintenance and repair.

Another very real problem, seemingly beyond the control of MSB, is that Aid Donors have given little thought to fleet management as they have supplied numerous types and makes of equipment. This has demonstrated a distinct lack of consideration or understanding of the problems faced by AMSB management in the operation, maintenance and supply of spare parts for such a mixed fleet.

Professional ability of the AMSB to deal with serious erosion problems like the gully at Nyakach was decidedly lacking (Photo 14). At the time of the team's visit to this site it was evident that the layout of a water catchment system had also developed into an erosion hazard.

No plans were available from Kipkelion or Migori stations relating to Nyakach. This particular example points to the urgency of establishing a professional Soil and Water Engineering design team within the AMSB.

It was observed that many of the mechanical faults with equipment were related to the lack of operator and mechanic training as well as inadequate facilities. The engine cylinders of a virtually new K£90,000 bulldozer were exposed to the rains for want of a cylinder head gasket. The resultant damage to the engine could multiply the cost of the original repair by a factor of 100! Station management by engineers, as opposed to agriculturalists, should stop the unnecessary loss of costly plant through technical unawareness.

In spite of all these difficulties, PHS are still able to field some operational equipment much of it over 15 years old! It is also acknowledged that there are some extremely experienced staff in the ranks of PHS who have been responsible for the construction of some commendable structures over the past two decades.

### 3 Tractor Hire Service (THS)

The performance of THS over the last 5 years was examined, and it was clear that the total work output had risen much less than the fleet size. The best year was 1980 when 173 tractors ploughed over 7000 ha and harrowed a further 2200 ha, but the average productive hours worked per tractor was only 167 h/yr. By 1982, although the fleet had increased to 196 tractors (+13%), only 5500 ha (-21%) were ploughed and the number of productive hours per tractor had declined to a very low 109 h/yr. Poor performance is not attributable solely to increasing machine age as in 1982 over 70% of tractors were less than 5 years old and very few had achieved 2000 hours work in total.

The proportion of productive hours to total running hours was around 70%. Reported rates of work averaged 3.5 h/ha (1.4 h/ac) for ploughing and 1.5 h/ha (0.6 h/ac) for harrowing. Farmers spoken to were satisfied with the quality of THS work which they felt compared well with that achieved by private contractors.

There was evidence of dissatisfaction by some farmers who had requested THS to plough their fields instead of private contractors. These farmers were unable to get their ploughing completed on time because the THS tractors were either broken or out of fuel. In these instances private contractors were generally no longer available.



Unable to compete with the low THS hire rates, they had moved on to other areas to find work.

AMSB station reports were examined to find the reasons for high down-time and poor work output, but they did not give adequate detail in most cases. However, it was clear that important reasons include:

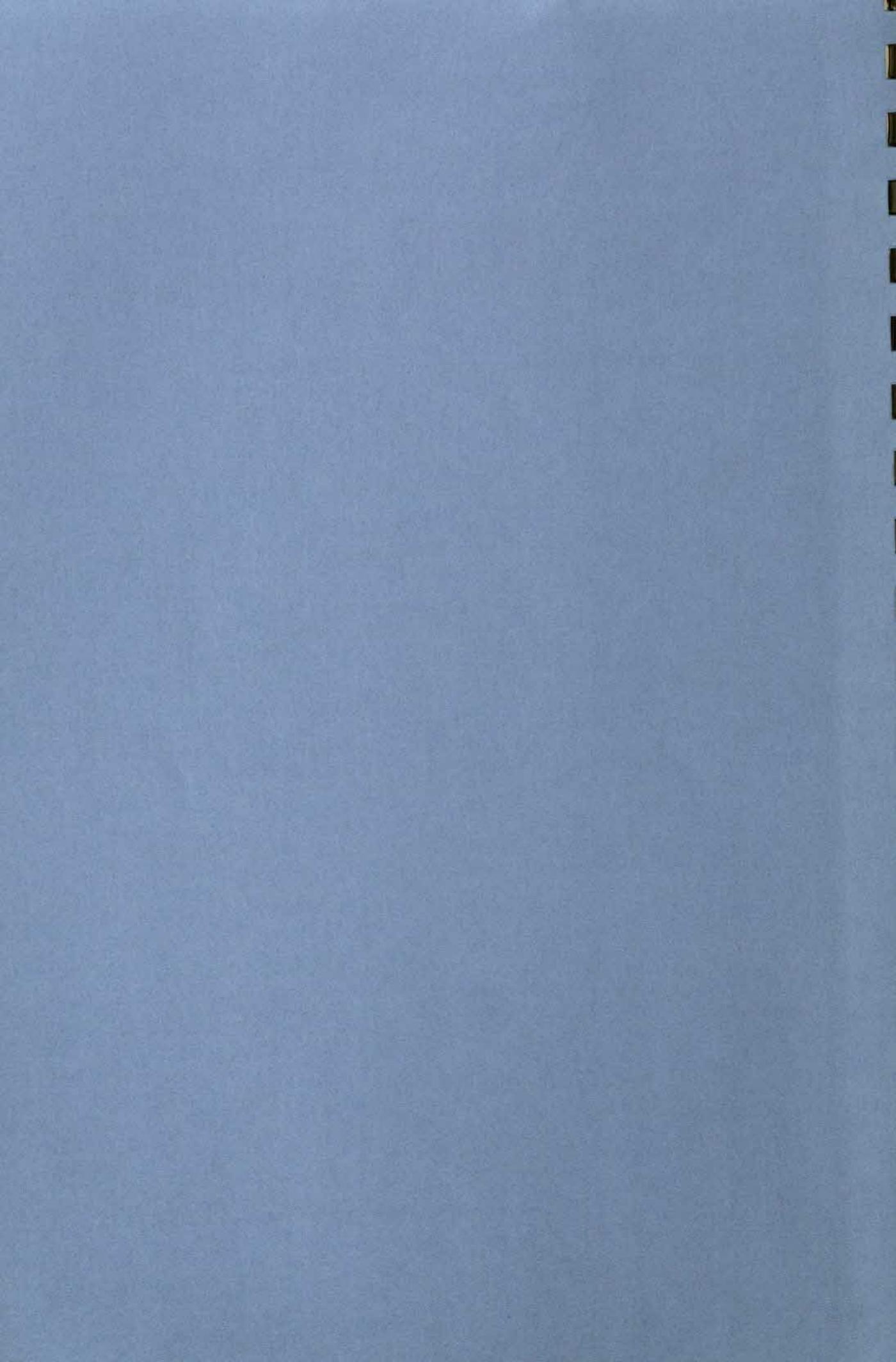
- Seasonality Tractor hire units are now based at specific locations and work mainly within the District where they are based. The peak work season is therefore limited to only 3 to 6 months per year in contrast to the extended work period achieved by formerly mobile THS units and by private contractors at present.
- Lack of fuel Fuel shortages were commonly given as the main reason for downtime. In fact absolute shortages of fuel were less of a problem than lack of funds to pay for it. Distribution of fuel to work sites is also a problem at some stations.
- Machine breakdowns Some breakdowns resulted from poor maintenance or from improper use by unskilled operators. Breakdowns are inevitable when machines work in difficult conditions. However, it was alarming how long even a straightforward breakdown could render a machine inoperative. Some tractors did no work for over a year because of lack of spare parts or of funds to purchase them. In such cases, further deterioration or cannibalisation sometimes resulted in a machine being written off as a result of what was initially quite a small breakdown. Dealers for some tractors had inadequate spares stocks. Foreign aid donors must accept some responsibility for providing machines to AMSB without satisfactory dealer support in Kenya.
- Finance Lack of finance is in part beyond the control of AMSB. However, more careful planning would ensure that limited resources were used more efficiently, and demonstration of the ability to perform could improve the sums allocated in the first place.
- Incentives Machines must operate for as long as possible during peak periods, but this requires better incentives for management and staff. Overtime payments for operators, and more thorough monitoring of management performance is urgently needed.

### iii) Cost

Based upon the 1982/83 allocation of funds of recurrent expenditure and including a notional depreciation charge based upon the estimated capital cost of equipment and facilities, the team derived the following overall figures for AMSB operations in 1982/83:

<u>Item</u>	<u>K£ million</u>
Recurrent spending	K£ 1.400
Notional capital cost	2.600
<u>Total cost</u>	<u>4.000</u>
Revenue earnings	0.725
Deficit 82/83	K£ <u>3.275</u> million

Details of the calculations from which the above estimates have been made are set out at Appendix I.



## PHS

Of the above recurrent spending, that attributed to PHS (including labour, fuel, station running costs, and headquarters expenditure) amounts to about Kf880,000. A notional depreciation allowance for machine and station capital costs adds a further Kf2,000,000, giving an annual estimated cost of Kf2,880,000.

At the 1982 achievement of some 22,000 productive hours for the whole fleet, the cost per hour of PHS operations is about KShs 2,580, (Kf129) per hour.

It is recognised that severe financial constraints have reduced efficiency in 1982/83. However, adopting the best annual output of 48,500 hours (in 1979) the cost per hour (KShs 1190; Kf59.50) would still be significantly in excess of the current hire rates.

## THS

Similar interpretation of THS output and performance shows that the cost per productive hours is KSh 1,070 (ie Kf53.5/h).

On an area ploughed basis this is equivalent to:

KSh 3,750/ha ie £187.5/ha (KSh 1,516/ac ie £75.8ac).

### iv) Summary of constraints confronting the AMSB

The main problems as perceived by the management are listed at Appendix J. These constraints have been categorised into Financial, Personnel, Organisational, Physical and Socio-economic factors. (The team does not necessarily agree with the order of priorities listed.)

## III VALIDITY OF ORIGINAL OBJECTIVES

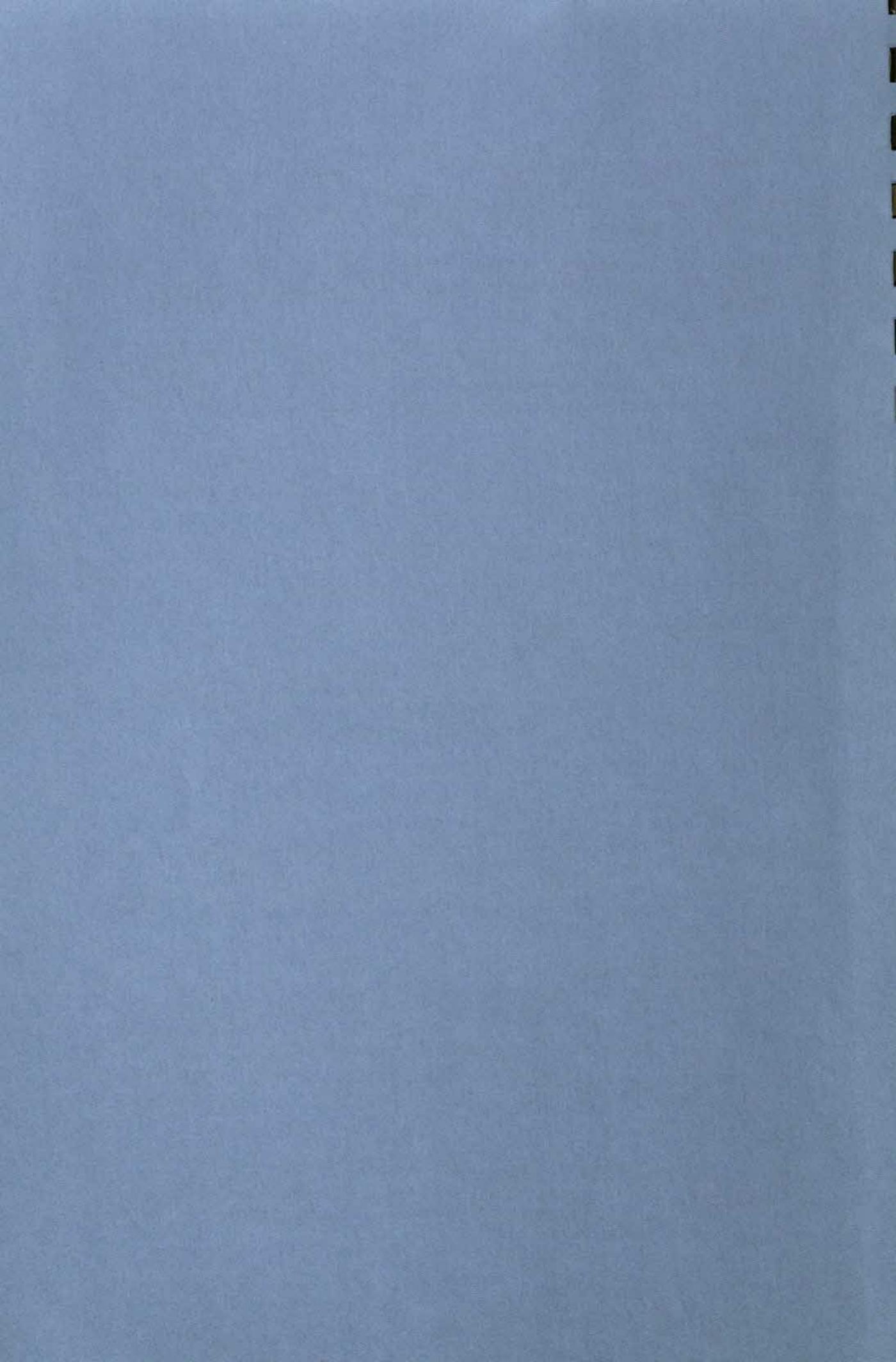
### i) Survey and Planning Unit/PHS

When the Soil Conservation Service (SCS) was established much of its work was aimed at the development of the large scale farms. This no longer remains a priority objective of PHS since many of the larger farms have been or are now being, divided for the settlement of small scale farmers.

What is urgently needed, is that the layout design for the division of these large farms be planned in accordance with sound resource conservation practices. Furthermore, with the increasing demand for activities ranging from gully control to water hole development, more attention should be directed towards survey and design procedures. A professional soil and water engineering design service will be needed to cater for this type of work.

### ii) THS

The objectives for THS remain valid. However in some areas they appear to be forgotten as there is evidence that the highly subsidised hire rates have discouraged the development of the private contracting sector e.g. Eldoret and Kipkelion.



During the past two decades, agriculture in Kenya has become increasingly Family Farm orientated with small farm units predominating. Farm size and profitability dictate that this sector relies largely on labour intensive means of cultivation. Accordingly, there is little scope for tractor hire services on small farms in Kenya. At the other end of the scale, most large-scale farmers have their own tractors and equipment and have little or no reason for calling contractors to do the work for them.

The demand for outside contracting services for land cultivation comes mainly from medium sized or 'gap' farms (average size of 25 ha) which constituted around 12 per cent of the privately owned farming area in 1978 (IBRD, 1982).

For these reasons, there is little justification for a public financed tractor hire service in relatively developed parts of the country. However, there is some justification for a service to be provided in remote newly developing areas.

iii) Organisation and Management with regard to decentralization of Government

Agriculture in Kenya is diverse and its effective management demands specialised knowledge of the numerous systems involved. The needs of smallholders living in the densely populated and humid districts of Kisumu Province are totally different to those experienced by dryland farmers in the semi-arid areas of Baringo or Machakos. Most Kenyans have a practical understanding of the agricultural problems within their districts and therefore the decentralisation of agricultural administration through PDAs and DAOs is appropriate.

Mechanisation requirements within the country are also heterogeneous. Tillage requirements are determined by climatic and soil characteristics with labour and land resources affecting the scale of mechanisation.

In contrast to the above, the management of plant and tractors demands adherence to specific engineering disciplines that remain independent of location. All the AMSB stations visited reported a basic lack of operational support and service facilities that quickly resulted in non-operational equipment regardless of age.

It is considered therefore that AMSB can provide an effective service only when it is allowed to function as a professional engineering body with direct vertical line management. (See Main Report Section 4.2).

The requirements for work must come from the agricultural sector through the PDAs, PLDOs and DAOs. The AMSB should, however, be accountable for the planning and execution of the mechanisation services.

The future of any technical service is dependent upon the professional ability to identify a tangible work programme, recognise the priority needs and deal with them effectively and efficiently. In the wider context, the AMSB should liaise closely with other government organisations which are also active in resource conservation and extension work.



## \*\* RECOMMENDATIONS OF THE TEAM

### IV PROPOSALS FOR THE FUTURE

#### i) Priorities

It is the firm belief of the Team that the AMSB can only provide an effective and economic service when:

- the number of Stations is significantly reduced to at about half the present level (Main Report Section 4.3) and
- the professional expertise of the organisation in Soil and Water Conservation Engineering and Management is upgraded (Main Report Section 4.1, 4.2 and 4.6).

The Team has also concluded that:

- there is no immediate need for any additional plant or tractors but
- some spare parts and tools are urgently needed. (Main Report Sections 4.5 and App. K.)

These important changes were discussed and agreed in principle with the senior staff of the MoA in Nairobi as outlined in the Summary Note at Appendix D. In addition to this the staff of the AMSB not only have an appreciation of the problems facing the organisation but also indicate a desire to improve its efficiency. The proposed plan of action listed below has been designed to yield the necessary improvements.

#### ii) Proposed plan of action

##### - Management/organisation

1. At present AMSB resources are spread too thinly to be effective since there are 19 stations throughout Kenya. This problem was discussed with AMSB HQ staff and it was agreed that the number of stations should be reduced to between 7 and 12 stations (see Section 4.3, p 107).

2. PHS In consideration of the present constraints and envisaged work load for PHS (Section 4.1) it is recommended that AMSB should increase their efficiency by concentrating their efforts on the operation of only seven PHS stations identified as 'essential' in Table 11 (p 108).

3. THS In view of the very high cost of providing tractor hire services (viz K£188/ha or K£76/ac for ploughing) and the apparent competition with private contractors in some areas, it is recommended that THS should be provided only in areas with substantial potential for the development of new land (Agric. Annex). A considerable reduction in the number of stations is therefore essential, particularly in areas where private contractors could provide the



required service and where ox cultivation is more appropriate (Section 4.3.1).

4. The team question the need for any government tractor hire services (Section 4.3.2). The complete closure of THS in the long-term would allow Government to concentrate on encouraging private tractor contractors, who generally appear to operate much more efficiently than THS. In the short-term this could be achieved by:

- a) the provision of short training courses for tractor drivers on machine operation and maintenance,
- b) reduction in the high level of import duty on tractor spares, and
- c) a substantial increase in AMSB charges.

5. The team, therefore, considers that the tractor hire fleet is excessive to the requirements of the objectives. Some of the THS tractors could be utilised for PHS activities (eg Waterhole construction and contour terracing, Section 5.2, p. 133). The remainder should be sold off so as to reduce the number of tractor types thereby easing management.

- Professional Inputs (Main Report Section 4.3 p 121 and 6.2 p 141)

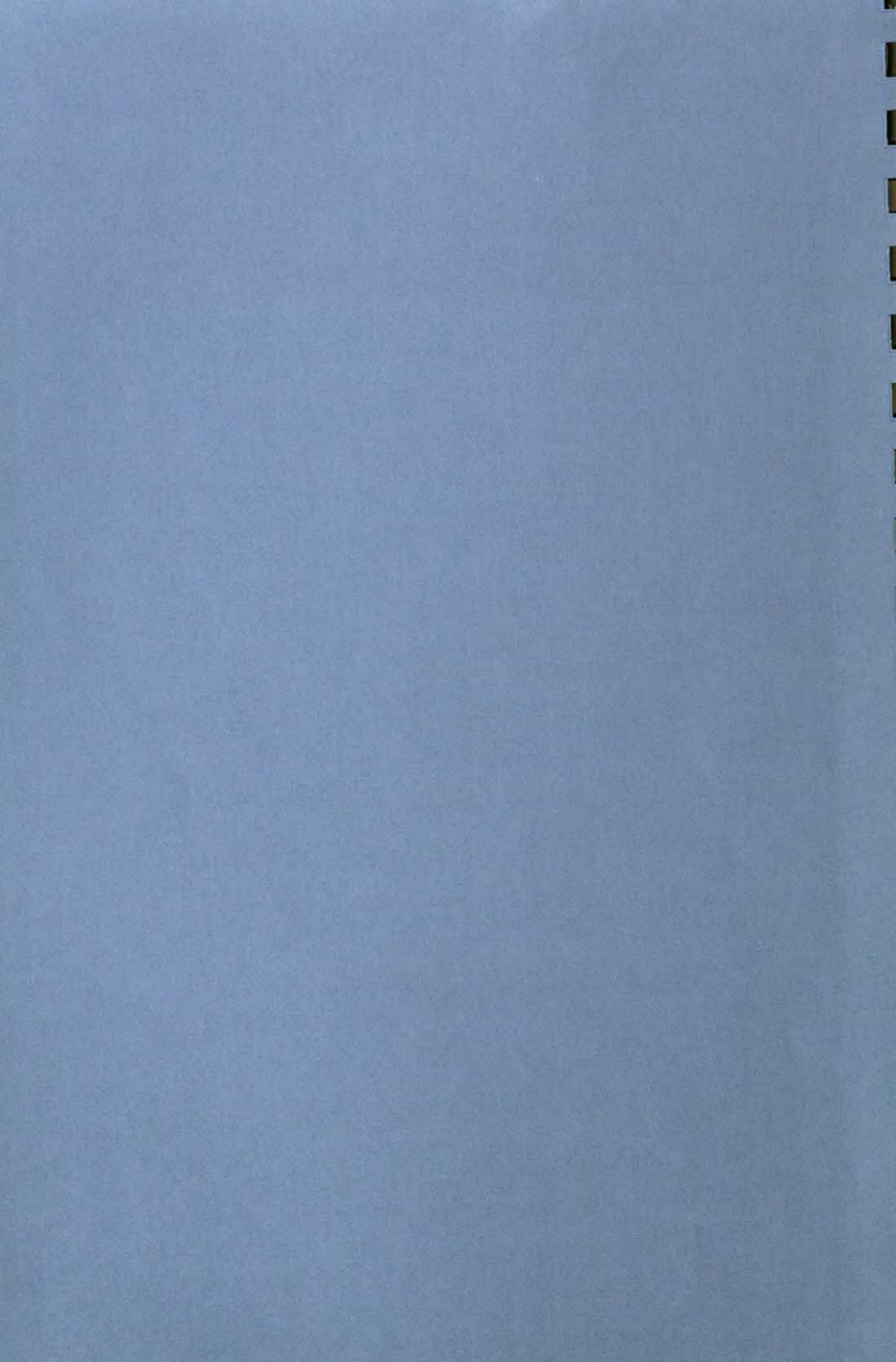
The scale and complexity of AMSB activities warrant the appointment of four professional officers (see 6, 7, 8 and 12 below).

6. A Senior Soil and Water Conservation Specialist (Management) is needed urgently to work in conjunction with AMSB HQ staff so that the following can be achieved during the next year:

- a) Appraise recent and current PHS work situation regarding soil and water conservation aspects of LRDD/AMSB
- b) Identify the immediate work load for plant, and implement a work programme.
- c) Assist in the reorganisation of AMSB as recommended by the team (Section 4.2)
- d) Draw up longer term work programme and plant requirements based on the findings of the new Survey and Planning Unit (ref 7a below)
- e) Organise overall staff training programme in AMSB.

7. A second Soil and Water Conservation Engineer (Planning) is required to:

- a) Initiate the establishment of a professional Survey and Planning Unit (SPU) so that future work programmes can be effectively planned and developed.



- b) Provide technical assistance in the survey and design of soil and water conservation works and resettlement programmes which are being undertaken by PHS. Large farm division needs specialised attention to ensure that future smallholder layouts are designed to conserve soil and water. Further attention is also needed to provide long-term water supplies in new settlement areas.
- c) Outline the requirements for training courses on the survey and design of resource conservation and reclamation works. Young graduates need to be given practical experience in the survey, design and implementation of road, contour and water catchment layouts.

8. An Accounting and Information Officer should be appointed during 1983 so that a management information and internal accounting system can be introduced to:

- a) restore the recording and collection of basic data which have been allowed to lapse during the past six or seven years
- b) augment the Government accounting practice which is of limited value to management. The inappropriateness of the Government's non-commercial accounting procedures calls for the design, development and operation, within the AMSB, of a suitable orientated accounting system that will:
- c) provide key operational information for planning, co-ordinating and control of AMSB activities. The system will provide AMSB management and Government with integrated operating and financial information not presently available, but considered essential for an effective organisation.

The team see the system being founded upon a small set of basic documents by means of which it will be possible to plan, progress and control the work load as it passes from the request stage to job completion, and at the same time to create a data base of machine utilisation and effectiveness (App P).

To ensure that information is accurate and complete, and is presented on time, it is essential that clerical procedures are made simple but formal, and are exercised with discipline at all times.

- d) draw up training programme in accounting procedures for AMSB staff.

#### - Equipment and spares

9. It was evident from station visits that the annual work load of PHS rarely exceeded 1,000 hours per station. Therefore the existing plant fleet is more than adequate for the next year providing spares are made promptly available to keep operational plant serviceable and to repair some machines that are presently grounded. Obsolete and severely damaged plant should be boarded.



10. A survey is being conducted by Central Workshops to establish spare parts and tool requirements. A list for Track Marshall (Aveling Marshall) spares and some tools has already been completed (see App. K). It is recommended that Donor funds be used for purchasing essential spares and tools locally.

11. Immediate attention should be given to the construction of an effective engine removal hoist for plant overhaul at Central Workshops (see Photos 6 & 7).

12. The maintenance and repair of expensive and specialised plant will require the continued services of an experienced Workshop Superintendent. It is acknowledged by the Head of AMSB that the continued services of the TCO Workshop Superintendent will be required to repair the PHS fleet. It has been requested (verbally) therefore by MoA and recommended by the Team that Mr A Pattinson's contract is extended (after UK leave) to conduct this work based at Central Workshop, Nakuru.

13. The repair of PHS equipment will provide good training opportunities for AMSB technical staff and enable material to be gathered for training courses in the longer term. The team recommends that a expatriot Track Marshall mechanic/operator be attached to the staff of Central Workshops, Nakuru for a period of about 3 months to carry out the main part of this training role. Training assistance should also be sought for the Caterpillar, GM Terex, International Harvester and Hanomag equipment.

#### - Charges

14. AMSB's equipment hire charges are based upon formulae derived from performance and cost profiles applicable to conditions and facilities in developed countries. Their relevance to the Kenya situation is questionable. The current charges for plant hire are undoubtedly offering the service at highly subsidised rates. It is recommended that hire charges are increased by an average of 20% pending the determination of the real costs of operating the service. The policy of charging on an hourly basis is endorsed.

15. The GoK wage scales for operators and mechanics should be raised to a comparable level to operators in the private sector. These men are often in charge of earthmoving plant that typically costs about K£100,000.

#### - Evaluation and Support

16. Annual review The team recommends that a further ODA/GoK short-term study be made with AMSB to monitor progress towards these objectives in approximately one year's time (Section 4.8). It is considered that the scale of AMSB operations warrants annual reviewing.



17. The team firmly believe that continuing technical support will be needed to assist AMSB in the implementation of the recommendations in this report and to follow up the advice arising from the annual reviews. Outline proposals for a support programme are given in Sections 4.8 and 6.4 of the Main Report.



B MAIN REPORT

SECTION 1

Background to Kenya



## B MAIN REPORT

### 1. BACKGROUND TO KENYA

#### 1.1 The Population

Kenya has one of the fastest growing populations in the world with an estimated increase of 3.9% per annum. At this rate of growth the national population would reach 23.35 million by the end of 1990, a 52% increase over the 12 years since the 1979 census. The estimated 1983 population of Kenya is 17.87 million giving an average density of 30.77 people per square kilometre. The country's birth rate of 50 per 1000 is also one of the highest in the world, and means that Kenya will need to feed nearly one million more people every year throughout the 1980s. The majority of people live in either the Lake Victoria area, the south-western highlands, or the coastal belt.

Employment opportunities have failed to keep up with the increasing population, both in rural and urban areas. There has been a considerable drift of people towards the urban centres, particularly Nairobi and Mombasa, and an increase in rural landlessness. At least 200,000 people are estimated to be living in poor landless households.

#### 1.2 The Economy

Since the end of the 1976/77 coffee boom the Kenyan economy has experienced a period of slow economic growth. Increasing oil prices and the inhibiting effects of world recession on demand for and prices of Kenya's exports have been major contributors to this lower rate of growth. The rate of growth of Gross Domestic Product (GDP) was over 5% p.a. in real terms between 1970 and 1979, but slowed to 3.5% in 1979 and to 2.4% in 1980. GDP per capita actually declined between 1979 and 1981.

As economic growth has declined the budgetary problems of the government have become more severe. The levels of government services and development activity embarked upon during periods of rapid growth are expected to continue when the economy slows down, although

government revenue fails to keep up with the ever-increasing demands for recurrent and development expenditure. Thus the government deficit increased from 5.4% of GDP in 1976/77 to 9.9% of GDP in 1980/81. As a result, the government is keenly aware of the need to reduce the deficits of public sector organisations wherever possible if emergency measures such as the current freeze on expenditures are to be avoided.

There are severe balance of payments constraints as earnings from exports and tourism have stagnated, and the costs of oil imports, which account for about 35% of the total import bill, have increased. The Kenyan shilling was devalued twice in 1981 and again in 1982. Imports are controlled by the Central Bank through the issue of import licences, and there are high import duties on many goods. While agricultural machinery can still be imported duty free (subject to the acquisition of import licences) spare parts are subject to duties which vary according to the possibility of local manufacture and the degree of interchangeability with non-agricultural spares.

The rate of inflation has slowed down, the annual rate of growth of the Consumer Price Index declining from 20.2% in 1981 to 14.4% in 1982. The government has restricted the growth of credit in line with IMF recommendations to contain price increases.

### 1.3 Agriculture

Agriculture continues to be the mainstay of the Kenyan economy although its share of GDP has declined in recent years to below 33 per cent. Over 80 per cent of the total population still make their living off the land and around 20 per cent of the people in paid employment are in the agricultural sector. However, more than one half of total agricultural output is subsistence production.

Kenya produces a relatively wide variety of cash crops which helps to make its economy less vulnerable to fluctuations in export prices. The principal cash crops are coffee, tea, sugar cane, sisal, pyrethrum and cotton. Fruit, vegetables and cut flowers are becoming increasingly important exports. The main food crops are maize and wheat. Following several poor crops, 500,000 tonnes of cereals had to

be imported in 1981, but good maize harvests during the past two years have decreased the reliance on imports significantly. The country is only 40 per cent self-sufficient in wheat and the gap between output and demand has been increasing steadily.

The country's principal export crop is coffee, with most of the output being of the high grade arabica type. In 1981 nearly 120,000 hectares were under coffee with smallholder production exceeding that from the large estates. Given the importance of the crop in Kenya, recent fluctuations in world output and prices have had a significant effect on the nation's economy. High quality tea has been a rapidly expanding crop during the past decade. The share of family farms in the total acreage under tea is expanding rapidly with over 50,000 hectares now being grown on these farms compared with about 23,000 hectares on large estates. Another important crop which is produced on estates is sisal. Total production has declined from a peak of over 86,000 tonnes in 1974 to less than 42,000 tonnes in 1981. Similarly, the output of pyrethrum decreased during the 1970s due to the competition from synthetic insecticides, but has recovered to some extent during the past four years.

Sugar production has grown steadily and Kenya is now an exporter of this commodity. The main sugar zones in the country are Mumias, Muhoroni, Chemelil, Miwani, Ramisi, Awendo and Nzoia with mills in each zone. Cotton production has also been growing in recent years with the GoK's aim being to reduce the imports of cotton for local textile mills.

The livestock industry is not as important now as was the case when Kenya exported butter and skim milk powder up to the late 1960s. Beef is now imported in some quantity.

#### 1.4 Soil conservation

Kenya has experienced soil erosion problems for many years. Aerial photographs taken in 1948 shown that severe gully erosion had occurred prior to that date on overcrowded communal land in some areas (Gibbons, 1982). Prior to independence soil conservation measures were compulsorily enforced and little emphasis was given to educating farmers in the need for, and the benefits of, soil conservation.

As a result of farmers' general lack of appreciation of the importance of soil conservation, more cut-off and contour terraces were destroyed in the first decade after independence than were constructed. With the rising growth in population, people in the relatively high rainfall areas have been forced not only to increase the intensity of land use, but also to find new arable land by felling forests and cultivating dangerously steep slopes up to 45°. The practices have accelerated soil losses, and have led to a decline in soil fertility in many cases.

In Agro-Ecological Zones (AEZ) IV and V (see Agric. Annex for explanation of AEZ's) excessive grazing on ranches and communal pasture land has resulted in denudation of the natural vegetation. Settlers have also cultivated new land in the semi-arid areas without first undertaking adequate soil conservation measures. As a result of these practices, severe erosion is taking place and is now devastating productive land at an ever increasing rate (see Agric. Annex). The intensified destruction of forests is helping to accelerate run-off in catchment areas as well as creating unnatural cyclical flows in rivers.

Kenya's economy and general prosperity are being increasingly threatened by the degradation of natural resources, especially in the case of soil erosion and the resultant declining levels of fertility. The country's leaders are aware of the dangers inherent in the mis-use of land.

In a speech delivered on June 1982, the President of Kenya stated that the country; "... cannot afford to go on losing topsoil and forest cover at the rate experienced over recent years. ... all of us must recognise the danger, to our own interests and to future generations, of entering a phase in which rapidly increasing numbers coincide with the erosion of natural resources and functions on which human life depends".

Immediately following this statement, the President announced the establishment of an organisation for co-ordinating the various national programmes concerned with the conservation of natural

resources. This organisation, to be known as the Permanent Presidential Commission for Soil Conservation and Afforestation (PPCSCA), is charged with the task of co-ordinating the work of the Ministries of Agriculture, Water, Livestock Development, and Environment and Natural Resources in soil and water conservation efforts. Specific recommendations made for the MoA were that all soil and water conservation activities of the Ministry should be administered by the LRDD and that this Division must work closely with the existing farm management and extension service units of the MoA. Up until now the PPCSCA has concentrated on organising and running the annual soil and water conservation week, the third of which took place from April 11 - 16th 1983. Major efforts still have to be made in co-ordinating the Government's efforts into an effective force for implementing sound conservation practices throughout the country.

### 1.5 Mechanisation

There are no reliable figures on the proportions of cultivation carried out by tractors, oxen, and hand tools in Kenya, and the compilation of such statistics is an important prerequisite to the formulation of government policy towards mechanisation. Even the numbers of tractors and draught oxen in use are not accurately known. Virtually all cultivation in the large farm sector (totalling about 500,000 ha pa) is carried out by tractors. It has been estimated that 84% of land preparation on small farms is carried out by hand tools, 12% by ox-drawn implements and 3.5% by tractors (CEBECO 1981). This represents approximately a further 50,000 ha of tractor cultivation, making a total of 550,000 ha. Assuming that 7000 tractors are engaged principally in cultivation work (see Section 2.2) then each tractor achieves an average of approximately 80 ha pa which is a reasonable figure but higher than THS output. More research is needed to confirm these estimates. Tractors are most widespread in the areas of former European settlement especially Rift Valley and parts of Central Province. Oxen use is determined to a large extent on tribal lines, the Luo, Luya, Kamba, and some Kikuyu around Mt. Kenya being the main ox-cultivators.

The major steps towards the mechanisation of Kenyan agriculture followed the arrival of European settlers. Indigenous and improved varieties of oxen were trained for transport and other farm tasks

including ploughing, harrowing and ridging. They became the main source of draught power on large farms, though still heavily supported by hand labour for many operations. The first tractors were introduced on a few large farms in the 1920s but they were widely adopted only from the time of World War II when great efforts were made to raise agricultural output. In 1945 the numbers of tractors and combines in use in Kenya were still small, but by 1960 they had risen to 6400 and 1000 respectively. They were owned almost entirely by large farmers or contractors working in the large farm sector.

Following Independence, mechanised cultivation services were introduced to settlers on several large settlement schemes and tractors were also available to small farmers on irrigation schemes such as Mwea Tebere. The tractor hire service now operated by AMSB is the only large-scale public sector operation, and its development is described in Section 3.1.

The demand for tractors is met entirely from imports. Around 20 different makes of tractor are imported into Kenya to meet an annual demand of not much over 1000 units. Dealer backup for some of these makes is inadequate as the volume of sales does not justify a heavy investment in workshop facilities and spares stocks.

In contrast most hand and animal-drawn implements are now locally manufactured, with some imported inputs. There are several large engineering companies which manufacture jembes and ox-ploughs, and numerous blacksmiths who produce tools on a small scale. Several firms fabricate tractor trailers, ploughs etc.

There has been no clear presentation of government policy towards farm mechanisation. Statements in, for example, the current Development Plan and the 1981 National Food Policy Paper show a commitment to appropriate technology in the shape of ox-drawn and hand equipment so as to reduce reliance on imported capital-intensive machines. The need for agriculture to provide a continued source of employment in view of rapidly increasing population and sluggish growth of employment opportunities in the industrial sector is also recognised. However, past government policy has in practice favoured tractor mechanisation (eg via an overvalued exchange rate, absence of import

duty on farm tractors, continued subsidies to the government tractor hire service), to the relative neglect of animal draught. Only recently has the improvement and dissemination of ox-drawn and hand-tools become a significant feature of government and foreign-funded projects.



Private Sector

The private sector is becoming increasingly important in the economy. It is the main source of employment and income. The government should encourage the private sector to invest in infrastructure and social services. This will help to create jobs and improve the standard of living. The private sector should also be allowed to compete with the public sector in providing services. This will help to reduce costs and improve the quality of services.

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## 2 PRIVATE SECTOR

### 2.1 Plant

The Private Sector is operating mainly in road construction and repairs, on buildings sites, and on dam construction. To a limited extent the plant is also used for bush clearing, e.g. by large estates such as those owned by sugar companies. Private forestry operations also apparently absorb a significant number of old crawler tractors.

Most major makes of plant are in use, including inter alia, Caterpillar, Aveling Barford, Champion, Komatsu, Fiat, MAN, JCB Hymac and Terex Poclain. The number of items is very difficult to estimate, but from indications given by plant agents and contractors, there must be a total of up to 2000 units. although a large proportion are inappropriate for PHS type activities because of their type or size (for example, large scrapers, or dump-trucks and excavators).

Although the agents have recently been having great difficulties in importing spares, the contractors have had few difficulties in obtaining their requirements up to now. The private sector has therefore not been greatly restricted by lack of spare parts, and a down-time of 2 to 3 weeks for even a major repair appears typical. Although this will probably change in the near future as import restrictions affect spares stocks even more, this down-time is in great contrast to the PHS situation, when repair times have often been in terms of months or even years.

From consultation with local contractors, it is clear that there is spare plant capacity which could be utilised on works in the same way as PHS. However, there are three main factors preventing the private sector from taking over nationally from PHS in an effective way.

These are:

- geographical distribution of plant is unsuitable, being concentrated round Nairobi, and to a lesser extent near Nakuru and Mombasa. A job would need to be large, such as a dam or large scale bush clearing, to attract a contractor to areas away from these centres;

- minimum costs for a contractor are approximately double the present level of PHS charges, and effectively no private farmers are interested in approaching contractors even at this time when PHS is not operating to any significant extent;
- difficulties in obtaining payment for small, casual jobs is a strong deterrent for a contractor. Such reluctance of farmers to pay has been noted by Government also.

Some contractors have already tried offering a plant hire service for earth moving equipment. However those who were met by the team had stopped some years ago because of the lack of effective demand and the difficulties of collecting payments. As these efforts were made during times of relative affluence in Kenya, it is unlikely that the contractors would find the market more favourable in the immediate future.

The main opportunity for private contractors to become involved in place of PHS is in the construction of dams in high potential areas, where the economics of irrigation of large farms are able to bear the higher cost of using the private sector. Indeed, some dams which were designed by the old Soil Conservation Service were subsequently constructed by private contractors.

## 2.2 Tractors

### 2.2.1 The tractor stock

Estimates of the total number of tractors in Kenya vary widely. Based on CBS National Sample Survey and Evaluation Programme results, Pollard estimates that there are 7150 tractors in Kenya (Pollard, May 1982), though some of those recorded in the survey may not be operational in which case this could be a slight over-estimate. The FAO estimated that in 1980 there were 6080 tractors in use in Kenya (FAO Production Yearbook, 1980), but CEBECO (1981) give a higher figure of 10,000 for the country as a whole.

Import figures for 1974-1981 averaged about 1300 tractors per year, declining slightly in 1980 and 1981. Figures for 1982 were not available but are likely to show a further decline in view of the stricter import licensing requirements. If average tractor life is assumed to be 6 years, the total stock at 1300 imports per year would be 7800 tractors, which is in reasonable agreement with Pollard's estimate. There are, therefore, probably around 7500 tractors in Kenya today.

### 2.2.2 Availability of tractors for hire

The majority of tractors are employed in the large farm sector. The CBS Agricultural Census of Large Farms (those above 20 acres) shows that in 1978, the latest year for which statistics have been published, 6013 tractors were owned by this sector so probably over 80% of tractors are owned by farmers with at least 20 acres of land. Apart from AMSB and other public sector tractors (say 300 operative machines in total), the remainder are owned by people with 0 to 20 acres of land, and most such tractors will undertake mainly contracting work as there would be inadequate work for them on the owner's farm. Some of the smaller "large farm" sector tractor owners no doubt also undertake a high proportion of contracting, and tractors from some of the really large-scale farms may carry out limited contracting work when the farm operations have been completed (though this is probably declining in the face of rising purchase and spares costs, as it becomes more important to avoid breakdowns). It is estimated therefore that about 1500 tractors are engaged wholly or principally in contracting work and that others are available for such work for shorter periods.

### 2.2.3 The private tractor hire sector

Tractor contractors vary in scale and type of operation. At one extreme there are large specialist operators with as many as ten or more tractors who undertake mainly large-scale jobs for organisations such as Kenya Breweries or East Africa Industries, and who obtain very high rates of machine utilisation by travelling over a wide area to find work. They employ high horsepower tractors, in many cases with 4-wheel drive, and so can achieve fast work rates on large and

well-cleared fields. Two such contractors were visited, plus a third company which had formerly been involved. They all reported a reduction in their scale of activities, partly because of increasing costs of operation and problems in getting payment from customers, and partly because of the greater profitability of other enterprises e.g. leasing land for wheat cultivation. In the longer term, it seems inevitable that as farms and estates are subdivided the demand for large-scale contracting will decline.

At the other extreme is the operator with just one tractor who cultivates his own farm first and then looks for additional work either in his immediate neighbourhood or further afield. This is the most common type of contractor in Kenya today, and the majority of tractor cultivation in the family farm sector is performed by such men. It is not unusual for a tractor to be owned by a group or partnership of 2, 3, or 4 farmers, and Agricultural Finance Corporation loans are available for such group purchases. Small contractors are more likely to go for lower hp tractors (e.g. the 40-50 hp MF 240, IH 384, and IMT 539) and one of the dealers visited said he tries to persuade purchasers to accept smaller machines which are cheaper and adequate for their needs. However, many higher hp tractors are also bought. There has been very little uptake of 4-wheel tractors of less than 40 hp. An increasing proportion of total tractor sales are to such operators with only one machine undertaking a mixture of own work and contracting. The MF agent at Eldoret reckoned that 75% of his customers undertake mainly contract work and 25% mainly own work, and that virtually all tractor purchasers do some contracting.

#### 2.2.4 Tractor Utilisation

Most of the contractors spoken to did not have records of the annual utilisation of their machines, and those who did were generally the more efficient, and therefore not necessarily representative of the remainder. However, the evidence that can be assembled suggests very much higher achievements than those of THS. Examples of very high work outputs per annum were reported, and in some cases verified from meter readings. Working very long hours during busy periods, including night work, with drivers working in shifts, is common. Travelling long

distances to find work is also usual among the larger scale contractors, and even some of the smaller farmer/contractors move away from their home areas to areas of higher demand.

One large contractor working mainly in Narok District claimed that his tractors achieve 2,500 hours per year, and could do more. He replaces his machines after 2 years work, thus avoiding major breakdown problems. Another large-scale operator said he aims for 1,500 to 2,000 hours per annum, and machines were seen which had achieved this level of output or close to it. Again, tractors were replaced regularly (at about 6,000 hours).

A contractor near Nakuru with 3 tractors reported that two of his machines had clocked over 1,700 hours each in the previous season, enabling him to repay the loan he had taken out for their purchase in one year. His newest tractor had reached 900 hours between January and April 1983.

The owner of a 3 year old Steyr tractor (meter broken) estimated that he cultivates 1,000 acres per annum which represents more than 1,000 hours of working time. A farmer/contractor near Kaloleni had recouped the K.Sh 50,000 which he had paid for a secondhand Leyland 344 from hire revenue in about a year, and had recently purchased a K.Sh 160,000 Fiat tractor which he was confident he could pay for from hiring. He was clearly achieving high output, with two drivers working from 3.00 a.m. to 6.00 p.m. at peak periods. The owner of a Ford 6600 near Eldoret had recorded over 2,400 hours in 2 years, and reported using 3 drivers in shifts when demand was high.

So although too few contractors were visited for a reliable estimate of average utilisation to be made, annual running hours in excess of 1,000 hours are clearly common in the private sector.

#### 2.2.5 Arranging work, charging, and payment

When a tractor is working in the owner's home area, farmers will usually come and ask him to cultivate their fields. Indeed one contractor complained about having queues of people outside his house from 5.00 a.m. at peak times! When working elsewhere, farmers will approach a tractor which they see working or travelling - the owner

generally arranges the contract and payment, and the work is carried out by a hired driver.

The bigger contractors do not undertake small jobs, and would, for example, not accept even a 30 acre job unless there were others close by. But some tractor owners working mainly in their home locality were willing to carry out any job they were asked to do and felt unable to turn farmers away. They would try to arrange to do several small jobs within one area on the same day, however. Between these two extremes there were tractor owners who set their own limits on jobs they would undertake, some doing a minimum of 2 acres, others 4 acres, etc.

Charging by the acre was universal. For small jobs it is usual for the contractor and the farmer to pace out the field, unless the contractor accepts the farmer's assessment of field size - he need not do this if he feels that it is an under-estimate as it is usually a seller's market for tractor hire services. One tractor operator in Coast Province said that the local Agricultural Officer measures the land before ploughing, and checks the quality of work afterwards. Another contractor said that if there is a dispute over the size of the land, the farmer engages a surveyor to measure it accurately.

Payment is usually made either in advance or immediately on completion of the job. Sometimes half is paid in advance so the contractor can purchase fuel, and half on completion. Many contractors complained about problems over payment, especially for work financed by AFC loans which are often not released until late in the ploughing season. Also delays in payments for maize crops leave farmers short of capital for the following season's cultivation. This indicates that delayed cultivation and failure to extend the period over which ploughing is carried out may be as much an institutional as a climatic or agricultural problem. One particularly enterprising contractor near Nakuru would do cultivation work for farmers on credit before the release of AFC loans, but this depends on a good knowledge of the local farmers and is a risk many contractors would not take except perhaps with neighbours and relatives.

### 2.2.6 Charges

One would expect hire charges to be fixed by free market forces as there are a large number of independent operators providing a service to a large number of customers. It is possible that THS, with almost 200 tractors available throughout the country, may act as a price leader, especially if farmers consider that the government charge must represent a "fair" price for the services. In some cases, attempts have been made to establish a reasonable charge for an area. For example, the DAO at Baringo was reported to have held a meeting between representatives of contractors and farmers at which the costs of operations were discussed and agreement reached on an acceptable level of charges.

Contractors charges were obtained from various sources (contractors, farmers, government officers) and for a variety of different areas. Charges were almost always stated in per acre terms. They tended to be higher than THS rates averaging K.Sh 455 per ha (K.Sh 184 per acre) for ploughing "old" land (i.e. that which has been cultivated before), and K.Sh 675 per ha (K.Sh 273 per acre) for ploughing new land (formerly uncultivated). These rates are 14% and 30% respectively above the THS rates.

Some contractors were not prepared to plough previously uncultivated land, because of the higher risks of breakdowns resulting from tree stumps, boulders, etc. This reluctance has probably increased with the recently raised import duty on spare parts resulting in higher repair costs. The difference in charges between new and old land is only 30% for THS but, on average, is almost 50% for private contractors. This suggests that THS may have underestimated the additional costs of cultivating new land.

### 2.2.7 Competition between THS and Private Contractors

There was some evidence that the relatively small difference in rates between THS and contractors was because contractors kept their rates down as a result of THS competition, and that the presence of THS acted as a disincentive to private contractors. It was stated that at one time in Baringo District prices were so low that many contractors did not consider it worthwhile doing contract work, but as THS were unable to cope with the demand many farmers did not get their

cultivation completed. The AMS manager at Kipkelion said that THS had "chased away" private contractors who formerly came into the district, and farmers in the area confirmed that few private contractors are available now in spite of the fact that THS cannot meet the demand. This is a clear case of the government hire service having the opposite effect to that planned - reducing the services available from the private sector rather than stimulating them.

However, it is clear that in some cases the availability of private contractors is taken into consideration in the deployment of THS tractors. DAOs in several locations (e.g. Embu and Nakuru) reported that THS machines are directed to areas with few private contractors and away from areas which are well served by the private sector.

It proved difficult to get an impression of the relative quality of work done by private contractors and THS as very little THS cultivation was being carried out at the time of our visit. Several farmers who had used both commented either that there was no difference between the two or, in a couple of cases, that THS was better as private contractors are inclined to hurry the job.

### 2.3 Animal Draught

There is wide disparity between the estimates of oxen numbers in Kenya, partly because of differences of definition between studies. For example, CEBECO (1981) estimated that there were 90-100,000 working oxen in Kenya, and World Bank (1978) put the number between 100,000 and 200,000. However, Pollard's (1982) estimate was much higher at 700,000 oxen - probably an overestimate unless large numbers of non-working oxen were included. The annual market for ox-ploughs is reported as 5000 - 12,000 p.a., and the total number of ploughs in use estimated at between 50,000 and 270,000 according to different sources.

There is a marked regional concentration of oxen use, resulting from historical differences, tribal attitudes, and the distribution of diseases. The National Sample Survey found that the percentage of rural households owning oxen is highest in the southwest of Kenya (34% in Bungoma and South Nyanza Districts, 26% in Kericho, 23% in Nandi,

and 22% in Kisii). The other main band of concentration is from Kajiado District (20%) and Machakos (30%), through Kitui (14%) and Embu (18%), to Kirinyaga District (17%): figures quoted in Pollard (1982). The proportion of households owning ox ploughs was higher in many districts than the number owning oxen, which might indicate that when farmers hire oxen they use their own plough, or that some households have given up ox cultivation.

Most ox owners provide a hire service to neighbouring farmers after completing their own cultivation. The per acre charges for ox cultivation appear to be very similar to those for tractor hire. The couple of farmers spoken to who had used both tractors and draught animals to do their ploughing did not think that there was any obvious difference in the quality of work done, the main disadvantage of oxen being that they are less suitable for heavy work such as ploughing "new" land. Shortages of draught animals for hire were reported.

Oxen have a limited work output per day and cannot plough heavy soils until they have been softened by the rains, so their seasonal work capacity is low. At a rate of work of 20 hours per ha and a daily achievement of 5 hours work, it would take an ox-pair 4 days to cultivate a hectare. With the period available for ploughing after the onset of the rains limited to only about 3 weeks in many areas, if yield reductions are to be avoided, the seasonal output of an ox-pair would be only about 5 ha. In contrast, the grazing required per animal would be 0.5 to 1 ha. A larger team of 4 or even 6 oxen (as sometimes used in Kenya) would achieve a faster work rate but have a higher grazing requirement.

The direct costs of keeping oxen are low when adequate grazing is available. Costs of veterinary inputs, harnessing, housing, and labour for herding are all likely to be modest. The major cost of keeping cattle is the opportunity cost of land used for grazing, and this will vary very much from area to area. Schmidt (1979) argues that in AEZ II, III, and to some extent IV, the opportunity cost of land is too high to make animal draught economically attractive, and that only in the lower potential areas can the allocation of land for grazing of draught animals be justified. Even there, the opportunity cost of the alternative use of the land for dairy farming must be taken into account.

Pollard considers that even allowing for the opportunity cost of land, animal draught is cheaper both in financial and economic terms than tractor cultivation, at least in three areas which he studied (Pollard and Wainaina 1982). He also points out that costs of ox cultivation could be reduced, e.g. by increasing utilisation of animals for operations other than ploughing, improving methods of feeding (such as growing fodder crops), and raising the quality of implements and of standards of operation. The direct foreign exchange costs of animal power are clearly much lower than those of tractor cultivation, and this is particularly important to Kenya. Greater use of dairy cows for draught purposes would result in savings in cultivation costs worth much more than the resultant loss in milk yields.

A detailed study of the relative costs and benefits of animal draught and tractor power is not within the scope of this study. Farmers are not usually faced with a direct choice between the two methods of cultivation, as oxen are limited to particular areas of the country, and commonly both tractors and oxen are in short supply so a farmer will settle for whichever he can obtain. However, the team were encouraged by the increased attention now given to improving animal draught in Kenya. We were told of a total of 13 foreign aid projects relating to ox cultivation and visited A.M.T.U. at Nakuru and the Australian-assisted Magoreni Settlement Project where work on this subject is being undertaken. The role of the Tractor Hire Service should be to complement rather than compete with ox cultivation: the ploughing of "new" land is one area in which THS may have a role even where draught animals are plentiful.





3.1 Background and objectives of AMSB

The Agricultural Mechanisation Services Branch of the Land Resources Development Division was created in 1980 by the amalgamation of the formerly separate Soil Conservation Service Machinery Unit (SCS), Tractor Hire Service (THS), Agricultural Machinery Testing Unit (AMTU) and the Farm Mapping Unit (FMU). The activities of AMTU were outside the scope of this review.

3.1.1 Survey and Planning

Prior to being absorbed into the LRDD the FMU was part of the now defunct Land Farm Planning Division. There is currently no special survey or mapping unit in the AMSB. Five of the older stations do have a section which carries out some survey and design work but this capacity is very limited. According to AMSB annual reports, a further 4 stations undertake a small amount of work. A few of the experienced staff, who originally worked in the Farm Mapping Unit or SCS prior to their absorption into the LRDD, still undertake survey and design work, albeit with very limited resources. Work currently undertaken by AMS personnel includes the survey and design of dams, and farm surveying and planning.

3.1.2 SCS/PHS

The Plant Hire Service (PHS) of AMSB has its origins in the Soil Conservation Service Machinery Unit of pre-Independence days. Its main objectives are outlined in section I.iv of the Summary Report. In addition to its soil and water conservation operations, PHS has undertaken other activities which contribute directly or indirectly to increasing agricultural output, e.g. bush-clearing and farm road construction. This is partly due to a change in role since 1980. Prior to then, PHS concentrated mainly on the implementation of Government programmes which were considered to be national or provincial priorities. The service has subsequently become essentially revenue earning, providing a construction service almost exclusively to private farmers.

Until 1978 the plant operated from seven stations: Kitale, Eldoret, Kipkelion, Nakuru, Nyahururu, Ruiru and Mariakani. Further stations were established as "Pilot Soil Conservation Stations" in the period 1978-1981 so that at amalgamation there were 19 stations planned in all, although some of them had virtually no facilities. As the new stations were opened plant was transferred to them from the older stations. The PHS fleet increased from 54 in 1974 to 113 in 1982, largely due to a re-equipping and expansion programme for crawler tractors during 1978-79 which resulted in a fleet of many different makes.

### 3.1.3 THS

The THS originated in 1966-67 when 50 tractors were introduced to provide a government hire service, primarily for areas under the Masai Wheat Scheme. The main objectives were to raise agricultural output and stimulate private ownership of farm machinery (Summary Report, section I.v).

Operating in mobile units, with no permanent bases, the tractors could be moved from area to area to follow the work with Kenya's diverse ecology and agriculture (due primarily to altitude variations) virtually year-round utilisation of machinery was possible. Fields on newly developed land were generally large and regularly shaped so high work rates could be achieved.

From 1974/75 onwards the THS was re-equipped and expanded, and its fleet became increasingly mixed. The proportion of work carried out for small farmers rose, and the geographical spread of operations widened. Originally all major repair work was carried out at a central workshop at Nakuru (Photo 8), but three new regional workshops (Photo 3) were constructed in 1979-1981 at Machanga, Mariakani and Migori under Netherlands technical assistance programme (CEBECO 1977 and 1981).

Since the creation of AMSB, the tractors and their implements have been assigned to 15 of the 19 stations which fall under the new organisation, and their mobility is thus greatly reduced.

The rapid expansion of the organisation (to 197 tractors by 1981), the increased emphasis on small farm cultivation, and the geographical dispersion of the machines, has led to a fall in efficiency resulting in official criticism of THS (see Summary Report I.v). As with PHS, there has been a conflict between working for customers in areas which are most justified on development grounds, and earning sufficient revenue to cover the costs of the operation.

### 3.2 Organisation and Management

AMSB is a component activity of the Land Resources Development Division (LRDD) of the Ministry of Agriculture. LRDD also contains the complementary components of the Soil and Water Conservation Branch (SWCB) and the Irrigation and Drainage Branch (IDB). The position of LRDD within the Ministry of Agriculture, and of AMSB within LRDD, are shown at Appendix F.

Plant and equipment (notably crawler tractors, graders, scrapers, and farm tractors and implements) - manned, serviced and supported by survey and ancillary resources - are offered on hire to both the public and private sectors. Charges, expressed as machine hour rates, are revised from time to time and are published in the Kenya Gazette.

When AMSB was formed in 1980, a Government policy decision was made that it should be decentralised to provincial and district levels, in common with other Ministry activities. Decentralisation effectively placed responsibility for administration in the hands of the Provincial Directors of Agriculture, while leaving technical and professional responsibility with the head of AMSB and his two coordinators, one for PHS and one for THS.

The locations of the present 19 AMSB stations are marked on the map at the end of the Report of these four (Kitale, Kitui, Nakuru, and Ruiru) provide PHSs only. The manning levels and disposition of skills at each station are included, with other key data, in the Station Summaries at Appendix H. As at the end of December 1982, the total manpower establishment of AMSB was about 1450.

It is clear that the Branch's achievements have fallen considerably short of expectations, and that the short fall has tended to increase

with the passage of time. While in the current 1982/83 fiscal year AMSB has suffered from the severe financial constraints on Government expenditure, this situation is common to all Government activities, and there is nothing to suggest that AMSB is bearing a disproportionate share of the reductions in financial allocations. As a means of expenditure containment, a cash limits policy inevitably is a blunt instrument which does not distinguish priorities with any degree of objective finesse.

There are a number of critical and inter-related reasons why AMSB is unlikely to fulfil its objectives efficiently. Contributory factors - including the qualifications, experience and ability of both the management and the labour force; planning and control information systems; and accounting and cost control procedures are discussed elsewhere in the Study Report.

The present organisation structure does not lend itself as a suitable vehicle for reaching the envisaged objectives. The division of responsibility between technical and professional (AMSB/HQ) on the one hand, and administrative (Provincial) on the other, begs the question as to who is responsible for the management of the undertaking. Despite AMSB's Government status, it is essentially a commercial enterprise that demands a commercial approach in its management structure and style. There is a need to identify where accountability lies.

As importantly, while the application of AMSB's resources may be agricultural by nature, it is primarily an equipment hire activity the management of which must, by definition, be both engineering-oriented and commercially minded. The key performance factor lies in the effective and efficient utilisation of machine hours.

Additionally, other factors are likely to impede progress, unless discipline and clear lines of command are established and enforced. In particular, from the Study Team's observations at HQ and at individual stations, it is apparent that

- resources are spread too thinly over too wide an area to be either effective or efficient. The rapid expansion of AMSB in the late

1970s coincides with a worsening performance record (Section 3.5). To some extent that expansion may be looked upon as self-defeating. By "localising" equipment, it reduced the available time during which machines could be utilised on a chargeable basis. Simultaneously, there was neither time nor the opportunity to develop a suitably qualified and experienced cadre of management and operatives to handle the suddenly enlarged fleet of machines;

- station management are often lacking in practical experience and management ability, and they are often inappropriately qualified in engineering terms to deal with machine applications and maintenance;
- repair and maintenance facilities are inadequate (Photo. 2);
- much of the plant and equipment is old and of diverse origin. The related aspects of spare part sourcing and procurement, and of mechanic familiarisation, compound the difficulties of keeping machines in good repair;
- the fragmentation of limited funds across a wide range of AIE (Authority to Issue Expenditure) holders, with no underlying financial evaluation of the physical levels of activity likely to be achieved in the AIE holder's station area, precludes any objective ranking of spending priorities either within or between stations. In 1982/83 fiscal year allocated funds for transport and equipment maintenance (the largest single item of expenditure other than personal emoluments) were held on the Permanent Secretary's votehead; and
- information systems, to be used by management to plan and control the utilisation of the machines at their disposal, have been allowed to lapse.

### 3.3 Equipment

#### 3.3.1 Survey and Planning

The various stations possess a minimal amount of surveying equipment which is in good working order. Most of the spirit levels and survey

staffs are more than twenty years old and some have been damaged beyond repair. Facilities for the drawing of maps and plans are available at the three new regional workshops which were built with the help of the Netherlands Aid Programme and at some of the older stations such as Eldoret and Ruiru. However, these facilities are poorly equipped and require mapping tables, drawers and other supporting furniture. At Migori AMS, the mapping room is being used as a general store-room.

### 3.3.2 Plant Hire Service

The Plant Hire Service operates mostly crawlers equipped with angle dozer blades and many also with rippers. These are backed up by motor graders, self-propelled scrapers, and some small plant including towed scrapers, terracers, rollers and a front loader. There are machines from 9 different manufacturers in all creating many problems of spares supplies and dealer service. Detailed lists of the main plant were supplied to the study team by AMSB based on the situation as at April 1983 (Table 1). The total recorded fleet size is 113, including some new units still being delivered.

The list included 94 crawler tractors of various sizes and manufacture. seven or an original 49 Aveling Marshalls (A-Ms) supplied in 1978/79 were unaccounted for, presumably having been effectively scrapped. Some cannibalised A-Ms were listed which would almost certainly be uneconomic to repair, although none are over 5 years old, and few if any of the A-M fleet have over 3500 hours recorded. The availability of the A-M has been particularly poor because of characteristic weaknesses in the transmission (notably the steering clutches), the dozer support 'C' frame, and to some extent the hydraulic system. The main clutches also tended to have a short life due to the machine applications which required frequent reversing. These problems have put a high demand on spares when there is no effective A-M agent in Kenya.

The self-propelled scraper fleet consists of one single engined elevating scraper and 3 twin-engined units. There are also 4 towed scrapers of smaller capacity at some of the older stations, plus several other scrapped (units). These towed scrapers are not included

TABLE 1 Summary of PHS Heavy Plant Types

<u>Manufacturer</u>	<u>Type</u>	<u>Total Nr</u>	<u>Principal Characteristics</u>		<u>Average Age (yrs)</u>	
			<u>Engine Power</u>			
<u>1) Crawler Tractors</u>			<u>kW</u>	<u>(hp)</u>		
Caterpillar	D4-88A	6	48	(65)	15	
"	D6-9U, 44A	7	69	(93)	23	
"	D6D-47J	7	104	(140)	8	
"	D7-17A	2	96	(128)	26	
"	D8H	1	176	(235)	18	
Aveling - Marshall	140	42	105	(141)	4.5	
Hanomag	D500B	3	85	(114)	5	
"	D600C	20	107	(144)	4	
International Harvester	TD20E	6	157	(210)	4	
	<u>Sub Total</u>	<u>94</u>				
<u>2) Self propelled Scrapers</u>			<u>kW</u>	<u>(hp)</u>	<u>Capacity (m<sup>3</sup>)</u>	<u>Age (yrs)</u>
Terex	S11E	1	107	(144)	8.4 heaped	5
"	TS14B	3	2 x 107	(2 x 144)	9.2 struck	4
	<u>Sub Total</u>	<u>4</u>				
<u>3) Motor Graders</u>					<u>Age (yrs)</u>	
Caterpillar	14	1			20	
Aveling - Barford	MG, MT	4			5	
Champion	-	2			8	
Ford	Atlas	1			?	
Faun Frisch	F105	6		(Being delivered, 1983)		
	<u>Sub Total</u>	<u>14</u>				
<u>4) Front Loaders</u>					<u>Age (yrs)</u>	
Aveling - Barford	-	1			5	
	<u>Sub Total</u>	<u>1</u>				
<u>Total fleet size</u>		<u>113</u>				

Source: AMSB (1983)

in the plant list, and only Ruiru station was using them to back-up the self-propelled units.

There are 8 motor graders of 4 different manufacturers currently at the stations, but none was serviceable at the time of the visit. Six new German Faun graders were being delivered which will compound the problem of maintaining multiple machinery types quite apart from the Fauns being unique in Kenya, and probably not having an effective dealer support system.

The heavy plant totals, with principle characteristics, are listed in Table 1. The individual distributions between the stations are listed in Table 2 which includes the distribution of low-loaders essential for transporting the larger crawler tractors.

Generally the plant operated by PHS is unnecessarily large for the bulk of the work carried out. The larger crawler tractors (> 140 hp) are essential only for the heavier bush clearing operations and for ripping of rock during dam constructions, and while they carry out the lighter work more quickly and generally more efficiently than smaller machines, the jobs are often so small that disproportionate time and effort are involved in organising and transporting the equipment. The large, self-propelled scrapers are of use only on full-scale dams, where there is room to manoeuvre and the rate of earthmoving can be critical: they are of no use on the small water holes which form by far the greater proportion of the water conservation activities of AMSB.

TABLE 2 Distribution of PHS Plant and Heavy Transport (19 Stations)  
(excludes 6 Faun Graders, being supplied 1983)

<u>Station</u>	<u>GK No.</u>	<u>Manufacturer &amp; Type</u>	<u>Year Obtained</u>	<u>Age (1983)</u>
1) <u>BUMALA</u>	285U	A-Marshall 140	1978	5
	870S	Hanomag 500B	1978	5
	305Y	Hanomag D600C	1979	5
	424Y	Hanomag D600C	1979	5
		Terex scraper	1980	3
2) <u>CHIAKARIGA</u>	7652	Caterpillar D4 88A	1968	15
	898S	A-Marshall 140	1979	4
	284U	A-Marshall 140	1979	4
	870W	A-Marshall 140	1979	4
	871S	Hanomag 500B	1978	5
	489Y	Hanomag D600C	1980	3
3) <u>ELDORET</u>	7655	Caterpillar D4 88A	1968	15
	625Q	Hanomag 500B	1976	7
	888S	A-Marshall 140	1978	5
	894S	A-Marshall 140	1978	5
	366W	Terex TS14B	1979	4
	868W	A-Barford MT	1979	4
	980W	IH TD20E	1979	4
4) <u>GARSEN</u>	7633	Caterpillar D4 88A	1968	15
	887S	A-Marshall 140	1978	5
	283U	A-Marshall 140	1978	5
	879W	A-Marshall 140	1979	4
5) <u>GARISSA</u>	7670	Caterpillar D4 88A	1968	15
	897S	A-Marshall 140	1978	5
	286U	A-Marshall 140	1978	5
6) <u>KAJIADO</u>	*8062	Caterpillar D6 44A	1963	20
	886S	A-Marshall 140	1978	5
	*889S	A-Marshall 140	1978	5
	*986S	A-Marshall 140	1978	5
	277U	A-Marshall 140	1978	5

\* Scheduled to be transferred after repairs

<u>Station</u>	<u>GK No.</u>	<u>Manufacturer &amp; Type</u>	<u>Year Obtained</u>	<u>Age (1983)</u>
7) <u>KIPKELION</u>	7623	Caterpillar D7 17A	1958	25
	7714	Caterpillar D6 9U	1960	23
	8064	Caterpillar D6 44A	1963	20
	829M	Caterpillar D6	1975	8
	278U	A-Marshall 140	1978	5
	883W	A-Marshall 140	1979	4
	8061	Caterpillar 14 M/grader	1963	20
	8111	Hippo low loader	1968	15
8) <u>KITALE</u>	828M	Caterpillar D6 47J	1975	8
	282U	A-Marshall 140	1978	5
	873W	A-Marshall 140	1979	4
	874W	A-Marshall 140	1979	4
	365Q	Champion M/grader	1975	8
	867W	A-Barford MT	1979	4
	775Q	Hippo low loader	1976	7
9) <u>KITUI</u>	898W	Hanomag 600C	1979	4
	903W	Hanomag 600C	1979	4
	425Y	Hanomag 600C	1979	4
	983W	IH TD20E	1979	4
10) <u>MACHANGA</u>	891S	A-Marshall 140	1978	5
	905W	A-Marshall 140	1978	5
	892W	IH TD20E	1979	4
	897W	Hanomag 600C	1979	4
	424Y	Fiat low loader	1980	3
11) <u>MAKUENI</u>	2184	Hanomag 600C	1979	4
		Hanomag 600C	1979	4
	896W	Hanomag 600C	1979	4
	900W	Hanomag 600C	1979	4
	904W	Hanomag 600C	1979	4
	978	IH TD20E	1979	4

<u>Station</u>	<u>GK No.</u>	<u>Manufacturer &amp; Type</u>	<u>Year Obtained</u>	<u>Age (1983)</u>
12) <u>MARIAKANI</u>	827M	Caterpillar D6 47J	1975	8
	281U	A-Marshall 140	1978	5
	874W	A-Marshall 140	1979	4
	876W	A-Marshall 140	1979	4
	884W	A-Marshall 140	1979	4
	886F	Ford Atlas M/grader		
	564R	A-Barford loader	1978	5
	702R	Terex S11E	1978	5
	776Q	Hippo low loader	1976	7
13) <u>MARIGAT</u>	419Y	Hanomag D600C	1979	4
	425Y	Hanomag D600C	1979	4
14) <u>MIGORI</u>	890S	A-Marshall 140	1978	5
	893S	A-Marshall 140	1978	5
	871W	A-Marshall 140	1979	4
	882W	A-Marshall 140	1979	4
	8860	Fiat low loader	1981	2
15) <u>NAKURU</u>	7632	Caterpillar D4 88A	1968	15
	883F	Caterpillar D6 47J	1975	8
	961M	Caterpillar D6 47J	1975	8
	394V	A-Marshall 140	1978	5
	878W	A-Marshall 140	1979	4
	880W	A-Marshall 140	1979	4
	979W	IH TD20E	1979	4
	729S	A-Barford MG	1978	5
16) <u>NAROK</u>	421Y	Hanomag 600C	1979	4
	422Y	Hanomag 600C	1979	4
	423Y	Hanomag 600C	1979	4
	426Y	Hanomag 600C	1979	4
	490Y	Hanomag 600C	1980	3
	491Y	Hanomag 600C	1980	3
	B861	Fiat low loader	1981	2

<u>Station</u>	<u>GK No.</u>	<u>Manufacturer &amp; Type</u>	<u>Year Obtained</u>	<u>Age (1983)</u>
17) <u>NAROMORU</u>	7838	Caterpillar D6	1962	21
	863M	Caterpillar D6 47J	1975	8
	279U	A-Marshall 140	1978	5
	280U	A-Marshall 140	1978	5
	869W	A-Marshall 140	1979	4
	872W	A-Marshall 140	1979	4
18) <u>NYAHURURU</u>	7393	Caterpillar D7	1955	28
	7428	Caterpillar D6	1969	14
	7702	Caterpillar D6 9U	1960	23
	716S	A-Marshall 140	1978	5
	895S	A-Marshall 140	1978	5
	877W	A-Marshall 140	1979	4
	728S	A-Barford MG	1978	5
	8110	Hippo low loader	1968	15
19) <u>RUIRU</u>	7538	Caterpillar D6 9U	1957	26
	7669	Caterpillar D4 88A	1968	15
	8209	Caterpillar D8H	1965	18
	832F	Caterpillar D6 47J	1975	8
	881W	A-Marshall 140	1979	4
	981Q	IH TD20E	1979	4
	364Q	Champion M/grader	1975	8
	730S	Terex TS14B	1978	5
	774Q	Hippo low loader	1976	7

Others:

ADC GARISSA 892S A-Marshall 140 1978 5

Source: AMSB

### 3.3.3 Tractor Hire Service Equipment

#### Tractors

At the time of the Team's visit the THS tractor fleet as dispersed between 15 of the 19 AMSB stations. Table 3 lists these tractors by station, GoK registration, make and model, year of purchase, horse power rating and where known whether 2 or 4 wheel drive. A total of 189 tractors are listed. The total fleet size is apparently 196 and this disparity is probably because some tractors are omitted due to recent transfers between stations or they are working with PHS units.

There are 9 different tractor models supplied by 6 manufacturers.

The average age of these tractors was 3 - 4 years old and almost 60% are in the 3 to 5 year bracket. Only 22% of the fleet are more than 5 years old.

During this visit only one tractor was seen running; it was being used as road transport. The fleet at large was grounded due to lack of funds for fuel, etc.

The condition of many of the tractors was poor, particularly in view of the low hourage achieved (<200h/yr) by most of those seen. Rough primary ploughing conditions had clearly caused premature breakages on some units. Transport of mounted implements on rough road/tracks had caused lower link arm breakages (eg on Deutz tractors at Migori). Two Massey Ferguson tractors had to be written off at one station because they were broken in half following road accidents caused by an inexperienced operator.

A combination of difficult conditios in small field with little or no effective servicing backup (eg Photo 2 has resulted in the premature breakdown of many tractors. Where servicing and repair facilities are available (eg Nakuru CW Photo 8) tractors frequently remain immobilised because of the lack of spare parts. Unfortunately tractors are often left in a stripped-down or unprotected state whilst awaiting spars and this leads to further deterioration.

The horsepower ratings of over 90%of the tractors have been obtained

TABLE 3 T.H.S. Distribution of THS Agricultural Tractors (15 Stations)

<u>No.</u>	<u>GK No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> <u>(Age 1983 yr)</u>	<u>Horse-Power</u>	<u>2 or 4 Wheel Drive</u>
1) <u>BUMALA</u>					
1	530W	MF 194 - 4	1978-79(5)	73	4
2	532W	" "	"	"	"
3	533W	" "	"	"	"
4	534W	" "	"	"	"
5	485Y	" "	1979-80(4)	"	"
6	531W	" "	1978-79(5)	"	"
7	164Y	" "	1979-80(4)	"	"
8	165Y	" "	"	"	"
9	181Y	" "	"	"	"
10	182Y	" "	"	"	"
11	183Y	" "	"	"	"
12	184Y	" "	"	"	"
13	210M	"	1974-75 (9)	"	"
14	477Q	Same Corsaro	1975-76 (8)	70	"
15	474Q	" "	"	"	"
16	480Q	" "	"	"	"
17	422M	" "	1974-75 (9)	"	"
18	207Q	" "	1975-76 (8)	"	"
19	825M	" "	1974-75 (9)	"	"
20	644S	Fiat 850DT	1977-78 (6)	85	4
21	627S	" 640	"	64	"
22	626S	" "	"	"	"
23	817M	JD 2030	1974-75 (9)	68	"
24	815M	" "	"	"	"

<u>No.</u>	<u>Gk No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> (Age 1983 yr)	<u>Horse-Power</u>	<u>2 or 4 Wheel Drive</u>
<b>2) <u>CHIAKARIGA</u></b>					
1	476Q	Same Corsaro	1975-76(8)	70	
2	824M	" "	1974-75(9)	"	
3	475Q	" "	1975-76(8)	"	
4	481Y	MF 194 - 4	1979-80(4)	73	4
5	482Y	" "	"	"	"
6	483Y	" "	"	"	"
7	484Y	" "	"	"	"
8	813M	JD 2030	1974-75(9)	68	2
9	478Y	MF 194 - 4	1979-80(4)	73	4
10	479Y	" "	"	"	"
<b>3) <u>ELDORET</u></b>					
1	281Y	IH 384	1979-80(4)	45	2
2	282Y	" "	"	"	"
3	283Y	" "	"	"	"
4	284Y	" "	"	"	"
5	286Y	" "	"	"	"
6	287Y	" "	"	"	"
7	288Y	" "	"	"	"
8	285Y	" "	"	"	"
9	629S	Fiat 640	1977-78(6)	64	"
10	638S	" "	"	"	"
<b>4) <u>GARSEN</u></b>					
1	1667	MF 194 - 4	1979-80(4)	73	4
2	185Y	" "	"	"	"
3	186Y	" "	"	"	"
4	187Y	" "	"	"	"
5	188Y	" "	"	"	"
6	189Y	" "	"	"	"
7	418Q	Same Corsaro	1975-76(8)	70	
8	484Q	" "	"	"	"
9	205Q	" "	"	"	"
10	206Q	" "	"	"	"

<u>No.</u>	<u>GK No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> (Age 1983 yr)	<u>Horse-Power</u>	<u>2 or 4 Wheel Drive</u>
5) <u>GARISSA</u>					
1	E887	IH	1981-82(2)		
2	E888	"	"		
3	E889	"	"		
4	E890	"	"		
5	E891	"	"		
6	E892	"	"		
6) <u>KAJIADO</u>					
1	630S	Fiat 640	1977-78 (6)	64	2
2	631S	" "	"	"	"
3	632S	" "	"	"	"
4	633S	" "	"	"	"
5	634S	" "	"	"	"
6	635S	" "	"	"	"
7	637S	" "	"	"	"
8	642S	" 850DT	"	85	4
9	648S	" "	"	"	"
10	819M	Same Corsaro	1974-75 (9)	70	
11	538W	MF 194 - 4	1978-79 (5)	73	4
7) <u>KIPKELION</u>					
1	770E	JD 2030	1977-78 (6)	68	2
2	771R	" "	"	"	"
3	772R	" "	"	"	"
4	773R	" "	"	"	"
5	774R	" "	"	"	"
6	775R	" "	"	"	"
7	776R	" "	"	"	"
8	777R	" "	"	"	"
9	778R	" "	"	"	"
10	645S	Fiat 850DT	1978-79(5)	85	4
8) <u>KITALE</u> No agricultural tractors					
9) <u>KITUI</u> " " "					

<u>No.</u>	<u>GK No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> <u>(Age 1983 yr)</u>	<u>Horse-power</u>	<u>2 or 4 Wheel Drive</u>
<u>10) MACHANGA</u>					
1	780R	JD 2030	1977-78 (6)	68	2
2	781R	" "	"	"	"
3	782R	" "	"	"	"
4	784R	" "	"	"	"
5	779R	" "	"	"	"
6	783R	" "	"	"	"
7	795R	IH 674	"	78	"
8	794R	" "	"	"	"
9	796R	" "	"	"	"
10	428Y	MF 194 - 4	1979-80 (4)	73	4
11	338Y	" "	"	"	"
12	339Y	" "	"	"	"
13	540W	" "	1978-79 (5)	"	"
<u>11) MAKUENI</u>					
1	921W	MF 194 - 4	1978-79 (5)	73	4
2	922W	" "	"	"	"
3	923W	" "	"	"	"
4	924W	" "	"	"	"
5	925W	" "	"	"	"
6	416Q	Same Corsaro	1975-76 (8)	70	
7	482Q	" "	"	"	
8	483Q	" "	"	"	
9	958M	" "	1974-75 (9)	"	
10	641S	Fiat 850 DT	1977-78 (6)	85	4
11	812M	JD 2030	1974-75 (9)	68	2
<u>12) MARIAKANI</u>					
1	413Q	Same Corsaro	1975-76 (8)	70	4
2	414Q	" "	"	"	"
3	415Q	" "	"	"	"
4	417Q	" "	"	"	"
5	813M	"	1974-75 (9)	"	2
6	956M	"	"	"	4
7	735Q	IH 674	1976-77 (7)	78	2
8	703R	" "	1977-78 (6)	"	"
9	721Q	" "	1976-77 (7)	"	"
10	639S	Fiat 850	1977-78 (6)	85	4
11	810M	JD 2030	1974-75 (9)	68	2

<u>No.</u>	<u>GK No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> (Age 1983 yr)	<u>Horse-Power</u>	<u>2 or 4 Wheel Drive</u>
<b>13) <u>MARIGAT</u></b>					
1	992W	MF 194 - 4	1978-79(5)	73	4
2	993W	" "	"	"	"
3	994W	" "	"	"	"
4	995W	" "	"	"	"
5	537W	" "	"	"	"
6	624S	Fiat 640	1977-78(6)	64	2
7	625S	" "	"	"	"
8	622S	" "	"	"	"
9	628S	" "	"	"	"
10	647S	" 850 DT	"	85	"
11	818M	JD 2030	1974-75(9)	68	2
12	996W	MF 194 - 4	1978-79(5)	73	4
13	993W	" "	"	"	"
<b>14) <u>MIGORI</u></b>					
1	478Q	Same Corsaro	1975-76(8)	70	
2	479Q	" "	"	"	
3	493Q	" "	"	"	
4	821M	" "	1974-75(9)	"	
5	723Q	IH 674	1976-77(7)	78	2
6	794R	" "	1977-78(6)	"	"
7	722Q	" "	1976-77(7)	"	"
8	796R	" "	1977-78(6)	"	"
9	640S	Fiat 850 DT	"	85	4
10	B881	Deutz DX90	1981 (2)	88	4
11	B887	" "	"	"	"
12	B886	" "	"	"	"
13	B896	" "	"	"	"
14	B877	" "	"	"	"
15	B893	" "	"	"	"
16	B885	" "	"	"	"
17	B883	" "	"	"	"

15) NAKURU No agricultural tractors

<u>No.</u>	<u>GK No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> <u>(Age 1983 yr)</u>	<u>Horse-Power</u>	<u>2 or 4 Wheel Drive</u>
<b>16) <u>NAROK</u></b>					
1	190Y	MF 194 - 4	1979-80(4)	73	4
2	191Y	" "	"	"	"
3	192Y	" "	"	"	"
4	334Y	" "	"	"	"
5	335Y	" "	"	"	"
6	336Y	" "	"	"	"
7	239Y	IH 384	"	45	2
8	415M	Fiat ?	1974-75(9)		
9	452T	IH 1055	1979-80(4)	100	
10	453Y	" "	"	"	
11	290Y	" ?	"		
12	291Y	" ?	"		
13	288Y	" ?	"		
14	B875	Deutz DX90	1981 (2)	88	4
15	B876	" "	"	"	"
16	B882	" "	"	"	"
17	B884	" "	"	"	"
18	B888	" "	"	"	"
19	B889	" "	"	"	"
20	B891	" "	"	"	"
21	B895	" "	"	"	"
22	451Y	IH 1055	1979-80(4)	100	
<b>17) <u>NAROMORU</u></b>					
1	488Y	MF 194 - 4	1979-80(4)	73	4
2	724Q	IH 674	1976-77(7)	78	2
3	B880	Deutz DX90	1981 (2)	88	4
4	B898	" "	"	"	"
5	B879	" "	"	"	"
6	B898	" "	"	"	"
7	B892	" "	"	"	"
8	B878	" "	"	"	"
9	B894	" "	"	"	"
10	B897	" "	"	"	"
11	337Y	MF 194 - 4	1979-80(4)	73	"

<u>No.</u>	<u>GK No.</u>	<u>Make and Model</u>	<u>Year of Purchase</u> (Age 1983 yr)	<u>House-Power</u>	<u>2 or 4 Wheel Drive</u>
18) <u>NYAHURURU</u>					
1	705R	IH 674	1977-78 (6)	78	2
2	706R	" "	"	"	"
3	707R	" "	"	"	"
4	724Q	" "	1976-77 (7)	"	"
5	797R	" "	1977-78 (6)	"	"
6	488Y	MF 194-4	1979-80 (4)	73	4
7	337Y	" "	"	"	"
8	975M	Same Corsaro	1974-75 (9)	70	
9	643S	Fiat 850 DT	1977-78 (6)	85	4
10	814M	JD 2030	1974-75 (9)	68	2

19) RUIRU No agricultural tractors

TOTAL LISTED = 189 AGRICULTURAL TRACTORS

SEVERAL TRACTORS ARE EXCLUDED FROM THE ABOVE LIST AS A RESULT OF RECENT TRANSFERS BETWEEN STATIONS

TOTAL FLEET = 196 TRACTORS

(for the remainder the precise model was not known). They ranged from 45 to 100 hp (34 - 75 kW) with an overall average of 73 hp (54 kW). Ninety-five per cent were between 60 and 90 hp (45 - 67 kW).

Due to oxygen depletion at altitude (approx. 11½%/1000m or 3½%/1000ft Ref. Manby, 1961) and the effects of frequent high ambient temperatures (eg 30°C) effective power ratings at 2000m (eg Nairobi @ 6000ft) can be as low as 75% of sea level outputs. For ploughing traction rather than power tends to be the limiting factor therefore tractors with a 60hp (45kW) rating should be adequate for most conditions.

Four wheel drive (4WD) tractors are safer for hilly terrain operations but their increased complexity does increase servicing and repair problems. For example the team were informed that replacement small diameter traction tyres, as fitted to some 4WD tractor front axles, were virtually unobtainable in Kenya. In compiling the THS fleet data in Table 3 information on whether tractors were 2 or 4 wheel drive was available for over 75% of the total. Of these 60% were 4WD.

### Implements

Three and four furrow disc ploughs were the most common implements seen at THS/AMSB stations. Disc ploughs are well suited for ploughing new land where soil inversion tillage is required and there is a high risk of obstructions from buried rocks or tree roots. Some unused chisel ploughs were seen at Nakuru and it was recommended that THS should use these for the tillage of sandy loam soils in semi-arid areas (section 5.3). Reversible mouldboard ploughs were also available but these were not particularly suited to the rough conditions. Where soil inversion ploughing is necessary for the control of weeds in well established arable fields mouldboard ploughs would be more effective than disc units.

Disc harrows are used by the THS for secondary tillage operations. Sophisticated seed drills were seen at several stations (eg Eldoret and Mariakani). Their use is obviously small (Fig 3) and their complexity is unsuited to many of the field conditions and support facilities.

#### 3.3.4 Transport

The transport fleet at each station consists of:

- Pick-ups and four wheel drive vehicles for personnel and light equipment and stores
- Lorries for heavier equipment and stores.

Over half the stations also have a fuel tanker to serve the agricultural tractors and heavy plant. There are also several low-loaders for transporting the heavy plant, and mobile workshops essentially to serve the tractor hire fleet.

The transport fleet has suffered from lack of funds for repairs, as have the machinery fleets. Where the condition of the transport has been reported, a large proportion has been broken down or accident damaged. In some cases half the vehicles have been out of action, and at one station the whole fleet. The low-loaders have generally been able to give an adequate service, but lack of small vehicles (a Government-wide problem) has caused problems with communications with sites.

The distribution of vehicles at the stations in 1982 is given in Table 4.

### 3.4 Facilities

The standard of workshop, office, stores and staff housing facilities varies very widely from station to station. Information on facilities, where available, is given in the station summary sheets at Appendix H. The older stations are reasonably well off for offices, stores and staff housing, but the workshops are typically inadequate open sheds (e.g. Eldoret, Photo 1a) and much of the work is done in the open (eg Ruiru, Photo 1b and Narok, Photo 2). Three stations were designated Regional Workshops (new stations at Machenga and Migori, and the existing one at Mariakani) and these were supplied under a Dutch Aid agreement with simple but modern workshop/office/stores facilities (Photo 3). However, these workshops were only designed to cater for farm tractors and are inadequate for the repair of heavy plant.

Staff housing, and water and electricity services, are also poor or absent at some of these stations. Others of the newly established stations have virtually no facilities. For example, Naromoru has until recently had no permanent site and operates from a patch of ground by the DAO's office. Narok also is without a proper workshop (Photo 2), and its mechanics have to operate in the open making contamination of components by dust and dirt almost inevitable. However, another station which was in a similar situation (Chiakariga: not visited) has apparently organised the construction of simple workshops through the initiative of its manager.

Central Workshop facilities remain unsuitable for the effective repair of plant, and most of the criticisms made by Willcocks (1974) remain valid today (Photos 4 and 5). One particularly urgent need is for the construction of a properly designed hoist facility that is high enough for engine removal and replacement work (Photos 6 and 7). The THS Central Workshop facilities are reasonable (Photo 8).

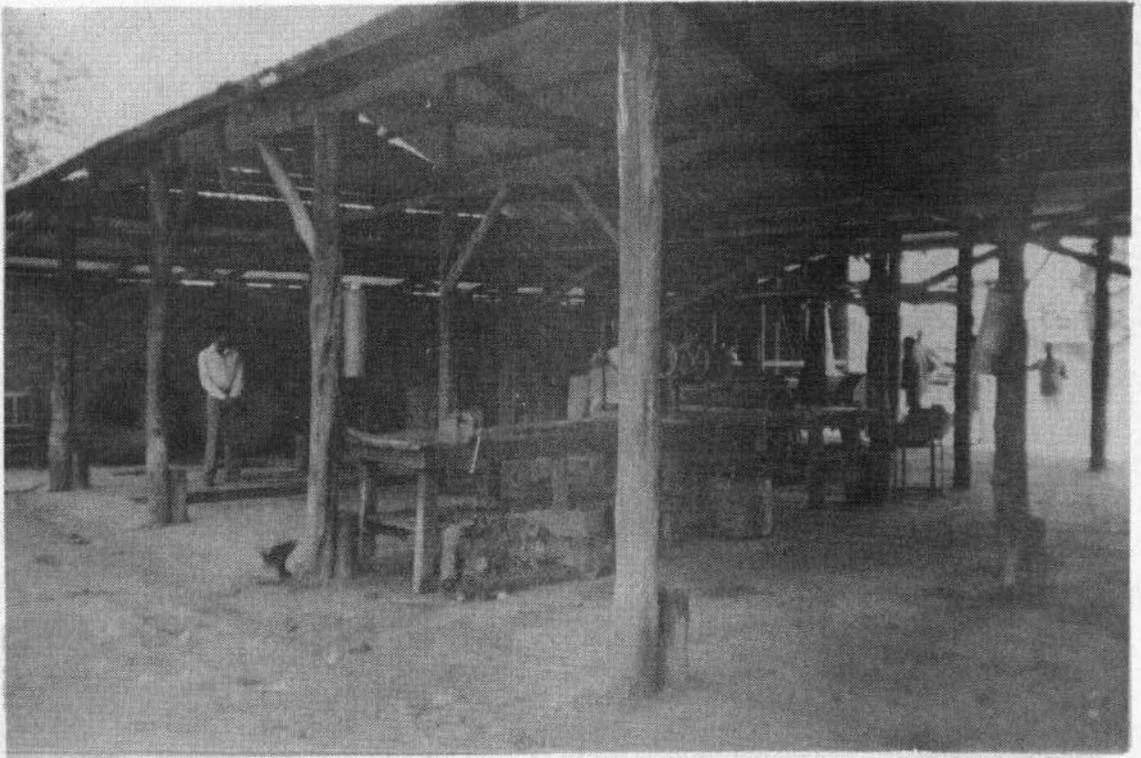
TABLE 4 Distribution of Transport, 1982

Station	Pick-up	4-WD	Lorry	Low-Loader	Tanker	Other
1. Bumala	1	4	3	-	1	1 motor cycle
2. Chiakariga	2	2	3	-	1	
3. Eldoret	1	2	2	-	1	
4. Garsen	-	2	1	-	-	
5. Garissa	N/R	N/R	N/R	-	N/R	
6. Kajiado	1	3	3	-	-	
7. Kipkelion	-	3	3	1	-	
8. Kitale	N/R	N/R	N/R	1	N/R	
9. Kitui	N/R	N/R	N/R	-	N/R	
10. Machanga	2	3	3	1	1	1 mobile workshop
11. Makueni	1	4	2	-	1	
12. Mariakani	1	6	2	1	1	
13. Marigat	1	2	3	-	1	1 dumper
14. Migori	1	4	1	1	-	
15. Nakuru	N/R	N/R	N/R	-	N/R	
16. Narok	1	2	2	1	1	
17. Naromoru	-	2	1	-	-	
18. Nyahururu	-	4	4	1	-	
19. Ruiru	2	3	3	1	1	
20. Central Workshop	N/R	N/R	N/R	-	N/R	1 mobile workshop
TOTAL	14+	46+	36+	8	9+	

Notes: N/R = Not Reported

Some additional vehicles omitted if seriously broken down or damaged.

Source: AMSB Annual Report



a) Eldoret Workshop



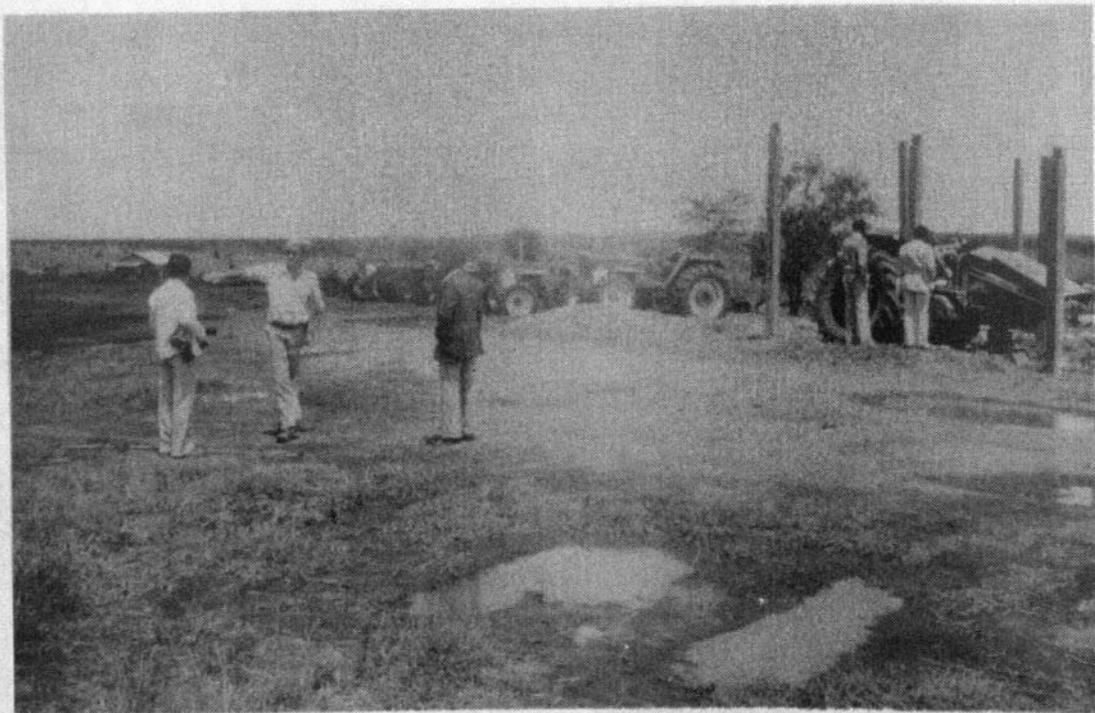
b) Repair of plant at Ruiru Station (A2991)

PHOTO 1 Basic conditions at the older AMSB stations  
(all photographs taken in 1983)



a)

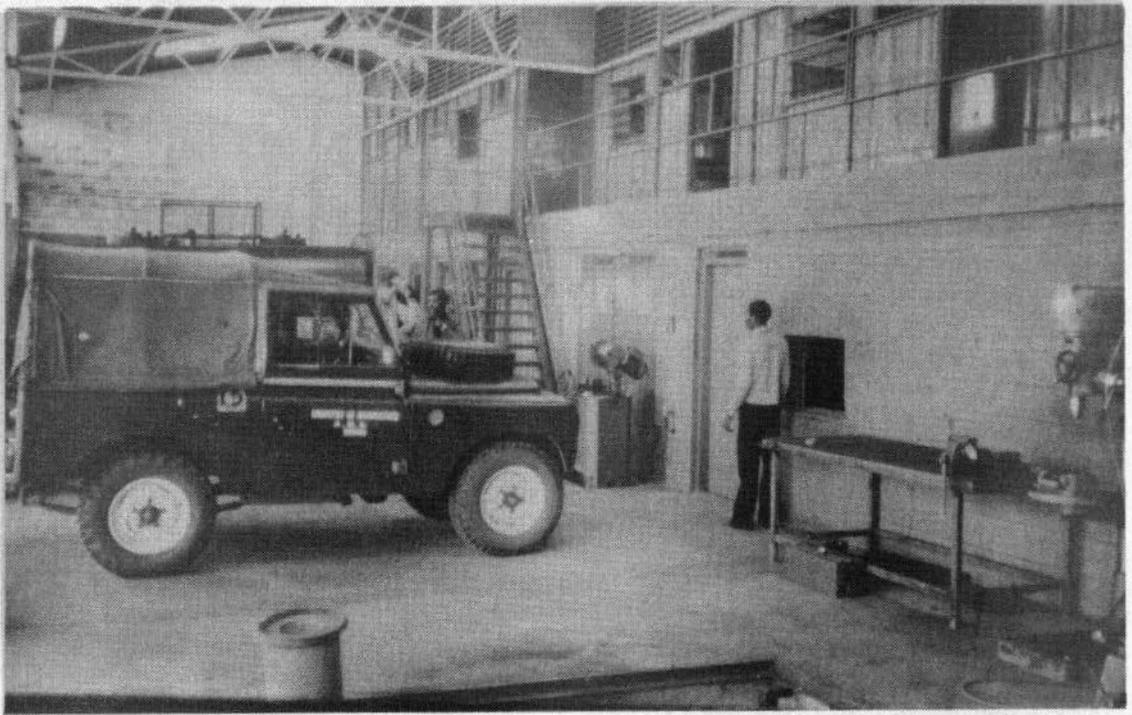
(A2974)



b)

(A2975)

PHOTO 2 AMSB Narok, one of several new stations with no covered workshop and very few facilities



a) Migori AMSB Station



b) Mariakani

(A2969)

PHOTO 3 Regional Workshops

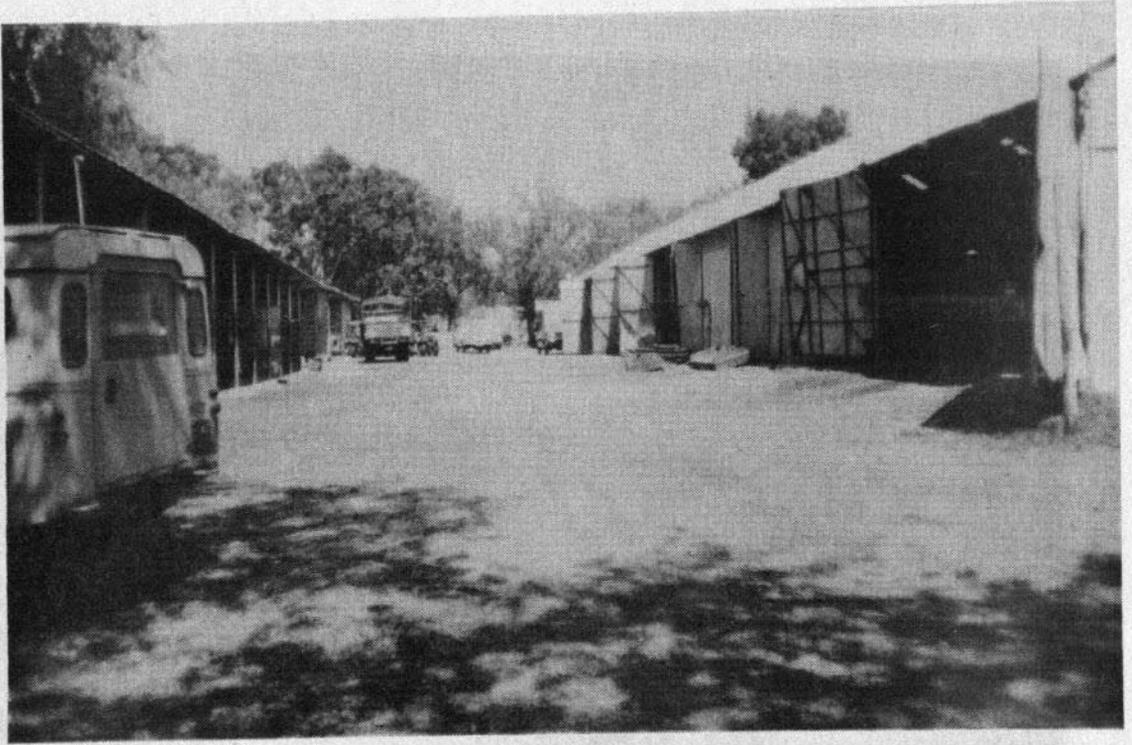


PHOTO 4 Plant Hire Services Central Workshops (PHS/CW), Nakuru 1983

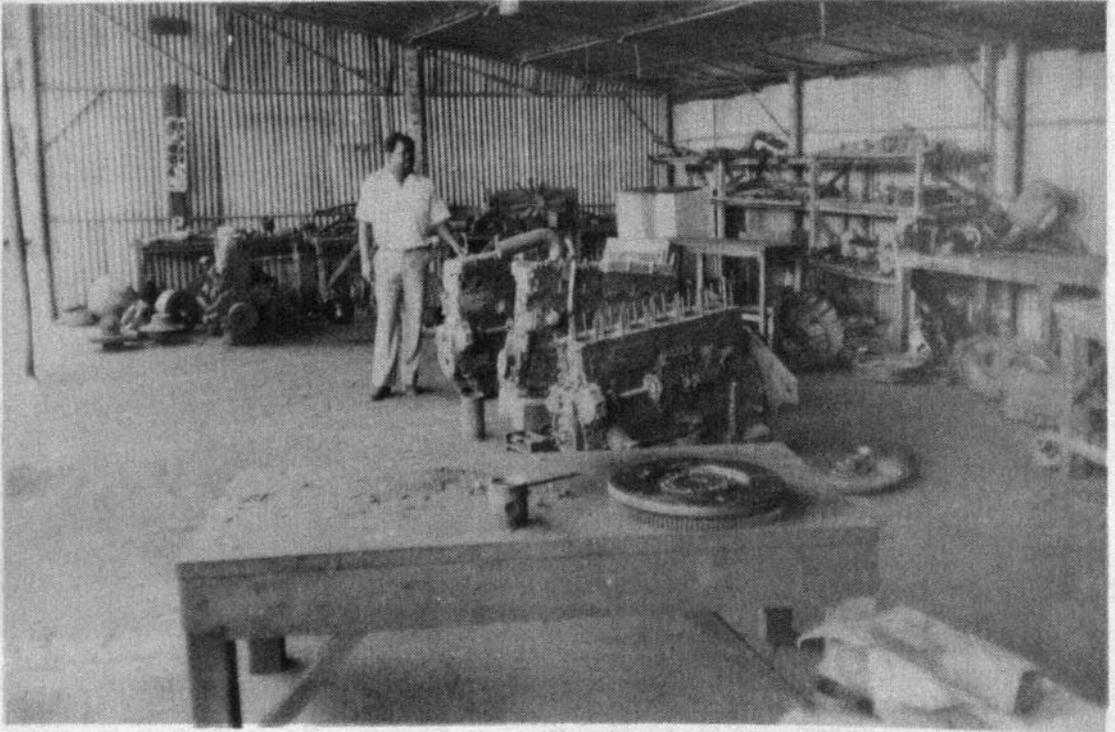


PHOTO 5 Plant Engine Bay at CW Nakuru (bldg. behind L.R. in Photo 4)

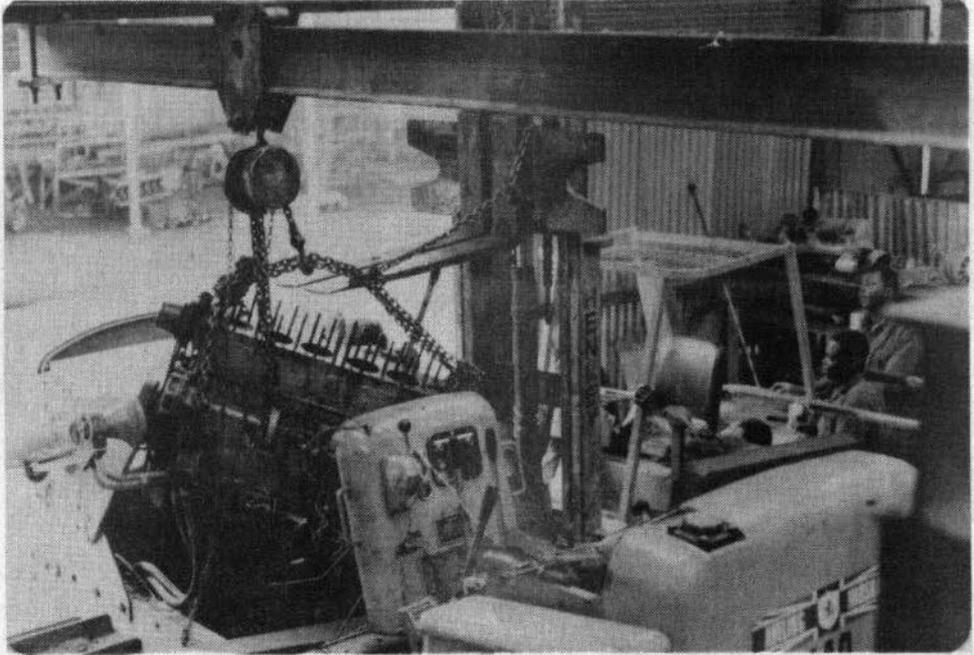


PHOTO 6 Hoist of inadequate height at PHS Central Workshop, note that a fork lift truck is needed to give sufficient height for engine block removal from a crawler tractor

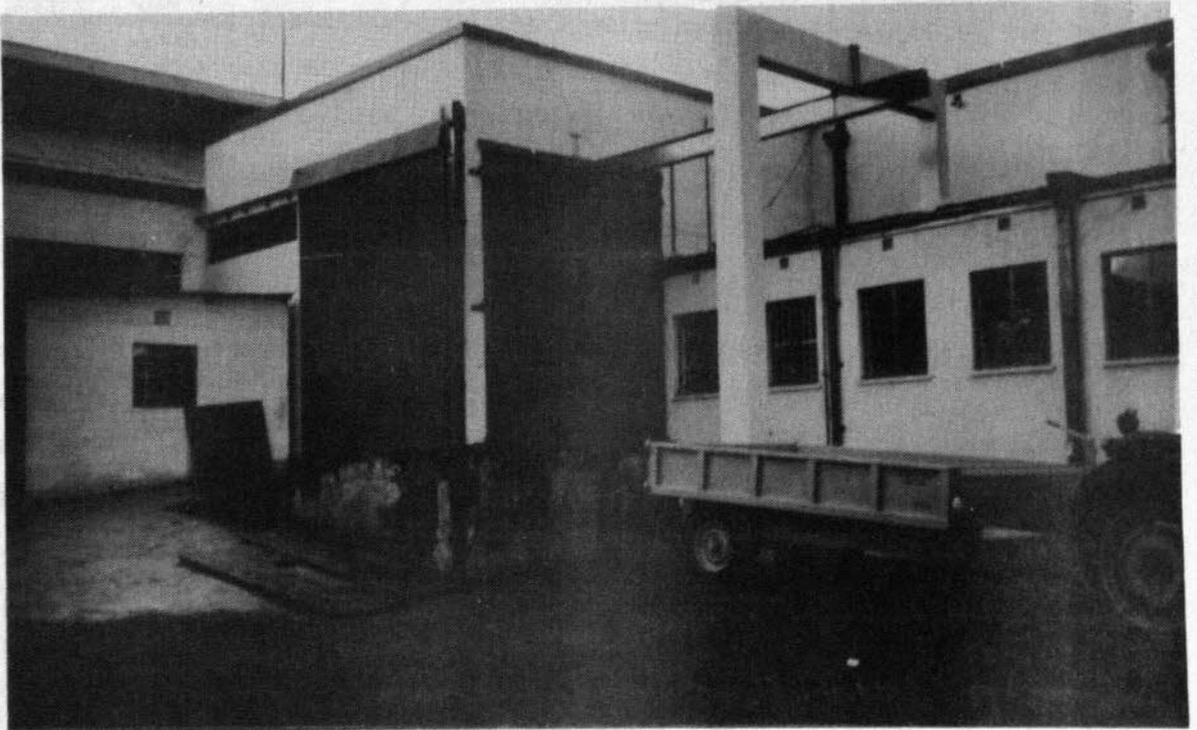
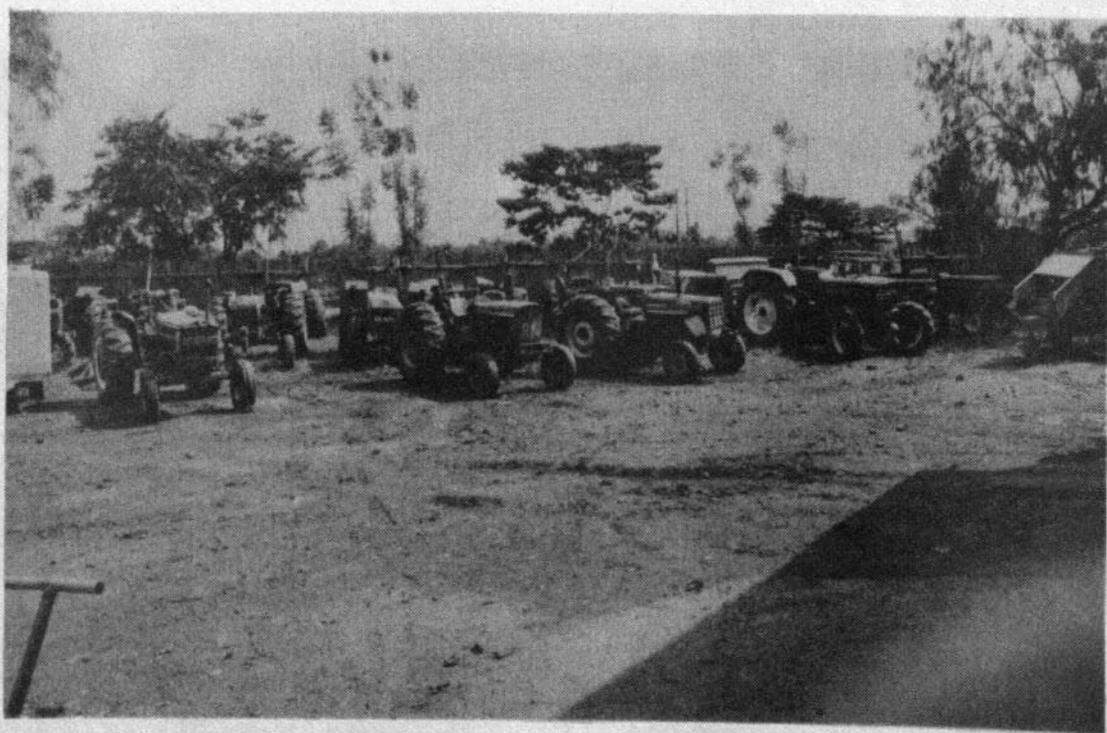


PHOTO 7 Workshop hoist suitable for the removal of complete engines from plant



a)

(I128)



b)

(I129)

PHOTO 8 Tractor Hire Central Workshop (THS/CW) Nakuru, 1983

### 3.5 Work Achieved

#### 3.5.1 Survey Section

Eight stations reported that nearly 12,000 hectares were surveyed in 1982. Kipkelion, Nyahururu and Eldoret each carried out 2,500 ha or more of survey work during the year. Most of this work consisted of perimeter surveying for boundary determination although some more detailed surveys were carried out for soil conservation and farm layout (See Agricultural Annex). At least one station (Nakuru) which did not report on survey work in 1982 is known to have carried out some work. Nothing is known of any possible survey work done at stations which did not cover this aspect in their annual report and which were not visited by the study team (i.e. Bumala, Chiakariga, Kitale, and Kitui).

An average of 1,500 ha of basic survey work (field work and mapping) per reporting station which reported any, represents not more than about 350 hours work per survey team. This means that survey personnel were productively engaged in work for approximately one-fifth of their time. No in-service training is being undertaken at present. Some station managers told the study team that experienced members of survey teams were disinclined to teach young members of staff in the practical techniques of their work. Thus it seems that the skills which some of the older officers no doubt possess are being lost as they retire.

#### 3.5.2 PHS

The scope of works executed by PHS, and an indication of the quantities achieved are shown by the outputs for 1982 reported by 11 stations (Table 5). These stations represent only 62% of the productive machine hours in that year.

TABLE 5 Physical Outputs Reported By PHS Stations\*, 1982

<u>Work Type</u>	<u>Quantity</u>
Dams (earth/masonry)	5 Nr
Waterholes	83 Nr
Bush clearing and ripping	946 ha
Terraces and drains	101.5 km
Land levelling	96 ha
Farm roads	534 km

Note \*: 11 stations only, representing 62% of total machine hours worked.

Source: AMS Annual Reports; Station Monthly Reports.

The total AMSB output was 22,327 machine hours in 1982, achieved with 107 machines. This is a dramatic drop from the 48,500 hrs of 1979, when the plant fleet was effectively smaller (the fleet was reported to be 108 in 1980, and 48 new machines were delivered in 1979-80, but a number of old machines were boarded over this period). The output per machine dropped from 415 hours in 1980 to 210 hours in 1982, which compares unfavourably with the period 1972/73 to 1974/75 when the outputs were 530 to 610 hours per annum (Spooner and Gota). The 1982 performance represents only 15% utilisation of the plant. This figure was calculated using PHS's own guideline for availability of 1,440 h. p.a. which is a reasonable maximum for the type of service being provided in a developing country.

The general drop in output may be due partly to a fall, especially since 1981, in the number of large Government-sponsored projects on which high rates of machine use can be achieved. There has also been an increase in the number of new stations which have been opened up. Some of these have very low work loads. Nevertheless the PHS average is only about 250 h. p.a. even if the 5 new stations with unit outputs below 100 h. p.a. in 1982 are ignored.

Although the reported major constraint on output has been availability of plant, the age of the majority of the plant has not been a major factor. Except for 16 old Caterpillar tractors, all machines are under 9 years old and most are under 5 years. Of 17 tractors that

could be checked from reports, only 2 had worked more than 3,000 hours and half had done less than 2,000 h. No clear relationship can be determined between age and availability in any case, because of the distortions of non-age related breakdowns and difficulties in obtaining spares.

The potential for stations to perform more efficiently is emphasised by two stations which performed relatively well before 1982: Nakuru, which averaged a unit output of about 660 h/yr. during 1979-81, and Eldoret which averaged about 725 h/unit/yr. over the same period.

Actual achievements compared to programmed outputs have followed the same pattern as for unit outputs, dropping from 45% in 1980 (AMSB Annual Report), to about 27% in 1982 (ref Station Reports and Table 6). The performance and productivity of the PHS fleet over the years is illustrated in Fig. 1, and details of the individual stations since 1979 are summarised in Table 6.

### 3.5.3 THS

Details of the performance of THS over the last five years are given in Table 7. Some of the figures are derived rather than actual, e.g. for several years the number of productive hours was obtained by multiplying reported hectarage figures by average recorded work rates for each operation. It is evident that although the size of the tractor fleet has increased steadily this has not been matched by a corresponding increase in the amount of work done, as the average annual output per tractor has declined (Figs. 2 and 3). For example, the number of tractors increased by +244% between 1976-77 and 1982, but the area ploughed increased by only +142%. The number of productive hours worked per tractor declined by 37% over the same period.

The levels of work output for each tractor per year are very low by any standards, averaging only 154 productive hours per year over the whole period. In no year has the average exceeded 200 hours, and it declined to 109 in 1982. Further deterioration is likely in 1983 unless present trends are reversed.

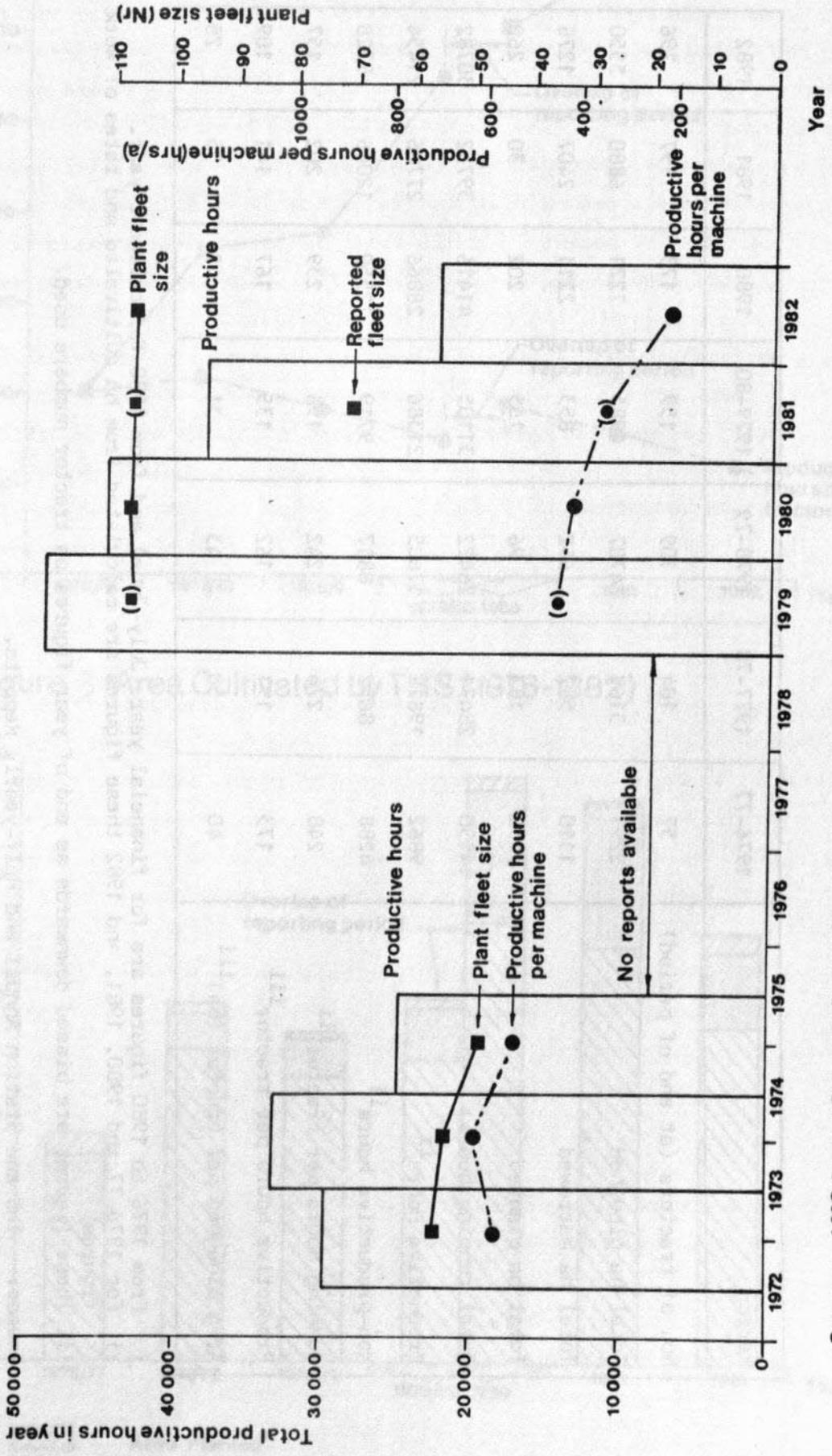
TABLE 6  
PHS Performance

STATION	1979			1980			1981			1982			
	Output (hrs)	Output (hrs)	Productivity (hrs/annum)	Output (hrs)	Fleet Size (No)	Productivity (hrs/annum)	Output (hrs)	Fleet Size (No)	Productivity (hrs/annum)	Programmed Output (hrs)	Actual Output (hrs)	Fleet Size (No) <sup>2</sup>	Productivity (hrs/annum)
1. Bumala	-	-	-	-	-	-	-	-	-	-	1,038	5	207
2. Chiakariga	-	-	-	-	-	-	982	2	-	-	314	6	52
3. Eldoret	8,158	4,838	-	6,909	-	-	NR	8	-	8,340	2,790	7	399
4. Garsen	-	-	-	-	-	-	-	-	-	-	328	4	82
5. Garissa	-	-	-	-	-	-	-	-	-	-	4	4	1
6. Kajiado	-	-	-	-	-	-	-	-	-	-	170	5	34
7. Kipkelion	3,766	6,358	-	2,695	-	-	4,495	6	-	10,430	1,326	7	189
8. Kitale	7,777	6,826	-	1,946	-	-	1,687	6	-	-	1,768	6	294
9. Kitui	-	546	-	1,946	3	-	-	3	-	-	1,460	4	365
10. Machanga	-	NR	-	1,687	2	-	-	2	-	3,800	720	4	180
11. Makueni	-	753	-	1,339	-	-	1,014	5	-	-	1,586	6	264
12. Mariakani	6,800	4,814	-	367	-	-	52	7	-	6,040	1,218	8	152
13. Marigat	-	NR	-	NR	-	-	6,095	2	-	-	479	2	240
14. Migori	-	NR	-	5,687	-	-	-	5	-	-	859	4	215
15. Nakuru	6,694	5,687	-	1,299	-	-	3,964	6	-	6,300	1,103	8	138
16. Narok	-	1,299	-	4,386	-	-	2,306	6	-	5,740	2,525	6	421
17. Naramoru	-	-	-	9,432	-	-	6,043	-	-	-	439	6	73
18. Nyahururu	5,510	4,386	-	9,432	-	-	-	6	-	6,155	1,315	7	188
19. Ruiru	9,744	9,432	-	44,939	-	-	39,894	6	-	-	2,882	8	360
TOTALS	48,500	44,939	416	39,894	108	416	39,894	70	(373) <sup>3</sup>	-	22,327	107	210

Note 1 Fleet size taken from AMSB annual report, which excluded unserviceable machines

2 Fleet size taken from list supplied by AMSB, not from station annual report

3 Based on total fleet of 107



Source : AMS Annual Reports ; Station Monthly Reports ; Spooner & Gota

Productivity and Performance of PHS (1972-1982)

TABLE 7 Summary of Tractor Hire Service Performance 1976 to 1982

Period	1976-77	1977-78	1978-79	1979-80	1980	1981	1982
No. of tractors (at end of period)	57	104	109	159	173	197	196
Total ha ploughed	2291	5167	4707	4985	7271	6880	5550
Total ha harrowed	1110	587	652	853	2211	2407	1278
Total ha planted	356	183	96	165	202	30	260
Total running hours	14150	28471	26422	31105	41416	39752	30782
Productive Hours <sup>ii</sup>	9862	19819	17605	21386	28866	27706	21454
Non-productive hours <sup>ii</sup>	4288	8652	8817	9719	12550	12046	9328
Running hours per tractor <sup>iii</sup>	248	274	242	196	239	202	157
Productive hours per tractor <sup>iii</sup>	173	191	162	135	167	141	109
Area ploughed per tractor (ha) <sup>iii</sup>	40	50	43	31	42	35	28

i From 1976 to 1980 figures are for financial year (July-June) and from 1980 for calendar year.  
 ii For 1976-77 and 1980, 1981, and 1982 these figures are calculated from ha cultivated and rates of work figures.

iii These figures are biased downwards as end of year figures on tractor numbers used.

Source: IHS and Station Annual and Half-yearly Reports.

Figure 2 Changes in Fleet Size and Output per Tractor (1976-1982)

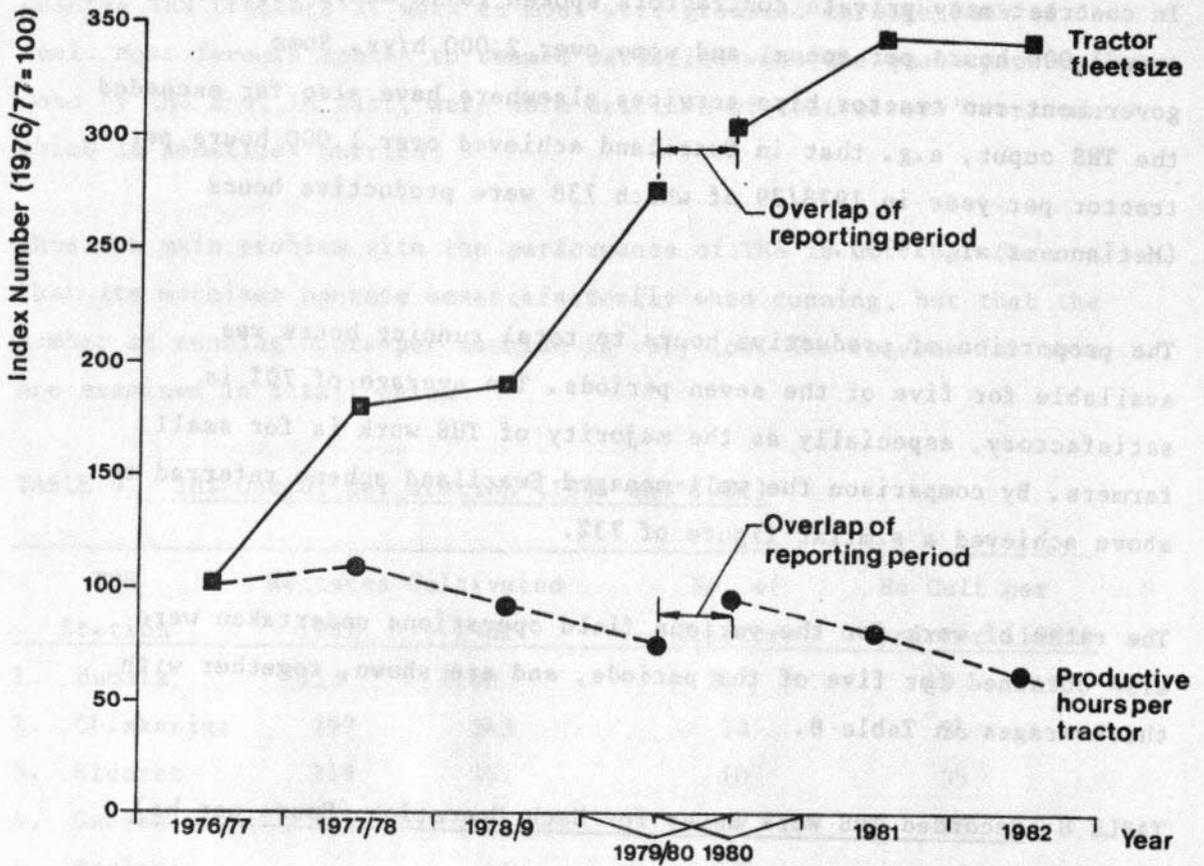
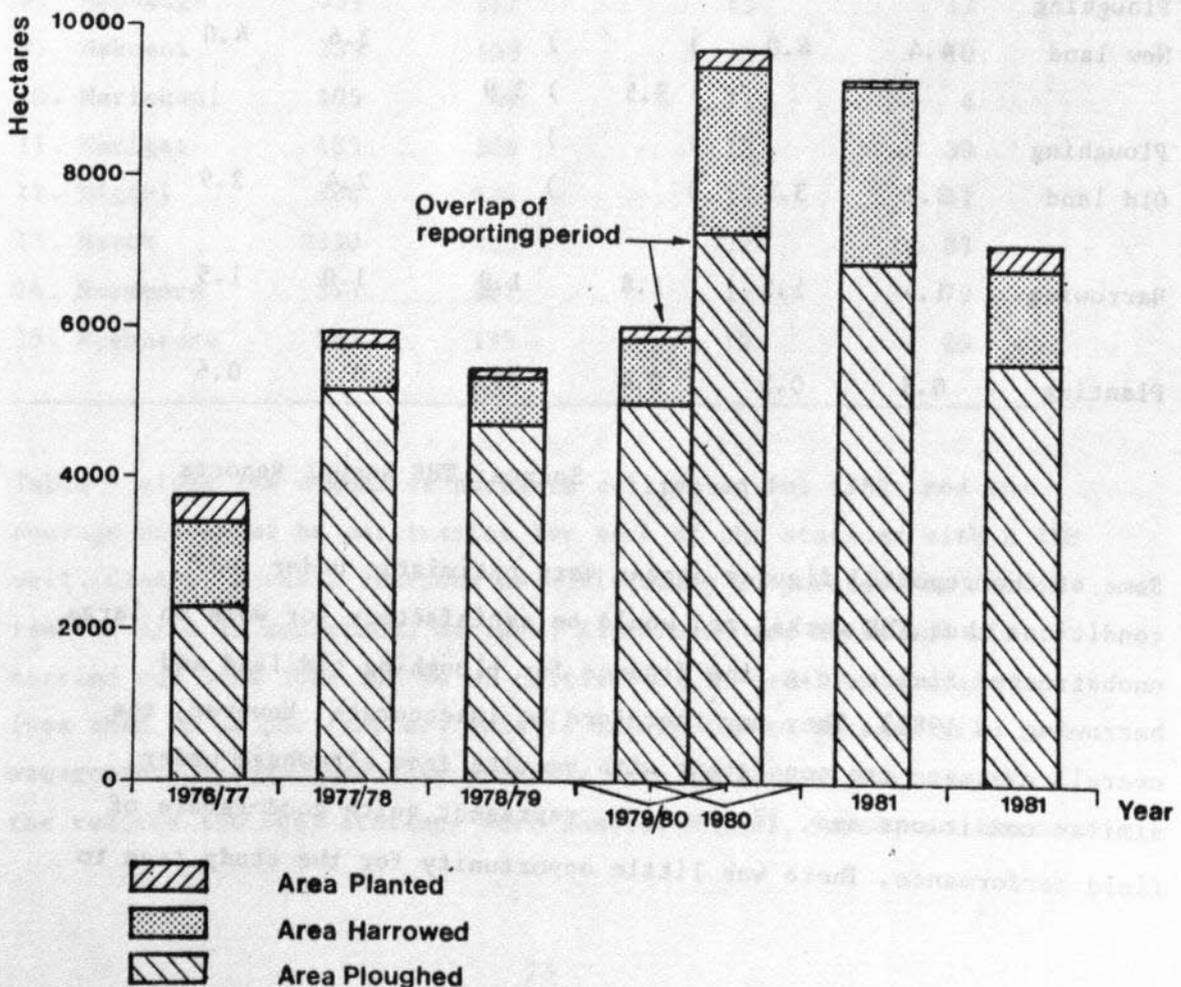


Figure 3 Area Cultivated by THS (1976-1982)



In contrast many private contractors spoken to in Kenya were achieving over 1,000 hours per annum, and some over 2,000 h/yr. Some government-run tractor hire services elsewhere have also far exceeded the THS output, e.g. that in Swaziland achieved over 1,000 hours per tractor per year in 1978/79 of which 738 were productive hours (Metianu et al, 1979).

The proportion of productive hours to total running hours was available for five of the seven periods. The average of 70% is satisfactory, especially as the majority of THS work is for small farmers. By comparison the well-managed Swaziland scheme referred to above achieved a similar figure of 73%.

The rates of work for the various field operations undertaken were also obtained for five of the periods, and are shown, together with the averages in Table 8.

TABLE 8 Recorded THS Work Rates for Each Operation (Hours per ha)

<u>Operation</u>	<u>1976/77</u>	<u>1977/78</u>	<u>1978/79</u>	<u>1979/80</u>	<u>1981</u>	<u>Average</u>
Ploughing						
New land	4.4	4.0	)	)	3.6	4.0
			) 3.5	) 3.9		
Ploughing			)	)		
Old land	3.2	3.2	)	)	2.4	2.9
Harrowing	1.4	1.2	1.8	1.9	1.0	1.5
Planting	0.5	0.5	0.4	0.9	0.5	0.6

Source: THS Annual Reports

Some of the reported figures appear very optimistic under the conditions that THS works, and would be satisfactory for work on large unobstructed fields (e.g. the figures for ploughing old land and harrowing in 1981). They may therefore be inaccurate. However, the overall averages are consistent with results from elsewhere under similar conditions and, if accurate, represent quite good levels of field performance. There was little opportunity for the study team to

observe THS tractors at work as most were grounded through lack of fuel. Most farmers spoken to seemed satisfied with the quality of work done by THS and, in fact, were more critical of contractors' work which is sometimes hurried.

Thus the main problem with the performance of THS is not therefore that its machines operate unsatisfactorily when running, but that the number of running hours per machine is very low. The reasons for this are examined in detail below.

TABLE 9 THS Output per station (1981 and 1982)

THS Station	Hectares Cultivated		No. of Tractors	Ha Cult per tractor (1982)
	1981	1982		
1. Bumala	853	1180	24	49
2. Chiakariga	297	343	10	34
3. Eldoret	719	351	10	35
4. Garsen	811	196	7	28
5. Garissa	-	11	6	2
6. Kajiado	-	251	11	23
7. Kipkelion	374	81	11	7
8. Machanga	439	217	13	17
9. Makueni	339	109	11	10
10. Mariakani	105	49	11	4
11. Marigat	485	506	13	39
12. Migori	386	694	17	41
13. Narok	3330	1820	22	83
14. Naromoru	344	867	11	79
15. Nyahururu	163	195	10	20

Table 9 gives the number of hectares cultivated for 1982, and the average number of ha per tractor for each of the stations with a THS unit. Clearly several stations were virtually inoperative as far as tractor hire is concerned. Garissa, Kipkelion, and Mariakani all carried out less than 100 ha of cultivation in total an average of less than 10 ha per tractor. This is mainly due to particularly poor management, though demand is probably very limited at Garissa. From the records the best stations were Bumala, Migori, Narok, and Naromoru

which all achieved over 600 ha in total and over 40 ha per tractor. The latter three are in areas where there is potential for new land development and therefore where demand for draught power is high.

Stations equipped with newer tractors tend to achieve better performance than those with older machines. For example, Naromoru, with eight 1981 Deutz tractors, cultivated 79 ha per tractor in 1982. Whereas at Mariakani and Kipkelion, where the majority of tractors were about five years old, the area cultivated per tractor was only around 5 ha. However, poor performance cannot be blamed solely on machine age, as in 1982 more than 70% of the tractor fleet was less than five years old and very few machines had achieved more than 2,000 hours in total. Twenty hour meter readings were noted from a mixture of tractors of different ages during station visits, but only one showed more than 1,500 hours, which is indicative of the very low levels of machine utilisation within THS.

The monthly station reports of three stations were examined to try and identify specific causes of poor performance. The stations chosen were Narok, Eldoret, and Mariakani, which represent good, average, and poor performance levels relative to other stations. Attempts had been made in the past to attribute THS down-time to different causes, but such an approach has two major drawbacks. First, it requires an estimate of the potential work output per year per tractor and such estimates (usually between 1,500 and 2,000 hours) have been far out of line with what THS could realistically achieve. Secondly, it assumes that down time can be attributed to one distinct cause. This may be true when a tractor is working regularly and misses occasional days for one reason or another. But when a station does no work for 6 months, the reasons are more complex - machines may be broken down, but there is no incentive to try and repair them if there is no money for fuel, no spare parts, and little demand anyway because of seasonality. Therefore it did not seem possible or particularly useful to quantify the importance of different factors contributing to down-time, but it was clear that the following had a major effect on the work output achieved:

a) Seasonality. Tractor hire units are now based at specific locations and work mainly in the District within which they are located. This limits the season during which they can work. Tractor

hire units are permitted to travel to other locations for work and this is done to a limited extent; e.g. tractors from Machanga worked in the Naromoru area during the off-season in Embu District. But in general, tractors do not travel long distances for work and this limits their busy season to usually between 3 and 6 months per year. This is in contrast to the earlier mobility of THS units which were shifted from district to district and so could find work over most of the year because of the varied agro-climatic zones in Kenya. Such movements are still carried out by the large private contractors, though small contractors tend to be location specific. The seasonality of demand and reduced flexibility of deployment of THS tractors is therefore responsible for idle months in many stations. The better level of performance achieved by Narok station is due in part to its ability to find work over a longer period.

b) Lack of Fuel. Fuel shortages are commonly stated as the main reason for down-time in station reports. For example, it was blamed for the lack of work during five months of 1982 at Eldoret Station. However, the main cause is usually that there are no funds for the payment of suppliers so that accounts are closed and supplies withheld. There were national shortages of diesel for most of December 1982 which caused problems for some stations, especially those with inadequate storage facilities. But absolute shortages of fuel seem to be a much less serious constraint on output than delays in the release of funds to pay for it. Distribution of fuel can also be a serious problem. For example, Narok has only one fuel tanker for 20 agricultural tractors and 6 units of plant working over a large area. As a result some tractors lost working days through lack of fuel although for most of the year the station managed to obtain supplies of diesel.

c) Machine breakdowns. Breakdowns are clearly responsible for a high proportion of down-time. Eight out of ten tractors at Mariakani did no work during 1982 because they were broken down for all or most of this period. Five out of twenty tractors at Narok were also grounded for the whole period, and none of these was older than 2 to 3 years. At Eldoret more than half the tractor-months lost during the peak period resulted from breakdowns.

The frequency of breakdowns may partly result from inadequate routine servicing and from improper use by unskilled operators (2 tractors at Mariakani were seriously damaged as a result of being driven by an untrained operator). However, breakdowns are inevitable when machines work in difficult conditions and where a high proportion of work is on previously uncultivated land. What is alarming is the length of time which a tractor can be out of action when waiting for a relatively minor component to be obtained. There are examples of machines grounded for weeks awaiting a replacement tyre, and more serious breakdowns such as hydraulic problems, engine overhaul, or transmission trouble can result in a tractor being out of action for a year or more. Such a long period in the workshop may result in further deterioration or even cannibalisation. Examples were observed of machines which were grounded for fairly minor reasons and were eventually written off for the above reasons.

Long delays in repairing machines usually occur due to the lack of spare parts, either because parts are not available in Kenya and have to be imported from Europe, or because there are no funds for AMSB to buy the spares. The ability of dealers to provide spares must be a major consideration in future machine acquisition, and it is clear that Foreign Aid Donors must shoulder responsibility for providing machines to AMSB for which there is no adequate dealer support within Kenya.

d) Finance. A high proportion of THS down-time is blamed on lack of finance, resulting to some extent from inadequate or delayed Central Government allocations which are beyond the control of AMSB. However, more careful budgeting and planning of expenditure is needed to ensure that available funds are used efficiently. There are possible ways of reducing THS dependence on Treasury allocations. For example, the introduction of a dual system of charges with a lower rate if the farmer provides fuel to allow machines to continue working in the absence of funds for diesel purchase.

e) Incentives. Especially where peak seasons are short it is important that machines are operated for as long as possible when work is available. At present there is no incentive for operators or managers to achieve high work rates. A system of overtime payments is probably the only way to achieve this at the field level. At the

station level, more detailed reporting of down-time is required so that headquarters can identify where managers are failing to take remedial action. It is alarming that many of the present monthly reports fail to give any information on idle tractors, managers apparently accepting, as inevitable, that many of their machines are inoperative.

### 3.6 Design and Construction Standards

#### 3.6.1 Technical aspects

During the study, the team met technical staff responsible for the design, layout, and construction of soil and water conservation structures. Dam designs were examined in the offices and some completed dams were seen in the field along with waterholes, terraces and cut-off drains which were generally not planned in detail before construction.

Some of the design and construction supervision staff who were met showed that they are very knowledgeable of design requirements, and that within the service there is some sound practical construction experience on major structures. However, it is apparent that, although most of the staff are conscientious, they sometimes go beyond the limit of their knowledge and experience, as shown by the deficiencies of design or construction of some of the structures examined. Particular points on the various types of structures are outlined below.

##### a) Earth dams

Problems with the earth dams cover all three aspects of site investigations, design and supervision of construction, as set out below:

- Site investigations of the dam sites during design were always inadequate, being aimed only at locating bedrock and ignoring the properties of overlying alluvium and residual soils. This reflects the general lack of appreciation of the effects that foundation materials can have on embankment stability and the requirements for the cut-off to control under-seepage.
- Effectively all the earth dams had poor internal drainage provisions, either because the toe drain appeared to be omitted or because the drain had a grading that was uncontrolled or was too coarse to act as a filter against the main fill. Some dams designed

by Ruiru and Nakuru stations, such as Mirui and Murera/Ruera had spillways excavated in earth which had inadequate provision for erosion control, and had eroded badly. Other dams, such as Karo dam, Eldoret, had been well designed and constructed.

- Supervision of construction appeared to be generally good judging from the state of the few completed dams seen at Ruiru and Eldoret, and from the operations observed by the team at the Koorali dam, Ruiru, which was under construction. However, compaction of the fill could very easily be poor, as often only earthmoving equipment is used to carry out the compaction, (acknowledged by Nakuru to have sometimes given poor results). Even when a roller is used this can be without the Vibration engine working, as was observed at the Koorali dam site. Fill contaminated with vegetation was observed also at Kooralie dam, although efforts were being made to clear out the worst of the matter. One dam (Karo dam, Eldoret) was observed with a highly undesirable low point on the crest. This was left when plant broke down near the end of the job but attempts to even off the crest should have been made.

General aspects and assessment of the design process, and principal characteristics of particular dams are given in Appendix L.

b) Masonry and concrete dams

Masonry dams at Machanga station have been designed on an arbitrary basis, due to misunderstandings of guidelines presented in Nissen-Petersen (Reference 39). This has resulted in safety factors being far lower than are normally considered acceptable. A concrete dam built by Kajiado station was reported by several sources to have been constructed without movement joints, leading to cracking and leakage.

c) Waterholes

The standard of planning and construction of waterholes is very varied. Some well constructed ones were seen on small catchments, and some at Machanga were commendably provided with draw-off pipes. Others were poorly planned or built to the extent that it was no surprise to hear accounts from both within and outside AMSB of waterholes which had been washed out (although none were seen during the study). The main faults observed were:

- little or not consideration given to the size of the catchment area above the site of the waterhole, in relation to the problems of siltation and the size of floods which occur on the larger streams. Waterholes on stream courses need to safely pass floods of similar size to those considered for small dams, though the waterhole embankment may be overtopped, if adequate grass cover has been established and maintained to prevent erosion of the fill material and the toe of the slope. Only a small proportion of the waterholes seen had this necessary protection.
- bunds constructed of unsuitable material. Several waterholes at different stations, have been constructed of highly expansive, black-cotton type soil. These Vertisols contain montmorillonite which is subject to extreme fissuring. One such waterhole at Eldoret, less than 2 years old, was seen to be in very poor condition, and a similar waterhole at Mariakani was acknowledged by the station staff to have breached because of the use of this material.
- poor construction. Some waterholes were seen with very uneven crests, this would concentrate water flows if overtopped by a flood due to an undersized spillway (as is normally the case), and this would encourage the bank to breach.

d) Soil Conservation Works

Little to no work is being carried out at present by the PHS on the planning and design of small-scale soil conservation works (see supporting Annex on Agriculture, Part Four).

The team observed that Eldoret and Mariakani were the only Stations that attempted to collect any relevant data on land resources prior to the design and construction of specific works. Even though some effort was made to produce topographical surveys of work areas, prior to implementing conservation measures by these stations, no survey was done of soil types, vegetation, land use and other important aspects. Thus water diversion and soil conservation structures, such as cut-off drains and contour terraces, were located in an arbitrary manner without any consideration of the physical features of the area.

The construction standards of drains and terraces seen by the team were considered to be adequate (with the exception of the work at Nyakach). The use of heavy earth moving machinery to construct small-scale works is effective but costly. Two wheel drive 70-80 hp tractors can adequately cope with the type of equipment needed to construct ridge and channel terraces. The cut-off terraces seen at Nyakach were very poorly constructed and, as described in the Agricultural Annex, some were not able to withstand the initial rains let alone a substantial wet period.

To summarise, although there is much sound technical expertise in AMSB, there also appears to be a widespread lack of understanding of the technical constraints on the structures concerned. There is also no back-up readily available even when problems are identified. There are approval procedures for dams, through the Ministry of Water Development, which are to check the technical acceptability of the designs. These procedures have not always been completed on particular schemes because some alterations required by MOWD were not implemented due to lack of detailed technical appreciation by AMSB of the problems involved. Unfortunately there inter ministry procedures sometimes lengthily resulting in serious delays due to the season dependant nature of much of the PHS work. The dam approval procedures in any case do not cover construction supervision when foundation material problems, requiring technical knowledge to recognise, are most likely to be found. There is a great need to build up further the existing professional technical expertise of AMSB in all fields earthworks of design and construction.

### 3.6.2 Plant Operation Standards and Outputs

Very few items of plant were operating at the time of the team's visit due to the Government expenditure restrictions. Only three units could be seen operating (Cat D4 and DG crawler tractor and a Terex TS14B scraper). Hence no conclusion could be reached on overall standards. However, some guidance on performance was obtained from comparisons of actual output on specific projects with theoretical values estimated from manufacturer's data. This was carried out for the scraper working on dam construction, basing comparisons on cycle times measured by the team, and for crawler tractors working on waterhole construction and bush clearing, using total times reported by AMSB.

Within the limits of assumption which had to be made, the production rates compared reasonably well with the theoretical estimates. The scraper cycle time was measured at an average of 5.1 minutes against 4.2 minutes theoretical. The difference may be accounted for by difficulties of manoeuvring in the very restricted borrow area and on the rough state of the haul road. Bush clearing times were reported to be from 4 h/ha in light bush to 10-25 h/ha in bush which was undefined. A theoretical time for the light bush example (the completed work was seen during the study) was estimated to be about 6 h/ha. Construction of a waterhole was estimated to have involved actually bulldozing production rates of about  $80\text{m}^3/\text{h}$ , while the theoretical estimate came to  $75\text{-}110\text{m}^3/\text{h}$  (say  $90\text{m}^3/\text{h}$ ). Details of theoretical estimates are given in Appendix M.

The information available is too restricted to be able to generalise on operators' abilities, but operator performance appears reasonable in terms of production. However, there were suggestions from some of the stations that operators' bad handling techniques could be exaggerating the weak points of some machines and increasing their tendency to break down. In any event the low pay of operators does not reflect the importance of their responsibility for very expensive (£100,000/unit) plant.

### 3.7 Finance

While acknowledging the severe cash limits policy which Government is presently obliged to pursue, the sums allocated to AMSB's recurrent and development expenditure have been insufficient either to ameliorate the poor state of repair of machines and vehicles or to motivate and sustain staff morale. The limited cash resources assigned to AMSB in the annual Allocation of Funds have been further constrained by Government budgeting and accounting procedures.

Draft budget submissions by AMSE are generally based upon forecasts of PHS and THS activity which are highly optimistic, since they relate to the theoretical potential of equipment rather than past achievements. The reductions which are subsequently applied by both the Ministry of Agriculture and the Treasury during the budget approval process disregard the commercial nature of the Branch's work. Expenditure

levels do not appear to be determined in relation to any specific work load nor to the variable cost profile of operating an item of earth-moving equipment or wheeled tractor.

Expenditure analysis within voteheads is also restrictive, offering only limited facility to detail the controllable and work-load related costs of operating plant and equipment. It is only in 1983/84, for instance, that equipment maintenance is being separated from equipment purchase. Fuel and lubricants remain an element of maintenance.

The preliminary draft expenditure estimate for 1983/84 also indicates that a substantial proportion of recurrent costs are being budgeted under the development head. This approach will only serve to compound the confusion which already permeates the financial and cost implications of the Branch's activities.

Notification of the sum assigned to individual AIE holders has been regularly delayed in recent years, effectively precluding expenditure commitment which might be required - e.g. to purchase fuel or carry out running repairs - in order to fulfil work obligations already paid for by the customer.

More recently, Government practice has been not only to allocate funds on a half yearly basis but to restrict monthly spending to one-sixth of that allocation. This effectively totally disables AMSB equipment as variable costs (fuel, lubricants and routine servicing) are a function of hours operated and not of elapsed time. It also prevents any flexibility in work output to accommodate seasonality of work load.

The limited allocations are further exacerbated by the delays inherent in the procedure for payment of supplier accounts. Accounting officers at provincial level handle payments emanating from a variety of Government departments. Apart from the inevitable delays caused by the invoice passing/cheque signing procedure, the disbursement of funds is regulated on an imprest basis. The local accounting officer is, therefore, especially cautious to ensure that his imprest limit is not exceeded. Random observations by the Study Team suggested that this play-safe approach possibly adds between four and five weeks to the

supplier account settlement cycle.

From 1st July 1983, the Treasury is assuming direct responsibility for provincial accounting practice. The proposed structure for AMSB is compatible with the concept of "line responsibility". It provides the opportunity to identify management responsibility with accountability within AMSB.

Government cash (receipts and payments) accounting conventions further distort attempts at commercial control of AMSB activities. There is a need, on a memorandum off-line basis, to adopt an accounting system within AMSB which relates income and expenditure to the work done (i.e. equipment production hours) in a given accounting period.

The use of stock accounts and adoption of such commercial accounting mechanisms as prepayments and accruals, applied to both income and expenditure, are essential to provide a sound and supplementary accounting base for recording and controlling AMSB operations.

The present circumstances of financial stringency have provided a ready-made escape clause - "no funds" - for failure to perform satisfactorily. It has been invariably used, doubtless unconsciously in a number of cases, to obscure the more fundamental weaknesses that exist in management ability, in management systems, and in basic operational skills and general good housekeeping procedures.

It is natural, but wrong in the view, of the Team, to attribute the poor and declining performance of AMSB mainly to a lack of funds. Finance is a finite resource for which there will always be justifiable and competing demands. If the Republic's liquidity was less constrained at this time, the team would still question the validity of any AMSB claim to a significantly greater share of available funds.

The Branch has persistently failed to perform or to demonstrate either the ability or commitment to improve. Successive and substantial inputs of resources, many of them derived from international aid agencies, have been nullified within a relatively short period of time. The failure of aid donors to consider the management problems resulting from the provision of a mixture of equipment has contributed to the problem.

That said, there has nevertheless been a marked deterioration in AMSB's internal good housekeeping discipline. Basic recording and filing procedures, at HQ and the stations, are lax and inefficient. Primary records - machine logs, job cards, stock records, application forms - are not fully and properly completed. It is difficult to trace the history of a job, from initial enquiry/request through execution to completion, from the current documentation and filing systems. There is no clear "audit trail". Station Reports are usually vague and inconclusive, and are frequently contradictory. The reporting format has not been standardised and therefore inconsistent from one station to another in terms of content. Much of the reported information is of little significance for management purposes. From some stations no report at all is submitted.

It is vital that an effective system of presenting information quickly and accurately to management is developed. Failure to exercise elementary "checks and balances" has contributed to the magnitude of the debt of some K.Sh 20 million outstanding for services rendered in past years. Much of that debt is now time-barred and irrecoverable. Without a "checks and balances" approach to the control of machine hours there is little scope for getting the financial outturn properly reconciled. On the other side of the coin, some stations have accepted deposits (representing 100% of the work value) on account of work to be done, and have then been unable to honour their commitment due to lack of fuel or operational equipment. This situation has potentially serious implications, too, upon future cash flow.

There are no grounds at present - and it is considered unlikely that any will be forthcoming in the short or medium terms - for postulating a revolving credit type of financing scheme by which AMSB might operate self-sufficiently.

The immediate need is to establish the real ongoing cost of maintaining AMSB as a service to farmers, in whatever size or shape that service might be. Only then will it be possible to determine what the level of hidden subsidy is and to identify where cost reduction measures can be applied. Thereafter, it will be possible to assess what scale of charges is most appropriate and how it might be "customised" to make it acceptable to both Government and farmer.

### 3.8 Operating costs

Any attempt to calculate the owning and operating costs of a particular machine is quickly negated by two main factors:

- the low level of machine utilisation which has been achieved over a series of 12 month periods, and
- the failure to maintain adequately detailed records of machine usage and cost incurred.

There is documentation and a procedure to accomplish this, but the increasing incompleteness of the records, year by year, reflects an attitude of indifference to their need and a basic lack of appreciation of their management purpose.

Because of these shortcomings, it is not possible to determine what the hourly operating cost of a machine over a period of time has been. Additionally lacking the basic data, it is not possible to establish what the hourly cost ought to be. No performance/cost statistics are available to allow comparison of similar machines located at different stations, nor to assess one make of machine against another, nor to compare fleet performance across the whole of AMSB.

There is no formal procedure to assign Central Workshop repair costs (spare parts, labour and overhead) of equipment repaired to the station on which the machine is normally based. While it may be fiscally appropriate to allocate recurrent expenditure for (major) repairs to the Central Workshop votehead, it is incumbent upon AMSB management to ensure that such expenditure is incorporated in the operating costs of the machines concerned.

Based upon the 1982/83 allocation of funds of recurrent expenditure, and making allowance for the notional depreciation charge related to the estimated capital cost of buildings, plant and equipment, and other facilities, the estimated annual operating cost of the combined PHS and THS is some £K4,000,000. Revenue earnings in the same period are estimated at £K725,000 leaving a net overall deficit of £K3,275,000.

Adopting simplistic and arbitrary bases for the allocation of expenditure to stations, and for the apportionment of expenditure between PHS and THS, the hourly cost of PHS equipment approximates to K.Sh 2,580 per item of plant. The equivalent THS cost is of the order of K.Sh 1,070 equal to K.Sh 3,759 per hectare cultivated. Comparable current charge out rates are K.Sh 520 and K.Sh 400 for PHS and THS respectively. A schedule setting out the calculations by station is shown at Appendix I.

The calculated costs should be regarded as no more than indicative, although their magnitude in relation to the scale of charges is cause for concern. There are many unquantifiable factors which have contributed in 1982/83 to the unsatisfactory cost rates. These include:

- the age of much of the plant and equipment
- the landed, duty-paid cost of spare parts
- the restrictions placed upon expenditure
- the working methods, degree of skill and low pay of operators
- the numbers, grades and level of skill of mechanics
- the inadequacy and inappropriateness of workshop facilities
- the delays in settling supplier accounts, and
- the size of the work-load.

The productive (i.e. chargeable) hours for the entire PHS fleet of about 110 units of plant amounted to some 22,000 hours in 1982. That is, an average chargeable utilisation of 200 hours per item of plant. The equivalent output statistics for THS machines in 1982 are 21,500 productive hours for a fleet of 196 farm tractors, or 109 productive hours per tractor year. These extremely low annual work outputs are less than 20% of what should be achieved by PHS and THS type of equipment if operation is to be economic.

Previous studies of AMSB's machine operating costs have all been rightly concerned to calculate the cost as a function of productive operating hours and cost incurred. All studies, while commenting upon the low and declining level of productive hours achieved, have nevertheless invariably based their calculations upon the "average

productive hours achieved in developed countries (DCs). History and experience of plant operation in LDCs, and certainly the AMSB track record in Kenya in the last 6 or 7 years, shows that LDC achievement seldom reaches 0.5 of the average DC performance and overall is possibly no more than 0.25 of that performance level.

In calculating operating costs, earlier studies have generally adopted the formulae for cost element determination postulated by the equipment manufacturers. This is in spite of the manufacturers' repeated caveats that their cost profiles are averages built upon a set of interdependent conditions that are essentially related to DC experience, viz

- working conditions
- plant operator skill and technique, and
- servicing and maintenance procedures.

Strict adherence to DC costing methodology is itself no bad thing. Making use of DC derived data to the exclusion of local data renders the cost calculation meaningless.

Few of the DC assumptions are likely to fit LDC application. Apart from differences, probably highly significant in the qualitative aspects of operator and mechanic working practice, the financially quantifiable difference in: wage rates, spare part prices and fuel prices are all likely to give an aggregate level of cost/performance capability that is well below the DC norm. As a result, standard approximations used in DCs will be inappropriate to LDC conditions, e.g. those relating spares expenditure to purchase price.

Again, in a commercial situation the accounting treatment of machine repair costs is looked at in the time scale of the machine's estimated useful life and is "equalised" over that period. Government accounting practice results in repair costs being charged to the period in which the expenditure is incurred. The year by year pattern is, therefore quite irregular and the resultant fluctuations render effective cost control impracticable.

What AMSB have singularly failed to accomplish over an extended period of time is the determination of the operating cost facts of the local

situation. More than enough time has now elapsed during which a data base of machine operating cost performance could have been assembled from primary records. To attempt to do so now, retrospectively, would be time-consuming and difficult since the primary records themselves are incomplete and the operating environment has been severely distorted by other major influences, not least of which is the present cash limits policy of Government.

### 3.9 Justification for AMSB

#### 3.9.1 Introduction

The continuation of AMSB can be justified only if:

- (i) the activities which it undertakes are desirable and necessary for the development of Kenya.
- (ii) an organisation such as AMSB is the most efficient way of undertaking these activities.

This report recommends some change of emphasis in the type of work which AMSB undertakes, so it is important to look at the viability of future as well as past activities. The report aims to improve not only the efficiency but also the effectiveness of AMSB. Past performance records are not therefore wholly relevant. At the same time, the year to year trend in the shortfall of achievement against expectation over the past six or seven years is not a gap that can reasonably be expected to diminish in the short term. So projections for the future must be discounted heavily to counter the over-optimistic norms which have been inappropriately adopted in the past.

In a free market for machinery hire, the justification for AMSB activities would be demonstrated if customers were willing to pay for them at a price at which it was profitable to provide them. In fact, such criteria do not provide a good guide to the justification for AMSB because: i) the prices charged for its services are well below the costs of providing them, and ii) the benefits of some of its activities are likely to be underestimated by the customer or potential customer. In the long term, and from the point of view of the country as a whole, the benefits may nevertheless be substantial. It may be very difficult to quantify the benefits, both to the farmer and to the country, of some conservation operations, though it is still clear that they are desirable or even essential.

#### 3.9.2 PHS

The soil and water conservation activities of PHS are prime examples of apparently desirable and necessary operations which are nevertheless difficult to demonstrate to be economically viable. The

costs of conservation works are often high and the benefits, in the shape of avoidance of yield reduction or loss of soil and land, may be hard to assess (what would have happened otherwise?) and very long term. Hence, using conventional discounting procedures, rates of return may be very low or even negative. Some attempts have been made in Kenya to quantify the benefits of soil conservation, but they have done little more than demonstrate the speculative nature of such studies. For example, research by the Netherlands team in the Soil and Water Conservation Branch of LRDD appeared to be highly optimistic in the benefits which it attributed to small-scale soil conservation works, offering little support for the yield gains assumed. The UK team on the EMI Project expressed the view that it is unproductive and undesirable to try and quantify conservation activities in many cases, as the work is obviously necessary if the productive potential of the land is to be preserved. It then becomes a mainly political decision as to what level of resources should be allocated to conservation works in competition with other national priorities. Once decided it then becomes a question of what is the most cost-effective way of carrying out the work.

The GoK has clearly and comendably decided to give high priority to conservation activities. This is demonstrated by the statements quoted in Section Iiii and 1.4, and, given the serious problems of erosion which exist in Kenya (some of them witnessed by the team) and the increasing pressure to expand cultivation in semi-arid regions, this is a justifiable emphasis.

The question remains of whether AMSB approach is the most effective way of carrying out the desired conservation operations. It has not always performed well in the past, having even contributed to erosion hazards in the construction of inappropriate cut-off drains at Nyakatch and bush-clearing in erodible areas in Kerio Valley (See Agric. Annex part 4). The proposed changes in the structure and management of AMSB, especially the formation of professional Survey and Planning Units (SPUs), should improve the performance of the plant hire operation, and ensure that its work follows sound engineering practices.

The private sector does not have the capacity to plan and administer

soil and water conservation programmes. At best it might be able to provide the plant to undertake operations planned and managed by a government organisation, but at present even this is not the case except near the large towns. This is partly a result of the subsidised rates charged by AMSB and the fact that direct subsidies for conservation works are not payable to private contractors (see section 4.4). While these disincentives should be reversed, it will be a long time before the private sector is able to provide the appropriate equipment in the appropriate locations to carry out the scale of conservation works which are now required in Kenya. A more efficient government service based on the existing AMSB is therefore seen as the only method of providing such a service in the next few years. Eventually government involvement should be confined to the planning and managing of conservation operations, and their physical implementation should be increasingly undertaken by the private sector.

### 3.9.3 THS

The economics of tractor use in Kenya has been more extensively researched than those of conservation works, but the conclusions of the work vary widely. For example, S J Pollard of AMTU/AEIP (part of LRDD) carried out studies of 3 areas of Kenya where different draught types predominated and his main findings can be summarised as follows:

- because of limited availability and regional variations in supply, few farmers can actually choose between oxen or tractors each ploughing season.
- animal draught is cheaper, both in private and social terms, than tractor cultivation.
- ownership of a power source ensures better timeliness (and therefore enhancement of crop yields) for the farmer than reliance on hiring, and this too favours oxen.

He concluded that, although Government policy has tended to favour tractors, "promotion of oxen at the expense of tractors would enable lower costs of cultivation and savings in foreign exchange" (Pollard and Wainaina, 1982).

The opposite view is represented by Schmidt and Swoboda (1979) who

argue that labour constraints and the high grazing requirements of oxen make mechanised cultivation preferable to animal draught in most AEZ's of Kenya. In high potential areas the opportunity costs of grazing land are particularly high, and in semi-arid areas mechanisation is recommended to ensure timely planting.

That researchers who have spent years studying the subject of farm mechanisation in Kenya can come up with such widely differing conclusions is a caution against making generalisations about the economic desirability of tractor utilisation after a short-term study such as this. Part of the differences in conclusions may be attributable to the different locations at which research was concentrated, and part is a result of different estimations of opportunity costs and shadow prices.

It is sufficient for present purposes to conclude that there is no strong evidence of a clear national advantage to either tractor or animal cultivation, and to therefore recommend that Government policy should not be biased in favour of one or other. The provision of a Tractor Hire Service at rates lower than it could be provided by the private sector and substantially lower than the costs of running it appears to represent a bias in favour of tractor cultivation which cannot be justified by the evidence.

Not only is there little evidence to favour tractor mechanisation over animal draught, neither is there a clear case for providing such a service from Government resources when similar services are provided by the private sector at substantially lower cost (although not necessarily lower charge). Government involvement might be defensible under certain circumstances eg:

- i) If there is reason to believe that private sector operators make excessive profits by charging inflated rates to the farmers (as might occur if there were a monopoly, or restricted access to the business).
- ii) If farmers do not understand the benefits which would result from the adoption of tractor cultivation and so are reluctant to hire at full cost. A subsidised Government service could then be justified as a temporary extension/launch exercise.

iii) If there are substantial economies of scale to be gained by operating a large fleet of tractors eg in spares availability, fuel purchase, field backup. Thereby keeping costs low.

iv) If there are areas with potential for agricultural development but which have not been cultivated in the past. The lack of previous demand for tractor hire and the problems (in terms of machine breakdowns and damage) resulting from working on previously uncultivated land may make private contractors reluctant to operate in such areas.

In practice, the only one of these points which may apply to THS is iv). The other points are not valid because i) The private contracting business appears to be sufficiently competitive to avoid excessive charges being made; ii) farmers in most areas are aware of the availability and advantage (particularly in reducing drudgery) of tractors; and iii) the economies of scale which may exist are heavily outweighed by the diseconomies of scale and of Government ownership. Even the argument for a government hire service in areas of new land development carries only limited weight, as the availability of good potential undeveloped land in Kenya is low, and the role of THS in such areas must only be short-term and result in handover to the commercial sector. Alternative methods of encouraging contractors to move into new areas should also be explored. For example, subsidies could be paid to farmers for the cultivation of new land (where deemed suitable for cultivation by the DAO) which would increase their ability to pay contractors to carry out the work. A substantial increase in the THS charge for ploughing new land would further encourage contractors to take over.

It is, therefore, recommended in Section 5 that the scale of THS be significantly reduced, and that tractor hire be withdrawn gradually from stations where it competes with animal draught or private contractors. Even in areas with potential for additional land development, THS activities should be regularly reviewed and phased out as the private sector takes over.





#### 4. RECOMMENDATIONS

##### 4.1 Objectives and Envisaged Workload

###### 4.1.1 Objectives

The primary aim of the AMSB should be to provide an effective planning and mechanised service for implementing soil and water conservation measures in the agricultural sector. It should also include the development of new land, and in certain limited circumstances the provision of mechanised tillage.

The detailed objectives for the main activities of the AMSB should conform to the principles summarised by the Permanent Presidential Commission for Soil Conservation and Afforestation (PPCSCA), i.e. to:

"i) Contribute towards the introduction and maintenance of appropriate soil and water conservation measures on land that is already being cultivated.

ii) Bring new land into cultivation by using plant to

- clear natural vegetation; and
- construct appropriate soil conservation measures e.g. terraces, cut off drains etc.
- implement land drainage measures

iii) Construct dams and waterholes in marginal cropping areas"

The above operations, which would be carried out for private farmers, groups of farmers or government organisations should be undertaken at commercial rates. In circumstances where certain soil and water conservation structures are urgently needed for regional conservation and development of resources, government subsidies should be used. The scale and administration of subsidies must be explicitly set out.

The above objectives would be achieved through different services and units within the organisation:

- 1) A Survey and Planning Unit (SPU) needs to be established within

AMSB. This unit is critical for the effective achievement of the first objective of AMSB above and for ensuring appropriate works are implemented in line with the other objectives.

The objectives of this Unit would be to:

- i) Survey and assess the physical resources available to farmers, or groups of farmers, within a given catchment area.
- ii) Plan the layout of farms to make optimal use of these resources in line with farmers' needs and Government guidelines for soil and water conservation.
- iii) Formulate implementation programmes based on approved plans.
- iv) Design appropriate structures and subsequently ensure that the contractor (PHS or private sector) builds structures according to the original engineering designs.
- v) Ensure that the division of large farms into smaller units follows sound soil and water conservation practices throughout the agricultural sector.
- vi) Promote, in conjunction with the SWCB, the need for effective resource conservation practices.

The SPU would work closely with the farm management and extension service units of the MoA and also the MLD, MWD and MENR as specified in the PPSCSA recommendations.

## 2) Plant Hire Service

The objectives of the PHS would be to:

- i) Provide and efficiently operate the plant required for implementing the plans developed or approved for farmers by the SPU.
- ii) Develop and maintain effective support maintenance and repair facilities for the above plant.

### 3) Tractor Hire Service

In line with GoK objectives and budgetary constraints, the future of the THS must be limited to the following roles as directed by the SPU:

i) Opening up of new land for agricultural production in areas with good agricultural and economic potential but where no private contracting services are yet available.

ii) Introduction of improved agricultural techniques to farmers, especially with regard to minimising the cost of land preparation, e.g. reduced tillage for dryland areas, etc (section 5.3).

iii) Providing tractors for soil conservation and land improvement measures where this is feasible to complement the heavy plant activities of the PHS e.g. in constructing waterholes and terraces.

#### 4.1.2 Envisaged workload

The team consider it essential that a realistic workload be defined and established for AMSB in line with the above objectives. This is of paramount importance for the effective development of the service and the motivation of its staff.

There is a substantial short and long-term demand for farm division and planning services from the proposed SPU, as part of the current national drive on subdivision of large farms which will continue for the foreseeable future. There are also old farms, of all sizes, and new farms being cleared, whose owners are asking for planning services for the efficient incorporation of soil and water conservation measures. The total surveying load should remain at the current several thousand hectares per year, but greater planning input is needed.

The short-term demand for heavy plant operations is extremely difficult to assess because of the many factors which affected farmers' demand in late 1982 and in early 1983. At the time of the team's visit, only one station (Ruiru) had a firm work load exceeding 500 hours although requests for additional work can be expected at

some other stations throughout the year. Some station forecasts of the potential work load, if constraints were removed, approached a similar volume to Ruiru. Few managers however, were able to quantify any of the potential load. The team, therefore, considers that the total 1983/84 work load is unlikely to exceed the output for 1982 of 22,000 hours. A breakdown of the work load by station is given in Table 10.

There is an obvious demand for waterholes, bush clearing and farm roads presumably because they are of immediate benefit, while soil conservation is more long-term and is perceived to be more readily postponed if there are constraints. The present low level of demand for soil conservation works may thus be reversed in the future. The demand for waterholes will be maintained, as it will be many years before all developing areas have reliable regional water schemes which can supply minor irrigation requirements as well as domestic and livestock demands.

There is a small but consistent demand for small dams (embankments between 5 and 10 m high) for irrigation. However, these tend to be concentrated in higher potential areas (Ruiru, Nakuru, Eldoret), and construction should normally be left to the private sector. The dam design service should continue, with appropriate boosting of engineering expertise in the proposed SPU. Some dam construction work should be retained to ensure adequate experience is available to implement schemes in marginal areas when required.

#### 4.2 Organisation, Management Structure and Management Systems

##### 4.2.1 Organisation and Management

The nature and scale of AMSB's envisaged role demand, for their successful execution, an autonomous organisation. Individual posts within the structure have to be unambiguously identified. Job responsibilities have to be clearly specified. A singular command and reporting structure that emphasises the accountability of each management level within the organisation should be adopted in order to overcome the practical operating difficulties to which the present decentralised arrangements contribute.

TABLE 10 PHS Station Performance in 1982 and Anticipated Short Term Workload

Station	1982 Productive hours	Applied for (hours)	Predicted Workload 1983 - 4 Estimated maximum <sup>1</sup> (hours)	Remarks
<b>Stations visited by Study Team:</b>				
3. Eldoret	2790	100	1000	maximum based on estimates
7. Kipkelion	1326	300	1000	maximum based on estimate
10. Machanga	720	?	>1500	detailed estimate provided
12. Mariakani	1218	?	1000	based on 1982
13. Marigat	479	100	500	maximum nominal
14. Migori	859	?	1000	nominal
15. Nakuru	1103	?	3000	based on detailed estimate
16. Narok	2525	500 <sup>2</sup>	1500	maximum based on 1982
17. Naromoru	439	400 <sup>2</sup>	500	maximum nominal
18. Nyahururu	1315	?	500	nominal
19. Ruiru	2882	3500	>3500	
<b>Stations not visited by Study Team:</b>				
1. Bumala	1038	-	500	nominal
2. Chiakariga	314	300 <sup>2</sup>	500	nominal
4. Garsen	328	-	<500	nominal
5. Garissa	4	-	<500	nominal
6. Kajiado	169	-	<500	nominal
8. Kitale	1768	-	1000	nominal
9. Kitui	1460	-	500	nominal
11. Makueni	1586	-	500	nominal
			<b>TOTAL</b>	<b>19500 h</b>

Notes: 1) Without constraints. 2) Estimated from discussions.

Given the run-down of AMSB's physical resources, the management and systems weaknesses in its operation, and the absence of any meaningful projections of workload, it is not appropriate at this time to recommend "privatisation" or re-structuring on a para-statal basis. If the future of the Branch does lie in the public sector, then consideration should also be given to which Ministry it would best be attached. For the present the team feel that AMSB should remain with MoA because of their ministry's active appreciation of resource conservation.

Whatever the outcome of these deliberations, there is a prior and urgent requirement for an intensive exercise in rationalisation and retrenchment. It is essential to begin to put the AMSB house in order now.

Options and action programmes are postulated at Section 4.3 and 4.4. AMSB's operating situation and the required inputs are shown schematically at Appendix N. The diagram seeks to emphasise the planning tasks and the delicate balance which exists between the customer and AMSB in the shape of the machine (manned, fuelled, properly serviced and professionally supported) performing the work. Conceptually, the structure may seem unstable, resting as it does ultimately upon the piece of equipment at work. In practice, maintaining stability is a management function - planning, co-ordinating and controlling the many and varied back-up activities which are required to fulfill the execution of the work efficiently and to the satisfaction of customer, Government and AMSB.

Three main line professional management functions are perceived:

- survey and design leading to the planning and programming of the work-load;
- maintenance of the fleets of machines and vehicles in good working condition; and
- execution of the work programme

Additionally, two professional staff functions are seen to be necessary

- manpower training and development, and
- the provision of an accounting and information service

both of which should be dedicated to AMSB requirements.

All of these roles are largely self-explanatory. In the case of the accounting and information service, it should be said that the creation of an in-house facility does not in any way imply that Government accounting conventions are to be abandoned. There are major gaps in the present accounting/operating information procedures which can only be overcome by augmenting and extending within AMSB the detail and analysis of primary documents concerned with work-load, performance, expenditure, revenue and cost control.

An outline organisation chart of the proposed structure is shown at Appendix O. The proposal retains management (professional, technical and administrative) responsibility entirely within AMSB. The roles of the PDA, PLDO and DAO are seen to be essentially concerned with identifying and generating work which AMSB can undertake, and with directing prospective customers to AMSB where alternative services (farmer groups and/or the private sector) are not available.

#### 4.2.2 Management Systems

Although there are major gaps and inconsistencies, it can be said that there is no lack of basic data concerning AMSB activity and performance. What is critically missing is a formal system which draws the data together to provide an information base upon which activities can be monitored and decision-making can be made more effective. There is neither collation, summarisation nor interpretation of the key factors of operating a machine hire business.

AMSB's effectiveness, and the efficiency of its performance, are ultimately measurable in the number of productive hours which are chargeable to, and recovered from, users of the service. The primary objective must be to maximise these hours so that revenue earnings are sustained at a high level, while costs are contained within acceptable limits.

In its formative years AMSB appears to have maintained comprehensive and meaningful records of machine performance. The rapid expansion of

the service in the late 1970s, however, was not matched by a complementary development of management information systems. The records of the last six or seven years are incomplete and of little value from a planning and control point of view.

Whatever the scale and nature of AMSB in the future, it has to be recognised that a management information system, properly integrated with the accounting requirements of Government, is an essential component of the management of the undertaking. This can only be achieved with an AMSB dedicated in-house accounting staff. The system outlined in the following paragraphs is not new. It is rather a restoration of what was originally there. Some minor refinements have been added, first, to exercise "checks and balances" on data derived from different sources and, secondly, to build the records into an integrated document flow. This latter purpose will help, for example, to provide an "audit trail" of the transactions from the initial request for service through execution of the work to completion and settlement of the customer's account.

The Application Form (LRDD/April/1982 photocopy at Appendix G) has been redesigned. In our view, the form requires modification

- to provide a means of gathering farm statistics which are pertinent to AMSB and which may be of use to other Government departments
- to strengthen its importance as a contract document
- to provide the details of the type of service being requested, and to use these data as the technical and cost estimate base for planning the work-load and for measuring actual job performance, and
- to provide documentary evidence of the transaction between the service user and ASB, and of indebtedness where that is required.

The proposed modifications are contained in the preliminary draft shown at Appendix P1, P2 and P3.

AMSB activity is generated in the first place by the Application Form.

The modifications allow it to be more effectively used for planning and controlling Station workload and performance. Discrete application numbers would be adopted, the number providing a coded reference to

- station
- type of work
- job number
- geographic district, and
- location

Separate sheets have been designed to register the particular work type requests

- A/Survey and Planning (App. P1)
- B/Plant Hire Service (App. P2)
- C/Tractor Hire Service (App. P3)

and to record the calculations used in arriving at the price to be charged for the work. Individual tasks in each category are numbered. The alpha-numeric code is used in the job or contract number and will be subsequently recorded on the Machine Week Log Sheet (App. P4).

Colour coding of the Application Forms would be desirable. Multicopy (5) sets would be required to distribute to the parties involved, namely

- the customer
- the PDA/DAO
- AMSB planning unit,
- the Station undertaking the work, and
- AMSB HQ (file copy)

It should be noted that the role of the PDA/DAO in the proposed structure is principally that of the "order office". The management responsibilities concerned with technical, professional and administrative practice within AMSB will rest in the Head of the Branch, with delegation to the appropriate functional managers within the organisation.

The contract between AMSB and the customer to provide the service requested should be properly evaluated in terms of man and machine hours before the contract price is agreed. The work content of the job can then be specified in detail, and the machine performance measured. A formal and systematic planning approach dictates the

control 'yardsticks' which are to be applied.

The Machine Log Sheet, being the job card on which execution of the work specified in the Application Form is recorded, has also been slightly amended. The proposed format is shown at Appendix P4.

The modifications are mainly concerned with providing a more detailed analysis of machine hours, particularly the causes of lost time. Five main causes have been allowed for, one of which (maintenance) is subdivided into three further heads of analysis. If a machine is idle, it is vital to know the reason(s) why. Management may then take remedial action. It is not enough simply to record productive hours. Lost time must also be causally accounted for.

The team recommends that a standard number of weekly shift hours be adopted as the reference base to which productive and downtime hours are reconciled. Fifty hour per machine per week is suggested at Appendix Q (5 days a week, each of 10 hours), but it is recognised that this must be exceeded at times of peak demand. In fact PHS units, with two operators per machine, should eventually be operated over a longer working day in order to achieve economic utilisation. The seasonality of THS crop production work would necessitate seventy hour weeks to achieve timeliness of planting etc. at peak periods.

Machine Week Log Sheets (App. P4) would be transcribed to the Quarterly Summary, a pro forma of which is shown at Appendix P5. The lower line of the log sheets is used for totals and can be fitted over the Quarterly Summary sheet to aid transcribing.

Downtime caused by maintenance would be crosschecked with reference to Maintenance Job Cards. Amended formats for Station and Central Workshop Job Cards are shown at Appendix P6. The amendments allow for repair and maintenance work to be costed and charged to the machine on which the work has been done. The repair cost profile of each piece of plant can then be recorded and kept up-to-date on the Machine Service Record, Appendix P7.

There is no formal procedure in the present system to assign Central Workshop costs (spare parts, labour and overheads) to the particular machine under repair and to log the details in the machine repair cost

profile. While it may be fiscally acceptable to allocate recurrent expenditure for major overhaul spare parts to Central Workshop, AMSB must ensure that all Central Workshop expenditure is "recovered" against the machines repaired. A simple procedure can be adopted to achieve this. It requires that detailed job cards are prepared and completed for each machine; that the job cards are "priced"; and that an internal invoice is raised by Central Workshop on the Station at which the machine is normally based. The internal invoice charge would comprise

- spare parts cost (item quantity unit price)
- labour cost (mechanic hours predetermined wage rate)
- overhead (labour predetermined overhead recovery rate).

From time to time spare parts are supplied with new equipment and are priced as a lump sum, say 10% or 15% of the value of the new equipment. The individual items should be priced before they are entered on the stock record cards. An arbitrary basis, proportionate to individual item prices from a local dealer, could be adopted for this purpose.

Government expenditure voteheads are inadequately detailed to be of use in cost control. The vote book control record should be augmented by a simple in-house memorandum account to show the expenditure incurred on specific expense elements - eg fuel, spare parts, tyres, external repairs - and analysed by plant item. While this degree of detail may be unnecessary for Government expenditure control purposes, it is absolutely essential for plant management purposes, ie equitably distributing the Allocation of Funds to individual stations on a machine basis. Conventional commercial accounting procedures should be adopted for stock accounting and AMSB's in-house accounting records should be established on an income and expenditure, instead of the present receipts and payments, basis.

A Quarterly Report should be submitted by each Station Manager to the Head of the Branch. A standard format should be used highlighting, for instance

- the size and nature of the forward work load and the

programme of execution

- an analysis of work done, time spent, revenue earned and revenue collected
- an analysis by type of work of revenue collected for which the work has not been started or, if started, has not been completed
- an analysis of machine performance, summarised by machine type, and indicating productive hours achieved; downtime hours analysed to cause; fuel consumption rates and costs; and repairs and maintenance work carried out and the cost thereof.

Narrative comment should be minimal, eschewing irrelevant matters such as listings of Station personnel which needlessly add bulk to the present reporting style.

The Branch's Accounting and Information Officer will be responsible for introducing the systems, establishing the procedures at HQ and at Stations and Workshops, reviewing their application and effectiveness, and co-ordinating all reports emanating from the Branch.

#### 4.3 Number of AMSB Stations

A reduction in the number of AMSB stations is essential to reduce costs, and to meet the revised objectives of the organisation. It will also permit the concentration of scarce resources e.g. managers and skilled mechanics, workshop equipment and transport. The team considers that a target of 7 to 12 stations is realistic for AMSB. They should be located in areas where there will be a continued demand for soil and water conservation services (as outlined in 4.1). THS work should be carried out only from stations in areas with large amounts of undeveloped good potential land and no possibility of private sector cultivation. The continuation of the Central Workshops(CW) is considered essential.

The team visited 12 of the 19 stations and were able to form opinions on the level of demand in the area of these stations and the efficiency with which it is being met. It was evident to the team that considerable savings could be achieved by the closure of about half of the AMSB stations. More detailed knowledge was, however, needed to make specific recommendations. Therefore the opinions of the Head of AMSB and the coordinators of PHS and THS were sought. They were encouraged to consider each of the stations and categorise them as: "essential", "desirable", or "not necessary".

This was done bearing in mind the severe financial constraints and the need to concentrate on areas of greatest need, and where private contractors are least able to take over. The needs for PHS and THS were considered separately and the results of the exercise are shown in Table 11. The only problems over categorisation related to a few PHS Stations listed as \*R and - in column 3 of Table 11.

It can be seen from Table 11 that 3 stations (Garissa, Nakuru and Nyahururu) were considered unnecessary for either service as the work in the areas is limited and could be carried out more effectively from other stations.

In addition to the Nakuru Central Workshop, 5 stations were considered essential for both PHS and THS activities (Bumala, Machanga, Makueni, Mariakani and Narok). Four further stations were denoted as essential for one of the services, (ie Kitale and Migori for PHS, and Naromoru

TABLE 11

## Assessment of AMS Stations Taken From Comments by AMSB Staff (6 May 1983)

AMSB STATION Column:	"ESSENTIAL"		"DESIRABLE"		"NOT NECESSARY"	
	PHS 1.	THS 2.	PHS 3.	THS 4.	PHS 5.	THS 6.
1. Bumala	*	*				
2. Chiakariga			*R			*
3. Eldoret			*			*
4. Garsen			-			*
5. Garissa					*	*
6. Kajiado		*			*	
7. Kipkelion			*R			*
8. Kitale	*					*
9. Kitui			-			*
10. Machanqa	*	*				
11. Makueni	*	*				
12. Mariakani	*	*				
13. Marigat			-			*
14. Migori	*			*		
15. Nakuru					*	*
16. Narok	*	*				
17. Naromoru		*	*			
18. Nyahururu					*	*
19. Ruiru			*			*
20. Nakuru CWS						
Total for PHS or THS	7	7	5(8)	1	4	11
Total for PHS & THS	9		6 (9)			

\*<sup>R</sup> = Service required in the area but station should be relocated  
 - = Stations of limited desirability

SUM OF "ESSENTIAL" PLUS "DESIRABLE" STATIONS FOR: PHS = 12  
 THS = 8  
 PHS & THS = 12

and Kajiado for THS) but only desirable or unnecessary for the other. A total of 9 stations would, therefore, be needed to cater for the PHS and THS services as categorised in columns 1 and 2 of Table 11.

The remaining 7 stations were considered to be of some value to PHS but unnecessary for THS. In 2 cases the PHS unit was desirable (Eldoret and Ruiru); 2 stations were unsuitably located (Chiakariga and Kipkelion); and 3 of the stations were regarded as of only limited value to PHS and therefore dispensable if financial constraints are severe (Garsen, Kitui and Marigat).

#### 4.3.1 Option One

The team accepts most of the comments made by AMSB staff on station desirability and therefore makes the following recommendations; which are summarised in Table 12.

(i) AMSB should close down 7 stations immediately: the 3 "unnecessary" stations (Garissa, Nakuru and Nyahururu), the 3 stations which were considered unnecessary for THS and of limited value for PHS (Garsen, Kitui and Marigat), and the station at Kipkelion which is inappropriately located and has demonstrated poor performance.

(ii) Eight of the stations that are considered "essential" for 1983 should be retained. Kitale should continue to provide PHS only, and Kajiado THS only. THS units at the remaining stations should work only in areas where private contractors are very scarce and little animal draught is used. Avoidance of competition with private contractors is particularly important at Narok, and with animal draught at Makueni, Machanga and Bumala. These stations must be kept under regular review (in conjunction with the relevant DAOs) to ensure they do not depress private sector activity. Withdrawal of THS from all locations remains the long term aim.

(iii) There is a need to review the need for the remaining 4 stations in 1984. Three of these are considered desirable for PHS but unnecessary for THS. The THS units at Chiakariga and Eldoret should be withdrawn (there is no unit at Ruiru). AMSB should review

TABLE 12 Team Recommendations on Station Futures

1. <u>Bumala</u>	Retain PHS & THS
2. Chiakariga	Review need for PHS in 1984, close THS
3. Eldoret	Review need for PHS in 1984, close THS
4. Garsen	Close
5. Garissa	Close
6. Kajiado	Retain THS only
7. Kipkelion	Close
8. <u>Kitale</u>	Retain PHS only
9. Kitui	Close
10. <u>Machanga</u>	Retain PHS & THS
11. <u>Makueni</u>	Retain PHS & THS
12. <u>Mariakani</u>	Retain PHS & THS
13. Marigat	Close
14. <u>Migori</u>	Retain PHS review need for THS in 1984.
15. Nakuru	Close
16. <u>Narok</u>	Retain PHS & THS
17. Naromoru	Review need for PHS & THS in 1984
18. Nyahururu	Close
19. Ruiru	Review need for PHS in 1984.

Retain = 8 ) ie a maximum of 12 stations

Review = 4 ) for 1983/84 operations

Close = 7

TOTAL 19

- Note: i) Demand for all retained stations must be regularly monitored and withdrawal of THS aimed for in all cases. Need for PHS at all retained stations must be reviewed annually.
- ii) Stations considered "essential" in Table 11 for 1983 PHS's have been underlined.

the need for stations at these 3 locations in advance of the proposed 1984 monitoring visit, and final decisions on the closure of these stations can be made at that time. Relevant points to consider are:

- the proximity of Eldoret to Kitale
- the feasibility of serving areas currently served by Chiakariga from Machanga and Naromoru
- the ability of private sector operators from Nairobi to carry out work that Ruiru undertakes at present.

Tractor hire operations at Naromoru station may be important at present but the need for this station will need reviewing in 1984.

The team recommend, therefore, that a maximum of 12 stations (+CW) be kept operational over the next year, 1983/84. This agrees with the information provided by AMSB HQ staff for the compilation of Table 11 (viz Sum of "essential" and "desirable" stations for PHS and THS = 12).

The projected cost of running 12 effective AMSB stations is given at Appendix Q. This includes the full costs of the operation, including for example depreciation of plant, transport and workshops and adequate provision for fuel purchase and spare parts. It is not surprising, therefore, that the total projected cost for 12 stations (at £K4.9m) exceeds the estimated cost for 19 stations in 1982/83 (£K4m - Appendix I) as the latter excludes many of these cost items. However, because of the higher work outputs which should then be possible, the projected costs per hour worked are lower than the 1982/83 (partial) cost figures:

	Estimated 1982/83 (19 Stations)	Projected (12 Stations)
PHS (KSh/hr)	2580/-	858/-
THS (KSh/hr)	1065/-	459/-

#### 4.3.2 Option Two

In view of the high cost and low productivity of the THS, consideration is also given to the immediate and complete closure of this service. It is after all an objective of THS to encourage the development of the private sector and therefore the closure of THS

could well hasten this process. Additionally farmers would not be dependant upon what has proved to be an unreliable service provided at great cost (£75/ac) to the Gok.

Adoption of this alternative strategy could prove to be the most effective use of limited resources. It would also allow greater attention to be given to the PHS activities and thereby a more tangible possibility of effectively providing a professional service through 7 stations (column 1, Table 11).

An indication of the scale of cost savings which could be achieved by cutting to only 7 AMSB stations can also be seen at Appendix Q. The overall costs of the service are reduced to a level of £K3.3m. However, under the assumptions used, costs and work achievements are reduced in line, so that there is no fall in cost per hour worked.

If the GoK do not choose this option for the present then the Team strongly recommend that AMSB should aim to reduce its number of stations to not more than 7 by 1985.

#### 4.4 Charges and Subsidies

The current scale of hire charges for AMSB plant and farm tractors has been derived using hypothetical data on machine performance, and cost formulae based on DC experience. There has been no thorough attempt to base charges on actual costs. This may be acceptable if a political decision has been taken to provide a highly subsidised service. However it removes the incentive to monitor and improve cost and performance levels and as a result AMSB staff were unaware of just how far out of line the rates are in relation to the cost incurred in providing the service.

In addition to the "hidden" subsidy inherent in AMSB's charging rates, certain types of work carried out by PHS are themselves directly subsidised by Government. The subsidy element e.g. for water conservation works in low rainfall areas, can amount to 50% of the full cost, and the revenue earned is recorded in AMSB accounts as a net figure. Revenue earnings are therefore understated, although it is not possible to quantify the amount involved.

A simple "grossing up" procedure in the Branch's earnings account, whereby the Government subsidy is shown on both sides of the account, would allow a more representative picture of actual earnings to be displayed. Simultaneously, it would show what the cost of the subsidy really is.

Ultimately, it would be preferable for subsidies on soil or water conservation works to be paid for from a separate allocation rather than via reduced revenue to AMSB, and then they could be paid to private contractors undertaking such work as well as for PHS work. This could prove an important stimulus to private sector activity.

We endorse the policy that expresses machine hire as a rate per hour. The Application Form, however, also quotes rates on the basis of areas (e.g. hectares ploughed) and these appear invariably to be used. We recommend that area rates should be suitably qualified - e.g. "approximate and subject to land condition and prior survey" - to ensure that time remains the constant unit of work content.

Pending decisions on the future scope and nature of AMSB, and the establishment of cost guidelines for running the revised service, the team believe that hire rates should be increased with immediate effect by not less than 20%.

When more complete cost data have been assembled, hire rates should be further revised

- to avoid depressing private sector competition in plant and tractor hire,
- to avoid providing mechanised services at a subsidised rate relative to the costs of alternative hand or animal-powered techniques,
- to move towards self-financing of AMSB, though this is so far from the case at present that it is not an achievable goal in the short-term.

## 4.5 Machinery Requirements and Distribution

### 4.5.1 Plant Hire Section

The average hours worked per year by heavy plant was around 600 per machine in the early 1970s, and some stations still achieved this until recently eg Nakuru AMS averaged 660 h/unit/yr over the 3 years 1979-81. It should be possible to return to higher levels of productivity for the whole fleet when the proposed reorganisation is fully implemented, viz a rationalised plant fleet and freer access to spares. This is unlikely to be possible in the near future, although as experience in the organisation and management of operations develops and workload increases, individual machine output of up to 1500 hours per year should eventually be possible.

### 7 PHS Stations

The maximum foreseen workload for PHS in the year 1983-4 does not exceed 22000 hours for the existing AMSB station network. If the number of PHS stations is reduced to 7 (in line with the recommendations of Section 4.3), some of the workload of the closed stations would be taken over by the remaining ones, but some of the demand could be lost. Assuming a net loss of 500 hours of work per station closed, the maximum total workload reduces to 16,000 hours, or say 14,000 hours for crawler tractors. While the estimate of work load should be reviewed as a major priority in the next year, it has been used as the basis of the comments below.

This estimated work load could be handled by a crawler tractor fleet of 23 machines at an average of 600 h/unit/yr, a rate which includes allowance for downtime of machines because of breakdown or occasional shortages of work. However, a PHS fleet of this size leaves some stations with very few machines, and therefore little flexibility to cope with: urgent projects in the face of prolonged breakdowns; short-term fluctuations in work load; or any longer term increases in demand. The limited size of the active plant fleet also means that there will be a large number of surplus tractors, either fully serviceable or requiring only minor repairs. Therefore, in order to take advantage of the present PHS fleet each station could usefully be provided with one spare machine. It is essential though that these are

not regarded as normal operational machines as their unnecessary use would lead to inefficient plant use planning and a dilution of vital field maintenance resources. Machanga and Mariakani regional workshops could maintain an extra reserve of two machines each (4 units) to cover the stations in their areas for long repair periods because of major breakdowns. Other areas can be covered from Nakuru CW which should maintain a reserve of 1 machine per station (7 in total).

This may sound unduly cautious but given the large size of the AMSB fleet at present (approx. 110 units), the unreliability of the machines and the very limited demand for secondhand plant in Kenya, the high reserve allowances are justifiable. On this basis, the total reserve requirement is 18 machines, giving a total crawler tractor fleet of 41 units, (see Table 13).

#### 11 PHS Stations

In the short-term it has been recommended that the number of AMSB Stations be reduced to 12 of which 11 have PHS units (Section 4.3 Table 12). In this case less of the present work load should be lost but more operational and reserve machines will be required. As can be seen from Table 13 the total required crawler tractor fleet size over this period is estimated at 53 (27 operational and 26 reserve). Possible distributions of the crawler tractor fleet in the short and longer term, based on estimated redistribution of work loads from closed stations, are also given in Table 13.

#### PHS Machines

The individual stations, and as far as possible the separate regions, should operate only one make of crawler tractor to simplify maintenance and repairs and monitoring of operators' use of the plant.

It will therefore be necessary for the A-Ms to retain an active role in the AMSB fleet supported as indicated in Table 13 by reserve units. The effective available tractor fleet, other than A-Ms, is estimated by the team to be 33 at present viz:

<u>Machine</u>	<u>Qty</u>
Caterpillar D6/476J	7 )
Hanomag 500/600 (D5/D6 equivalent)	20 ) <u>Total 33 units</u>
International Harvester TD20E (D7/D8 equiv.)	6 )

TABLE 13 Possible Size and Distribution of PHS Crawler Tractor Fleet

Station	11 STATIONS (Short Term)			7 STATIONS (Longer Term)		
	Operational	Regional reserve	Operational Reserve	Operational	Regional reserve	Operational Reserve
1 <u>Bumala</u>	2	1	1	1	-	1
2 <u>Chiakariga</u>	1	1	1	-	-	-
3 <u>Eldoret</u>	3	1	1	-	-	-
4 <u>Garsen</u>	-	-	-	-	-	-
5 <u>Garissa</u>	-	-	-	-	-	-
6 <u>Kajiado</u>	-	-	-	-	-	-
7 <u>Kipkelion</u>	-	-	-	-	-	-
8 <u>Kitale</u>	3	1	1	6	-	1
9 <u>Kitui</u>	-	-	-	-	-	-
10 <u>Machanga</u>	3	1	1	6	2	1
11 <u>Makueni</u>	1	1	1	1	-	1
12 <u>Mariakani</u>	3	1	1	3	2	1
13 <u>Marigat</u>	-	-	-	-	-	-
14 <u>Migori</u>	3	1	1	3	-	1
15 <u>Nakuru</u>	-	-	-	-	-	-
16 <u>Narok</u>	3	1	1	3	-	1
17 <u>Naromoru</u>	1	1	1	-	-	-
18 <u>Nyahururu</u>	-	-	-	-	-	-
19 <u>Ruiru</u>	4	1	1	-	-	-
20 <u>Central w/shop</u>	-	-	-	-	11	-
SUB TOTAL	27	11	11	23	15	7
TOTAL		53		43		11

NB: Stations considered "essential" in Table 11 for 1983 PHS's have been underlined

Unserviceable machines need individual examination to see if they are economic to repair. There are also 4 Caterpillar D4s which are excluded from the considerations of plant availability because of their age (over 15 years) although this sized tractor clearly has an active place for AMSB operations in the future (see Section 5.2). There is thus a nominal requirement for between 11 and 20 A-Ms to bring the fleet of reasonably modern plant up to the required size. As of September 1982 there were 15 serviceable A-Ms (some have since broken down and others been repaired). It is thus not essential to undertake a complete rehabilitation programme of all the A-Ms in order to provide an effective tractor fleet. Some machines will need major overhauls and all operational ones must be thoroughly checked. Therefore between 10 and 30 of the A-Ms can be taken out of service, either for immediate boarding or for systematic cannibalisation for spares. Additionally the second-hand market for rehabilitated A-Ms should be tested, and the economic viability of repair for sale examined.

The 6 new Faun Frisch graders, and the 4 Aveling-Barford graders, if rehabilitated, will be an adequate grader fleet for the short-term, and boarding the Champion and Ford graders will simplify the problem of multiple machine types. The grader fleet should be evenly distributed among the stations.

The number of self-propelled scrapers is more than adequate for the anticipated amount of work for which they could be used. However, at present some dam-building capacity can usefully be retained in the areas where the scrapers are based. Second-hand equipment values are low at present, because of the general over-capacity in the private sector, and therefore the full scraper fleet should be kept in the short term.

In the longer term, consideration must be given to the introduction of smaller-scale equipment which may be more appropriate to the type of work undertaken by PHS. At present crawler tractors of 140 to 215 hp are used for water hole construction, a single machine doing the excavation, transport of fill, compaction and trimming. The small scale of many water holes involves very tight manoeuvring for the machine, which puts a heavy strain on the tractor transmission and

leads to increased breakdowns, especially if operator technique is not good. The large size of these crawler tractors makes repairs very expensive and can involve long down-times. In addition to this an expensive low loader is required to transport the machines, which gives a high mobilisation cost for what may be a very small job. The problems are similar for much of the bush-clearing carried out, where the tractors are often unnecessarily large for the light bush involved.

The problems of mobilising and operating large plant, and of organising a large number of very short jobs, can be much eased by using smaller, simpler equipment which is cheaper to transport and maintain and easier to operate. Additionally a longer time is needed to complete each job and this requires less critical planning of movement between jobs.

Appropriate equipment for constructing waterholes would be small towed scrapers (3.5 - 4.5 cu. m. capacity), operated by standard wheeled agricultural tractors as are already available in the THS fleet. 90-100 hp, 4 w.d. tractors can operate 4.5 cu. m. scrapers satisfactorily by themselves and smaller 60-70 hp tractors can manage providing a small crawler tractor is available to assist in push-loading. Two wheel drive tractors could also be used, if suitably weighted at the front. These would be more suited to smaller scrapers of say 3.5 cu. m. capacity. This type of equipment therefore should be considered for re-equipping PHS in the long-term, and the possible formation of construction units based on this is considered in Section 6.2. A similar drop in size of equipment, if not in type, could be made for clearing of light bush. If there are only few trees over about 0.3 m diameter, a 75-100 hp (58-75 kw) crawler tractor would be adequate and a second similar sized machine could be readily provided to carry out piling operations and act as a standby. If however there is a significant number of mature trees over 0.3 m diameter, then the small tractor would take a long time to clear them. In addition a crawler tractor of 140 hp (100 kw) would be desirable to keep times within reasonable limits and minimise wear and tear on the machines. Some of the larger crawler tractors will still therefore be required in the long-term.

Graders will be required for the foreseeable future for the construction of farm roads, terraces and drains.

#### 4.5.2 Tractor Hire Service

The need for THS tractors will be determined by the option chosen regarding the reductions recommended in 4.3 above.

##### i) A reduced THS fleet

From Table 11 and 12 it can be seen that the continuation of tractor hire services could be of some value, over the next year, at eight stations (ref 4.3.1). Present fleets at these stations are shown - Table 14 Column 1.

TABLE 14 Future THS Fleet Size

Station	Number of THS Tractors with		
	12 AMSB Stations (viz 8 THS Stn)	7 THS Stations	No THS
	1.	2.	3.
1) Bumala	24	10	
6) Kajiado	11	10	Close
10) Machanga	13	10	
11) Makueni	11	10	
12) Mariakani	11	10	
14) Migori	17	10	
16) Narok	22	10	
17) Naromoru	11	Close	Close
Total	120	70	0

The estimated cost of operating a reduced THS fleet of 120 units is given at Appendix Q.

The poor management of the THS work programme and the serious limitations in the technical support facilities indicate that a fleet

size of 120 units too large. In addition to this a smaller fleet would encourage the development of the private tractor hire sector; a principal aim of THS.

It is recommended, therefore, that no station should have more than 10 THS tractors. If THS activities are to be continued (see Section 4.3.2) then only the 7 stations listed in column 2 of Table 11 should be maintained during 1984. This would entail a THS fleet size of 70 tractors, see column 2 Table 14. The estimated cost of operating a THS fleet of this size is also given at Appendix Q. If this option is chosen the Team recommend that the performance and cost of such a fleet should be reviewed in 1984.

ii) No THS tractors

The complete closure of the Tractor Hire Services in the near future is the overall recommendations of the Team (section 4.3.2).

#### 4.5.3 Plant Repair

In order to establish the reduced plant fleet on a sound base, and to provide refresher training for mechanics, the work on the machines needing major overhauls should be carried out by Central Workshop under direct supervision of staff from the machinery agents. All plant at the stations should then be checked by the agents and the CW staff. Also any specialised servicing techniques would be passed on by the Central Workshop mechanics during refresher courses for the station mechanics. For most of the machine makes, the supervision of overhauls will involve only short inputs from the local agents. For the Aveling-Marshalls, however, it would be strongly advantageous for a longer term input of say 3 months to be provided, to cover the complete rehabilitation of several machines. As there is no effective local agent, the supervision will have to come direct from Track-Marshall (the successors to Aveling-Marshall). The mechanic seconded to AMSB should be sufficiently skilled in machine operation to provide re-training of A-M operators, to minimise poor technique causing unnecessary breakdowns (Spares and Tool lists at App.K).

Several new senior posts are required within AMSB if the revised objectives are to be met, the proposed management systems introduced and the machine overhaul programme successfully implemented. These posts should ultimately be filled by suitably qualified and experienced Kenyan staff. However at present it is unlikely that officers of the required calibre will be readily available within the Government service. Therefore, it is recommended that ODA consider the provision of TCO funding to recruit suitably qualified and experienced expatriate officers to fill these posts.

It is recommended that, in addition to the continuation of the TCO Workshop Superintendent post, the following 3 new posts be created:

- 1) Senior Soil and Water Conservation Engineer (Management)
- 2) Soil and Water Conservation Engineer (Planning)
- 3) Accounting and Information Officer

The position of these posts within the structure of AMSB is shown in Appendix O, and the Job Specifications recommended are as follows:

NB Please see Section 6.2 p 142 for a proposal for an additional post within LRDD for an agriculturalist to identify optimum programmes for the effective conservation of limited natural resources within the context of efficient land planning.

1) POST: Senior Soil and Water Conservation Specialist (Management)

RESPONSIBLE TO: Chief LRDD, through the Head of AMSB

GENERAL JOB DESCRIPTION: The SSWCE(M) will provide expertise in soil and water engineering to the management of AMSB and will have an executive role within the organisation second only to the Head. He will set specific and attainable objectives for AMSB, and produce, in collaboration with senior staff, detailed programmes for the organisational, technical, training, and financial changes required to attain the agreed objectives. He will supervise the execution of these agreed programmes within the targets set.

MAIN RESPONSIBILITIES

1. Organisation

1.1 Establish and maintain, in agreement with CLRDD and HAMSBS, the reorganised management structure of the Branch as recommended by the Team (Section 4.2).

1.2 Monitor the demand for the remaining Agricultural Machinery Stations, and make recommendations as and when appropriate (eg before 1984 monitoring) on the removal or relocation of AMSB services.

1.3 Detail, in conjunction with officers in charge of sections, job specifications for various staff positions and categories and ensure specified duties are carried out effectively.

2. Technical

2.1 Appraise recent and current PHS soil and water conservation work, and review procedures for the planning and implementation of such activities.

2.2 Identify the immediate work load for plant, and draw up, for the short and longer term, projections of demand and planned work programmes (a priority if AMSB is to be effective).

2.3 In collaboration with senior staff and in the light of projected work programmes, estimate the required types, numbers and distribution of plant, and the necessary facilities for its maintenance and repair.

3. Personnel

3.1 Ensure a high level of technical and managerial performance and development of staff, through the introduction of effective work

incentives and control.

3.2 Assess the requirements for internal and external training courses.

3.3 Assist officers in charge of sections in drawing up detailed programmes for in-service training courses, and monitor and evaluate the usefulness of these courses in the field.

#### 4. Financial

4.1 Assist the CLRDD and HAMS B with the drawing up of an annual operating budget for the branch.

4.2 Agree with officers in charge of the various sections operating budgets for each section.

4.3 Monitor, with the assistance of the Accounting and Information Officer, the adherence of each section to its agreed budget.

4.4 Supervise the compilation of cost estimates and cash flows for each individual PHS project.

4.5 Monitor the progress of these projects, and ensure that they are completed within the specifications of the agreed budget.

4.6 Assess annually the hire charges for plant and machinery and, with assistance from relevant sections, recommend changes where necessary.

#### 5. External

5.1 Assist the HAMS B in coordinating the Branch's activities, wherever possible, with those of other relevant bodies both within the MoA (SWCB, PDAs etc) and outside (PDDCSCF, MLD, MWD, MENR etc).

5.2 Inform the CLRDD and others where appropriate, of external events and information that may be useful in developing the Division's plans and policies.

2) POST: Soil and Water Conservation Engineer (Planning)

RESPONSIBLE TO: Head of AMSB through the Senior Soil and Water Conservation Engineer (Management)

GENERAL JOB DESCRIPTION: To establish, in conjunction with senior staff, a Survey and Planning Unit (SPU) within the AMSB including organisational, technical and training requirements as specified in the overall objectives of the organisation. To undertake the management of the unit according to agreed programmes to achieve targets set.

MAIN RESPONSIBILITIES

- 1) Detail, together with senior staff, the objectives of the SPU and execute an agreed programme for the establishment of the unit. Particular attention should be given to the strengthening of co-ordination and liaison with farm management and extension service units of the Ministry of Agriculture.
- 2) Assist the Senior Soil and Water Conservation Engineer in detailing job specifications for staff positions and categories in the SPU and appoint, in conjunction with AMSB senior staff, suitable personnel to the various posts.
- 3) Ensure that the work of the unit is organised, monitored and reported in a standardised and regular manner.
- 4) Detail the requirements for internal and external training and educational courses for SPU staff and, in consultation with senior staff, action these requirements.
- 5) Establish detailed work procedures for the survey and assessment of physical resources on a catchment basis. Plan and design soil and water conservation measures and assist in the implementation of these procedures in the field.
- 6) Provide technical assistance in the survey and design of soil and water conservation works and resettlement programmes which are

undertaken by the AMSB.

7) Assist in co-ordinating the AMSB's activities with other organisations which are involved in resource conservation and land resettlement programmes.

3) POST: Accounting and Information Officer

RESPONSIBLE TO: AMSB Headquarters, Nairobi (Occasional visits to Stations and Central Workshops will be called for).

MAIN RESPONSIBILITIES:

1. Staff, and direct the activities of, the accounting and information department in maintaining financial and cost records to meet both Government accounting and AMSB financial planning and control requirements.
2. Co-ordinate the activities of the department with those of others in the preparation of annual budgets and in the reports of performance during the budget period.
3. Supervise the development and implementation of accounting and related procedures to achieve the necessary accuracy, quality and timeliness of the accounting and information service.
4. Assist and advise the Head, AMSB, in controlling expenditure, both development and recurrent, and in establishing expenditure limitations on particular officers and managers within AMSB.
5. Ensure procedures are properly enforced to provide for
  - scrutiny and approval of accounts payable,
  - billing, receiving, banking and accounting for all monies recoverable from customers,
  - maintaining stock accounting records and reconciling book and physical stocks at frequent but irregular intervals,
  - accurate and detailed machine costings and performance statistics.

IMMEDIATE SUBORDINATES:

Section Heads (3) 1) Accounts 2) Costs + Statistics 3) Registry

NOTE The Accounting and Information Officer is also responsible for ensuring that sound accounting principles and practice are enforced and procedures are properly applied, at Station and at Central Workshops. Consequently, the Station Accounting Officers and the Workshop Accountant are responsible solely to the Accounting and Information Officer for ensuring that the accounting practice carried out at their particular locations is wholly in accordance with that laid down and specified by the officer.

#### 4.7 Training

The work load of the AMSB is expected to increase steadily in future as the changes recommended above become fully effective. This outcome, together with the creation of new functions within the branch such as the SPU and the Accounting and Information Department, will result in an increased requirement for skilled and semi-skilled staff. Furthermore each category of staff within AMSB will have a job description drawn up detailing tasks and responsibilities. The team recommend that several internal and some external training programmes be implemented to meet this demand for staff development.

##### 4.7.1. Internal Training Programmes

###### i) Technical Training

As the need for further skilled personnel is urgent, training efforts should be concentrated on staff already in-post rather than relying on ex-post or pre-service training. Separate in-service training programmes should be devised and run within the AMSB for: topographical and water resource surveyors, soil conservation planners, water design engineers, mechanics, plant and tractor operators. It is estimated that these programmes will need to operate for at least two years to train a sufficient number of staff in the main requirements (land surveying and machinery repair and operation). The expatriate technical experts recommended above should assist with the setting up and the initial running of the courses, which must aim at training approximately 250 staff including 50 surveyors, 50 mechanics and 100 plant operators, within two years.

These specialists will work closely with the training officer and the officers in charge of the Field Operations and the Plant Servicing Sections. The aim will be to hand the running of the courses to these senior officers when they are established. Initial assessment of the requirements for these courses could be carried out by the specialists with assistance from OD/NIAE (Silsoe). Training programmes will be designed to a standard commensurate with requirements, and certificates awarded to staff who attain the required level of technical competence.

## ii) Administrative Training

The team recommended that in-service courses be established to train accountants, cost controllers and field data recorders in their duties. A specialist management accountant will need to be seconded to the AMSB, initially to head the Accounting and Information Section, who will undertake the establishment and operation of specific courses in cost accountancy and data collection and recording. Further special courses are needed to instruct Regional and Station Managers in sound administrative practices and procedures. The team recommend that these be short courses and that they be undertaken by the management specialist working in conjunction with the training officer. It is further recommended that the workshop superintendent be involved in short in-service training courses for workshop foremen assigned to the various stations.

### 4.7.2. External Education

There are several formal teaching institutions in Kenya which offer good technical training in land use planning, soil conservation and land reclamation. Two such institutions are the University of Nairobi and Egerton College. The former offers a one year diploma course for postgraduates who wish to study soil conservation methods and related subjects. The Agricultural Engineering Department of Egerton College teaches preservice students in soil and water engineering, or farm power and machinery theory and techniques in its two year agricultural engineering diploma course.

Aspects of agricultural machinery management are also taught. Other institutions, such as the Kenya Polytechnic also teach water engineering and related subjects. Outside Kenya, the National College of Agricultural Engineering (NCAE) at Silsoe, UK, offers similar, more detailed courses, for people who have had experience in the field. The courses include soil and water engineering (2 year Diploma or MSc), land use planning (1 year Diploma) and land use management (2 year MSc). These courses would be suitable for station managers who would benefit from further training which broadened their knowledge in agricultural engineering and related subjects.

These courses are considered to be very useful in training agricultural engineers and resource conservationists in the basic techniques of their profession. However the major objective must be for staff already in the service to build up practical experience in the field. The team recommends therefore that this objective be accomplished by specially designed in-service training courses, with teaching assistance being obtained from local academic institutions as well as suitably qualified specialists within the service and from overseas. The job specifications of the soil and water conservation engineer and management accountant are detailed at 4.6.

#### 4.8 Monitoring and Support

The team recognizes the need for on-going technical support of AMSB if the above recommendations are to be fulfilled. The Overseas Division, NIAE has extensive experience of the selection, support, and maintenance of agricultural plant and equipment in developing countries and of cultivation and conservation practices. It is therefore proposed that Dr T.J. Willcocks of OD/NIAE should coordinate specialist advice and support in these areas. At this stage it is estimated that about 20 man weeks (MW) of specialist advice are likely to be needed in Year One providing the recommended new senior posts (Section 4.6) are filled promptly.

It is anticipated that it will be several years before all the recommendations can be fulfilled. It is therefore recommended that there should be a review of progress towards the achievement of the reports recommendations by a joint ODA/GoK team each year for the next 3 years. For the first review the UK team members should be: an agricultural engineer; a soil and water conservation specialist; and a financial and management specialist. Specific aspects which must be examined include:

1. Objectives Assess the new objectives which have been recommended for AMSB (Section 4.1) and evaluate whether these are attainable and realistic in the light of work accomplished during 1983-84. Ensure that objectives are consistent with the priorities of the 5th Five Year Development Plan, and suggest amendments where necessary.
2. Organisation and Management Review the progress on management

reorganisation and evaluate its impact on operations and performance at station and headquarters level. In particular report on the development of the proposed accounting and information section and the survey and planning unit, and examine their work achievements during this initial period.

3. Station Numbers Check that station closures have been implemented as recommended. With the cooperation of AMSB and on the basis of evidence assembled in advance by AMSB staff, make recommendations on the closure or continuation of Chiakariga, Eldoret, and Ruiru Stations. Ensure that remaining stations are operating in a manner which does not depress private sector activity in the fields of plant and tractor hire.

4. Plant and Machinery Review progress on the repair and redistribution of plant to ensure that the rehabilitation programme is on target. Check that recommendations on the revised fleet sizes for PHS and THS are being implemented, and examine procedures for the disposal of surplus machinery. Make recommendations for additional inputs for repair or replacement of equipment if necessary. In particular, consider the need for smaller scale earth-moving equipment such as tractor towed scrapers and dam scoops (section 5).

5. Standards of Work Inspect soil conservation and water storage works undertaken by AMSB during the past year and report on survey, design and construction standards of these works. Make recommendations for continued improvement where necessary.

6. Staff and Training Report on staffing developments, including the relocation of staff from redundant stations, the selection of counterparts for the proposed TCO posts, and the introduction of in-service training courses.

7. Finances and Charges Study the current financial position of the AMSB in the light of changing government budgetary constraints and the introduction of new accounting and budgeting procedures within the Branch. Examine in particular revised methods of assessing operating costs, and if necessary make recommendations on the revision of hire charges, bearing in mind cost levels and private sector charges.

8. Coordination With Other Bodies Assess the progress of efforts made to coordinate the activities of PHS with those of other bodies concerned with soil and water conservation, both within and outside the MoA.

9. Overall Study the overall accomplishments of the AMSB in 1983-84 and make recommendations as to what further steps can be made towards improving the services provided. Detail any changes within or outside the organisation which make revision of the recommendations of the current report necessary. Specify any additional outside assistance which is needed for AMSB to achieve its objectives.



Opportunities for Technical Innovations



## 5. OPPORTUNITIES FOR TECHNICAL INNOVATIONS

### 5.1 Possible Accounting Developments

Given the establishment of a disciplined and fully integrated accounting information system, it is likely that much of the routine work could be computerised in the future. The work content is certainly both sufficiently volume-oriented and repetitive to lend itself readily to micro-computer application.

Particular applications would include budgeting and monitoring of station expenditure, recording and calculating machine utilisation and cost/performance statistics, and (subject to Treasury approval) maintaining the Vote Book accounting records. The greatest advantage of computerisation is to be found in the ease and speed with which the financial implications of alternative plans can be evaluated.

Computerisation, however, must be looked upon at this time as very much a long-term development. It is essential, in the first instance, to develop a manual accounting system that fulfils the requirements of both Government and AMSB executive management. Only when that system has been proved practical will conversion to computerised processing and the establishment of a data base be worth pursuing.

### 5.2 Waterhole Construction

#### 5.2.1 Waterhole Construction Units

Small waterholes of only a few hundred cubic metres for individual farmers only need a single, small crawler tractor or small (tractor towed) scraper to construct them. However, good planning of farm divisions should create more opportunities for larger communal water holes and hafirs (off-stream storage ponds) to be developed. These larger structures would justify the creation of specialised water hole construction units, based on small towed scrapers and wheeled tractors. These units would be more versatile, more mobile and more self-contained than a large crawler tractor that would otherwise be used on the construction of the holes.

A unit with a capacity of about 1000 cu.m/day would consist of:

- a) 1 crawler tractor (approx 75 hp, 58 kW) with angle dozer.
- b) 1 trailer for transport of above (eg low C of G 4 wheel or tilt type) tractor towed.
- c) 2 x 4 WD tractors (70-100 hp, 50-75 kw).
- d) 2 x 4.5 cu.m tractor towed scrapers.
- e) 1 x 4 WD vehicle (truck or Land Rover) equipped for servicing items a - d.
- f) Fuel tank trailer to be towed by e).

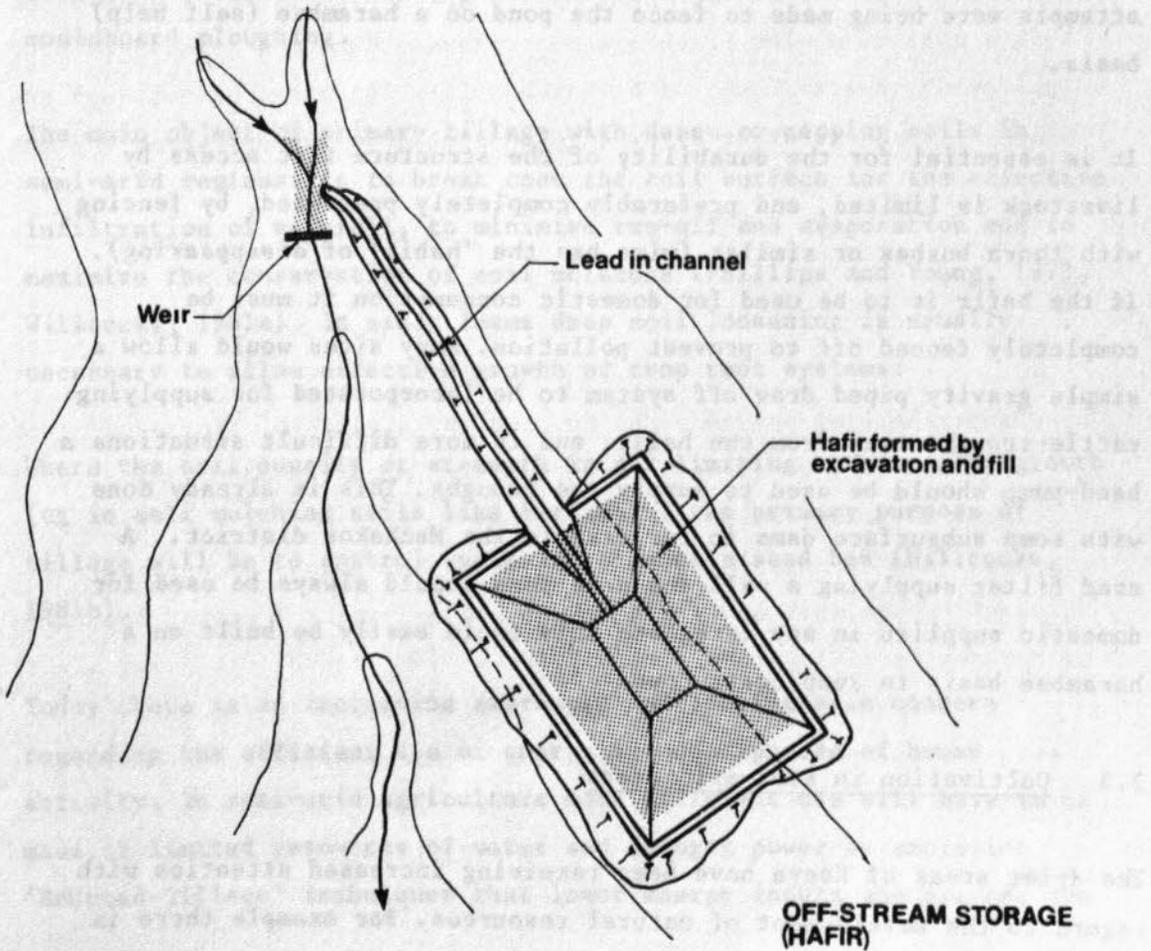
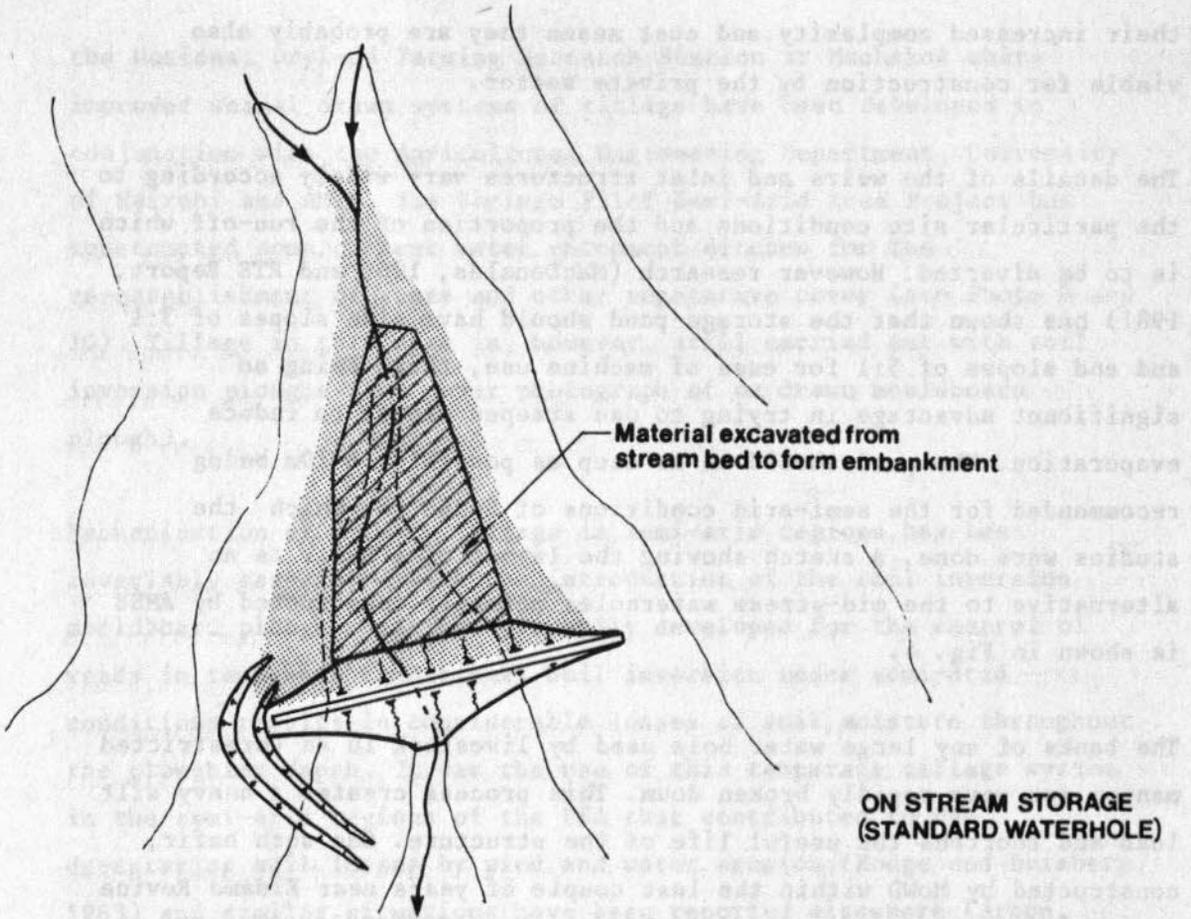
The crawler tractor would be used for ripping and hard excavation and trimming operations on embankments. It could also be used to push load scrapers when poor traction is experienced by the wheeled tractors that are used for towing the scrapers, or where conditions are particularly difficult.

Such units would have a large earthmoving capacity, potentially up to about 1,000 cu.m/day and would complete small waterholes rapidly: their main advantage from the planning aspect would be in their mobility. They could however also undertake larger works very easily by combining 2 or more units. Even large dams could be undertaken, given possible support by a larger crawler tractor for heavier excavation, and a wheeled-tractor drawn roller for more effective compaction than obtainable by use of the scrapers alone.

#### 5.2.2 Hafirs (off-stream storage ponds)

A major problem with some water holes noted during the study was that they were being sited on streams which were too large for the size of pond and spillway being constructed. This led to excessive siltation and a very high risk of the bund being washed away during a flood. The well-established solution to this problem is to construct an excavated water hole adjacent to the stream (Fig 4), and construct only a small weir in the stream to divert water by large pipe or open channel into the water hole. The large floods thus bypass the water hole, and most silt is either similarly passed over the weir or is deposited in the main stream channel. Such structures, commonly called "hafirs" are already being constructed by the MoWD, although

**Figure 4 Alternative Water Storage Layouts**



their increased complexity and cost means they are probably also viable for construction by the private sector.

The details of the weirs and inlet structures vary widely according to the particular site conditions and the proportion of the run-off which is to be diverted. However research (MacDonalds, 1969 and HTS Report, 1981) has shown that the storage pond should have side slopes of 3:1 and end slopes of 5:1 for ease of machine use, there being no significant advantage in trying to use steeper slopes to reduce evaporation. The pond should be as deep as possible, 6-10m being recommended for the semi-arid conditions of Sudan for which the studies were done. A sketch showing the layout of a hafir as an alternative to the mid-stream waterholes normally constructed by AMSB is shown in Fig. 4.

The banks of any large water hole used by livestock in an unrestricted manner are very rapidly broken down. This process creates a heavy silt load and shortens the useful life of the structure. One such hafir, constructed by MoWD within the last couple of years near Eldama Revine was observed by the study team to be already in a very poor state and attempts were being made to fence the pond on a harambee (self help) basis.

It is essential for the durability of the structure that access by livestock is limited, and preferably completely prevented, by fencing with thorn bushes or similar (wire has the 'habit' of disappearing). If the hafir is to be used for domestic consumption it must be completely fenced off to prevent pollution. Many sites would allow a simple gravity piped draw off system to be incorporated for supplying cattle-troughs away from the hafir, and in more difficult situations a hand-pump should be used to supply the troughs. This is already done with some subsurface dams in for example the Machakos district. A sand filter supplying a well and hand-pump should always be used for domestic supplies in any case, and this could easily be built on a harambee basis to keep costs down.

### 5.3 Cultivation in semi-arid areas

The drier areas of Kenya have been receiving increased attention with regard to the development of natural resources. For example there is

the National Dryland Farming Research Station at Machakos where improved animal drawn systems of tillage have been developed in conjunction with the Agricultural Engineering Department, University of Nairobi and AMTU. The Baringo Pilot Semi-Arid Area Project has constructed some crescent water catchment ditches for the re-establishment of trees and other vegetative cover (see Photo 9 and 10). Tillage in this area is, however, still carried out with soil inversion ploughs (see cover photograph of ox drawn mouldboard plough).

Mechanisation of primary tillage in semi-arid regions has been invariably associated with the introduction of the soil inversion mouldboard plough which was primarily developed for the control of weeds in temperate conditions. Soil inversion under semi-arid conditions results in considerable losses of soil moisture throughout the ploughing depth. It was the use of this temperate tillage system in the semi-arid regions of the USA that contributed to the devastating soil losses by wind and water erosion (Hodge and Duisberg, 1963) and similar situations have been reported elsewhere (Arnon, 1972). In addition to this, soil conditions are often too hard for mouldboard ploughing.

The main object of primary tillage with dense or capping soils in semi-arid regions, is to break open the soil surface for the effective infiltration of rainfall, to minimise run-off and evaporation and to maximise the conservation of soil moisture (Phillips and Young, 1973, Willcocks, 1981a). In sandy loams deep soil loosening is usually necessary to allow effective growth of crop root systems.

Where the soil density or strength is not limiting to crop root growth (eg in self mulching soils like Vertisols) the primary purpose of tillage will be to control weeds and produce a seed bed (Willcocks, 1981b).

Today there is an increasing awareness and considerable concern regarding the efficient use of energy in most spheres of human activity. In semi-arid agriculture more efficient use will have to be made of limited resources of water and draught power by employing 'Reduced-Tillage' techniques that lower energy inputs and prevent the

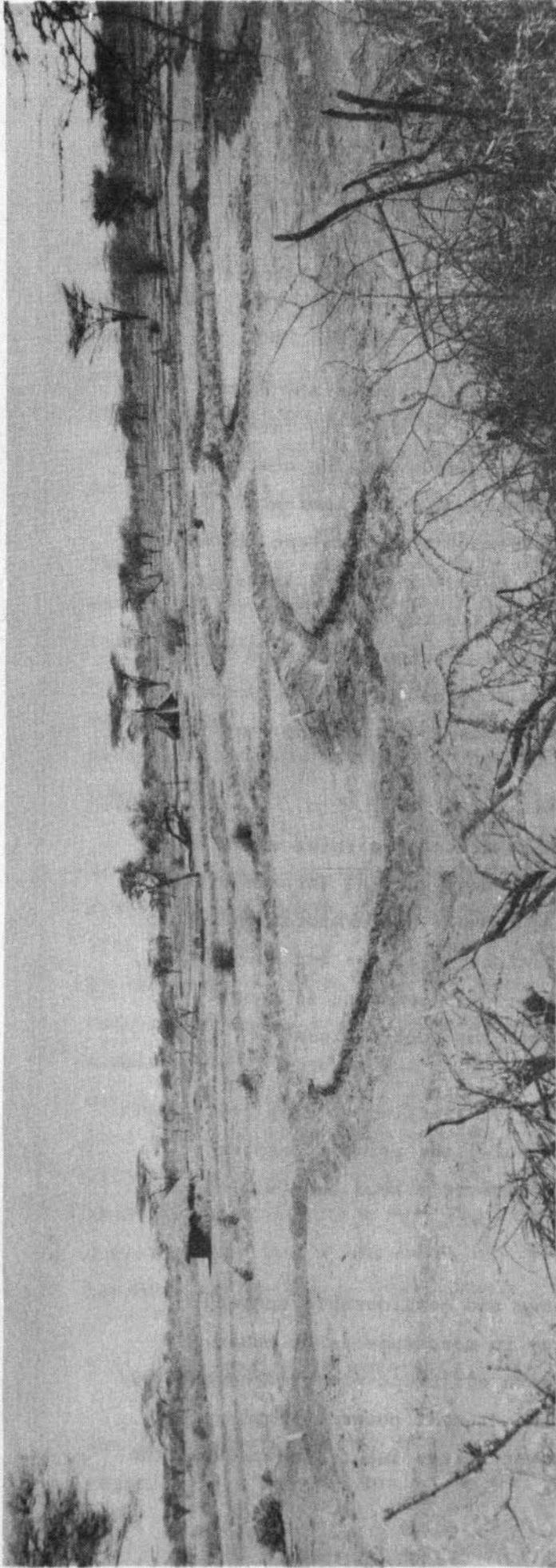


PHOTO 9 (above)  
Construction of present water catchment ditches  
for erosion control and re-establishment of vege-  
tative cover (Baringo Pilot Semi-Arid Area Project)

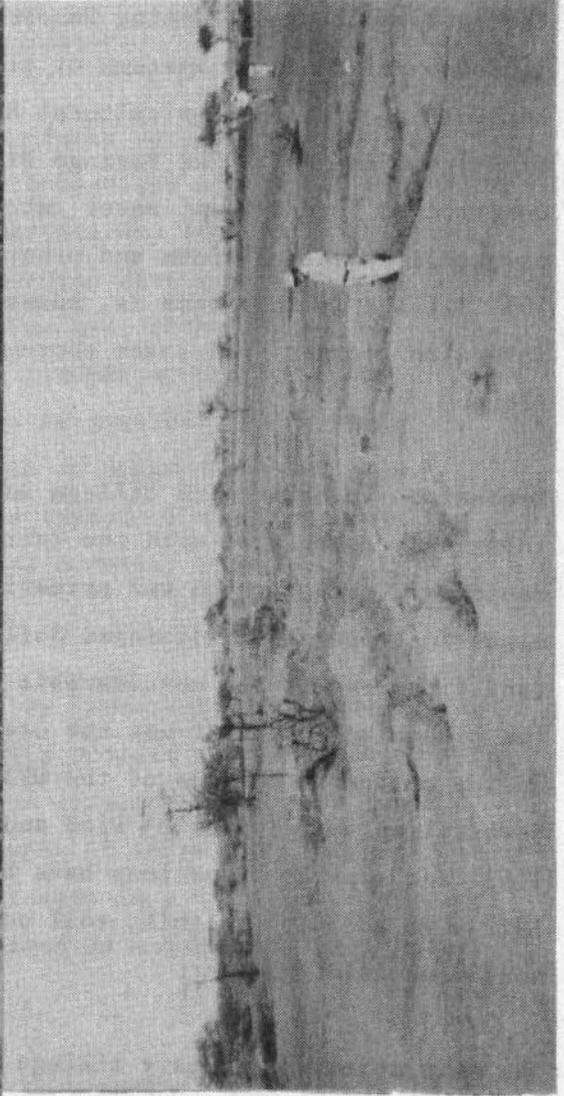


PHOTO 10 (right)  
Watercourse (200 m NW of 9) without erosion  
control measures and eroded due to over-  
grazing in catchment area

total breakdown of soil surface clods (Arnon, 1972). Tillage is the only crop production operation requiring high draught input; Patterson et al (1980) reported a net implement requirement reaching 320 MJ/ha clearly therefore, reductions in these energy requirements should significantly reduce crop production input costs. In the USA nearly one-third of the total power consumption in agriculture was used for tillage (Luttrell et al 1964) and much of this is considered unnecessary.

The Team recommended, therefore, that chisel ploughs should be used for the loosening of sandy loam soils in semi-arid areas. Strip catchment tillage techniques (Willcocks, 1981a) should be used in capping soils so that more effective use can be made of limited and sporadic rainfall.

No-tillage techniques should be tried on Vertisols. A manually operated sprayer (eg Pull-Along CDA Sprayer (Kemp and Immink, 1983) can be used to apply an effective herbicide like glyphosate to kill weeds before planting.

Soil inversion ploughing in semi-arid areas using tractor mounted disc or mouldboard ploughs is inappropriate and costly in scarce water and energy resources. The use of tined implements is recommended for sandy loam soils. Herbicides or shallow polydisc tillage should be used for Vertisols.

There is an urgent need to reclaim denuded pasture land in semi-arid areas (Gibbons, 1982) and this can be done by increasing soil surface roughness to enhance infiltration of rain water. The Study Team recommends that the PHS, possibly with assistance from foreign donor agencies, test the feasibility of using pasture reclamation machines. Suitable equipment might include land imprinters (R.M. Dixon, 1980), pitter and contour seeders (Kimberley Seeds, 1982) and wide level discs to improve denuded areas where labour intensive methods are not possible. Some of these machines are already operating successfully in North Africa with a 45 kW tractor easily handling this type of equipment.



Implications for Aid Donors

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## 6.1 IMPLICATIONS FOR AID DONORS

### 6.1 Background

A variety of aid donors have provided AMSB with a series of inputs, including plant and equipment, workshop tools and facilities, and skilled personnel. While some of these have been vital to the achievement of even the modest output levels which have been attained in the past, others have been of questionable value to the organisation and might even have proved a handicap in the long term. The problems of running a fleet of mixed manufacture have already been alluded to, and are particularly serious when some makes do not have adequate dealer representation within the country. Some equipment has been unsuitable for the type of work which AMSB undertakes. Frequent changes in expatriate staff, each with their own ideas of management methods has done little to build up established and well-understood management reporting procedures. It is important, therefore, that future aid inputs fit into an integrated plan for the AMSB, and some of the main considerations which must be borne in mind by donors are discussed below.

### 6.2 Staffing

The new senior staff posts which are likely, in the team's opinion, to require expatriate personnel were outlined in detail in 4.6. If GoK requests that these posts are filled by Technical Cooperation Officers it is important that:

- suitable candidates are identified as quickly as possible, as many of the organisational changes depend on the activities of experienced senior staff.
- candidates appointed are experienced in practical management in developing countries, as well as in the particular technical skills required.
- they have a clearly defined executive role within the organisation, allowing them to ensure that recommended programmes are in fact implemented.

- they are prepared to make a sufficiently long commitment to AMSB to see through the programmes which they will initiate: 3 years appears to be a minimum period for this to be achieved.

There will be a need for a 3 month attachment of a mechanic/operator trainer from Track Marshall (TM) see Section 4.5.3. TM have a suitable individual to conduct this work but it is hoped that aid funds will be available to finance this activity.

It is considered that a further new post will be needed in LRDD; that of an agriculturalist specializing in development planning, soil conservation and extension. This post should be created to ensure that the work of AMSB is aimed at optimum programmes for the effective conservation of natural resources within the content of efficient land use. It is recommended that this proposal is urgently considered by MoA and the matter addressed by ODA in the formulation of its aid inputs for this programme.

### 6.3 Equipment

In the short-term (1-2 years) the equipment needs of AMSB will be very small, as there is little to be gained by providing new equipment until the organisational and technical problems have been tackled.

The principle demand over this period will be for spare parts for the rehabilitation of existing machines which are worth repairing, and which are needed to bring the fleet up to the recommended strength (Section 4.5.1). In the longer term there must be an allocation of funds from the Branch's budget sufficient to finance spares purchases, but given the run-down nature of the fleet and the current shortages of finance, this is a justifiable subject for aid at present.

Appendix K provides details of spares and tools which are needed for the rehabilitation of the Aveling-Marshall fleet.

The replacement of the THS and PHS fleets must be on a planned basis, related to the work programme and the condition of existing machinery. For example, it is quite conceivable that the existing THS fleet will be adequate to provide a service, in those areas where private sources of draught power are at present lacking, for as long as is needed for the expansion of the private sector to make a government service

unnecessary (providing of course that appropriate policies to encourage private tractor and animal draught are pursued). In that case, the provision of additional THS tractors under aid would not be needed.

The provision of smaller scale plant, (such as tractor towed scrapers, small crawler tractors and support equipment) as recommended in Section 4.5, should be considered as an alternative to the importation of additional heavy plant. 4WD tractors for the proposed waterhole construction units in Section 5.2 probably could be provided from the existing THS fleet.

When any further inputs of aid in the form of equipment are considered, the precise form which they take must be agreed with the technical staff of AMSB, and the following questions must be borne in mind:

- Is the equipment of a type and size which is appropriate to the activities being undertaken by AMSB?
- Is it of a manufacture which has effective dealer representation within Kenya, and a model for which spare parts can readily be supplied?
- Is training of AMSB operators or mechanics needed on any aspect of the operation, maintenance, or repair of the equipment.
- Does AMSB have the backup facilities needed to support the equipment (e.g. specialised tools, transport, etc)?
- Is the supply of the equipment at a rate at which it can readily be absorbed into operation by the organisation?

#### 6.4 Monitoring and Reviews

A one-off review of AMSB activities can be of only limited value unless it is followed up by regular advice and back-up to the organisation as it tries to introduce the changes which are recommended. Modifications to recommendations may also be needed as experience is gained in their implementation and as external

circumstances change. The progress towards the fulfilment of the revised objectives should also be assessed.

Therefore it is recommended (Section 4.8) that ODA provide ongoing technical support for AMSB. ODA should also sponsor a review visit by a 3-man team (Agricultural Engineer, Soil and Water Specialist, and Financial and Management Specialist) one year after the date of this report and similar but possibly smaller ODA/GoK reviews in 1985 and 1986.





## 7. ACKNOWLEDGEMENTS

The team would like to express their gratitude to all the government officers, businessmen, and farmers who generously shared their time and knowledge with us during our stay in Kenya. Thanks are due to the staff of the British High Commission and the East Africa Development Division in Nairobi for their support and hospitality, and particularly to Mrs. J. Groom and Mrs. P. Galley for their excellent secretarial work. Ministry of Agriculture staff at headquarters, Provincial, and District level provided us with a great deal of information and assistance, and we are particularly grateful to Mr. Were and his staff in the AMSB both in Nairobi and at the individual stations. Special mention must be made of Mr. P. Ndethi (Coordinator PHS) and Mr. G. Mwangi (Coordinator THS) who travelled extensively with us and shared their considerable experience of AMSB. The findings of this report owe much to their contributions.

Theo Willcocks, Janol Scott, John Parkinson,  
Richard Doake and Robert Fieldson

June 1983

The team would like to express their gratitude to all the government officials, businessmen, and citizens who generously shared their time and knowledge with us during our stay in Korea. It was our hope to be able of the Korean High Commission and the local district governments. Decision in Korea for their support and hospitality, and particularly to Mrs. J. Carter and Mrs. F. Carter for their excellent practical work. Ministry of Agriculture, Ministry of Health, Ministry of Education, and District level provided us with a great deal of information and assistance, and we are particularly grateful to Mr. Kim and his staff in the WASH team in Seoul and at the individual stations. Special mention must be made of Mr. T. Hwang (Coordinator WASH) and Mr. G. Kwang (Coordinator WASH) who provided extremely with us and shared their considerable experience of WASH. The findings of this report are due to their cooperation.

Two witnesses: Jack Scott, John Parkinson,  
Richard Jones and Robert Johnson

June 1967

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MINISTRY OF AGRICULTURE  
GENERAL ROAD  
PO BOX 1000, NAIROBI  
KENYA

Permanent Secretary,  
Office of the Vice-President &  
Ministry of Finance,  
P.O. Box 3000,  
Nairobi.

(Att: Mr. J. B. Agoya)

REPORT OF THE COMMISSIONERS OF AGRICULTURE  
ON THE PROPOSED INVESTMENT SERVICES (A.M.S.)

I refer to your letter of 12/12/51 dated 12/12/51 November 1951, concerning the U.K. assistance to the A.M.S., and would hereby like to confirm our concurrence with the views expressed, above the subject terms study on the proposed investment services.

Such a study is necessary as a prelude to any substantial investment in the A.M.S., as the recently proposed in a capacity and listing for financing by the U.K. Government.

Herewith please find the summary of the background information and the suggested terms of reference for the proposed investment services study.

*A. B. G. G. G.*  
(A. B. G. G. G.)  
DEPUTY PERMANENT SECRETARY  
AGRICULTURE

C.C.  
Director of Agriculture,  
(Att: J. K. Muthoni)  
Chief, I.R.D. Division,  
(Att: Mr. C. J. Waga)



## APPENDIX A1

## MINISTRY OF AGRICULTURE

Telegrams: "MINAG", Nairobi

Telephone: Nairobi 335855

When replying please quote

Ref. No. **OFTA/116/VOL.XI/74.**  
and date

KILIMO HOUSE

CATHEDRAL ROAD

P.O. Box 30028, NAIROBI

7th January, 1982

Permanent Secretary,  
Office of the Vice-President &  
Ministry of Finance,  
P.O. Box 30007,  
**NAIROBI.**

(Att: Mr. H.B. Agoya)

**REP: U.K. ASSISTANCE TO AGRICULTURAL  
MECHANISATION SERVICES (AMS).**

I refer to your letter No. BA/TA/93/78/02 dated 19th November 1981, concerning the U.K. assistance to our A.M.S., and would hereby like to confirm our concurrence with the views expressed, about the short term study on the present state of A.M.S.

Such a study is necessary as a precedent of any substantial external aid to the A.M.S. as was recently proposed in a commodity aid listing for financing by the U.K. Government.

Herewith please find the summary of the background information and the suggested terms of reference to the proposed short term study

*A. N. Getao*  
(A.N. Getao)

**DEPUTY PERMANENT SECRETARY  
AGRICULTURE.**

C.C.  
Director of Agriculture,  
(Att: J.K. Muthama)

Chief: L.R.D. Division,  
(Att: Mr. C.R.J. Nyaga)

(A) Summary of Background Information about AMS.

- (i) Our AMS has expanded rapidly since 1978 from 7 AMS stations and one Central Workshop to now 18 AMS stations and 3 Regional Workshops. The SCS machinery fleet (Construction equipments) has expanded from 56 plants & equipments to 132 plants, and the THS machineries (Farm tractors & implements) have expanded from 60 tractors and implements to 184 tractors at the moment.
- (ii) Of the 184 farm tractors, we have at least 8 different makes of tractors. Of the 132 SCS machineries, 43 are Track Marshalls which, though relatively new, have no local agents for the supply of spare parts and complicated repairs. These machineries are delicate, and their break-downs <sup>are</sup> rather frequent. The other lot of SCS machineries consist of about 50 old caterpillar plants and equipments which require to be replaced immediately. Only about 30 SCS machineries can be said to be productive on continuous basis, and these are very few considering the chronic problems of spare parts for all types of machineries and the expanded demand for agricultural machineries in the country.
- (iii) Our AMS is lacking in some important equipments which affect our effectiveness in the field. For example we are lacking dam construction and drainage equipments. We also do not have inter row cultivation equipments for weed and pest control, as well as combine harvesters. It is only now we are trying to introduce small scale farm mechanisation equipments and techniques. The demand for all forms of AMS has continued to rise especially as many of our small scale farmers are changing from subsistence to commercial production.
- (iv) The budgets for running of the equipments and payment of field staff have gone down considerably since 1978 despite the said expansion (para (ii) above) of the service and an escalating cost of running and maintenance expenses. For example in 1981/82 alone, the plant & equipments running expenses was slashed by K£ 200,000. The funds for the payment of staff field allowances, staff uniforms and for operating the transport are extremely inadequate these days despite the fact that these expenses have gone up by double or tripple since 1978. Even if all the machineries were in good working condition, the reduced budgets would not be able to maintain and run them for more than a maximum of six months in a year.
- (v) The effect of recent decentralisation of AMS under the extension service was a sudden reduction in output. We expect this to pick-up with time but it might never attain the level of a central management. There is alot of room for improvement of service management through regular inservice courses for managers and unit supervisors both locally and abroad.

- (vi) In all, the mixed constitution of our agricultural machineries, lack of sufficient back up service and local agent for some of the machineries, reduced AMS budgets, lack of repair facilities (Workshops & Spares) in some of the newly established operational areas for AMS, have all contributed to the low productivity of the AMS and these are all physical problems that we feel can be minimised considerably through a carefully selected package of recommendations.

It is our view therefore that an independent study about the constitution and operational problems of AMS should result in a package of recommendations that will guide our future development and improvement of the services.

(B) Proposed terms of Reference for the short term study of AMS.

The following terms of reference are recommended:-

1. To study the present constitution and operations of the AMS, with special reference to the followings:-
  - (a) Importance of the Ministry's AMS in Kenyan Agriculture:  
To establish the importance and necessity of the Ministry's Agricultural Mechanisation Services to the Kenyan farmers, and in particular to the majority of the small scale farmers in both high potential, and in the densely populated rain marginal areas of this country where most of the new AMS stations have been opened. Also in this connection, to establish to what extent the needs of the services are met - Future recommendations.
  - (b) Organisation Structure:  
To study the organisation structure of the services with a view to pointing out any weakness and strong areas in the system, and thereby establish future needs for the services.
  - (c) Finances:  
Financial allocations, administration and control. How do they meet the needs of the service.
  - (d) Personnel:  
Manning levels, strengths and weakness of the available manpower. Present and future needs.
  - (e) Training needs:  
To examine the present and future training requirements for all types of service personnel.
  - (f) Equipments:  
To examine the suitability of the present equipments and the requisition and replacement policies.

- 3 -

**(g) Foreign Aid:**

To examine the role of the present and future donors and examine the effectiveness of various forms of aid and the probable future needs of the AMS.

**(h) AMS Stations:**

Their distribution and effectiveness in meeting the tasks of AMS. Future needs for re-equipments and possible expansion.

**(i) Technical back up of the services:**

Examine present methods & the resources, in use i.e. physical, personnel, administrative and financial resources.

**(j) General Administration:**

Station management; the role of the D.A.O., PDA, and the headquarters as far as service administration are concerned.

2. To make recommendations for the future operations of the AMS, to achieve maximum cost effectiveness. The package of the recommendations to be based on the findings of 1 above.

**DRAFT TERMS OF REFERENCE FOR STUDY OF AGRICULTURAL MECHANISATION BRANCH (AMB),  
MINISTRY OF AGRICULTURE (MOA), KENYA**

**Historical Assessment**

1. Analyse (MOA) records for 1974 - 1981 to show for each station and for AMB as a whole, distinguishing as far as possible between soil conservation service and tractor hire service
  - a. output: for soil conservation service show hours spent on and physical units completed of different activities (dams, waterholes, terracing, roads etc) distinguishing between private farmer and public schemes;
  - b. productivity: for tractor hire service show numbers of clients and hours ploughed; distinguishing between private farms and public schemes;
  - c. classification of non-productive hours;
  - d. comparison of actual revenue by type of work with that projected from output data;
  - e. recurrent costs by item, and development (capital) costs, including energy costs and consumption on both in total and per productive hour;
  - f. comparison of total recurrent costs with revenues;
  - g. subsidies for soil conservation service activities by type;
  - h. stock of machinery by age;
2. Comment on data collected at 1 above, and in particular on reasons
  - a. for low productivity, and
  - b. for discrepancies between costs and revenues (including problems of poor debt recovery, abuse etc)
  - c. for variation between stations.

3. Compile a historical record of tractor hire service and soil conservation service charges and comment on how these compare with rates charged by private sector operators.

#### Economic Assessment

4. Quantify private sector tractor hire and use in agriculture and private contractor activity in soil and water conservation. Assess and give reasons for extent to which AMB substitutes for or complements private sector tractor ownership/hire, soil and water conservation activities. Examine the availability of private sector statistics to complement the analysis in 1 above.

5. Conduct the following analyses in financial and economic terms making clear (1) the sensitivity of results to whether assumptions are based on past AMB achievements or on theoretical potentials, and (2) the extent to which results vary regionally:

- a. compare costs and benefits of oxen with tractor cultivation;
- b. assess costs and benefits (in terms of agricultural output impact) of tractor hire service activity. (This will mean taking into account how tractor hire service activity affects output through eg extending areas cultivated, improving timeliness of cultivations, reducing weed competition etc);
- c. compare costs and benefits of labour - with machine - intensive soil and water conservation techniques;
- d. conduct cost benefit analysis of relevant types of soil and water conservation (taking into account eg dams and waterholes permitting livestock development in new areas, bush clearing permitting cultivation of new land, soil and water conservation reducing siltation in downstream dams, soil and water conservation reducing soil loss and future need for famine relief etc).

#### Future Development

6. Assess the demand over the period 1983 - 88 for tractor cultivation and soil and water conservation services in different parts of Kenya. In the light of

- a. the findings of the economic assessment (paras 4 and 5 above);
- b. the undesirability of using scarce GOK budgetary resources to substitute for private sector activity;

- c. the possible constraints on reducing AMB costs of unit output
- d. the possibility of the private sector expanding into areas of operation hitherto handled by AMB;
- e. the high financial and resource cost of energy;

make recommendations to the extent to which the role of AMB should be altered to encourage other sources of soil and water conservation and how far demand has to be met by AMB, in different parts of Kenya. This may involve reducing the scale of AMB activities at some stations and increasing them at others.

7. Review the present arrangements and make recommendations (with options where they exist) for improving:

- a. organisational structure (including relationships between Ministry headquarters, provincial administrations and AM stations, and between the tractor hire service and soil conservation service);
- b. accounting and financial arrangements (including financial control). Inter alia, examine the case for making AMB financially independent of the rest of GOK on a revolving fund basis, and investigate the possibility of increasing incentives for AM stations to collect payments due;
- c. new financial organisation procedures (recording, staff control, stores and ordering, work programming);
- d. staffing levels and remuneration
- e. training (in UK, in Kenya, in third countries, counterpart arrangements and other);
- f. policies for acquisition and replacement of equipment;
- g. technical design standards, physical planning techniques, and machine operating practices in field work.

8. Review, and, in the light of the likely impact on AMB unit costs of the improvements recommended, make recommendations on charge and subsidy levels for tractor hire service and soil conservation service and on procedures for regularly updating them. Include an examination of the case for tractor hire service charging per hour rather than per hectare.

9. In the light of paras 6 and 7 above and data on the size and age structure of the existing equipment stock at each station, make recommendations for the future development of AMB, including possible future requirements for capital (development) funds and possible sources.

10. Make recommendations for any Technical Cooperation assistance which is required to facilitate implementation of the recommended AMB development programme.

11. For the recommended AMB development programme, conduct

a. a cost-benefit analysis in economic terms distinguishing between local and offshore costs, and showing clearly what shadow wage, shadow exchange, and discount rates have been used, and

b. a financial analysis.

OUTLINE APPROACH FOR THE SHORT-TERM STUDY OF THE AGRICULTURAL MECHANISATION BRANCH (AMB), MINISTRY OF AGRICULTURE (MOA), KENYA

A BACKGROUND

A 5 man team is needed for a short-term, TC financed study of the management and operations of the Agricultural Machinery Branch (AMB) of the Ministry of Agriculture (MOA) Kenya. The AMB is responsible for:

- a) The Soil Conservation Service (SCS) which is engaged in bush clearing, the construction of dams, water holes and cut off drains and land levelling using a fleet of about 130 units of plant.
- b) The Tractor Hire Service (THS) which is concerned with ploughing and other mechanised crop production activities using a fleet of nearly 200 agricultural tractors.

These combined services are operating from 19 stations throughout Kenya.

The short-term study should review the activities of AMB, assess the importance of these services today and make recommendations for the future from the engineering, economic and management standpoints.

The team will consist of: I) Agricultural Engineer (Ag. Eng)  
 II) Agricultural Economist (Ag. Econ)  
 III) Civil Engineer (C. Eng)  
 IV) Management Accountant (Man. Ac)  
 V) Agriculturalist (Agric.)

Details of the draft Terms of Reference (ToRs) for this study have been drawn up in Kenya (ref BHC/EADD) and these in particular highlight the economic and financial aspects of the study.

Many aspects of the study will require the attention of several or all team members but the primary responsibilities of each adviser/consultant are tabulated below.

A final 'over-view' assessment is also required and this will be the combined responsibility of the whole team.

Theo J Willcocks  
 OD/NIAE  
 15 February 1983

## B INDIVIDUAL RESPONSIBILITIES

### I) Agricultural Engineer (Ag. Eng)

The Agricultural Engineer will be responsible for the overall co-ordination and direction of this study as the Team Leader.

Specific technical responsibilities will include:

#### Tractor Hire Service (THS)

- 1) An appraisal of the THS and the Government of Kenya (GoK) policy and objectives on farm power to establish the current and probable future demand for THS. Report on the capacity of the THS to meet these demands, identify the major limiting factors to THS output, comment on the technical suitability of equipment specification for major operations and make recommendations for improvement.
- 2) The work will entail an assessment of the THS operational performance in the field. Recommendations are required concerning efficiency of field use, allocation of units and backup services for the management of tractors operating in remote agricultural areas.
- 3) Appraisal of the management of spares and repair services (workshops).
- 4) Recommendations are required concerning the priority objectives for a more effective THS including training needs and the specification of new equipment.

#### Soil Conservation Service (SCS)

- 5) In conjunction with the C. Eng an assessment with recommendations will be made of the management and maintenance of SCS plant.

## II) Agricultural Economist (Ag. Econ)

The main work will be to investigate and report on the overall economic and social benefits of the HTS and SCS to the agricultural sector in Kenya and to the nation as a whole. There are four components:

### 1) Historical assessment

Review, in collaboration with the Management Accountant the historical performance of the THS and SCS in terms of output, productivity, downtime, costs, revenue, types of client, etc (see ToRs para 1). From this evidence highlight the main achievements and failures to date, and the reasons for any low productivity and variations between stations.

### 2) Viability of operations

Undertake an analysis in financial and economic terms of:

- i) The costs and benefits of tractor cultivation over oxen or hand cultivation (taking into account how tractor cultivation affects output through extending areas cultivated, improving timeliness of cultivation, reducing weed competition etc).
- ii) The costs and benefits of relevant types of soil and water conservation (eg dams and waterholes permitting livestock development in new areas, bush clearing permitting cultivation of new land, soil and water conservation reducing siltation in downstream dams, etc), and comparing mechanical with labour-intensive techniques.

The analysis should make clear (a) the sensitivity of the results to whether assumptions are based on past AMB achievements or on theoretical potentials, and (b) the extent to which results vary regionally.

### 3) Private sector potential

Review the existing capacity of the private sector (and other state sector services) for tractor hire in agriculture and contractor work in soil and water conservation. Assess and give reasons for the extent to which AMB substitutes for or complements private sector tractor ownership/hire, and soil and water conservation activities. Examine, estimate and assess private sector statistics to compare with the analysis of AMB performance (Para 1).

4) Future Development

Assess the demand over the period 1983-88 for tractor cultivation and soil and water conservation services in different parts of Kenya. In the light of:

- i) the findings of the economic assessment above.
- ii) the undesirability of using scarce GoK funds to substitute for private sector activity.
- iii) the costs of operation of AMB compared to the private sector and the probable constraints on reducing them
- iv) the possibility of the private sector expanding into areas of operation hitherto handled by AMB.
- v) the financial and resource cost of energy

make recommendations on the future role and scale of AMB activities in different parts of Kenya. Produce high and low scenario options which may involve reducing the level of operations at some stations and increasing it at others.

### III) Civil Engineer (C. Eng)

The Civil Engineer's primary responsibility will be to:

- 1) Conduct a technical review of the construction activities of the Soil Conservation Service (SCS) since 1974 and report on the current demand for SCS services in Kenya. Particular attention will need to be given to the deployment of resources (man, machine and finance) relative to the overall objectives of the SCS and the contribution available from the private sector.
- 2) The work will entail specific case studies of major projects and structures to check if earthworks match original designs and whether the designs are applicable to the particular needs of each project eg have unnecessarily large safety factors been employed in dam design relative to flood frequencies etc.
- 3) Recommendations are required concerning alternative strategies for SCS eg in assessing the suitability of designs. Consideration should also be given to the relative advantage of a few large dams or many smaller dams, (whose construction requires simpler equipment) which may be more applicable to the agricultural needs of a given catchment area.
- 4) Specify and quantify plant and equipment requirements for specific SCS activities.
- 5) Advise on the maintenance and workshop repair facilities for SCS in conjunction with the Ag. Eng.
- 6) Estimate the future demand for SCS services and recommend priorities for future development giving specific attention to overall policies, work load, equipment needs and management.

IV) Management Accountant (Man. Ac)

The Management Accountant will:

- 1) Review the past performance of AMB in collaboration with the Agricultural Economist and highlight the reasons for successes and failures.
- 2) Review the present arrangements in the Agricultural Machinery Branch (ie SCS and THS) with regard to:
  - i) Organisation structure (including relationship between Ministry headquarters, provincial administrations and agricultural machinery stations, and between the THS and the SCS).
  - ii) Accounting and financial arrangements (including financial control). Inter alia, examine the case for making AMB financially independent of the rest of GoK on a revolving fund basis, and investigate the possibility of increasing incentives for AM stations to collect payments due.
  - iii) Financial organisation procedures (recording, staff control, stores and ordering, work programming) at HQ central workshop and outstations.
  - iv) Staffing levels and remuneration.
  - v) Training.
  - vi) Policy for acquisition and replacement of equipment and spares.
- 3) Make recommendations on the available options for improving the above aspects of AMB's management.

V) Agriculturalist (Agric.)

The Agriculturalist will review the agronomic and land-use aspects of AMB activities. His specific technical responsibilities will be:

Tractor Hire Service (THS)

To assess, in close collaboration with the Agricultural Engineer and Agricultural Economist:-

- 1) The importance of mechanised draught power for arable agriculture in relation to alternative sources of draught power.
- 2) The overall efficiency of local farming systems which currently depend on AMB draught power.

Soil Conservation

To assess, in close collaboration with the Civil Engineer:-

- 3) Technical and social aspects of current and proposed soil and water conservation programmes dependent on AMB services.
- 4) The feasibility of introducing alternative, cheaper soil and water conservation techniques and systems which are consistent with sound land use practices.



## APPENDIX B

## ITINERARY

<u>Date</u>	<u>Team Members</u>	<u>Activity</u>
<u>April 1983</u>		
	NAIROBI	
Sun 10	All	0605 hrs Arrive Nairobi from London, Flt. BA055
	All	pm Team meeting and discussion of method of approach.
Mon 11	All	am Meeting, EADD, BHC, Nairobi.
	All	pm Meeting, LRDD, MoA, Nairobi.
Tue 12	Dr Willcocks & Mr Scott	Meeting with PMM & Co, Nairobi office partners.  HQ, Reading of Reports.
	Mr Parkinson	Mr Goldsack, EADD, Agriculture and Soil Conservation
	Mr Fieldson	Discussions with AMSB staff and collection of information of MoA.
	Mr Doake & Dr Willecocks	am Contacting earth-moving contractors and plant agents.
	All	pm AMSB data collection, meeting.
	Dr Willcocks & Mr Parkinson	Mr Schmidt, Farm Management Division, MoA.
	All	Eve Discussion reference commercial sector
Wed 13	Dr Willcocks & Mr Parkinson	am EADD Dr J Goldson ADC Planning Branch Mr T Wachter ADC Marketing Branch
	Dr Willcocks & Mr Doake	am Meeting Mr Rotherford, Construction Equipment and Blackwood Hodge.
	Mr Scott	Discussion with Mr Kimaru, AMSB/HQ " " Mr Ndethi, PHS
	Dr Willcocks, Mr Parkinson, Mr Fieldson & Mr Doake	pm Meeting at Presidential Commission on Soil Conservation & Afforestation met Mr G Mbarthi with Mr J Goldsack.
	Dr Willcocks	EADD
Thu 14	All	Mr Mbugwa and staff - Ruiru AMSB Station.

<u>Date</u>	<u>Team Members</u>	<u>Activity</u>
Fri 15	Dr Willcocks (TJW)	Visit Mr Mutooni MF Agent, Blackwood Hodge & Hughes Ltd, Ford Agents
	Mr Parkinson (JRP) & Mr Fieldson (RSF)	Mr Kimaru, Agric. enumerator, Central Bureau of Statistics
	TJW & JRP	Mr A Parzer, Agricultural Attache, Dutch Embassy. Min. of Agric. Dr R Armstrong & Mr Gibbons, USAID (Kitui Project).
	JRP	Mr J Goldsack, EADD.
	Mr Scott (JS)	AMSB/HQ, Station Reports, Data extraction.
	Mr Doake (RMD)	Visit to Ruiru, AMS.
Sat 16	TJW	Discussion with Peter Ndethi.
	JRP	Mr G Mwangi, THS.
	TJW	Drs Goldman & Gordon, Harvard MoA group.
	JS	AMSB/HQ, Station Reports, Data Extraction.
	RMD	am Meetings, Ministry of Water Development, PHS, MoA.
	TJW	Mr Lampard, Ag. Economist Consultant.
	All	pm Writing up notes, team meeting.
Sun 17	TJW	Mr Muchiri, of Univ. Nairobi.
	All	NAKURU Travel to Nakuru.
	TJW, RMD	Meet John Norman.
	JRP & RSF	pm Mr Nambera, ADC Ngata Estates, Nakuru. NB Mr Peter Ndethi PHS and Mr Godfrey Mwangi THS accompanied the team on field trips.
Mon 18	All	am Mr Alan Pattinson, AMSB, CW Nakuru Meeting, Rift Valley Province PDA, PLRDO many AMS managers and Provincial Accountant.
	TJW	Mr Odiembo, PHS, CW.
	JRP & RMD	Mr Mwaniki, PLRDO, in field to see At Menegai - contour terracing by PHS At Kiplombe (nr Eldama Ravine) - gully erosion control and Hafir tank.
	TJW	pm CW Mr Mbogori, THS, CW.
	RSF	Visit Contractors and Harvesters Ltd Njoro, M Tahir, Accountant.

<u>Date</u>	<u>Team Members</u>	<u>Activity</u>
Mon 18 cont.	TJW	Visit Boguls Garage, Nakuru. Visit MF Agent & meet contractors.
Tue 19	All	AMSB, CW, Nakuru.
	RMD	Mr Wanyuni, Inspector of works and head of dam construction unit, Min. of Water Development.
	JRP & TJW	AMS Marigat, Mr Maero and staff at office and in field. (Ox drawn ploughing seen, cover photo). Mr Chikwani, Baringo PSAA Project, in office and field.
	RSF	am Mr B Muckle, AMTU, Nakuru. Visit Mr Mwaniki, PLRDO, Rift Valley.
	RSF	pm Visit Farm & Industrial Machinery Ltd, MF Agents.
	All	Eve With Mr Muckle, AMTU.
Wed 20	TJW	am Visit Hughes Ltd Ford Agents, Bogles Garage (T Magent) and Peter Kitheka at CW.
	JRP	Mr A Hussein, Provincial Crops Officer. Mr Kitui, Manager Agric. Machinery Ltd. Mr J Mokaya, Head of Accounts, KFA.
	RMD	Meeting Nakuru, AMSB Manager.
	JS	AMSB, Nakuru, CWS.
	RSF	am Visit P & F Tundo Contractors/Farmers Njoro. Visit P Muhiri, Contractor, Nakuru.
	RMD, JRP & TJW	pm Dr P Misiko, Head of Agricultural Engineering Dept, and Mr McRota Egerton College.
	JRP, TJW, RSF & RMD	Eve Travel to Eldoret.
Thu 21	TJW, JRP, RMD & RSF	ELDORET am Mr Njuki & Staff, Eldoret, AMS
	RSF	Mr Ndethi accompanied to variety of companies.

<u>Date</u>	<u>Team Members</u>	<u>Activity</u>
Thu 21 cont	TJW & JRP	Mr Njuki, in field to see land levelling (cover photo) and contour terracing plus pvt. contractor.
		pm Mr Yobera, Eldoret Inst. of Agric. College.
	JS	Nyahururu - AMSB Station with A Pattinson, CW/TCO.
	RMD	pm Water conservation work sites.
Fri 22	TJW, JRP RMD & RSF	Mr W Kituyi, PDA Province, Kisumu. Mr Mukindia Prov. Project Co-ordinator Nyanza Province. Mr Mugami, Manager Migori AMS, and staff in field to see gully erosion control at Nyakach in Nyando Division.
	JS	AMS, Nakuru, CWS.
		Travel to Kericho to meet rest of team.
Sat 23	All KERICHO	am Visit AMS Kipkelion, Met Mr Cairo and staff.
	JRP & RSF	Infield with Mr Kamana, PO, to see private contractors and farmers.
	JS	Kericho meeting with J S Norman, farmer, TCO.
	All	pm Travel from Kericho to Nairobi.
Sun 24	All NAIROBI	Team discussion in Nairobi.
Mon 25	TJW	BHC & EADD
	JRP	Mr Ndethi, Head of PHS H Schmidt, Farm Management Branch, MoA.
	JS	Nairobi, MoA.
	RMD	Data Collection from AMSB reports, and analysis.
	RSF	Data Analysis. Discussions.
	TJW	pm Visit Ag. Eng. Dept. Univ. Nairobi discussions with Mr G Muchiri and Staff.
Tue 26	TJW	EADD
	JRP	Mr Osoro, Head Irrigation & Drainage Branch, LRDD.
	TJW	Discussion at AMSB.
	TJW & JRP	Mr D Thomas, lecturer in soil water cons. University of Nairobi.
	JS	Nairobi, MoA.

<u>Date</u>	<u>Team Members</u>	<u>Activity</u>
Tue 26 Cont	RSF	Data Analysis, Discussions.
	TJW	pm Mr Nyaga of PPCSCA
	RMD	Data collection from AMSB reports, and analysis and writing up.
Wed 27	JRP & MIGORI/ TJW EMBU	Migori AMS, Mr Mugambi and staff in office and field with DAO (Andrew ?) to see farmers.
	JS	am AMSB, Nairobi.
		pm BHC and PPCSCA
	RMD & RSF	Travel to Embu
		am Visit PLRDO Eastern Province.
		pm Visit AMS Machanga, Messrs Mairia and Nganga.
Thur 28	TJW, JS & JRP	Narok AMSB Station, Mr E Mawenda and staff, DAO and Local Councillor (former private contractor) - Mr Ntimama.
	RMD & RSF	am Visit ODA Embu-Meru-Isiolo Project
		pm Visit AMSB Naromoru
Fri 29	All MOMBASA	Travel to Mombasa, Mariakani AMS, staff at office.
	TJW, JRP & RSF	Mr E K Mureithi, PDA Coast Province.
	JS & RMD	Met private contractor at Mariakani, (Saleh Al Nahdi).
Sat 30	JRP & RMD	With Mr Osindo to Malindi and Marigani to see Mr Janes, project manager, Marigani Settlement Project.
	JS & TJW	Discussion and report preparation.
	RSF	Visit private contractors, Kaloleni Area.

<u>Date</u>	<u>Team Members</u>	<u>Activity</u>
<u>May 1983</u>		
Sun 1	All	Report writing. Team Discussion. Return to Nairobi.
Mon 2	All NAIROBI TJW JRP	Team discussion Report writing. EADD Mr C Osoro, Head IDB, LRDD Mr S Njoroqe, Co-ordinator Extension and Training Section, SWCB, LRDD.
Tue 3	JRP, RMD & JS TJW All	Mr S Njoroqe, ETS Kier International & National Youth Service. AMSB, Nairobi, Mr Kimaru. EADD & AMSB Report writing.
Wed 4	JRP JS & TJW RMD RSF	Mr C Osoro, IDB Report writing. Nairobi, AMSB. Report writing. Meeting Kumdan Singh, Construction Report writing. Agricultural Finance Corporation
Thur 5	All All	Roundup meeting EADD, ODA. Mr Njima, PS to Minister of Agriculture. Report writing.
Fri 6	All TJW JRP RMD	Final meeting with AMSB staff Messrs Kimaru, Mwangi & Ndethi. BHC & EADD Mr Hedfors, SIDA team manager, SWCB, LRDD Visit to Ruiru, AMS dam site, meeting with AMS manager.
Sat 7	All	Return to UK

APPENDIX C      CONTACTS

1) Ministry of Agriculture Staff

Mr Acheri	Accountant, MoA.
Mr Adienge	ex Survey Unit, AMS Kipkelion and Migori.
Mr Andrew	DAO, Migori.
Mr Cairo	AMS, Kipkelion
Mr Chernan	Mechanisation Officer, CWS, Nakuru.
Mr Dibo	DAO, Migori.
Mr Githere	DO, AMS, Ruiru.
Mr Gure	Machinery Co-ordinator, CWS.
Dr Gordon	Harvard Institute, Project Team, MoA, Nairobi.
Mr Hussein	PCO, Rift Valley Province, Nakuru.
Mr Kagiu	Deputy Manager, AMS, Narok.
Mr Kairo	Manager, AMS, Kipkelion.
Mr Kapkasuni	Field Supervisor/TO, AMS, Eldoret.
Mr Karobia	Provincial Accounting Officer, Nakuru.
Mr Kimaru	Chief, AMSB.
Mr Kimbani	PO, AMS, Eldoret.
Mr Kinama	PO, AMS, Kipkelion.
Mr Kituyi	PDA, Nyanza Province.
Mr Kitheka	Workshop Manager, CW, Nakuru.
Mr Maina	Manager, AMS, Machanga.
Mr Makanga	Co-ordinator AMS, Ruiru.
Mr Malro	Manager, AMS, Marigat.
Mr Mawenda	Manager, AMS, Narok.
Mr Mbara	PPO, Coast Province.
Mr Mbugua	Manager, AMS, Ruiru.
Mr Megera	Assistant Manager, AMS, Migori.
Mr Muckle	AMTU, Nakuru.
Mr Mugambi	Manager, AMS, Migori.
Mr Mukindia	Provincial Programme Co-ordinator, Nyanza Province.
Mr Mureithi	PDA, Coast Province.

Mr Mwakio	TA Survey Section, AMS Mariakani.
Mr Mwangi	THS Co-ordinator, AMSB.
Mr D M Mwaniki	PLDO, Rift Valley Province.
Mr Mwanjama	Dept. Manager, AMS, Ruiru.
Mr Mwaura	TO, AMS, Ruiru.
Mr Mukabi	Land Resources Dev. Officer, Narok.
Mr Mwenda	Manager, AMS, Narok.
Mr Mbogori	Manager, CWS, THS.
Mr Nammondi	Field Supervisor, AMS, Marigat.
Mr Nasieku	Dept. Sec. (Finance) MoA, Nairobi.
Mr Ndethi	PHS Co-ordinator, AMSB.
Mr Nderito	TA Survey Section, AMS, Mariakani.
Mr Nganga	Deputy Manager, AMS, Machanga.
Mr Njima	PS to Minister of Agriculture, Narok.
Mr Njendge	Co-ordinator, SWCB of LRDD, Mariakani.
Mr Njuki	Manager, AMS, Eldoret.
Mr Ngera	Machinery Co-ordinator, AMS, Migori.
Mr Nyoka	PHS Field Service Co-ordinator, AMS, Mariakani.
Mr Odel	PO & Farm Machinery Co-ordinator, AMS, Marigat.
Mr Omidio	Machinery Co-ordinator, AMS, Migori.
Mr Osero	Head, IDB, LRDD, Nairobi.
Mr Osindo	Manager, AMS, Mariakani.
Mr Othiambo	Workshop Supervisor/TO, AMS, Eldoret.
Mr Oulo	Workshop Foreman, AMS, Migori.
Mr Oyimbo	DAO, Narok.
Mr E O Odiembo	Asst. Manager, PHS, CWS, Nakuru.
Mr Okunyuku	Mach. Extn. Officer, Eldoret (not seen)
Mr Samburu	PLDO, Eastern Province.
Mr Symayu	Station Manager, AMS, Nakuru.
Mr Twei	PDA, Rift Valley Province.
Mr Wabwile	Mechanical Officer, AMS, Mariakani.
Mr Wambua	Personnel Chief, MoA, Nairobi.
Mr Wanjama	Deputy Manager, AMS, Ruiru.
Mr Were	Chief, LRDD, MoA.

2) Others

Mr Abwonji Planning Officer, Corporate Planning Dept.  
Agricultural Finance Corporation, Nairboi.

Mr Al Nahdi Chief Executive, Various Companies, Mombasa.

Dr Armstrong Co-ordinator, Kitui Project, USAID.

Mr Azada Corporate Planning Advisor, Agricultural  
Finance Corporation, Nairobi.

Mr Bogul Boguls Garage, Nakuru (Track Marshall).

Mr Burmen Branch Manager, Lima Limited (IH Agents).

Mr Cahill Partner, PMM & Co, Nairobi.

Mr Chikwani Project Coordinator, BPSIAP, Marigat.

Mr Darr Earthmoving Sales, Caterpillar, Nairobi.

Mr Dyer-Melville Holman Brothers Ltd, Nairobi.

Mr Elkis Mechanical Equipment Services Ltd, Nairobi  
(Track Marshall Agent).

Mr Ferraine Hughes Ltd, Ford Agents.

Mr Gibbons Project Manager, USAID, Kitui.

Mr Githua Sales Director, Farm & Industrial Machinery  
Distributors Ltd, Nakuru (MF Agents).

Mr Goldman Harvard Institute Project Team, MoA, Nairobi.

Mr Goldsack Natural Resources Adviser, EADD, Nairobi.

Mr Goldson Head-Planning Section, ADC, Nairobi.

Mr Hedfors SIDA Team Manager, SWCB - LRDD, Nairobi.

Mr Holdsworth Team Member, EMI Project.

Mr Isaakson Harvard Institute Project Team, MoA, Nairobi.

Mr Janes Project Manager (ASAD) Margarini Settlement  
Project, Malindi.

Mr Kerr	Assistant (Aid), BHC.
Mr Kerr	Senior Partner, PMM & Co, Nairobi.
Mr Kiptui	Manager, KFA Ag. Machines Ltd, Nakuru.
Mr Komen	Branch Manager, KFA, Eldoret.
Mr Kurim	Senior Enumerator (Ag), CBS.
Mr Little	Engineering Adviser, EADD, Nairobi.
Mr Lombard	Consultant Economist.
Mr Macintosh	Team Member, EMI Project.
Mr Mansfield	Team Member, EMI Project.
Mr Mbarathi	Chief Executive, PPCSCA.
Mr Mbatia	Loans Department, AFC.
Mr Mehrens	Ministry of Water Development.
Dr Migiko	Head of Ag. Eng., Egerton College.
Mr Mokaya	Accountant, KFA Agric. Machines Ltd, Nakuru.
Mr Moody	Incoming Economist/Project Coordinator, EMI Project.
Mr Morris	Natural Resources Economist, ODA.
Mr Mttama	Director of Agriculture, Whitfield.
Mr Muchiri	Head of Ag. Eng. Dept., University of Nairobi.
Mr Mutooni	Farm & Industrial Machinery Distributors Ltd (MF and Hanomag Agent).
Mr Mzee	Asst. Sales Manager, Hughes Ltd, Nairobi.
Mr McRota	Station Manager, Egerton College.
Mr Napier	Branch Manager, KMC, Nakuru.
Mr Nbwera	Complex Manager, ADC Ngata Estates, Nakuru.
Mr Ndiera	Principal, Eldoret Institute of Agriculture.
Mr Nerton	Ag. Attache, US Embassy.
Mr Norman	Plant Maintenance Engineer, Brook Bond (Former TCO/AMSB).
Mr Ntimama	Local Councillor (former contractor) Narok.
Mr Nyaga	PPCSCA, Nairobi.
Mr Nayland	Contractor, Nakuru.
Mr Parzer	Ag. Attache, Dutch Embassy.
Mr Pattinson	TCO, CWS (Nakuru).

Mr Ramakrishna	Harvard Institute Project Team, MOA, Nairobi.
Mr Ria	Contractor, Kaloleni.
Mr Rotherford	Construction Equipment Ltd (Caterpillar Agent).
Mr Roy	Senior Financial Adviser, Treasury, Nairobi.
Mr Schmidt	GAT, Farm Management Branch, MoA.
Mr Singh	Kundam Singh Construction.
Mr Soddy	Blackwood Hodge (Kenya) Ltd, Nairobi.
Mr Sparkhall	Economist, EADD.
Mr Stump	First Secretary (Aid), BHC, Nairobi.
Mr Tahir	Contractors and Harvesters Ltd, Njoro.
Mr Tate	Keir International Ltd, Nairobi.
Mr Taylor	Farm & Industrial Machinery Ltd, Nakuru (MF Agent).
Mr Tebbutt	Blackwood Hodge (Kenya) Ltd, Nairobi.
Mr Thaiya	Project Manager Achelis (Kenya) Ltd, Nairobi.
Mr Thuo	Senior Planning Officer, Agricultural Finance Corporation, Nairobi.
Mr Tundo	Contractor, Njoro.
Mr Tuwei	Kenya Motor Corporation Ltd (MF Agent).
Mr D Trotman	Agricultural Adviser, EADD, Nairobi.
Mr D B Thomas	Soil & Water Lecturer, Ag. Eng. Dept., Univ. Nairobi.
Mr Wachter	Head of Marketing, ADC, Nairobi.
Mr Wanyimi	Inspector of Water Supplies, Min. of Water Development, Marigat.
Mr White	Team Member, EMI Project.
Mr Wiggery	Administration/Accounts, EADD.
Mr Wiggins	Outgoing Economist/Project Coordinator, EMI Project.



APPENDIX DSUMMARY OF MAIN FINDINGS AND RECOMMENDATIONSAgricultural Mechanisation Services BranchReview Team (5 May 83)

1. The Agricultural Mechanisation Services Branch of the Land Resources Development Division consists of the formerly separate Plant Hire Service and Tractor Hire Service. It operates approximately 110 units of heavy machinery and 200 farm tractors based at 19 Agricultural Machinery Stations throughout Kenya.
2. There is an evident need in Kenya for soil and water conservation, but the role of the Plant Hire Service (PHS) in fulfilling this need has not been clearly specified. The primary activity of PHS has changed from the implementation of Government initiated conservation projects to a low charge plant hire service to private farmers. Professional soil and water conservation expertise is now needed for the planning and management of the future work role of the service.
3. The aim of Tractor Hire Service (THS) to provide a land preparation service where private contractors or draught animals are lacking, especially in areas where new land is being opened up, remains valid. The replacement of mobile tractor units with permanently based units has reduced the potential level of annual machine utilisation, and has discouraged the withdrawal of THS services from locations where private contracting is now well developed.
4. Costs  
The recurrent costs of the PHS (including labour, fuel, station running costs, and headquarters expenditure) amount to about K£280,000 in 1982/83. A realistic allowance for machine and station capital costs adds a further K£2,000,000 to this i.e. total annual costs for PHS of about K£2,880,000. At the 1982 achievement of some 22,000 productive hours for the whole fleet, the cost per hour of PHS operations is about KShs2,580, though it is recognised that 1982/83 has seen severe financial constraints which have reduced efficiency. Even taking the best ever annual achievement of 48,500 hours (1979) the cost per hour worked would be KShs1,190. Following a similar procedure for THS, the cost per productive hour is approximately KShs1,070 for 1982. This is equivalent to KShs3,750/ha (KShs1,516/acre) ploughed.

## 5. Recommendations

The engineering nature and scale of AMSB as a supplier of a professional service demands an autonomous organisation structure within Government.

6. The demand for work will come from the agricultural sector through the DAOs, PCDOs and PDAs.

7. Professional management inputs are needed for the development of AMSB.

- Planning Engineer
- Soil and Water Conservation Engineer
- Management Information Officer
- Equipment Maintenance Officer
- Operations Officer
- Personnel Development (Training) Officer.

Given the enormous cost of the operation, it is the firm belief of the team that more professional engineering expertise is required.

8. The team intend to recommend that technical assistance be made available to complement the staffing of some of the above executive functions.

9. At present AMSB resources are spread too thinly to be effective since there are 19 stations throughout Kenya.

## 10. Donors

Foreign aid donors have provided AMSB with a mixture of machines of different makes and types, some of them lacking adequate dealer support within Kenya. This demonstrates a lack of understanding or consideration of the problems faced by AMSB Management in the operation, maintenance and supply of spare parts for such a mixed fleet.

## 11. PHS

It was evident from station visits that the annual work load of PHS rarely exceeded 1,000 hours per station. Therefore the existing plant fleet is considered adequate for the next year providing spares are made available to mobilise serviceable plant that is presently grounded

12. Examination of the PHS output at some stations revealed that the apparent work load did not warrant the permanent placement of sophisticated plant in the area. Further details will be given in the main report.

13. PHS general objectives remain valid except more emphasis is needed on surveying and planning.

14. THS

In view of the high cost of providing this service and the apparent competition with private contractors in some areas, we recommend that THS activity be concentrated in areas with substantial potential for the development of new land.

15. We therefore recommend a reduction in the number of stations in areas where private contractors could provide the required service and where ox cultivation is more appropriate (e.g. Makueni). Specific recommendations will be detailed in the final report, but stations such as Eldoret and Kipkelion appear to be unnecessary.

16. The team considers that encouragement should be given to private tractor contractors, who generally operate much more efficiently than THS. This can be achieved by (a) the provision of short training courses for tractor drivers on machine operation and maintenance, (b) a reduction in the high level of import duty on tractor spares, and (c) a review of AMSB charges (discussed below).

17. It is considered that the THS tractor fleet is excessive to the requirements of the objectives. Some of the agricultural tractors could be utilised for the PHS activities (e.g. Water hole construction). The remainder should be sold off to reduce the number of machine types (ref para 10) thereby easing Management.

18. Spares

A survey is being conducted to establish the spare parts requirement as suggested in para 11 above. It is recommended that Donor funds be used for purchasing essential spares locally.

### 19. Charges and Accounting System

AMSB's equipment hire charges are based upon formulae derived from performance and cost profiles applicable to DC conditions. Their relevance to the Kenya situation is questionable. The current scale is undoubtedly offering the service at highly subsidised rates. We recommend an all-round increase of 20% pending the determination of the real costs of operating the service. We endorse the policy of charging on an hourly basis. We recommend that the THS rates quoted for areas (e.g. hectares) should be qualified as "approximate and subject to land condition".

20. A Management information/internal accounting system has to be introduced to

- restore the recording and collection of basic data which have been allowed to lapse during the past six or seven years
- augment the Government accounting practice which is of limited value to management, and
- provide key operational information for planning and control

### 21. Monitoring

The team intends to provide specific targets and timescales for the fulfillment of the above objectives in its final report. It is recommended that a further short-term study be made with AMSB to monitor progress towards these objectives in approximately one years time.

TJW/JS/JP/RD/RSF

REPUBLIC OF KENYA  
MINISTRY OF FINANCE



THE TREASURY  
P.O. Box 30007  
NAIROBI

9th November 1982

Telegraphic Address:  
FINANCE-NAIROBI  
Tel. No. 338111  
When replying please quote  
Ref. No. EA/FA 93/78/07  
and date

The British High Commission,  
P.O. Box 30465,  
NAIROBI. (Att: Mr. M.R. Crompton)

UK/KENYA PROGRAMME AID ON SOIL  
CONSERVATION AND AGRICULTURAL  
MACHINERY

The Ministry of Agriculture submitted a list of equipment and other aid requirements which we forwarded to you in 1981. I note that there have been several aid reviews carried out by your Government and that you will soon be extending the assistance to Kenya through Sector Aid. I attach herewith a copy of the requirements previously submitted by the Ministry of Agriculture which I request you to now consider under the Sector Aid.

In our recent discussions with Mr. Aitken of the Overseas Development Administration (ODA) it was indicated that one of the areas you will be concentrating aid in will be the Agricultural Sector. I therefore, hope that the equipment listed in the attached schedule will fall within the areas of your Government's interest.

*H. B. AGOYA*  
H. B. AGOYA

for: PERMANENT SECRETARY, TREASURY

c.c. The Permanent Secretary,  
Ministry of Energy,  
P.O. Box 30582,  
NAIROBI.

M The Permanent Secretary,  
Ministry of Agriculture  
P.O. Box 30028,  
NAIROBI.

① Mr. Hartley - psc ack  
② " " copy to EAOL  
" " to EWAAL  
③ Eaten and resubmit.  
*mu*

*M. Stamp*  
*McC. & advise*

9/11/82  
*McC*

BRITISH COMMODITY AID LISTING FOR  
SOIL CONSERVATION EQUIPMENTS &  
AGRICULTURAL MACHINERIES

(i) Summary

Total initial project costing is worked out at K£14,714,752. This includes K£12,603,540 on development costs, and K£2,109,212 on recurrent costs. Of the total project budget it is proposed that the K£12,603,540 of development costs and K£192,200 of overseas training be paid out of the British Commodity Aid. The balance of K£1,917,012 of recurrent costs should be paid by the Kenya Government.

The proposed Commodity Aid by British Government should be seen as a Phase II of the S.C.S. Machinery re-equipment programme whose Phase I was concluded in 1979-80. The British Government has reaffirmed that with the poor workshop and servicing facilities we have at the moment, they are not willing to give us additional support in form of machineries and equipments. Hence, a large portion of the Commodity aid is requested in form of support services and workshop improvement.

It is important to note that since the establishment of our S.C.S Machinery Unit in this country, we have received encouraging support from the British Government and that they are the sole donors that understand this our vital soil and water conservation section more than any other. The continuity of aid by the same donor for this unit has our highest preference.

(ii) Objectives

- To re-equip the two already existing dam construction units at Eldoret and Ruiru A.M.S. Stations.
- To re-establish a further 8 dam construction units in the new soil and water conservation machinery stations as follows:-
 

1 unit for AMS Bumala	- Western Province
1 unit for AMS Migori	- Nyanza Province
1 unit for AMS Marigat	- Rift Valley Province
1 unit for AMS Nyeri	- Central Province
1 unit for AMS Makueni	- Eastern Province
1 unit for AMS Kitui	- Eastern Province
1 unit for AMS Machanga	- Eastern Province
1 unit for AMS Garseni	- Coast Province
- To re-equip and strengthen four of the newly established SCS Machinery stations namely:
 

AMS Kajiado	- Rift Valley Province
AMS Chiakaria	- Eastern Province
AMS Garissa	- North Eastern Province
AMS Narok	- Rift Valley Province.
- To improve and re-equip the existing workshop facilities in 8 of our AMS stations

A.M.S. Mariakani	-	Coast Province
A.M.S. Machanga	-	Eastern Province,
A.M.S. Ruiru	-	Central Province
A.M.S. Nyahururu	-	Central Province
A.M.S. Eldoret	-	Rift Valley Province
A.M.S. Kitale	-	Rift Valley Province
A.M.S. Kiokelion	-	Rift Valley Province
A.M.S. Migori	-	Nyanza Province

- To re-construct and re-equip 9 A.M.S. Stations workshops in the new S.C.S. Machinery stations namely:-

A.M.S. Ciakariga	-	Eastern Province
A.M.S. Kitui	-	Eastern Province
A.M.S. Makueni	-	Eastern province
A.M.S. Marigat	-	Rift Valley Province
A.M.S. Narok	-	Rift Valley Province
A.M.S. Kajiado	-	Rift Valley Province
A.M.S. Garsen	-	Coast Province
A.M.S. Nyeri	-	Central Province
A.M.S. Bumala	-	Western Province

- To improve and re-equip the two main A.M.S. Central Workshops and depots for spare parts supply at Nakuru and Kabete in Nairobi.
- To train locally and abroad our Machinery Supervisors , mechanical officers including plant mechanics and plant operators.  
assistance
- To supply technical/in the field of agricultural Engineering (mechanical etc) and spare parts supply - (Stores Superintendents) with the primary objective of improved management and servicing of the field machineries.

## (A) PLANT AND EQUIPMENTS - S.C.S. MACHINERIES.

DESCRIPTION OF ITEM	No.	Size	Manufacturer Make and Type	Local Agents In Kenya	UNIT COST IN KE	TOTAL COST IN KE
1. Self loading Scrapers	8	TS 148	General Motors Int. International Harvesters	Blackwood Hodge	KE 1,000,000.00	KE 8,000,000.00
2. Medium Heavy Dozers	16	82-30 Ferex TD-20	General Motors International Harvesters	Blackwood Hodge K.Ltd Lima Limited	KE 90,000.00	KE 1,440,000.00
3. Medium Light dozers and rippers	36	Case 1150C TDC 15	CASE Intern. Harvesters	Blackwood Hodge Lima Limited	KE 45,000.00	KE 1,620,000.00
4. Motor Graders	6	130-140 HP			KE 50,000.00	KE 300,000.00
5. Sheep foot Rollers	10	W 651 S	Vibromax Bromford Ltd.	Blackwood Hodge Lima Ltd.	KE 12,500.00	KE 125,000.00
6. Bush Chippers	2	TAS	Bonford	TRACKSMA LTD.	KE 200.00	KE 400.00
7. Drenchers	2	-	M.F.	Fara & M. M. Machinery Ltd.	KE 35,000.00	KE 70,000.00
8. Drainage Equipment	4sets				KE 2,000.00	KE 8,000.00
9. Water pump sets	12	14HP		Machinery Services	KE 14,000.00	KE 168,000.00
10. Concrete Mixers	10	-	Intern. Harvesters	Lima Limited	KE 20,000.00	KE 200,000.00
11. Generating sets	8	-	Transmits Ltd, etc		KE 12,000.00	KE 96,000.00
12. Stone pickers	2				KE 15,000.00	KE 30,000.00

DESCRIPTION OF ITEM	NO.	Size	Manufacturer Make & Type	Local Agents in Kenya	Unit Cost in KES	Total Cost KES
13. Heavy Harrows	8	-	-	-	KES 6,110.00	KES 49,080.00

+ 15% of spare parts = KES 470,740  
**Overall total for (A) = KES 5,178,140.00**

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(B) AGRICULTURAL MACHINERIES AND EQUIPMENTS

Description of Item	No.	Size	Manufacturers Make & Type	Local Agents	Unit Cost in KES	Total Cost in KES
1. Farm Tractors	128	60-80HP	David Brown Massey Ferguson Intern. Harvesters	Birkwood Hodge Fara & Ind. Mech. Lima Limited	KES 7,500.00	KES 960,000.00
2. Disc Ploughs	150	394disc	-	-	KES 10 00.00	KES 150,000.00
3. Row Crop Cultivators	50	-	-	-	KES 1,000.00	KES 50,000.00
4. Combine Harvesters	6	-	-	-	KES 15,000.00	KES 90,000.00
5. Seedrills	12	-	-	-	KES 2,000.00	KES 24,000.00
6. Disc Harrows	24	-	-	-	KES 2,500.00	KES 60,000.00
10% spare parts				-	KES 127,400.00	
Totals for (B)				-	KES 1,401,400.00	

(C) OTHER SUPPLY SERVICES(i) WORKSHOPS.

Improvement and re-equipment of 8 workshops @ K£50,000.00	K£ 400,000.00
Construction and re-equipment of 9 workshops @ K£80,000.00	= K£ 720,000.00
18 service tracks @ K£15,000.00 each	= K£ 270,000.00
Improvements and re-equipment of 2 Central Workshops @ K£100,000.00	= K£ 200,000.00
	<hr/>
Sub-totals for (i)	K£1,590,000.00

(ii) SURVEY EQUIPMENTS:

20 complete survey sets @ K£5,000.00 each	= K£100,000.00
300 Bush tents @ K£250.00 each	= K£ 75,000.00
36 caravans @ K£6,000.00 each	= K£216,000.00
	<hr/>
Sub totals for (ii)	= K£390,000.00

(iii) TRANSPORT EQUIPMENTS:

8 Motorised fuel tankers 7000 litre capacity @ K£15,000.00 each	K£ 120,000.00
80 trailed tankers of 2000 litre capacity @ K£1,200.00 each	K£ 96,000.00
18 longwheel base tracks 8 tonner capacity @ K£15,000.00 each	= £ 270,000.00
36 long wheel base land rovers @ K£8,000.00 each	= K£ 288,000.00
20 dampers @ K£6,000.00 each	= K£ 120,000.00
	<hr/>
Sub-totals for (iii)	K£1,114,000.00

Overall totals for (C) = K£3,094,000.00

(D) PERSONNEL REQUIREMENTS AND EXPENSES

Number & Title	Recurrent Costs		Development Costs
	Salary Kf.p.a.	Field Allowances Kf.p.a.	
400 plant operators and vehicle drivers	180,000	144,000	1,200,000.00
400 subordinate staff	120,000	144,000	1,200,000.00
36 plant mechanics	16,200	12,960	108,000.00
36 Supervisors/Surveyors	30,672	32,400	144,000.00
36 Technical officers	43,200	48,600	180,000.00
18 Mechanical Officers	32,400	13,500	108,000.00
18 Agricultural Engineers (Mechanical)	54,000	189,000	-
2 Stores Superintendents	5,440	2,000	-
<b>TOTALS</b>	<b>481,912</b>	<b>415,460</b>	<b>2,930,000.00</b>

Overall totals for (D) - Kf. 2,930,572.00

(E) OTHER PERSONNEL RECURRENT EXPENSES

(i) Training - Supervisors and mechanical officers 4 courses of 12 officers each for 2-3 months @ K£4,000 Local training for operators and mechanics	= K£ 192,000.00 = K£ 192,000.00 = K£ 25,000.00
(ii) Uniforms and clothing 872 junior officers @ K£ 50 p.a. 74 Senior Officers @ K£100 p.a.	= K£ 43,600.00 = K£ 7,400.00
(iii) Miscellaneous and other charges 10% of (i) and (ii)	= K£ 26,800.00
(iv) Maintenance of stations £2,000 for 20 stations	= K£ 40,000.00
(v) Materials for labour intensive soil and water conservation works @ K£10,000.00 for 6 labour intensive S.C.S. Stations	= K£ 60,000.00
	<u>K£ 394,800.00</u>

(F) RECURRENT EXPENSES - MACHINERY AND TRANSPORT

8 Scrappers @ K£24,000.00 p.a. each = K£192,000.00	= K£ 480,000.00
16 Medium heavy crawlers @ £16,000.00 p.a. = K£256,000.00	= K£ 806,000.00
48 Medium light equipments @ K£12,000.00 p.a. = K£576,000.00	= K£1,728,000.00
126 Farm tractors @ K£3,200 p.a. = K£403,200.00	= K£ 504,800.00
44 Lorries/tankers/service tracks @ K£3,200.00 = K£140,800.00	= -
8 Lowloaders @ K£6,000.00 p.a. = K£48,000.00	= -
56 Landrovers and dampers @ K£2,000.00 = K£112,000.00	= -
Totals for (F) = K£1,728,000.00	<u>K£3,619,200.00</u>

Appropriation in Aid

THE UNITED STATES OF AMERICA

IN SENATE, JANUARY 10, 1910

REPORT OF THE COMMISSIONERS OF THE GENERAL LAND OFFICE  
ON THE PROGRESS OF THE PUBLIC LANDS DURING THE YEAR 1909

WASHINGTON: GOVERNMENT PRINTING OFFICE: 1910

THE GENERAL LAND OFFICE HAS THE HONOR TO ACKNOWLEDGE THE RECEIPT OF THE ABOVE REPORT FROM THE COMMISSIONERS OF THE GENERAL LAND OFFICE, JANUARY 10, 1910.

REPORT OF THE COMMISSIONERS OF THE GENERAL LAND OFFICE ON THE PROGRESS OF THE PUBLIC LANDS DURING THE YEAR 1909

CHAPTER I. PUBLIC LANDS UNDER SURVEY

SECTION 1. PUBLIC LANDS UNDER SURVEY AT THE CLOSE OF THE YEAR 1909

SECTION 2. PUBLIC LANDS UNDER SURVEY AT THE BEGINNING OF THE YEAR 1909

SECTION 3. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 4. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 5. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 6. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 7. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 8. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 9. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

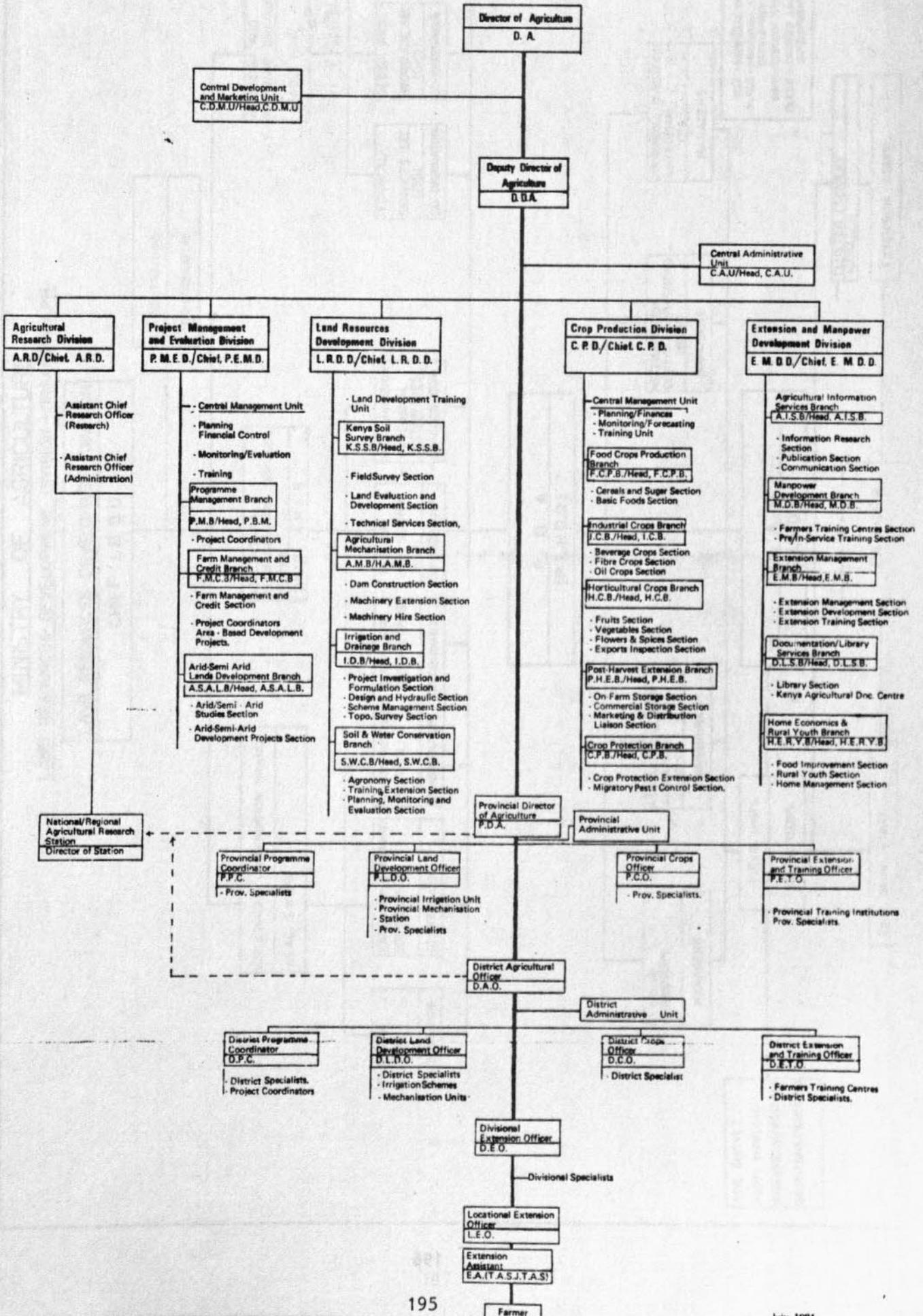
SECTION 10. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 11. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

SECTION 12. PUBLIC LANDS UNDER SURVEY AT THE END OF THE YEAR 1909

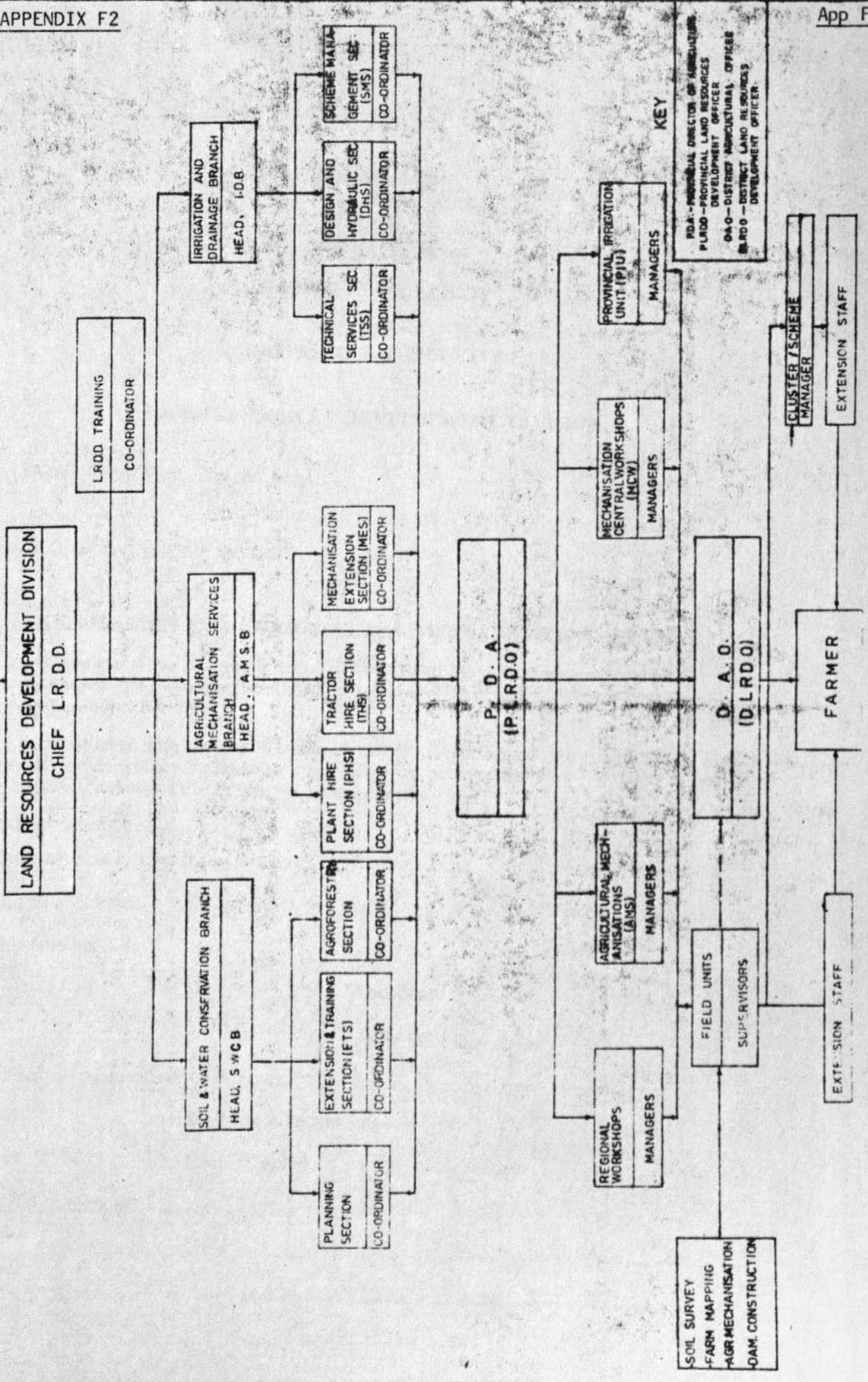
# MINISTRY OF AGRICULTURE

## The Organisation of the Department of Agriculture





**MINISTRY OF AGRICULTURE**  
**LAND RESOURCES DEVELOPMENT DIVISION - ORGANOGRAPH**





FORM LRDD/APRIL/1982



REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE

LAND RESOURCES DEVELOPMENT DIVISION

To: The Manager,
Agricultural Mechanization Services,

Station,

P.O. Box

APPLICATION FOR AGRICULTURAL MECHANIZATION SERVICES

The applicants are advised to read and understand the conditions under which the work will be carried out, which are outlined in sections CDEF and G, before completing and signing this application form.

In accordance with the requirements of the Permanent Secretary for Agriculture, I wish to apply for agricultural mechanization services, to be carried out on my farm as per my instructions, or those of my authorized representatives.

(A) PERSONAL DETAILS:

Name (IN BLOCK LETTERS)

Residential address Phone

Farm Number LR District

Location

Sub-Location

Method of payment (a) Cash

(b) Banker's Cheques

(c) Loan (Specify)

Other information

## (B) WORK DETAILS:

(Farmer to indicate type of work required)

1. Farm Mapping (with contours) ..... Hectares
2. Farm survey and layout ..... Hectares
3. Farm survey and demarcations ..... Hectares
4. Perimeter survey for hectarage or boundary determination ..... Hectares
5. Survey and design for dams, water holes, Hafir tanks ..... Numbers
6. Dam construction, water holes, etc. .... Numbers
7. Terracing and cut of drains ..... Hectares/Km.
8. Bush clearing and ripping ..... Hectares
9. Land levelling ..... Hectares
10. Transport lorry, lowloader, L/Rover, Small vehicle below 1600 cc ..... Kilometres
11. Ploughing, harrowing, planting ..... Hectares
12. Other works (specify) .....

I am aware of the Agricultural Mechanization conditions and charges in force, which have been published in the Kenya Gazette Notice No. 808, Ministry of Agriculture General Notice No. AGRIC/1/1982.

I also understand that payment in respect of ploughing, harrowing, planting and transport is made in full before the work commences. In case of heavy industrial machineries, 50 per cent of the estimated cost should be paid in advance and for any bills outstanding one month after the date of the invoice I agree to pay an interest at the rate of 1 per cent per month. I also understand that no work will be undertaken unless the application form is completed and signed.

Applicant's signature ..... Date .....

Witness's name .....

Address .....

Signature ..... Date .....

### CONDITIONS AND CHARGES

(C) HIRE RATES:	<i>Charge per hour K.Sh.</i>
<i>(a) Constructional machinery</i>	
1. Cat D8 new model and Terex Scraper (TS 14) ... ..	740
2. Cat D8 old model and Cat D7 new model including TD 20E (I.H.) ... ..	560
3. Cat D7 old model, Cat D613 shovel, D6C new model, including TD 15 (I.H.) ... ..	520
4. Cat D6 old model, A.M. 140 HP, Michigan dozer 180, Cat 14 M/G and Champion 14 M/G, MF 600C. ... ..	400
5. Cat 12 M/G and Champion 12 M/G Track Marshall Model 25, MF 500B ... ..	300
6. Track Marshall 56 ... ..	210
7. Cat D4, TD dozer, Bucket Loader 955, and B/Loader 175 ...	200
<i>(b) Agricultural machinery</i>	
1. Agricultural machinery 101 HP and above ... ..	190
2. " " 81 to 100 HP ... ..	170
3. " " 61 to 80 HP ... ..	140
4. " " 41 to 61 HP ... ..	110
5. " " Below 40 HP ... ..	100
6. Vibrating roller 10 T ... ..	125
7. " " 15 T ... ..	160
	<i>Charge per hectare</i>
1st ploughing (new land) per hectare ... ..	520
1st ploughing (old land) per hectare ... ..	400
2nd ploughing (old or new land) per hectare ... ..	300
1st harrowing per hectare ... ..	230
2nd harrowing per hectare ... ..	170
Planting per hectare ... ..	130
Combine harvesting per hectare ... ..	300
Shelling ... ..	2.50 per bag
Transport for agricultural machineries with trailers, etc., will be charged on per hour basis according to the tractor HP.	
(D) OTHER TRASPORT RATES:	<i>K.Sh.</i>
Lowloader (Transporter) ... ..	70 per Km.
5 to 7 tonner lorry ... ..	10 per Km.
Land-Rover ... ..	5 per Km.
Small vehicles below 1500 cc ... ..	3 per Km.

(E) SURVEY CHARGES:	K.Sh.
1. Dam Survey and design ... ..	6,000
2. Perimeter Survey for hecтарage or boundary determination ...	25 per hectare
3. Detailed Survey with contours ... ..	50 per hectare
4. Farm Survey and Layout or plan ... ..	70 per hectare

## (F) HIRE OF PERSONNEL:

1. Professional staff K.Sh. 120 per day or part of the day.
2. Technical officer K.Sh. 100 per day or part of the day.
3. Technical Assistants K.Sh. 70 per day or part of the day.
4. Technicians such as plant operators, mechanics, artisans, etc. K.Sh. 50 per day or part of the day.
5. Subordinate Staff K.Sh. 25 per day or part of the day.

## (G) CONDITIONS OF WORK:

1. All jobs applied for and started on or after 1st April, 1982 will be charged on the specific rates outlined above.
2. The applicant should complete, sign, and submit this application form to the officer in charge of the nearest Agricultural Office at least three (3) months prior to the commencement of his job.
3. A 50 per cent deposit is payable before commencement of all jobs estimated in excess of K.Sh. 20,000. Such a deposit should not be less than K.Sh. 20,000.
4. All other jobs estimated at K.Sh. 20,000 or less shall be paid in advance before the commencement of the job.
5. The total payment of the work is required upon completion of the job, and any outstanding bills will develop an interest of 1 per cent per month, one month after the date of the invoice. No work will be undertaken before the application forms are completed, signed, and the necessary payments made.
6. For survey services, only one copy of the map will be given to the farmer, and any extra copies will be sold to him at K.Sh. 100 per copy.
7. The Government machineries, equipment and transport, shall not be hired to the private contractors, unless a prior permission is granted in writing by the Director of Agriculture himself.
8. Where the machinery services rendered are classified conservational, or drainage, the Ministry of Agriculture will give a 50 per cent subsidy to the applicant if his farm is planned or has a soil conservation layout.
9. No subsidies are given to the Government Ministries, departments or corporations.
10. The water conservation subsidy for structures designed or approved by the Ministry of Water Development is given at 40 per cent for all areas with less than 500 mm. of rainfall, and 25 per cent for all other areas.
11. If the applicant is not pleased with the type of services rendered, he is free to instruct the withdrawal of the service.
12. The applicant, however, should sign a certificate of work done for any services rendered to him during the withdrawal of the services or at completion of the job.

## APPENDIX H

## STATION SUMMARIES

The following sheets summarise the locations, staff, facilities and performance of each of the AMSB stations in alphabetical order. The amount of information available varies considerably, according to whether the station was actually visited by team members and according to the quality of reports produced by the station.

Most of the information on the summary sheets is self-explanatory. All revenue figures are in Kenya Shillings. The only section which requires further explanation is Section 4 on Land Use. The information in this section is derived largely from the FMH, and the details of each point are as follows:

#### 4.1 Climate

The symbols in the first part of this section denote the Agro-Climatic Zones (ACZ) as classified by the Kenya Soil Survey in 1982 (Exploratory Soil Map and ACZ Map of Kenya). This work classifies the ACZs by moisture availability (annual average precipitation expressed as a percentage of potential evaporation) and annual mean temperature. The first zone symbol indicates the moisture availability (from I to VII) and the second symbol shows the temperature range (from 1 to 9) within the ACZ. In the station summary sheets the ACZ is given for each station, followed by the moisture availability symbol.

#### 4.2 Agro-Ecological Zone (AEZ)

The AEZ in which the station is situated is listed (FMH 1982) together with the predominant soil type in the region (KSS, 1981)

#### 4.3 Land Availability and Population Density

This section gives the average amount of agricultural land available in hectares per person and the average density of the population for the District in which the station is located.

#### 4.4 Land Use

The three items of information contained in this section of the summary sheet are:

- Cropping Percentage indicating the area of arable land estimated to be under crops in 1977 compared with the total agricultural land available in the District
- Crop Intensity shows the number of crops grown per year
- Main enterprises show the main crop and livestock enterprises which are undertaken by farmers in the AEZ at present

## STATION SUMMARY SHEET

1. STATION NAME: BUMALA
2. LOCATION: Western Province Busia District
3. VISITED?: No
4. LAND USE: 4.1 I3; 80% at 21°C  
4.2 LM 1-3; Upland Ferrasol  
4.3 2.72 ha; 17 per km<sup>2</sup>  
4.4 55%; 0.9% maize, cassava, sugar cane, cotton, fuger millet
5. STAFF: Mechanics – 2 (plus Plant operators – 41 Total – 97  
casuals)
6. FACILITIES/BUILDINGS: N/A
7. PHS OUTPUT (1982): N/A km terraces, km roads, dams,  
ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): ha ploughed, ha harrowed, ha planted,  
bags shelled Total Cultivation = 1180 ha
9. SURVEY SECTION OUTPUT: ha surveyed N/A (1981) (1982)
10. TRANSPORT: 5 Personnel vehicles, 2 Lorries, Lowloaders,  
1 Tankers, 1 Motorcycles
11. SOIL & WATER CONSERVATION NEEDS: N/A

12. PHS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1980				
1981	1	128		
1982	5	1038		354,600

13. THS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1981			853	
1982	25		1180	620,000

## STATION SUMMARY SHEET

1. STATION NAME: CHIAKARIGA
2. LOCATION: Eastern Province Meru District
3. VISITED?: No
4. LAND USE: 4.1 III4-7; 50-65% at 16°C  
4.2 UM5; Upland Luvisol  
4.3 1.80 ha; 32/km<sup>2</sup>  
4.4 56% 1.4; Livestock, sorghum/maize, millet
5. STAFF: Mechanics -- 5 Plant operators -- 13 Total -- 97  
(of which 3 workspaid)
6. FACILITIES/BUILDINGS: N/A
7. PHS OUTPUT (1982): N/A km terraces, km roads, dams,  
ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): 315 ha ploughed, 23 ha harrowed, ha planted,  
bags shelled 6 ha ridged 82 ha harvesting
9. SURVEY SECTION OUTPUT: ha surveyed N/A (1981) (1982)
10. TRANSPORT: 4 Personnel vehicles, 3 Lorries, Lowloaders,  
1 Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS: N/A
12. PHS UNITS: PRODUCTIVITY AND FINANCE
 

	No. of Units	Hours worked	Revenue earned	Expenditure
1980				
1981	2	982	287,840	
1982	6	314	100,200	
13. THS UNITS: PRODUCTIVITY AND FINANCE
 

	No. of Units	Hours worked	Revenue earned	Expenditure
1981		1040		
1982	10	1154	119,634	

## STATION SUMMARY SHEET

1. STATION NAME: ELDORET
2. LOCATION: Rift Valley Province Uasin Gishu District
3. VISITED?: Yes
4. LAND USE: 4.1 III 5-6; 50-60% at 16°C  
4.2 LH3; Plateau Ferrasol  
4.3 5.94 ha  
4.4 NA; maize, wheat.
5. STAFF: Mechanics — 3 — Plant operators — 22 — Total — 69
6. FACILITIES/BUILDINGS: Office; Stores
7. PHS OUTPUT (1982): 40 km terraces, 100 km roads, 1 dams,  
20 ha bush cleared, 5 water holes, 60 levelling, 40 ditches
8. THS OUTPUT (1982): 351 ha ploughed, ha harrowed, ha planted,  
4656 bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed 2902 (1981) (1982)  
Revenue earned = Ksh 144,876
10. TRANSPORT: 3 Personnel vehicles, 2 Lorries, Lowloaders,  
Tankers, Motorcycles  
(5 further vehicles for boarding)
11. SOIL & WATER CONSERVATION NEEDS: Yes, Survey and Design Unit.

12. PHS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1980		4838	1,585,600	
1981	8	6609	2,022,140	
1982	7	2790	806,630	

13. THS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1981		2517		
1982	10	1229	127,369 (collected)	

## STATION SUMMARY SHEET

1. STATION NAME: GARSEN
2. LOCATION: Coast Province Tana River District  
(most work done in Kilifi District)
3. VISITED?: NO
4. LAND USE: 4.1 VII; 15 - 25°C at 27°C  
4.2 L5; Upland Cambisol.  
4.3 NA  
4.4 NA; millet, livestock
5. STAFF: Mechanics — 0 Plant operators — 17 Total — 39
6. FACILITIES/BUILDINGS: None
7. PHS OUTPUT (1982): 0.5 km terraces, km roads, dams,  
22.5ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): 196 ha ploughed, ha harrowed, ha planted,  
bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed None (1981) (1982)
10. TRANSPORT: 2 Personnel vehicles, 1 Lorries, Lowloaders,  
Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS: No

## 12. PHS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1980				
1981				
1982	4	328	78,060	

## 13. THS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1981		2839		
1982	7	686		51,238

## STATION SUMMARY SHEET

1. STATION NAME: GARISSA
2. LOCATION: North Eastern Province Garissa District
3. VISITED?: No
4. LAND USE: 4.1 VII 1; <15% at 27°C  
4.2 L7; Sedimentary Plain Planosols and Solonetz  
4.3 NA  
4.4 NA; Nomadism
5. STAFF: Mechanics — NA Plant operators — Total —
6. FACILITIES/BUILDINGS: None
7. PHS OUTPUT (1982): NA km terraces, km roads, dams,  
ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): 11 ha ploughed, ha harrowed, ha planted,  
bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed NA (1981) (1982)
10. TRANSPORT: NA Personnel vehicles, Lorries, Lowloaders,  
Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS: Yes, Soil and Water Conservation  
Works essential
12. PHS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              |              |                |             |
| 1981 |              |              |                |             |
| 1982 | 3            | 4            | Nil            |             |
13. THS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              |              |                |             |
| 1982 | 6            | 38.5         |                |             |

## STATION SUMMARY SHEET

1. STATION NAME: KAJIADO
2. LOCATION: Rift Valley Province Kajiado District
3. VISITED?: No
4. LAND USE: 4.1 V 3-4; 25-40% at 20°C  
 4.2 UH<sub>2</sub> and LH<sub>2</sub>-4, Upland Luvisol and Rendzinalis  
 4.3 NA  
 4.4 NA; maize, cattle, sheep.
5. STAFF: Mechanics — 3 Plant operators — 4 Total — 33
6. FACILITIES/BUILDINGS: NA
7. PHS OUTPUT (1982): km terraces, km roads, dams,  
 ha bush cleared, 3 water holes, some land levelling, ditches
8. THS OUTPUT (1982): 251 ha ploughed, ha harrowed, ha planted,  
 bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed None (1981) (1982)
10. TRANSPORT: 4 Personnel vehicles, 3 Lorries, Lowloaders,  
 Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS: Yes, soils easily erodable.

## 12. PHS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1980				
1981				
1982	3	170	40,860	

## 13. THS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1981				
1982	2	878	72,646	

## STATION SUMMARY SHEET

1. **STATION NAME:** KIPKELION
2. **LOCATION:** Rift Valley Province Kericho District
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 II4-6; 65-80% at 17°C  
 4.2 UM2, 5-6 and LH2; Volcanic Footridge Intosols  
 4.3 2.88 ha; high population density  
 4.4 Tea; maize, beans
5. **STAFF:** Mechanics — 1 Plant operators — 27 Total — 60
6. **FACILITIES/BUILDINGS:** Offices; Stores; Workshop (?)
7. **PHS OUTPUT (1982):** NA km terraces, km roads, dams,  
 ha bush cleared, water holes, levelling, ditches
8. **THS OUTPUT (1982):** 64 ha ploughed, 17 ha harrowed, ha planted,  
 1147 bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed 4036 (1981) (1982)
10. **TRANSPORT:** 3 Personnel vehicles, 2 Lorries, Lowloaders,  
 1 Tankers, Motorcycles  
 (plus 3 vehicles for boarding)
11. **SOIL & WATER CONSERVATION NEEDS:**  
 Yes, steep slopes require protection
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 | ?            | 6,359        | 1,720,975      |             |
| 1981 | 6            | 2,695        | 703,830        |             |
| 1982 | 8            | 1,326        | 458,250        |             |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              | 1309         |                |             |
| 1982 | 11           | 250          | 25,618         |             |
14. **SURVEY**
- |      |         |
|------|---------|
| 1982 | 200,000 |
|------|---------|

## STATION SUMMARY SHEET

1. STATION NAME: KITALE
2. LOCATION: Rift Valley Province Trans Nzoia District
3. VISITED?: No
4. LAND USE: 4.1 IIII5; 50-65% at 17°C  
4.2 UM3-4; Upland Ferrasols  
4.3 3.67 hs  
4.4 NA; barley, maize
5. STAFF: Mechanics — NA Plant operators — Total —
6. FACILITIES/BUILDINGS: NA
7. PHS OUTPUT (1982): NA km terraces, km roads, dams,  
ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): None ha ploughed, ha harrowed, ha planted,  
bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed NA (1981) (1982)
10. TRANSPORT: NA Personnel vehicles, Lorries, Lowloaders,  
Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS: No

## 12. PHS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1980		6,826	1,678,950	
1981	6	4,495	745,820	
1982	8	1,768	394,900	

## 13. THS UNITS: PRODUCTIVITY AND FINANCE

	No. of Units	Hours worked	Revenue earned	Expenditure
1981				
1982				

## STATION SUMMARY SHEET

1. STATION NAME: KITUI
2. LOCATION: Eastern Province Kitui District
3. VISITED?: No
4. LAND USE: 4.1 V 1-2; 25-40% at 24°C  
4.2 LM5; Upland Acrisols and hilly Cambisols  
4.3 23.94 ha  
4.4 NA; livestock, millet.
5. STAFF: Mechanics — NA Plant operators — Total —
6. FACILITIES/BUILDINGS: NA
7. PHS OUTPUT (1982): NA km terraces, km roads, dams,  
ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): None ha ploughed, ha harrowed, ha planted,  
bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed NA (1981) (1982)
10. TRANSPORT: NA Personnel vehicles, Lorries, Lowloaders,  
Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS:  
Yes, upkeep old terraces
12. PHS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 | ?            | 546          | 138,450        |             |
| 1981 | 3            | 1,946        | 323,000        |             |
| 1982 | 4            | 1,460        | 578,800        |             |
13. THS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              |              |                |             |
| 1982 |              |              |                |             |

## STATION SUMMARY SHEET

1. **STATION NAME:** MACHANGA
2. **LOCATION:** Eastern Province Embu District
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 IV 1-2; 40-50% at 24°C  
 4.2 LM5; Plateau Vertisols  
 4.3 4.44 ha; 45/km<sup>2</sup>  
 4.4 44%; 1.5; millet, cotton, livestock
5. **STAFF:** Mechanics — 6 Plant operators — 19 Total — 97
6. **FACILITIES/BUILDINGS:** Good workshop built as Regional THS Workshop, but unsuited to heavy machinery. Lack of water, and fuel storage. Excellent offices. Very poor staff housing.
7. **PHS OUTPUT (1982):** 83 ha bush cleared, 12 km terraces, 12 water holes/dams, km roads, levelling, dams, ditches
8. **THS OUTPUT (1982):** 217 ha ploughed, in Embu ha harrowed, ha planted, bags shelled (additional work in Naro Moru not specified)
9. **SURVEY SECTION OUTPUT:** ha surveyed NA (1981) (1982)
10. **TRANSPORT:** 3 Personnel vehicles, 3 Lorries, 1 Lowloaders, 1 Tankers, Motorcycles 1 Mobile Workshop
11. **SOIL & WATER CONSERVATION NEEDS:**  
 Yes, survey and design unit.
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              |              |                |             |
| 1981 | 2            | 1,687        | 567,720        |             |
| 1982 | 6            | 720          | 42,692         |             |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              |              |                |             |
| 1982 | 13           | 1537         | 334,700        |             |
14. **SURVEY** 192,181

<sup>1</sup> See 8 above

## STATION SUMMARY SHEET

1. STATION NAME: MAKUENI
2. LOCATION: Eastern Province Machakos District
3. VISITED?: No
4. LAND USE: 4.1 IV 2-4; 40-50% at 21°C  
4.2 LM4-5; Upland Acrisols  
4.3 6.79 ha  
4.4 NA; millet, livestock
5. STAFF: Mechanics — 4 Plant operators — 25 Total — 146
6. FACILITIES/BUILDINGS: NA
7. PHS OUTPUT (1982): NA km terraces, km roads, dams,  
ha bush cleared, water holes, levelling, ditches
8. THS OUTPUT (1982): 109 ha ploughed, ha harrowed, ha planted,  
bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed 300 (1981) (1982)
10. TRANSPORT: 5 Personnel vehicles, 2 Lorries, Lowloaders,  
1 Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS:  
Considerable need for S&WC services - survey and design unit  
- THS equipment for PHS field Units
12. PHS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              | 753          | 425,104        |             |
| 1981 | 5            | 1,339        | 455,580        |             |
| 1982 | 6            | 1,587        | 572,920        |             |
13. THS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              | 1187         |                |             |
| 1982 | 13           | 382          | 36,530         |             |

## STATION SUMMARY SHEET

1. STATION NAME: MARIAKANI
2. LOCATION: Coast Province Kilifi District
3. VISITED?: Yes
4. LAND USE:
 

4.1	IV1; 40-50% at 27°C
4.2	L3-4; Upland Cambisols and Luvisols
4.3	4.40 ha; 140/km <sup>2</sup>
4.4	66%; 1.3; maize, cassava, cashew, coconut
5. STAFF: Mechanics — 9 Plant operators — 17 Total — 69
6. FACILITIES/BUILDINGS:
 

Workshop built as THS Regional Workshop by Dutch. Unsited to heavy machinery.
7. PHS OUTPUT (1982):
 

4 km terraces/dams	12 km roads,	dams,
106 ha bush cleared,	Some water holes,	levelling, ditches
8. THS OUTPUT (1982):
 

49 ha ploughed,	ha harrowed,	ha planted,
bags shelled		
9. SURVEY SECTION OUTPUT:
 

ha surveyed	1234	(1981)	(1982)
-------------	------	--------	--------
10. TRANSPORT:
 

6 Personnel vehicles,	2 Lorries,	1 Lowloaders,
1 Tankers,	Motorcycles	
11. SOIL & WATER CONSERVATION NEEDS:
 

Yes, soil highly erodable - THS equipment for PHS Field Units
12. PHS UNITS: PRODUCTIVITY AND FINANCE
 

	No. of Units	Hours worked	Revenue earned	Expenditure
1980		4,814	698,307	
1981	7	2,651		
1982	8	1,219	397,800	
13. THS UNITS: PRODUCTIVITY AND FINANCE
 

	No. of Units	Hours worked	Revenue earned	Expenditure
1981		368		
1982	10	172		
14. SURVEY
 

1982	71,064
------	--------

## STATION SUMMARY SHEET

1. **STATION NAME:** MARIGAT
2. **LOCATION:** Rift Valley Province Baringo District
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 III4; 50-60% at 18°C  
 4.2 UM4/LM5; Footslope Luvisol  
 4.3 9.70 ha; 1 18/km<sup>2</sup>  
 4.4 66%; 0.9; maize, beans, cotton
5. **STAFF:** Mechanics — 4 Plant operators — 14 Total — 82
6. **FACILITIES/BUILDINGS:** NA
7. **PHS OUTPUT (1982):** km terraces, km roads, dams,  
 5 ha bush cleared, 8 water holes, levelling, ditches  
 (other summary gives much higher figs. ie 74 waterholes in 1982 - check)
8. **THS OUTPUT (1982):** 506 ha ploughed, ha harrowed, ha planted,  
 bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed 400 (1981) (1982)
10. **TRANSPORT:** 3 Personnel vehicles, 1 Lorries, Lowloaders,  
 Tankers, Motorcycles
11. **SOIL & WATER CONSERVATION NEEDS:** Considerable S&WC needs -  
 soils highly erodable: 1. PHS survey and Design Unit.  
 2. THS equipment to PHS Field Unit.  
 3. Training in equipment operation
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units   | Hours worked | Revenue earned | Expenditure |
|------|----------------|--------------|----------------|-------------|
| 1980 |                |              |                |             |
| 1981 | 2 <sup>2</sup> | 377          | 60,210         | 65,370      |
| 1982 | 2 <sup>2</sup> | 479          | 173,720        | 81,380      |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              | 1698         |                |             |
| 1982 | 13           | 1771         | 237,785        |             |
14. **SURVEY**
- |      |        |
|------|--------|
| 1982 | 16,000 |
|------|--------|

Note 1 Southern part of District only  
 2 Additional machine doing work for Nakuru AMS

## STATION SUMMARY SHEET

1. **STATION NAME:** MIGORI
2. **LOCATION:** Nyanza Province South Nyanza District
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 II 3-4; 65-80% at 20°C  
 4.2 LM 23; Upland Cambisols and Luvisols  
 4.3 5.90 ha; 149/km  
 4.4 46%; 0.9; sugarcane, cotton, cassava
5. **STAFF:** Mechanics – 8 Plant operators – 20 Total – 89  
 (of whom 6 casual)
6. **FACILITIES/BUILDINGS:**  
 Regional workshop; staff housing: 15 (+10 more being constructed)  
 Site lacks service utilities (telephone, water, power)
7. **PHS OUTPUT (1982):** km terraces, km roads, dams,  
 some ha bush cleared, water holes, levelling, ditches  
 some terracing/drains
8. **THS OUTPUT (1982):** 422 ha ploughed, 272 ha harrowed, ha planted,  
 bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed 307.5 (1981) (1982)
10. **TRANSPORT:** 5 Personnel vehicles, 1 Lorries, 1 Lowloaders,  
 Tankers, Motorcycles
11. **SOIL & WATER CONSERVATION NEEDS:**  
 Soil conservation needed as soils highly erodable  
 1. PHS survey and design unit  
 2. THS equipment to PHS field units  
 3. Training in equipment operation.
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              |              |                |             |
| 1981 | 5            | 52           |                |             |
| 1982 | 4            | 859          | 293,698        |             |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              | 1351         |                |             |
| 1982 | 18           | 2648         | 288,425        |             |
14. **SURVEY**
- |      |        |
|------|--------|
| 1982 | 21,202 |
|------|--------|

## STATION SUMMARY SHEET

1. **STATION NAME:** NAKURU
2. **LOCATION:** Rift Valley Province Nakuru District
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 III 4-5; 50-65% at 18°C  
 4.2 UH2-5, UM4-6 Upland Cambisols  
 4.3 4.63 ha NA  
 4.4 33%; 1.0; wheat, maize, livestock
5. **STAFF:** Mechanics — NA Plant operators — Total —
6. **FACILITIES/BUILDINGS:** Offices and Stores
7. **PHS OUTPUT (1982):** 15 km terraces, 13 km roads, dams,  
 40 ha bush cleared, 3 water holes, levelling, ditches
8. **THS OUTPUT (1982):** None ha ploughed, ha harrowed, ha planted,  
 bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed (1981) (1982)  
 Considerable area
10. **TRANSPORT:** NA Personnel vehicles, Lorries, Lowloaders,  
 Tankers, Motorcycles
11. **SOIL & WATER CONSERVATION NEEDS:**  
 No - most large farms already have soil and water conservation works.
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              | 5687         | 1,363,010      |             |
| 1981 | 6            | 6095 (?)     | 1,104,780      |             |
| 1982 | 7            | 1103         | 300,700        |             |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              |              |                |             |
| 1982 |              |              |                |             |

## STATION SUMMARY SHEET

1. **STATION NAME:** NAROK
2. **LOCATION:** Rift Valley Province Narok District
3. **VISITED?:** Yes
4. **LAND USE:**
- |     |                                  |
|-----|----------------------------------|
| 4.1 | II5-7; 50-65% at 14°C            |
| 4.2 | LH4 and UM4-5; Plateau Phaeozems |
| 4.3 | 33.55 ha; 0.5 km <sup>2</sup>    |
| 4.4 | 25%; 0.7; wheat, livestock       |
5. **STAFF:** Mechanics — 4 Plant operators — 31 Total — 78
6. **FACILITIES/BUILDINGS:**  
Workshop: None; Store: 1 (wooden); Offices: 2 (wooden) + incomplete administration block
7. **PHS OUTPUT (1982):** 512ha bush cleared, km terraces, 2 water holes, 330 km roads, levelling, 1 dams, ditches
8. **THS OUTPUT (1982):** 617 ha ploughed, 653 ha harrowed, 250 ha planted, bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed None (1981) (1982)
10. **TRANSPORT:** 3 Personnel vehicles, 2 Lorries, Lowloaders, 1 Tankers, Motorcycles
11. **SOIL & WATER CONSERVATION NEEDS:** Yes, to arrest erosion on hill footslopes in Osupuk and Trans-mara
1. Workshop and admin. facilities
  2. PHS survey and design unit
  3. THS equipment to PHS field units
  4. Training in equipment operation
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              | 1,299        |                |             |
| 1981 | 6            | 3,964        | 1,189,110      |             |
| 1982 | 6            | 2,525        | 887,916        |             |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              |              |                |             |
| 1982 | 20           | 3,739        | 334,428        |             |

## STATION SUMMARY SHEET

1. **STATION NAME:** NARO MORU
2. **LOCATION:** Central Province Nyeri District
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 III5-6; 50-65% at 16°C  
 4.2 LH4-5 UM2; volcanic footridge Phaeozems  
 4.3 1.80 ha; NA  
 4.4 NA; wheat, coffee, livestock
5. **STAFF:** Mechanics — 4 Plant operators — 13 Total — 56  
 (of whom 3 are casual)
6. **FACILITIES/BUILDINGS:**  
 None: Based at DAOs office, Land acquired for workshop.
7. **PHS OUTPUT (1982):** 6 km terraces, (bench) km roads, dams,  
 ha bush cleared, 19 water holes, 3 levelling, ditches
8. **THS OUTPUT (1982):** 867 ha ploughed, ha harrowed, ha planted,  
 bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed None (1981) (1982)
10. **TRANSPORT:** 2 Personnel vehicles, 1 Lorries, Lowloaders,  
 Tankers, Motorcycles
11. **SOIL & WATER CONSERVATION NEEDS:**  
 Water conservation needed
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              |              |                |             |
| 1981 |              |              |                |             |
| 1982 | 4            | 439          | 115,440        | 88,949      |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              | 1204         |                |             |
| 1982 | 8            | 3035         | 231,376        | 171,788     |

## STATION SUMMARY SHEET

1. **STATION NAME:** NYAHURURU
2. **LOCATION:** Central Province Nyandarua District  
(Serving Nyandarua and Laikipia Districts)
3. **VISITED?:** Yes
4. **LAND USE:** 4.1 II 5-6; 65-80 at 16°C  
4.2 UH2-3 UH3 volcanic footridge Phaeozems  
4.3 5.33 ha; 66km/km<sup>2</sup>  
4.4 23% 1.1; wheat, potatoes, pyrethrum
5. **STAFF:** Mechanics — Plant operators — Total — 67  
Grades not recorded in Annual Report
6. **FACILITIES/BUILDINGS:**  
Workshop facilities inadequate; no appropriate buildings; new office block construction remains incomplete. Site lacks service utilities (power/water).
7. **PHS OUTPUT (1982):** 7 km terraces, km roads, 2 dams, repaired  
19 ha bush cleared, 12 water holes, 29 levelling, ditches  
13 km grading, 4 silo pits constructed
8. **THS OUTPUT (1982):** 159 ha ploughed, 13 ha harrowed, 10 ha planted,  
bags shelled
9. **SURVEY SECTION OUTPUT:** ha surveyed 3,478 (1981) (1982)
10. **TRANSPORT:** 4 Personnel vehicles, 4 Lorries, 1 Lowloaders,  
Tankers, Motorcycles
11. **SOIL & WATER CONSERVATION NEEDS:** Yes
12. **PHS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              | 4,387        | 704,930        |             |
| 1981 | 6            | 2,306        | 594,270        |             |
| 1982 | 8            | 1,315        | 292,850        | 219,824     |
13. **THS UNITS: PRODUCTIVITY AND FINANCE**
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 | 11           | 571          |                |             |
| 1982 | 10           | 628          | 59,644         | 43,500      |
14. **SURVEY**
- |      |         |
|------|---------|
| 1982 | 217,840 |
|------|---------|

## STATION SUMMARY SHEET

1. STATION NAME: RUIRU
2. LOCATION: Central Province Kiambu District
3. VISITED?: Yes
4. LAND USE: 4.1 III 4-5; 50 - 65% at 18°C  
 4.2 LH2-3 UM 2-5; volcanic footridge phaeozems  
 4.3 1.13 ha; 157/km<sup>2</sup>  
 4.4 72%; 1.4; maize, beans, potatoes, coffee
5. STAFF: Mechanics - 2 Plant operators - 26 Total -
6. FACILITIES/BUILDINGS: Offices, Stores
7. PHS OUTPUT (1982): 29 km terraces, 66 km roads, dams,  
 23 ha bush cleared, water holes, 4 ha levelling, ditches
8. THS OUTPUT (1982): None ha ploughed, ha harrowed, ha planted,  
 bags shelled
9. SURVEY SECTION OUTPUT: ha surveyed (1981) (1982)  
 Not functioning
10. TRANSPORT: 4 Personnel vehicles, 3 Lorries, 1 Lowloaders,  
 1 Tankers, Motorcycles
11. SOIL & WATER CONSERVATION NEEDS:  
 Yes, terracing on steep slopes
12. PHS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1980 |              | 9,432        | 3,053,905      |             |
| 1981 |              | 6,043        | 1,820,140      |             |
| 1982 | 9            | 2,883        | 1,127,263      | 530,682     |
13. THS UNITS: PRODUCTIVITY AND FINANCE
- |      | No. of Units | Hours worked | Revenue earned | Expenditure |
|------|--------------|--------------|----------------|-------------|
| 1981 |              |              |                |             |
| 1982 |              |              |                |             |

APPENDIX I

Allocation of (Recurrent) Funds 1982/83 [R10]  
Cost Spread Sheet/Cost per Productive Hour

	GRAND TOTAL	HQ	CEN W'P	BUMALA 1	CHIAKARIGA 2	ELDORET 3	GARSEN 4	GARISSA 5	KAJIADO 6	KIPKELLION 7	KITALE 8	KITUI 9
HEAD COUNT	1450	10	68	97	97	69	39	15	33	60	82	59
E/MOVING PLANT	110	-	-	5	6	7	4	3	5	7	6	4
AGRIC. TRACTORS	189	-	-	24	10	10	10	6	11	10	-	-
(EK000)												
PHS ALLOCATIONS	98.5	975.3	4.2	0.4	4.6	8.0	0.4	0.2	8.4	8.0	7.5	5.1
PS EQUIP/TPT	178.2	(178.2)	(4.2)	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
PS EMOLUMENTS	603.9	(603.9)	-	35.5	35.5	25.2	14.3	5.5	12.1	21.9	59.9	43.1
DEPRECIATION	880.6	-	-	45.5	49.7	42.8	24.3	15.3	30.1	39.5	77.0	57.8
	2000.0	-	-	90.9	109.1	127.3	72.7	54.5	90.9	127.3	109.1	72.7
	2680.6			136.4	158.8	170.1	97.0	69.8	121.0	166.8	186.1	130.5
THS ALLOCATIONS	42.2	315.5	-	7.7	-	-	7.7	2.4	-	-	-	-
PS EQUIP/TPT	109.5	(109.5)	-	7.3	7.3	7.3	7.3	7.3	7.3	7.3	-	-
PS EMOLUMENTS	399.2	(399.2)	-	35.4	35.4	25.2	14.2	5.5	12.1	22.0	-	-
DEPRECIATION	550.9	-	-	50.4	42.7	32.5	29.2	15.2	19.4	29.3	-	-
	594.0	-	-	75.4	31.4	31.4	31.4	18.9	34.6	31.4	-	-
	1144.9			125.8	74.1	63.9	60.6	34.1	54.0	60.7	-	-
PHS HOURS	22326			1939	313	2790	328	4	170	1326	1768	1460
KSh/hr	2580			2626	10115	1219	5915	349000	14235	2516	2105	1788
THS HOURS	21498 (derived)			4131	1154	1229	686	38	877	249	-	-
KSh/hr	1065			609	1284	1040	1767	17947	1231	4876	-	-

MACHANGA 10	MAKUENI 11	MARIAKANI 12	MARIGAT 13	MIGORI 14	NAKURU 15	NAROK 16	NAROMORU 17	NYAHURURU 18	RUIRU 19
95	146	69	82	89	57	78	56	67	82
5	6	8	4	4	8	7	6	7	8
13	11	11	13	17	-	22	11	10	-
8.4 9.6 34.7	8.0 9.6 53.4	0.2 9.6 25.2	8.2 9.6 29.9	0.2 9.6 32.6	7.8 9.6 41.7	8.7 9.6 28.5	0.4 9.6 20.5	3.1 9.6 24.5	6.7 9.6 59.9
52.7 90.9 143.6	71.0 109.1 180.1	35.0 145.5 180.5	47.7 72.7 120.4	42.4 72.7 115.1	59.1 145.5 204.6	46.8 127.3 174.1	30.5 109.1 139.6	37.2 127.3 164.5	76.2 145.4 221.6
7.3 34.7	7.3 53.4	7.7 7.3 25.2	- 7.3 30.0	7.7 7.3 32.5	- - -	- 7.3 28.5	7.7 7.3 20.5	1.3 7.3 24.6	- - -
42.0 40.9 82.9	60.7 34.6 95.3	40.2 34.6 74.8	37.3 40.9 78.2	47.5 53.4 100.9	- - -	35.8 69.1 104.9	35.5 34.6 70.1	33.2 31.4 64.6	- - -
720 3989	1586 2271	1218 2964	479 5027	859 2680	1103 3710	2525 1379	439 6360	1315 2502	2883 1537
760 2182	382 4990	171 8749	1769 884	2648 762	- -	3740 561	3035 462	629 2054	- -

DATE	DESCRIPTION	AMOUNT	CHECK NO.	BANK	BALANCE	CHECK NO.	BANK	BALANCE	CHECK NO.	BANK	BALANCE
10/1	...	...	...	...	...	...	...	...	...	...	...
10/2	...	...	...	...	...	...	...	...	...	...	...
10/3	...	...	...	...	...	...	...	...	...	...	...
10/4	...	...	...	...	...	...	...	...	...	...	...
10/5	...	...	...	...	...	...	...	...	...	...	...
10/6	...	...	...	...	...	...	...	...	...	...	...
10/7	...	...	...	...	...	...	...	...	...	...	...
10/8	...	...	...	...	...	...	...	...	...	...	...
10/9	...	...	...	...	...	...	...	...	...	...	...
10/10	...	...	...	...	...	...	...	...	...	...	...
10/11	...	...	...	...	...	...	...	...	...	...	...
10/12	...	...	...	...	...	...	...	...	...	...	...
10/13	...	...	...	...	...	...	...	...	...	...	...
10/14	...	...	...	...	...	...	...	...	...	...	...
10/15	...	...	...	...	...	...	...	...	...	...	...
10/16	...	...	...	...	...	...	...	...	...	...	...
10/17	...	...	...	...	...	...	...	...	...	...	...
10/18	...	...	...	...	...	...	...	...	...	...	...
10/19	...	...	...	...	...	...	...	...	...	...	...
10/20	...	...	...	...	...	...	...	...	...	...	...
10/21	...	...	...	...	...	...	...	...	...	...	...
10/22	...	...	...	...	...	...	...	...	...	...	...
10/23	...	...	...	...	...	...	...	...	...	...	...
10/24	...	...	...	...	...	...	...	...	...	...	...
10/25	...	...	...	...	...	...	...	...	...	...	...
10/26	...	...	...	...	...	...	...	...	...	...	...
10/27	...	...	...	...	...	...	...	...	...	...	...
10/28	...	...	...	...	...	...	...	...	...	...	...
10/29	...	...	...	...	...	...	...	...	...	...	...
10/30	...	...	...	...	...	...	...	...	...	...	...
10/31	...	...	...	...	...	...	...	...	...	...	...

APPENDIX J

## SUMMARY OF CONSTRAINTS CONFRONTING THE AMSB AS PERCEIVED BY THE STAFF

- 1) Financial constraints
  - No clearly defined financial objectives
  - Financial control difficult as management and administration badly co-ordinated
  - No proper financial planning or budgeting of projected level of activities
  - Operating problems due to inadequate funds (fuel and spares shortages, low staff morale etc)
  - Payment procedures for purchased supplies too rigid and time consuming
  - Lack of cost control procedures
- 2) Personnel constraints
  - Lack of technical (engineering) and administrative training (operation and maintenance, layout and structure design, financial management, etc)
  - Low morale of staff due to lack of incentives and difficult working conditions
  - Loss of trained personnel to the private sector
- 3) Organisational constraints
  - Confusion as to proper chain of command
  - Structure too loose resulting in operational difficulties
  - Bureaucracy and outside interference
  - Lack of mobility of tractor fleet
  - Poor communications in the field and between mechanisation stations, CW, and HQ
  - Overmanning at some AMS
- 4) Physical constraints
  - Unsuitable or inappropriate plant and equipment
  - No standardisation of machinery makes
  - Lack of technical support facilities, especially maintenance and repair
  - Lack of administration and staff facilities (communications, power, water, work and residential buildings)
  - Inadequate dealer support available for some makes
  - Difficult working conditions for tractor cultivations (small parcels of land spread over wide areas, poorly prepared virgin lands, etc)
- 5) Socio-economic constraints
  - low profitability of the family farming sector
  - Farmers' apathy towards implementing soil conservation measures, especially in the family farming sector (new settlement, resettlement)
  - 100% deposits for work requested often not possible for FFS.



## APPENDIX K1

## MARSHALL 140 TRACTOR SPARES URGENTLY REQUIRED AS OF 1 MAY 1987

Item	Part Number	Description	Quantity	Unit Cost	Total
1	DGJ 1009	Dipstick	8		
2	1011516	Spring washer $\frac{3}{8}$ "	20		
3	1013201	Bolt $\frac{5}{8}$ " BSF	100		
4	1012905	Bolt $\frac{3}{8}$ " X 1"	20		
5	1013111	Bolt (flywheel)	100		
6	1013425	Set Screw $\frac{5}{8}$ "	30		
7	1017703	Nut $\frac{3}{8}$ " BSF	50		
8	1017705	Nut $\frac{1}{2}$ " BSF	50		
9	1017707	Nut $\frac{3}{4}$ " BSF	150		
10	1019802	Nut 2 B A	40		
11	1020511	Washer Copper	20		
12	1030000	Locking Wire	7 rolls		
13	1030209	Woodruf Key	6		
14	1031238	Lubricator	4		
15	1031366	Stud	10		
16	1031704	Jubilee Clip	10		
17	1031708	Jubilee Clip	10		
18	1032005	Tap Washer	20		
19	103207	Bolt	20		
20	1032621	'O' Ring	150		
21	1032645	'O' Ring	150		
22	1032667	'O' Ring	60		
23	1040218	Bearing	6		
24	1042914	Bearing	10		
25	10622853	Crankshaft	1		
26	10624894	Pipe No 1	2		
27	10624895	No 2	2		
28	10624896	No 3	2		
29	10624897	No 4	2		
30	10624898	No 5	2		
31	10624899	No 6	2		
32	108-55 TVS	Starter Switch	10		
33	1115629	Capscrew	30		
34	140002	Tip	100		
35	140003	Pin	100		
36	140004	Bush	100		
37	140005	Cyl Pack	8		

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Item	Part Number	Description	Quantity	Unit Cost	Total
38	140050	Nut 1½" UNF	10		
39	2010532	Roller	12		
40	2011508	Keep Plate	2		
41	2013069	Casing	2		
42	2013191	Nut	3		
43	2013194	Bolt	20		
44	2013475	Joint	16		
45	2013738	Cotter	10		
46	2013761	Track plate	50		
47	2015304	Bolt	18		
48	2016132	Clutch shaft	4		
49	2016653	Adj. socket	5		
50	2017748	Nut T.P.	600		
51	2019306	Housing	10		
52	2030102	Clutch engine	10		
53	2030703	Gauge W.T.	15		
54	2031287	Lub. pipe	8		
55	2031630	Piston	1		
56	2031633	Seal	30		
57	2031639	Sealing Ring	20		
58	2031660	Oil filter assem.	4		
59	2031724	Lining	20		
60	2031725	Lining	300		
61	2031727	Rivet	1500		
62	2031785	Bush	8		
63	2031973	Trunion	15		
64	2032196	Pipe	2		
65	2032589	Grill	2		
66	2032796	Jaw end	6		
67	2032870	Pivot pin	2		
68	2032893	Gasket	6		
69	2033067	Gasket	15		
70	2033195	Pipe Ex.	6		
71	2033523	Clutch D.M.	5		
72	2033705	Clutch shaft	6		
73	2033707	Housing Bug	4		
74	2033708	Coupling Flange	4		
75	2033716	Propeller shaft	9		
76	2033752	Spacing shaft	4		

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Item	Part Number	Description	Quantity	Unit Cost	Total
77	2033780	Yoke C.O.	4		
78	2034000	Clutch lever	2		
79	2034156	Dash plate	2		
80	2034630	Brake band	16		
81	2034965	Drain pipe	2		
82	2034971	Return pipe	2		
83	2034979	Housing	2		
84	2035028	Sprocket	4		
85	2035080	Bolt guard	4		
86	2035081	Bolt guard	4		
87	2035091	Clutch plate	24		
88	2035115	'O' Ring	10		
89	2035279	Back nut	4		
90	2035298	Brake plate	4		
91	2035558	Cam C.O.	4		
92	2035559	Cam C.O.	4		
93	2035579	Return pipe	5		
94	2035790	Friction disc	300		
95	2035932	Clutch housing	2		
97	2035980	Selector fork assem.	10		
98	2036073	Brake disc w/lining	10		
99	2036100	Gearbox complete	2		
100	2036119	Bolt T.P.	600		
101	2036169	Filter	4		
102	2036204	Cover	4		
103	2037175	Gear lever	2		
104	2037561	Change speed mech.	2		
105	2038362	Bracket	6		
106	2038364	Cross beam F.	1		
107	2038375	Idler	5		
108	2038719	Breather	5		
109	2039117	Carrier roller	6		
110	2039836	Silencer	3		
111	2130892	Air cleaner	3		
112	2131717	Pre cleaner	3		
113	2131398	Wiring harness	14		
114	2131538	Battery cable	6		
115	2150002	Track Assem 20" plate	4		
116	2161063	Master pin kit	10		

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Item	Part Number	Description	Quantity	Unit Cost	Total
117	227781	Bearing	4		
118	227783	Bearing	20		
119	227843	Washer	6		
120	227844	Washer	6		
121	227866	Con rod	6		
122	234009	Cap oil filler	4		
123	236795	Oil pump (incl. 10332937)	2		
124	240955	Elbow	2		
125	2514251	Pipe oil press.	6		
126	2581020	Cutting edge	10		
127	2584229	Plough bolt	400		
128	2584707	Plough bolt	800		
129	2584927	Side arm	2		
130	2585024	Corner cutting edge	20		
131	258250	Corner shoe L.H.	20		
132	2585251	Corner shoe R.H.	20		
133	2585368	Bolt	20		
134	2585369	Nut	20		
135	2585600	Adaptor	6		
136	2585016	Filter housing L.H.	1		
137	2585017	Filter housing R.H.	1		
138	2585603	Bolt	30		
139	2585868	Coupling	6		
140	2586895	Control valve	2		
141	2586937	Hydraulic tank	6		
142	2587466	Ram assem.	10		
143	2587077	Flexible hose	10		
144	2587076	Banjo bolt	10		
145	2587298	Locknut	6		
146	2587795	Flexible hose	10		
147	2591141	Pump	2		
148	2591706	Hyd. hose pipe	10		
149	2591652	Ram assem.	2		
150	2711241	Oil gauge	10		
151	2711711	Diesel engine coup.	1		
152	2714377	Stop control	4		
153	2715636	Pre-cleaner	4		
154	2715749	Oil Pump	3		
155	2715946	Flexible mounting	10		

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Item	Part Number	Description	Quantity	Unit Price	Total
156	2715981	Hose, bottom	40		
157	2716253	Flexible coupling	7		
158	2716573	Air cleaner	2		
159	2717428	Rod, fuel control	2		
160	2717429	Rod, stop control	6		
161	2717688	Radiator	6		
162	280843	Liner	36		
163	281325	Valve guide	48		
164	283718	Bearing	4		
165	BWL 30613-1	Fair lead sleeve	4		
166	304896	Drive fuel pump	1		
167	307989	Sump, top	1		
168	BW 30904	Spring	2		
169	311104	Bearing	15		
170	311884	Oil cooler	2		
171	314288/3	Counter	6		
172	321928	Fan	2		
173	325003	Water pump	3		
174	ABL 3673	Sump, bottom	2		
175	WAL 4654	Breather sub assem.	4		
176	541815	Sleeve	12		
177	604728	Cyl. head cover	2		
178	605402	Nozzle assem.	24		
179	608532	Valve inlet	24		
180	608533	Valve exhaust	24		
181	609791	Fuel filter	2		
182	610977	Bearing set	6		
183	611572	Bearing set	6		
184	612000	Piston e/w rings & pin	24		
185	613177	Oil filter assem.	2		
186	7111493	Cover, filter	4		
187	PD7210-23	Seal kit	10		
188	AAL8693	Cyl. head	4		
189	850277	Starter	8		
190	9002946	Driven plate	18		
191	9002974	Back plate complete	4		
192	9002975	Pressure plate assem.	4		
193	9002977	Bush	4 pairs		
194	9002981	Cam shaft	4		
195	9002987	Return spring	12		

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Item	Part Number	Description	Quantity	Unit Price	Total
196	9002989	Return stud	12		
197	9003105	Fan belt	40		
198	9005766	Filter element	50		
199	9006229	Oil Filter	200		
200	9007684	Element	200		
201	9006942	Fland washer	40		
202	9006944	Spring	8		
203	9006947	Gland packing	50		
204	9006948	Seal	120		
205	9006960	Piston rod	12		
206	9006962	Gland housing	20		
207	9006973	Fluid seal	100		
208	9007690	Primary element	10		
209	9007691	Safety element	10		
210	9007684	Fuel element	2		
211	9007720	Alternator	6		
212	9007696	Cup assem.	10		
213	9007698	Sealing kit	20		
214	9008077	Seal	20		
215	9008080	Seal	20		
216	9008081	Seal	20		
217	9008082	Seal	20		
218	9008180	Seal	20		
219	9008078	Seal	20		
220	9008079	Seal	20		
221	9450021	Clutch	5		
222	9450075	Final drive	6		
223	2039545	Driving axle	6		
224	9450032	Bush pin	20		
225	9450116	Idler wheel	6		
226	9580386	Package	10		
227	9902040452	Set screw	10		
228	9903040021	Nut	10		
229	9956040021	Nut	50		
230	9953140021	Nut $\frac{7}{8}$ " U.N.C.	1200		

## APPENDIX K2

## MINISTRY OF AGRICULTURE

Telephone: Nakuru 2863, & 2341  
When replying please quote

Ref. No. ....  
and date



LAND AND FARM MANAGEMENT  
DIVISION

A.M.S. CENTRAL WORKSHOP  
P.O. Box 470  
NAKURU

June....., 1983.

AVELING BARFORD MOTOR GRADER SPARES REQUIREMENTS

<u>ITEM</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>QTY.</u>
1 - 1	AZB 050	Elemnt	3
2 - 3	PLO 1066	Elemnt	2
3 - 10	CL 11551-3	Outer disc	4
4 - 11	CL 12074-2	Rivet	6
5 - 22	UCL 13-11553	Inner disc	4
6 - 29	139 p 32	'O' ring	1
7 - 30	139p 33	'O' ring	1
8 - 33	139 49	'O' ring	6
9 - 44	165-131/12-3	hose	1
10 - 59	240p 25 5/58	brass-rivets	12
11 - 64	250p 40	ball bearing	2
12 - 65	251p 30	" "	2
13 - 66	251 p 55	" "	2
14 - 69	251 p 45	" "	1
15 - 74	R 28795	Bowl glass	3
16 - 104A	PGH 454001	Outer axle	1
17 - 107	507PO	thermometer	1
18 - 129	6002-529	Yoke	2
19 -131	6151-0017	Package	2
20 - 132	MTQ 616013	gasket	2
21 - 133	MTT 616020	piston ring	2
22 - 134	MGT 616088	release bearing	1
23 - 137	PGT 618115	oil seal	4
24 - 139	SLH 621001	exhaust-silencer	1
25 -	PGT 626354	oil seal	4
26 142	MGT 628006	bearing	1
27- 144	MGT 628009	bearing	2
28 - 146	PGT 628201	oil seal	4
29 - 151	MGF 645019	Propeller shaft	2

30 - 153	MGT 650006	wiper ring	2
31 - 162A	MRH 650052A	half shaft	2
32 - 163	MTQ 650067B	chain wheel	1
33.-	MTH 650077	gear	1
34 -	MTH 650078	spur pinion & hub	1
35 - 165A	MTH 650093	axle stub shaft front	1
36 - 167	PGT 650149	hose	1
37 - 168	PGT 650166	stud	6
38 - 169	MTT 650109	oil seal	1
37 172	PGT 651103	gasket	4
39-	PGT 660104A	bolt	4
40 -179	PGT 660169	bearing hub gear	2
41 - 181	MGH 66023	spiral B.G.assembly	1
42 - 187	MGQ 696008	End bit	18
43 - 189	MGQ 696014	End bit R/H	15
44 - 191	PGT 696123	5/8 UNC bolt	401
45 192	MGT 696158	nut	397
46 -	PGQ 696165A	cutting bit	22
47 - 195	PGT 706118	20' ring	2
48 - 210	712p 45-337	hose	2
49 - 214	MGT 75212	cylinder washer	2
50 - 225	PGT 75410	chevron - seal	8
51 -	PGT 75413	felt wiper	1
52 - 230	PGQ 75414	wiper	3
53 - 234	PGQ 75612E	tooth point	6
54 - 237	MGQ 75814A	cup spreader	2
55 - 239	PGT 7585	chevron seal	8
56 - 241	PGHT 7587	felt wiper	2
57 - 246	MGT 759189	hose	2
58 - 247	MGT 759190	hose	6
59 - 261	MGT 760123	ball- bearing	1
60 - 262	MGT 760124	lay shaft bearing	1
61 - 263	MGT 760125A	ball bearing	2
63 - 273	MGQ 760 - 30	needle - roller	215
64 - 277	MGQ 760 35B	wahser	2
65 - 278	MGT 760-39B	thrust whsher	1
66 - 280	MGT 760-46	gasket	1
67 - 283	PGQ 760-56	snap ring	2
68 - 292	MGQ 760-73	linning	2
69 -	PGT 76126	gasket	1
70 - 307	MGQ 761045	snap ring	2

71 - 313	MGT 761104	ball bearing	3
72 - 321	MGT 761131	bearing	2
73 - 322	MGE 761132	bearing	2
74 -	MGT 761139	bearing	4
75 - <del>RMQ</del> 329	PGQ 762 31A/1	shim	2
76 - 330	PGQ 762 31A/2	shim	2
77 - 331	PGT <del>762112A</del> 762106A	gasket	4
78 -	PGT 762112A	bolt	16
79 - 332	PGQ 762 31A/3	shim	2
80 -	MGT 762178	oil seal	9
81 - 337	PGQ 762555	felt	2
82 - 338	PGQ 76238	oil seal	2
83 -	MGF 763115E	spiral berel gear	1
84 - 344	MGT 763128	chain	4
85 -	MEF 763133A	cap	2
86 -	MGQ 76310	gasket	1
87	MGH 763140	Hub R.H.	4
88 -	MGH 763141	hub L.H.	4
89 -	MGT 763142	washer	2
90 -	MGT 763153	stud	4
91 -	MGT 763162	bearing	2
93 - 353	MGT 76363A	stud	12
94 - 355	MGT 763158	bearing	1
95 - 363	PGT 768-7	spring	2
96 - 366	PGT 770-20A	seal	12
97 - 372	MGT 77258	radiator mounting	2
98 - 881p	870p 110A	element	4
99 - 382	91210317	wheel nut	6
100 - 383	920p 135	element	10
101 - 394	970p 110A	Element	4.

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AMS CENTRAL WORKSHOPS PO BOX 470 NAKURU  
 ADDITIONAL & REPLACEMENT TOOLS NECESSARY FOR REPAIR OF PLANT

	<u>Qty.</u>
1. Impact wrench 1" sq. drive	2
2. Nut splitter kit hydraulic	2
3. Steel rules 12"	30
4. Serviceman's tool kit (crawler tractor)	10
5. Flaring tool 3/16" - 3/4"	2
6. Bolt cutters	4
7. Chain hoist 3 ton hand operated	2
8. Sling mutiple 3 leg 1/2"x4ft HTS chain	4
9. -do- " " 3/8" x 3 ft HTS Chain	4
10. -do- 2 " 5/8" x 2 ft " "	4
11. -do- " " 1/2" x 6 ft " "	4
12. -do- " " 5/8" x 6 ft " "	4
13. Engine test bed-dynamometer 200 BHP	1
15. Powdered metal welding torch oxy/acet.	2
16. Heavy duty puller 3 leg	2
17. -do- 2 leg	2
18. Adjusting spanner 12"	3
19. Enginees vices 5"	6
20. Tools & holders for CSM 63 shaper	3 sets
21. Drill bits H.S. up to 1" or 25 mm	7 sets
22. 5 ton hydraulic jacks	2
23. Centre punch	10
24. Taps & dies BSF up to 1" dia	2 sets
25. -do- N.C. up to 1" dia	2 sets
26. -do- metric 25 mm dia	2 sets
27. Tyre pressure gauge & hose	2
28. Sledge hammer 3 kg.	4
29. Vernier calipers 0 - 450 mm	2
30. 12 c.f.m. air compessor	1
31. Towing ambulance	1
32. Battery tester	1
33. Blacksmith forge 3 phase supply for blower	1
34. Volume grease pump	3
35. hydraulic trolley jacks 15 tons	3
36. Letter and number stamps	2 sets
37. Ball-peam hammers 500 gm	6
38. Universal pliers	6
39. Hydraulic hand operated press	2

40. Hacksaw frames (pistol grip)	10
41. Hydraulic jacks 10 tons	4
42. Feeler gauges (metric and british combined)	6 each
43. claw hammers	4
44. Nail pinches	6
45. Stud screw drivers	2
46. Blacksmith hammers	2
47. Pull push tapes-metric & british 3 metres	6
48. Electric soldering kits	2
49. foot pumps (heavy duty)	4
50. Industrial markers- for all surfaces	1

### RAW MATERIALS FOR WORKSHOP MACHINES

(six lengths for each size)

#### 1. Round bars:-

- (a) Mild steel :-  $\frac{1}{2}$ " to 3"
- (b) Brass bars:- sizes from  $\frac{1}{2}$ " to 3"
- (c) Aluminium bars:- sizes fro  $\frac{1}{2}$ " to 3".

#### Hexagonal bars:-

For mild steel, brass and aluminium as above.

#### 3. Flat bars:-

For mild steel, brass and aluminium :-

- (a)  $\frac{3}{8}$ " x 1";  $\frac{1}{2}$ " x 1";  $\frac{3}{4}$ " x 1"; 1" x 1".
  - (b)  $\frac{3}{8}$ " x  $1\frac{1}{2}$ ";  $\frac{1}{2}$  x  $1\frac{1}{2}$ ";  $\frac{3}{4}$  x  $1\frac{1}{2}$ "; 1 x  $1\frac{1}{2}$ ".
  - (c)  $\frac{1}{2}$  x 2";  $\frac{3}{4}$  x 2"; 1 x 2";  $1\frac{1}{2}$  x 2"; 2 x 2".
  - (d) 3" x  $\frac{3}{8}$ "; x  $\frac{1}{2}$ "; x  $\frac{3}{4}$ "; x 1";  $1\frac{1}{2}$ "; x 2".
  - (e) 4" x  $\frac{3}{8}$ "; x  $\frac{1}{2}$ "; x  $\frac{3}{4}$ "; x 1"; x  $1\frac{1}{2}$ "; x 2".
- ( all measurments in inches)

#### 4. Cast steel round bars:-

sizes :-  $\frac{1}{2}$ "; 1";  $1\frac{1}{2}$ "; 2";  $2\frac{1}{2}$ "; 3".

.....

10	Hand saw (12 inch)	10
5	Wrenches (12 inch)	5
5 each	Level gauges (metric and British combined)	5 each
4	Claw hammer	4
6	1-1/2 inch	6
2	Stud screw driver	2
2	Blacksmith hammers	2
2	Ball punch (3/8 inch) & British 2 screw	2
2	Electric soldering iron	2
4	Foot pump (heavy duty)	4
1	Industrial saws - 10 inch	1

HOW TO USE THE MACHINES

(1) Instructions for each item

1. Round bars

- (a) Mild steel - 1/2" to 3"
- (b) Brass bars - also from 1/2" to 3"
- (c) Aluminium bars - also from 1/2" to 3"

Hexagonal bars

For mild steel, brass and aluminium see above

1. Flat bars

For mild steel, brass and aluminium:-

- (a) 1/2" x 1/2" x 1/2" to 1" x 1"
  - (b) 1/2" x 1/2" x 1/2" to 1" x 1"
  - (c) 1/2" x 1/2" x 1/2" to 1" x 1"
  - (d) 1/2" x 1/2" x 1/2" to 1" x 1"
  - (e) 1/2" x 1/2" x 1/2" to 1" x 1"
- (All measurements in inches)

2. Flat steel round bars

also:- 1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3"

APPENDIX L - EARTH DAMSPROJECT DEVELOPMENT PROCEDURE AND ASSESSMENT OF DESIGN1. BACKGROUND

The comments given below are generally based on procedures at Ruiru AMS, being the most active station, but the procedures are equally applicable to Nakuru and Eldoret unless particularly mentioned otherwise. Several designs, 2 completed dams and one dam under construction were seen at Ruiru, several designs and one completed dam were seen at Nakuru, and one design and one "completed" dam were seen at Eldoret (the crest had not been levelled on the Karo dam). None were seen at Mariakani.

The principal characteristics of several of the dams, extracted from the designs, are listed in Table L.

2. PROJECT DEVELOPMENT

2.1 Origins of Projects - Requests by local farmers, usually large estates, may be joint project of 2 estates.

2.2 Site Location - Determined essentially by estate:

There may be other dams on the river, either upstream or downstream.

2.3 Sizing of Reservoir - None on hydrological basis. Farmers may indicate area to be supplied, but no area demand figures are usually available, and a hydrological study is not carried out. The available yield has to be found out in practice by the owner, accepting the reservoir created by the dam sized from other considerations.

2.4 Sizing of Dam - 35 feet (10.7 m) high is the maximum wall height that AMSB are allowed, to build, by legislation. The maximum size is always provided, unless there are constraints from topography, camps, or level of coffee plantations etc.

2.5 Investigations - Site and reservoir area surveys, to determine

TABLE L Summary of Dam Characteristics

Dam	Station	Design Date	Catchment Area (km <sup>2</sup> )	Spillway Design Flood (m <sup>3</sup> /s)	Reservoir Capacity (10 <sup>3</sup> m <sup>3</sup> )	Embankment				
						Maximum Height (m)	Freeboard (m)	Upstream Slope	Downstream Slope	Fill Volume (m <sup>3</sup> )
Gitindiri Koorali	Ruiru	1975 (1977)	2.24	25.5	410	9.3	1.52	3:1	2:1	32,000
	Ruiru		3.23	34.0	187	6.5	?	3:1	2:1	27,700
Mirui Sirikwa Keldo	Nakuru	(1976) 1980 Not Constructed	3.50	27.2	6	10.4	1.22	3:1	2:1	3,000
	Nakuru		4.20	28.2	69	7.3	1.22	3:1	2:1	10,700
	Nakuru		3.72	22.7	54	9.1	1.52	3:1	2:1	7,700
Kibuswa	Eldoret	1979	11.80	38.2	73	9.4	1.83	3:1	2:1	?

Source: AMSB

basic quantities.

- Trial pits are put down along the dam centre line to determine depth to sound rock, none in borrow areas, or in upstream or downstream shoulder foundation areas; no records of overlying materials are kept.

2.6 Embankment Design - Appears to be based on a single old 'type' design, with no new designs carried out.

- Embankment slopes are based on nominal values for a sandy-clay fill material.

- A sloping sided or vertical sided cut off trench is provided down to sound rock or other impervious layer.

- Toe drains provided are generally of undefined rockfill, without a filter layer: one design has a "graded" rock drain (Koorali dam - see Figure L1), another has a short blanket drain as well (Gitindiri dam, Figure L2). Some other designs have no drains shown, but they are said to be provided in practice.

- There is no upstream slope protection, apart from grassing above retention level; the only exception was Karo dam, Eldoret, with hand-dumped rocks on upstream and downstream slopes.

- A 0.3 m settlement allowance on the crest profile is included at the centre of the dam; some designs indicate a corresponding change of shoulder slopes, others show the allowance only on the crest itself. A 0.6 m allowance was made by Nakuru station if compaction was by scrapers only, and felt to be poor.

2.7 Draw-Off Works - Steel pipes are used, with concrete collars at every joint. The intake is usually an upstanding perforated pipe, otherwise the pipe is open ended (one dam seen had an inaccessible upstream valve). A downstream guard valve is provided.

2.8 Spillway Design Flood - Floods are taken from a nomograph, developed in 1962 from USDA: Farmers Bulletin Nr. 1859. The nominal return period is taken to be 25 years. Derived floods vary from 6.25 to 11.4 cu.m/s/sq.km.

2.9 Spillway Type - Wide, shallow channels are used, at low gradients, with or without a small control weir at the high point. The downstream channel discharges some distance downstream of the dam,

MINISTRY OF AGRICULTURE
LAND & FARM MANAGEMENT DIVISION RUIRU
<b>KOORALI DAM</b> SCALE 1:600
KOORALI ESTATE LTD. (L.R. No 10865) P.O. BOX 270 THIKA

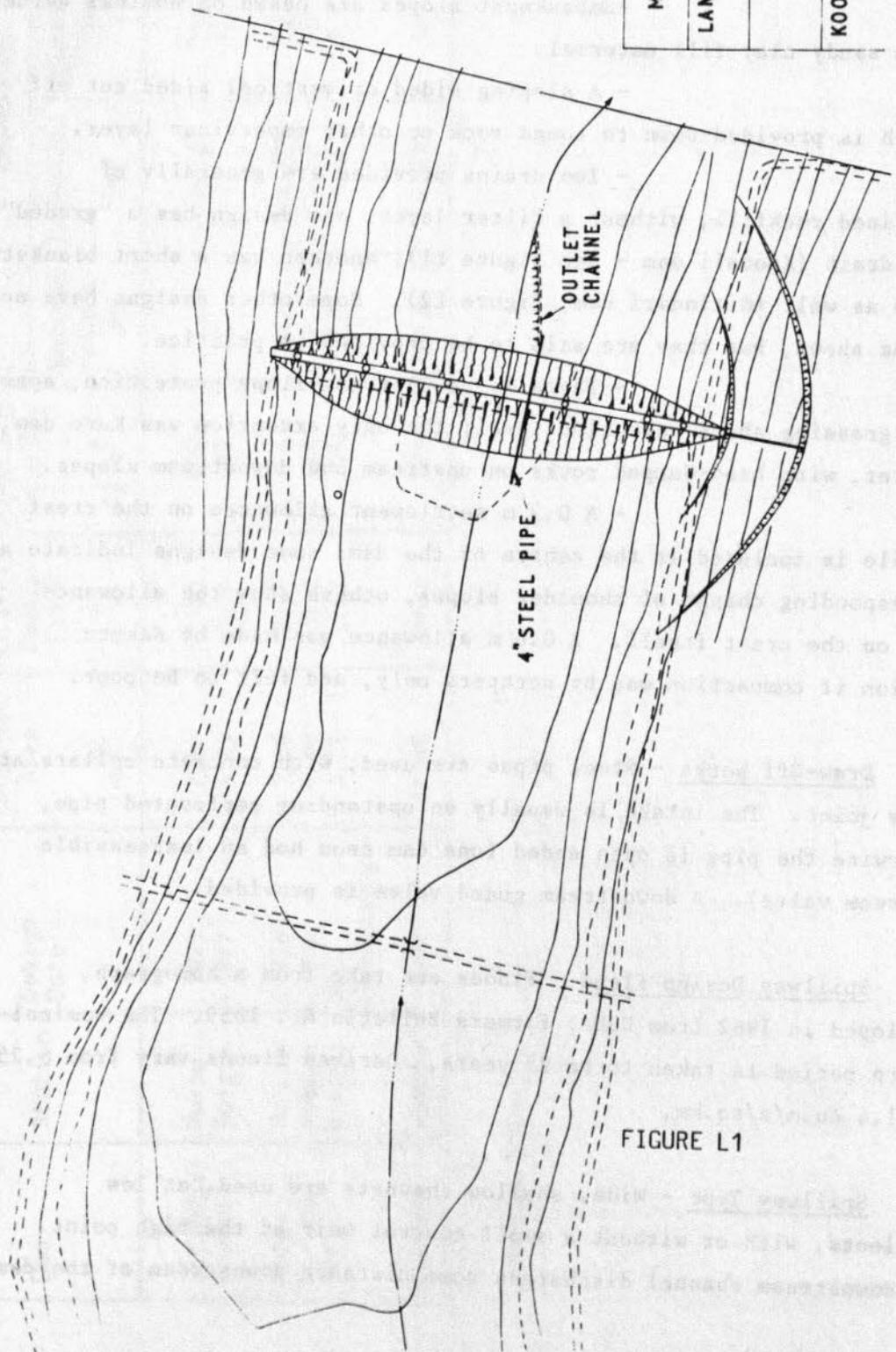


FIGURE L1

MINISTRY OF AGRICULTURE
LAND & FARM MANAGEMENT DIVISION RUIRU
<b>GITINDIRI DAM</b> SCALE 1:1,200 M.
RUERA ESTATE LR. 11285 P.O. BOX 46 RUIRU

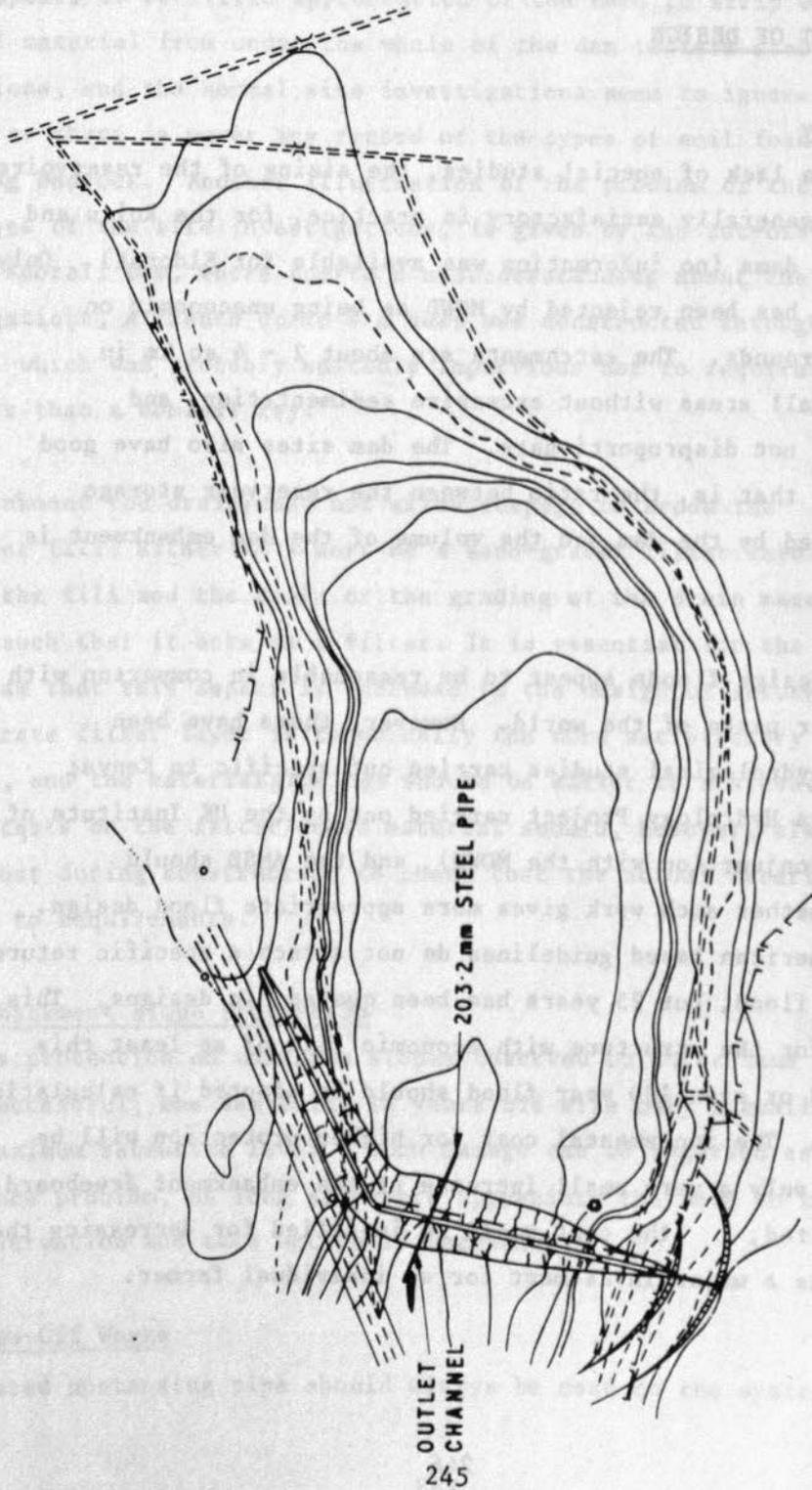


FIGURE L2

usually part way up the valley side. If the channel is not mainly in rock, weirs/cascades are theoretically provided to minimise the effective slope of the channel.

2.10 Freeboard - The spillways are designed for 0.6 - 0.9 m head over the control point. Wave freeboard is an additional 0.6 m.

2.11 Checking Procedure - All dams by law have to be approved by the Ministry of Water Development, before construction.

### 3. ASSESSMENT OF DESIGN

#### 3.1 Hydrology

In spite of the lack of special studies, the sizing of the reservoirs appears to be generally satisfactory in practice, for the Ruiru and Nakuru station dams (no information was available for Eldoret). Only one recent dam has been rejected by MOWD as being uneconomic on hydrological grounds. The catchments are about 2 - 4 sq km in moderate rainfall areas without excessive sedimentation, and evaporation is not disproportionate. The dam sites also have good efficiencies - that is, the ratio between the reservoir storage capacity created by the dam and the volume of the dam embankment is high.

The spillway design floods appear to be reasonable in comparison with floods in other parts of the world. However, there have been considerable hydrological studies carried out specific to Kenya; (e.g. the Kenya Hydrology Project carried out by the UK Institute of Hydrology in conjunction with the MOWD), and the AMSB should investigate whether such work gives more appropriate flood design. The present American based guidelines do not attach a specific return period to the flood, but 25 years has been quoted, in designs. This is too short for the structure with economic life of at least this time, and a 50 or even 100 year flood should be adopted if calculation methods allow. The incremental cost for higher protection will be very small as only a very small increase of the embankment freeboard would be required, the cost would be justified for decreasing the risk to what is a major investment for an individual farmer.

### 3.2 Embankment and Foundation Materials

The nominal embankment slopes adopted have performed satisfactorily, although normally no material testing was carried out during design. However, the slopes are based on the use of clayey sand material on stable foundations. It is doubtful if the actual material always has the correct grading and grading tests should be carried out for more of the designs.

There appears to be little appreciation of the need to strip weak alluvial material from under the whole of the dam to form stable foundations, and the normal site investigations seem to ignore this problem as there is never any record of the types of soil found overlying bedrock. Another illustration of the problem of the objectives of the site investigations, is given by the cut-off trench for the Koorali Dam, where due to a misunderstanding about the site investigations, a trench up to 8 m deep was constructed through material which was probably suitably impervious not to require any cut off other than a nominal key.

The embankment toe drains must not allow seepage to erode the embankment fill. Either there must be a sand-gravel filter layer between the fill and the drain or the grading of the drain material must be such that it acts as a filter. It is essential for the safety of the dam that this aspect is included in the design of future dams. The separate filter layer is technically the more satisfactory solution, and the material gradings should be easier to achieve. Grading tests on the filter/drain material should, however, always be carried out during construction to check that the actual material conforms to requirements.

### 3.3 Embankment Slope Protection

The grass protection on upstream slopes observed on three dams was fairly successful, one dam being 10 years old with only a small bench cut at maximum retention level. Such damage can be regarded as a maintenance problem, as long as owners appreciate the need to keep it under observation and take action if necessary.

### 3.4 Draw-Off Works

A perforated upstanding pipe should always be used on the upstream end

of the draw-off pipe, to allow relatively clean water to be drawn off from the above silt level as the silt builds up over the years.

### 3.5 Spillway Layout

The normal spillway design effectively assumes that bedrock is at a shallow depth at the downstream end of the discharge channel, so that little damage is caused by flood flows eroding overburden until a stable channel is formed. This assumption is not always justified, as severe gulleying was observed downstream of one dam near Ruiru.

Catastrophic erosion of the side of the gorge was observed at another dam (Mirui dam, Nakuru), where the end of the channel had cut back approximately 15 m from the gorge edge in 5 years leaving less than 25 m until the spillway control point is reached.

Greater use must be made of properly protected cascades such as at Karo dam, Eldoret, to bring the discharge channels nearer to river bed level. In extreme situations such as Mirui, the AMSB must ensure that adequate discharge structures are constructed, bringing in specialised dam engineers if necessary to design the structure.

The recommended establishment of a professional Survey and Planning Unit (SPU) within AMSB should equip the PHS to effectively deal with these problems in the future (see Section 4.1 and 4.6 in the main report).

APPENDIX M PLANT OUTPUT COMPARISONS

A: SCRAPER OPERATION (KOORALI DAM, RUIRU)

Earth moving by scraper Terex TS 14B : (2 x 144 hp engines).

Travel times based on Cat. 621B (1 x 330 hp engine).

1 Basic Data:

Layout:	Grade	10%	0%	0%
	Length	30m	170m	80m
	Section	A:Cut	B:Haul	C:Fill
From tables:		RR= 10% Effective Grade	RR= 75% Effective Grade	RR= 10% (Fill) = 5% (Return)
Material:		Sandy, clay, damp.		
Bank Density:		1.4 tonne/m <sup>3</sup> .		
Load Factor:		0.8		
Shrinkage Factor:		0.85		
Altitude:		1700m		

2 Total Effective Grade: (Rolling Resistance and Grade):-

A :	10% RR	-	10% GR	=	0
B :	7.5%	+	0%	=	7.5%
C :	10%	+	0%	=	10%

Return

A :	10%	+	10%	=	20%
B :	7.5%	+	0%	=	7.5%
C :	5%	+	0%	=	5%

3 Derate for Altitude: Cat. 927B - 93% 1500-2300 m.

4 Travel times from curves for Cat. 621

Haul:	A	0.15 minutes
	B	0.70 minutes
	C	0.47 minutes
		<hr/>
		1.32 minutes

Return: A 0.20 minutes  
 B 0.50 minutes  
 C 0.28 minutes  
 0.98 minutes

Total travel time =  $1.32 + 0.98 = 2.30$  minutes

Adjust for altitude =  $\frac{2.30}{0.93} = 2.47$  minutes

5 Fixed times: say loading equivalent to manoeuvring and loading for 627B/PP plus 0.2 minutes.

Load = 1.0 minutes  
 Spread = 0.7 minutes  
 1.7 minutes

6 Total time =  $2.47 + 1.70 = 4.17$  minutes

Actual cycle time measured = 5.10 minutes (average of 6)

#### Remarks

The discrepancy from the theoretical time can be accounted for by poor state of haul road and difficulty on manoeuvring to start loading, in cramped borrow area.

## B: WATER HOLE CONSTRUCTION

International Harvester TD 20E (215 hp).

Taken to be equivalent to Cat. D7G (200 hp).

Overall construction time reported to be 30 hrs: assumed 1/3 dozing; 1/3 compaction; 1/3 trimming, shaping, clearing. Volume of material moved estimated to be 800 m<sup>3</sup>.

### 1 Basic Data:

Material: "Black cotton" soil - very sticky if wet; loose, non-cohesive if dried; hard to drift.

Average distance dozed = 30m - 35m

Average grade = 0%

Average material weight = 1200 kg/m<sup>3</sup>

Operator: - average.

Job efficiency = 50 min/hr.

### 2 Basic Capacity:

From curves for D7 with S - blade:-

Basic production = 400 m<sup>3</sup>/hr loose.

### 3 Correction factors:

Hard-to-drift material	= 0.80
Average Operator	= 0.75
Angle Blade	= 0.60 (0.5-0.75)
Job Efficiency	= 0.84
Overall correction factor	= 0.30

### 4 Production:

Production = 400 x 0.30 = 120 m<sup>3</sup>/hr loose

Compacted density = 1,600 kg/m<sup>3</sup>

∴ Compacted production = 90m<sup>3</sup>/hr (75-110m<sup>3</sup>/hr)

Estimated actual production = 800 m<sup>3</sup> in 10 hrs.

= 80 m<sup>3</sup>/hr.

## C: BUSH CLEARING (KISSIMA ESTATE, NAKURU)

Bush Clearing by Avelling Marshall AM140 (141 hp) with angle blade.

Production times based on Cat. D6D (140 hp).

- Conditions:
- Occasional trees about 400 mm diameter, say 40 metre  
centres = 7 nr/ha.
  - Bush very light, no heavy vines.
  - Gradient low, but greater than 10%.

1 Clearing:- Production of 140 hp tractor with  
Rome KG blade.

$$\text{- Time} = X (AB + M, N,) X^1$$

From Tables:- Basic time:	B = 100 minutes/ha.
Density Factor:	X = 0.7 (light bush)
Vines Factor:	A = 1 (no vines)
Grubbing in one operation:	$X^1 = 1.25$
Nr. of trees:	N, = 7 nr/ha
Time per tree:	M, = 0.8 minute

$$\therefore \text{Time } T = 92 \text{ minutes/ha}$$

Correction Factors:-

Grade:	steep, loose footing
Blade:	angle blade rate fair, KG blade rated excellent

Allow overall factor of say 1.5 (own estimate).

Total time for  
clearing: 140 minutes/ha.

2 Piling: Production of 140 hp tractor with raking tool, piling in windrows  
at about 60 m spacing: - Time  $T = B + M, N, .$

From Tables:- Basic time:	B = 185 minutes
Time per tree:	M, = 0.6 minute
Nr of trees:	N, = 7 minutes
Very light bush:	$B^1 = 0.7B$

$$\therefore \text{Time: } T = 135 \text{ minutes/ha.}$$

Correction Factor:

Same constraints apply as for clearing and adopt same factor for 1.5.

Total Time for Piling:

200 minutes/ha3 Total times:

Total time for clearing and piling in windrows

= 140 + 200 minutes/ha.

= 5.7 hrs/haActual time = 4 hrs/haRemarks

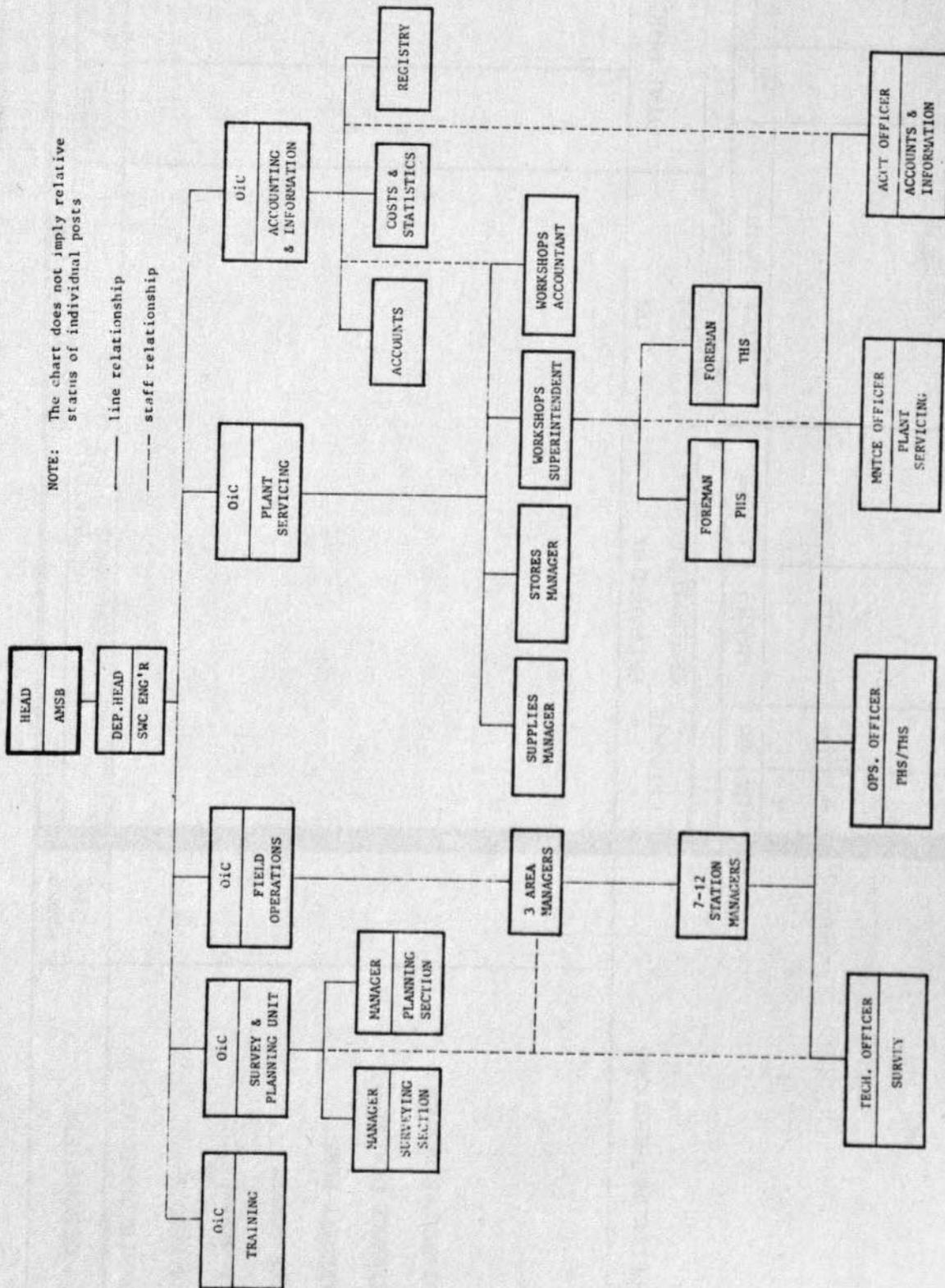
The use of the correction factor for the angle blade appears unjustified in the example examined, but clearance rates of 10-25 hrs/ha were quoted by another station in what were probably much more difficult ground and bush density conditions.

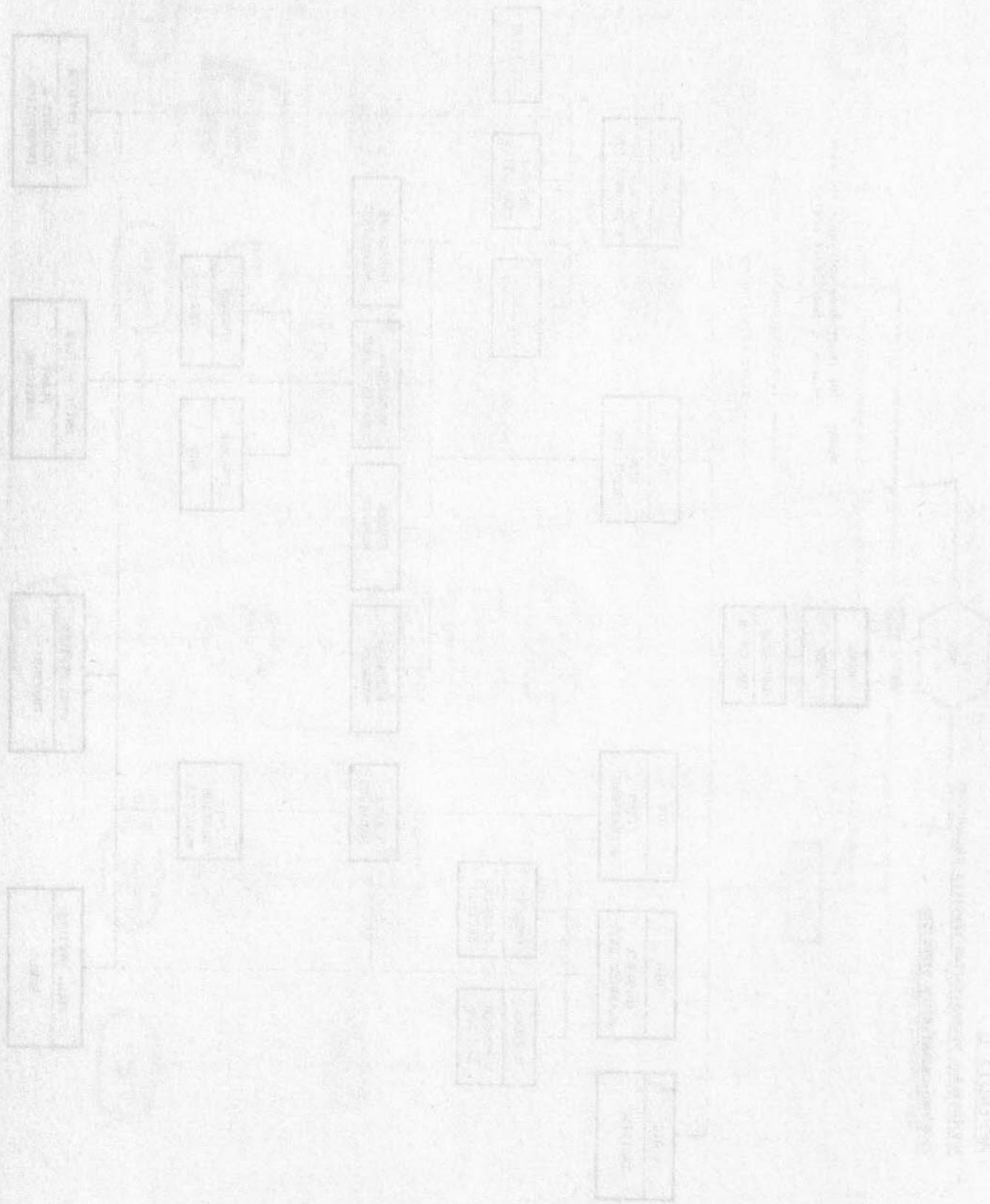


APPENDIX 0

AGRICULTURAL MECHANISATION SERVICES BRANCH (A.M.S.B.)

PROPOSED ORGANISATION STRUCTURE







# APPLICATION for AGRICULTURAL MECHANISATION SERVICE

DATE	
------	--

<b>B Plant Hire Service</b>
-----------------------------

NAME	DISTRICT	FARM NO.
------	----------	----------

APPLICATION NO.	
-----------------	--

		OFFICIAL USE ONLY				
TASK	DESCRIPTION	Approx. Size	ESTIMATE DATA (DRAWINGS TO BE ATTACHED)	WORK HOURS	RATE (KSh/HR)	PRICE (KShs)
01	DAM CONSTRUCTION					
02	WATERHOLE CONSTRUCTION					
03	TERRACING CONTOUR					
04	TERRACING FLAT					
05	CUT-OFF DRAINS					
06	BUSH CLEARING & RIPPING					
07	LAND LEVELLING					
08	ACCESS ROAD CONSTRUCTION					
09	FIREBREAK CONSTRUCTION					
10						

ESTIMATE	PREPARED BY	ON
	CHECKED BY	ON
<b>TOTAL PRICE:</b>		

		EQUIPMENT SCHEDULE						
ITEM	GK	MAKE	SIZE	ATTACHMENTS	FUEL L/HR	L	ON	OFF
1								
2								
3								
4								
5								

**SPECIAL INSTRUCTIONS**

# APPLICATION for AGRICULTURAL MECHANISATION SERVICE

DATE	
------	--

APPLICATION NO.	
-----------------	--

NAME	DISTRICT	FARM NO.
------	----------	----------

<b>C Tractor Hire Service</b>
-------------------------------

		OFFICIAL USE ONLY				
TASK	DESCRIPTION	ESTIMATE DATA (DRAWINGS TO BE ATTACHED)	WORK HOURS	RATE (KSh/HR)	PRICE (KShs)	
01	NEW LAND PLOUGHING					
02	OLD LAND PLOUGHING					
03	HARROWING					
04	PLANTING					
05	SHELLING					
06						
07						
08						
09						
10						
SPECIAL INSTRUCTIONS						
		ESTIMATE	PREPARED BY	ON	TOTAL PRICE:	
		CHECKED BY		ON		
EQUIPMENT SCHEDULE						
ITEM	GK	MAKE	SIZE	ATTACHMENTS	FUEL L/HR	SITE ON OFF
1						
2						
3						
4						
5						

## CONDITIONS AND CHARGES

(TO BE ATTACHED TO EACH AAMS FORM)

I <u>HIRE RATES:</u>	<i>Charge per hour K.Sh.</i>
<u>(a) Constructional machinery</u>	
1. Cat D8 new model and Terex Scraper (TS 14) ... ..	740
2. Cat D8 old model and Cat D7 new model including TD 20E (I.H.) ... ..	560
3. Cat D7 old model, Cat D613 shovel, D6C new model, including TD 15 (I.H.) ... ..	520
4. Cat D6 old model, A.M. 140 HP, Michigan dozer 180, Cat 14 M/G and Champion 14 M/G, MF 600C. ... ..	400
5. Cat 12 M/G and Champion 12 M/G Track Marshall Model 25, MF 500B ... ..	300
6. Track Marshall 56 ... ..	210
7. Cat D4, TD dozer, Bucket Loader 955, and B/Loader 175 ... ..	200
<u>(b) Agricultural machinery</u>	
1. Agricultural machinery 101 HP and above ... ..	190
2. " " 81 to 100 HP ... ..	170
3. " " 61 to 80 HP ... ..	140
4. " " 41 to 61 HP ... ..	110
5. " " Below 40 HP ... ..	100
6. Vibrating roller 10 T ... ..	125
7. " " 15 T ... ..	160

	<i>Charge per hectare *</i>
1st ploughing (new land) per hectare ... ..	520
1st ploughing (old land) per hectare ... ..	400
2nd ploughing (old or new land) per hectare ... ..	300
1st harrowing per hectare ... ..	230
2nd harrowing per hectare ... ..	170
Planting per hectare ... ..	130
Combine harvesting per hectare ... ..	300
Shelling ... ..	2.50 per bag

Transport for agricultural machineries with trailers, etc., will be charged on per hour basis according to the tractor HP.

II <u>OTHER TRANSPORT RATES:</u>	<i>K.Sh.</i>
Lowloader (Transporter) ... ..	70 per Km.
5 to 7 tonner lorry ... ..	10 per Km.
Land-Rover ... ..	5 per Km.
Small vehicles below 1500 cc ... ..	3 per Km.

\* These are given as guidelines only and are subject to land condition and measurement.

### III SURVEY CHARGES:

	<i>K.Sh.</i>
1. Dam Survey and design ... ..	6,000
2. Perimeter Survey for hectarage or boundary determination ...	25 per hectare
3. Detailed Survey with contours ... ..	50 per hectare
4. Farm Survey and Layout or plan ... ..	70 per hectare

### IV HIRE OF PERSONNEL:

1. Professional staff K.Sh. 120 per day or part of the day.
2. Technical officer K.Sh. 100 per day or part of the day.
3. Technical Assistants K.Sh. 70 per day or part of the day.
4. Technicians such as plant operators, mechanics, artisans, etc. K.Sh. 50 per day or part of the day.
5. Subordinate Staff K.Sh. 25 per day or part of the day.

### V CONDITIONS OF WORK:

1. All jobs applied for and started on or after 1st April, 1982 will be charged on the specific rates outlined above.
2. The applicant should complete, sign, and submit this application form to the officer in charge of the nearest Agricultural Office at least three (3) months prior to the commencement of his job.
3. A 50 per cent deposit is payable before commencement of all jobs estimated in excess of K.Sh. 20,000. Such a deposit should not be less than K.Sh. 20,000.
4. All other jobs estimated at K.Sh. 20,000 or less shall be paid in advance before the commencement of the job.
5. The total payment of the work is required upon completion of the job, and any outstanding bills will develop an interest of 1 per cent per month, one month after the date of the invoice. No work will be undertaken before the application forms are completed, signed, and the necessary payments made.
6. For survey services, only one copy of the map will be given to the farmer, and any extra copies will be sold to him at K.Sh. 100 per copy.
7. The Government machineries, equipment and transport, shall not be hired to the private contractors, unless a prior permission is granted in writing by the Director of Agriculture himself.
8. Where the machinery services rendered are classified conservational, or drainage, the Ministry of Agriculture will give a 50 per cent subsidy to the applicant if his farm is planned or has a soil conservation layout.
9. No subsidies are given to the Government Ministries, departments or corporations.
10. The water conservation subsidy for structures designed or approved by the Ministry of Water Development is given at 40 per cent for all areas with less than 500 mm. of rainfall, and 25 per cent for all other areas.
11. If the applicant is not pleased with the type of services rendered, he is free to instruct the withdrawal of the service.
12. The applicant, however, should sign a certificate of work done for any services rendered to him during the withdrawal of the services or at completion of the job.

## APPENDIX P4 & P5

### THE DESIGN OF FORMS FOR TIME RECORDING

In this Appendix there are various points and notes relating to the design of forms for data recording systems recommended for the plant or tractor hire schemes. The system is based on that developed by Johnson and Metianu at OD/NIAE.

There are five main points on which the system given as an example, has been based.

- 1) "Filling In" forms in a left to right direction along rows and working sequentially down the form.
- 2) "Totalling Up" performed vertically down columns.
- 3) "Transferring Data" from one sheet to another kept as simple as possible to reduce errors caused by the transference of data. This can often be achieved by placing the 'Total' row as close to the lower edge of the form as possible.
- 4) Asking for the minimum amount of data. This helps to simplify the form.
- 5) Placing the most important data and results in a prominent position on the form to make sorting and checking easier.

For the data recording system given, these five points and others are given below.

#### Machine Week Log Sheet (Appendix P4)

This is a multiple form requiring the operator or field manager to keep an account of the work of the machine, problems with the machine and the amount of fuel and other consumables (cultivator points, baler twine, tyres, etc) used. His immediate supervisor is responsible for the actual cost of the 'other consumables' as well as totalling the hours and providing a breakdown into groups of the DOWNTIME and WORK.

The log sheets can be sorted easily by machine number and also by operator. Normally the cards will be filed in chronological order so that 'Week Ending' is of less importance.

The totals are the very last row on the sheet to facilitate accurate transferenceto the next form in the system. The columns on the two forms will align for this purpose. An extra line for % Time and Work Rates is provided in case the need arises to provide this information.

Unit Quarterly Summary Sheet (Appendix P5)

This follows on from the Machine Week Log Sheet, the details being directly transferred from the bottom TOTALS row of that sheet. Further columns are provided on this sheet for a more comprehensive breakdown of the work undertaken by the machine.

Again the TOTALS row is on the bottom of the sheet to help with transferring data to another sheet, eg AREA WEEKLY - SUMMARY (an example of which is not given but it is basically the same).

# MACHINE WEEK LOG SHEET

MACHINE TYPE	
REG. NO.	
OPERATOR	
SUPERVISOR	

STATION: \_\_\_\_\_  
 WEEK ENDING: \_\_\_\_\_  
 (OR WEEK No.) \_\_\_\_\_

Signed: \_\_\_\_\_ OPERATOR  
 \_\_\_\_\_ SUPERVISOR  
 \_\_\_\_\_ STATION MANAGER

Checked: \_\_\_\_\_

DAY/DATE (DAY No.)	JOB NUMBER & NAME OF FARMER	HOUR METER		HOURS (h)							CONSUMABLES			COMMENTS	Work Area Com- -plete			
		READING	NET h	PROD. h	SHIFT h	NO WORK	WEATHER	MOVING	NO FUEL	DOWNTIME (h)			FUEL (litre)			OIL (litre)	OTHER	
										FIELD	STN	C.W.						
MON																		
TUE																		
WED																		
THU																		
FRI																		
SAT																		
SUN																		
		Percentages		100														
		TOTALS																

# QUARTERLY SUMMARY

STATION:

QUARTER, 19 / /

13 WEEKS TO / /

MACHINE	
TYPE	
REG. NO.	

WEEK ENDING	NOMINAL		HOURS (h)										CONSUMABLES			WORK ANALYSIS					
	PROD.	TOTAL	NO WORK	WEATHER	MOVE	DOWNTIME (h)			NO FUEL	F. REP	S. REP	C. W.	FUEL (litre)	OILS (litre)	OTHER	TYPE	HOURS	FUEL l/h	AREA ha/h	REMARKS	
						NO FUEL	F. REP	S. REP													
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
Percentages																					100
TOTALS																					

<b>Job Number</b>	<b>Mechanics Name</b>	<b>Machine Ref</b>
<b>Date Started</b>	<b>Machine Make / Model</b>	<b>Year</b>
<b>Hourmeter Reading</b>	<b>Machine Number</b>	<b>Engine Number</b>

Item	Work	Author ized	Comp leted	Ch'ked	Time start	Time finish	Total time
1							
2							
3							
4							
5							
6							
7							
8							
9							
					<b>Total time</b>		
					<b>Labour cost</b>		

Job Card Overseas Division NIAE

Item	Qty	Description of spare part	Part No	A O	Iss Rec	Cost
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

<b>Job completed</b>												<b>Date</b>			<b>Spares cost</b>		
1	2	3	4	5	6	7	8	9	10	11	12	Labour cost	Spares cost	Total cost			

Grid for location information

Machine No

Make & model

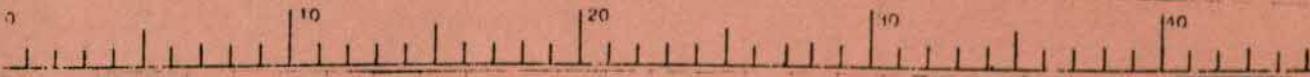
(Side 1 of A5 card)

Location

Engine No Chassis No

Purchased from Date Price

Table with 5 columns: Date, Hourmeter, Repair record, Est cost, Job No



Next service due Jan Feb Mar Apr May June July Aug Sept Oct Nov

(Side 2 of A5 card)

Table with 5 columns: Date, Hourmeter, Service record, Est cost, Ch



APPENDIX Q

AN ANALYSIS OF THE ESTIMATED COST OF OPERATING 7 AND 12 AMSB STATIONS

Contents

- APPENDIX Q1 Estimated costs of operating 7 and 12 AMSB Stations with Accurate Management Improvements.
- APPENDIX Q2 Projected Manpower Levels and Costs.
- APPENDIX Q3 Projected Headquarters and Administrative Expenses.
- APPENDIX Q4 Projected Annual Earthmoving Plant Operating Costs.
- APPENDIX Q5 Projected Annual Agricultural Tractor Operating Costs.
- APPENDIX Q6 Projection of Vehicle Fleet and Vehicle Operating Costs.
- APPENDIX Q7 Projected Depreciation (including vehicles).
- APPENDIX Q8 Summary of Projected Hourly Cost Rates.

The first part of the report is devoted to a general  
 description of the project and its objectives. It  
 is followed by a detailed account of the work  
 done during the period covered by the report.  
 The results of the work are then presented and  
 discussed. Finally, a summary of the work is  
 given, together with some conclusions and  
 suggestions for further work.

APPENDIX Q1 Estimated Costs of Operating 7 and 12 AMSB Stations with Assumed Management Improvements

ESTIMATED WORK POTENTIAL	EARTHMOVING PLANT	AGRICULTURAL TRACTORS
Maximum Average Available Hours Per Working Week (See 4.2.2) <sup>i</sup>	50h <sup>i</sup>	50h
Maximum Available Weeks Per Year <sup>ii</sup>	48	24 <sup>ii</sup>
Maximum Available Hours Per Year	2 400h	1 200h
Downtime Due to: Servicing, Maintenance, and Repairs		
Movement of Machinery	% 10	% 10
Lack of Work/Weather	20	15
	10	15
	—	—
	40%	40%
Productive Hours available per Machine Year	= $\frac{-960}{1\ 440h}$	= $\frac{-480}{720h}$
Number of AMSB Stations	7	7
Numbers of Plant/Tractors of which Reserve	$\frac{7}{42}$	$\frac{7}{70}$
Effective Plant/Tractors Available	4	14
	38	56
Total Productive Hours Available	54 720h	40 320h
	77 760h	69 120h

<sup>i</sup> In the longer term PHS should aim to achieve higher weekly work outputs from plant, by shift working, overtime, etc.  
<sup>ii</sup> Assumes that THS fleet can work for 6 months of the year as a result of increased mobility.



APPENDIX Q3 Projected Headquarters and Administrative Expenses

	7 STATIONS		12 STATIONS	
Manpower establishment and cost	503	349707	767	521145
<u>Deduct:</u> Shown separately - operators - earthmoving	(76)	(40356)	(108)	(57348)
- agric tractors	(70)	(37170)	(120)	(63720)
	357	272181	539	400077
Under transport - drivers, mates, ancillary	(92)	(41676)	(127)	(57531)
	265	230505	412	342546
<u>Add:</u> Passage & leave allowance @ K£300 per capita	-	79500	-	123600
	265	310005	412	466146
<u>Add:</u> Contingency, 10%, to allow higher job rating	-	31000	-	46614
	265	341005	412	512760
MANAGEMENT & ADMINISTRATION	265	341000	412	513000
PLANT OPERATORS inc. passage & leave allowance @ K£300 per capita	146	121326	228	189468
DRIVERS, MATES & ANCILLARIES inc. passage & leave allowance - do.	92	69236	127	95631
	503	531602	767	798099
HQ administration, station maintenance, etc. say, 25% of manpower cost		132900		196200
Management & Administration manpower Rate per machine hour		72		70
HQ, Admin etc. Expenses		28		27
		100		97

## APPENDIX Q4

Projected Annual Earthmoving Plant Operating Costs1. FUEL, LUBRICANTS, GREASE, FILTERS

Annual working hours per machine		1440 h		
Litres consumed per hour		20 l		
Annual consumption per machine		28800 l		
Fuel price per litre	KSh	8		
Fuel cost per machine year	K£	11520		
Lubs, grease etc (@ K£5/hour)	K£	<u>4320</u>	<u>7</u>	<u>12</u>
Total annual fuel cost per machine	K£	15840		
Number of effective machines			38	54
Annual fleet cost of fuel etc	K£		<u>601920</u>	<u>855360</u>
Fuel etc. cost per working hour	KSh		<u>220</u>	<u>220</u>

2. SERVICING, MAINTENANCE & REPAIRS (Materials only)

General	KSh		96	96
Undercarriage	KSh		160	160
Ripper points, shanks etc	KSh		<u>25</u>	<u>25</u>
			281	281
Standby machines 4/6 x K£10000			<u>15</u>	<u>15</u>
	KShs		<u>296</u>	<u>296</u>
Annualised fleet cost of S, M & R	K£		<u>809856</u>	<u>1150848</u>

3. OPERATOR EMOLUMENTS

Number of operators		76	108
Wage rate	K£	531	531
Annual leave passage allowance		<u>300</u>	<u>300</u>
	K£	<u>831</u>	<u>831</u>
Annual cost of operator emoluments	K£	<u>63156</u>	<u>89748</u>
Rate per working hour	KSh	<u>23</u>	<u>23</u>

## APPENDIX Q5

Projected Annual Agricultural Tractor Operating Costs1. FUEL & LUBRICANTS

Annual working hours per machine		720 h	
Litres consumed per working hour/ including allowance for travel to site etc)		10 l	
Annual consumption per machine		7200 l	
Fuel price per litre	KSh	8	
Fuel consumption annual cost	K£	2880	
Lubs., grease etc @ 30% of fuel	K£	86	
TOTAL ANNUAL FUEL COST per machine	K£	<u>2966</u>	

## NUMBER OF STATIONS

		<u>7</u>	<u>12</u>
Number of effective machines		56	96
ANNUAL FLEET COST OF FUEL	K£	<u>166096</u>	<u>284736</u>
Fuel Cost per machine working hour	K£	<u>82</u>	<u>82</u>

2. SERVICING, MAINTENANCE & REPAIRS (Materials only)

Capital cost per tractor (Approx)	K£	13,500	
Cost of spare parts over life of machine at 160% of capital cost	K£	20,250	
Economic life estimate:		6 years	

Annualised SM & R cost	K£	3,375	
Number of effective machines		56	96
Fleet annualised cost	K£	189000	324000
Standby machines (14/24) @ 50% of K£33		<u>23625</u>	<u>40500</u>
ANNUALISED FLEET SM & R COST	K£	<u>212625</u>	<u>364500</u>
SM & R Cost per machine working hour	KSh	<u>105</u>	<u>105</u>

3. OPERATOR EMOLUMENTS

Number of operators		70	120
Wage rate	K£	531	531
Leave & passage allowance		<u>300</u>	<u>300</u>
	K£	831	831
ANNUAL OPERATOR EMOLUMENT COST	K£	<u>58170</u>	<u>99720</u>
OE cost per machine working hour	KSh	<u>29</u>	<u>29</u>

APPENDIX Q6

Projection of Vehicle Fleet and Vehicle Operating Costs

	Low loaders	Land Rovers	Pick-ups	Estate Cars	Flat Lorries		
1) Headquarters	-	-	-	5	-		
2) Area Offices	-	-	3	-	-		
3) Central Workshops	3	1	2	1	1		
4) Stations	-	7-12	14-24	1	7-12		
	3	8-13	19-29	4	8-13		
<u>Number of Stations</u>						7	12
Unit Costs	K£ 25 000	5 000	6 000	6 000	15 000		
Total	75 000	64 000/104 000	114 000/174 000	24 000	120 000/195 000	397 000	572 000
Estimated life (years)	7	7	4	4	7		
Annual Depreciation	10 500	9 000/14 500	28 500/43 500	6 000	17 000/27 850	71 000	102 350
M & R (Spare parts only)							
Cost over life of machines @ 150% of capital costs	112 500	96 000/156 000	171 000/261 000	36 000	180 000/292 500		
Annualised	16 071	13 714/ 22 286	42 750/65 250	9 000	25 714/41 786	107 249	154 393
<u>Fuel, Lubricants, etc</u>							
litre/km	15	6	7	7	10		
kms/year	10 000	20 000	20 000	20 000	15 000		
Vehicle litres consumed say:	700	3 500	3 000	3 000	1 500		
Number of vehicles	3	8/13	19/29	4	8/13		
Total litres consumed	2 100	28 000/45 500	57 000/87 000	12 000	12 000/10 500		
Total cost @ 8 KShs/litre	K£ 840	11 200/18 200	22 800/34 800	4 800	4 800/7 800	44 440	66 440
<u>Drivers, Mates &amp; Standby</u>						222 689	323 183
HQ	3	2	5				
Area - car	3	3	6				
- low loaders	3	9	12				
C. Workshops	5	6	11				
Station Cars	21/36	10/15	31/51	92 @ 753		69 276	
Station Lorries	7/12	20/30	27/42	127			95 631
						K£ 291 965	418 814
						=KShs 5 839 300	8 376 280
						Working hours	
						Earthmoving	54 720 77 760
						Agric. tractors	40 320 69 120
							95 040 146 880
						Transport cost per machine hour	61 57

APPENDIX Q7  
Projected Depreciation (including Vehicles)

7 Stations    12 Stations

**1. EARTHMOVING PLANT**

Plant items, including standby		42	60
Estimated average capital cost	K£	80 000	80 000
Estimated economic life		8 yr	8 yr
Annual charge	K£	<u>420 000</u>	<u>420 000</u>
Depreciation rate per hour	KSh	<u>154</u>	<u>154</u>

**2. AGRICULTURAL TRACTORS**

Plant items, including standby		70	120
Estimated average capital cost	K£	13 500	13 500
Estimated economic life		6 yr	6 yr
Annual charge	K£	<u>157 500</u>	<u>270 000</u>
Depreciation rate per hour	KSh	<u>78</u>	<u>78</u>

**3. WORKSHOPS**

Refurbishment of stations @ K£50 000	K£	350 000	600 000
Refurbishment of central workshops		<u>200 000</u>	<u>200 000</u>
	K£	<u>550 000</u>	<u>800 000</u>
Estimated economic life		10 yr	10 yr
Annual depreciation charge	K£	<u>55 000</u>	<u>80 000</u>
Depreciation rate per machine hour	KSh	<u>12</u>	<u>11</u>

APPENDIX Q8 Summary: Projected Hourly Cost Rates

	7 Stations		12 Stations		
	E-Moving	Agric.	E-Moving	Agric.	
No. of machines available	<u>42</u>	<u>70</u>	<u>60</u>	<u>120</u>	
No. of effective machines	<u>38</u>	<u>56</u>	<u>54</u>	<u>96</u>	
Projected annual working hours	<u>54 720</u>	<u>40 320</u>	<u>77 760</u>	<u>69 120</u>	
<u>Rates per machine hour:</u>					
(c) Fuel, lubricants, etc.	P	220	82	220	82
Servicing, Maintenance & Repairs	P	296	105	296	105
(c) Operator Emoluments	P	<u>23</u>	<u>29</u>	<u>23</u>	<u>29</u>
		539	216	539	216
Depreciation	P	<u>154</u>	<u>78</u>	<u>154</u>	<u>78</u>
		693	294	693	294
Transport support	0	<u>61</u>	<u>61</u>	<u>57</u>	<u>57</u>
		754	355	750	351
Workshop equip. depreciation	0	12	12	11	11
(c) Management & Service emolument	0	72	72	70	70
(c) HQ/Branch expenses	0	28	28	27	27
	KSh	<u>866</u>	<u>467</u>	<u>858</u>	<u>459</u>
	P	693	294	693	294
	0	173	173	165	165
COMPARE 1982/93 CHARGING RATES		400/500	200	400/500	200

Items marked (c) are cash outgoings on a regular basis; SM & R costs are basically similar but cash outgoings will increase as the plant ages. The estimated life cycle SM & R cost has been "annualised" to smooth the hourly rate calculation. The accounts should make provisions on this basis and charge outgoings against the provision.

Depreciation is a non-cash cost. It represents an initial capital outlay of

	<u>7</u>	<u>12</u>
Workshop refurbishment	K£ 550 000	800 000
Earthmoving plant	3 360 000	4 160 000
Agricultural Tractors	525 000	900 000
Vehicles	397 000	572 000
	<u>K£ 4 832 000</u>	<u>6 432 000</u>

Some of this may be avoidable if existing equipment/plant can be rehabilitated, but depreciation charge should stand simply to provide a replacement reserve for procuring the next generation of plant and equipment.



**THE INSTITUTE**

The National Institute of Agricultural Engineering is one of a group of agricultural and food research establishments organised and co-ordinated by the UK Agricultural Research Council. The NIAE together with the Scottish Institute of Agricultural Engineering is administered by the British Society for Research in Agricultural Engineering. In addition to ARC support, NIAE receives funds from the Ministry of Agriculture, Fisheries and Food, from the Department of Industry and from manufacturing industries serving agriculture for contracted research, development and testing. The Overseas Division of the Institute is funded by the UK Foreign and Commonwealth Office, Overseas Development Administration.

The work of NIAE is divided between eight divisions with the following primary responsibilities:

- Crop Engineering, Engineering Design and Development, Farm Buildings, Field Machinery, Horticultural Engineering. Instrumentation and Control, Agricultural Vehicles, Overseas.

The activities of these Divisions are augmented by common services including a Design Department, Drawing Office, Engineering Workshop, Central Laboratory, Information Service and Farm. The Institute publishes a Biennial Report and a Programme of Research.

Specific aspects of the work are displayed at Silsoe two or three times a year during BSRAE Association Members Days. Membership of the Association is open to individuals and organisations involved in agricultural engineering, both in UK and overseas. Much of the research of NIAE is also reported in the Journal of Agricultural Engineering Research, published by Academic Press Limited and available at reduced subscription rates to BSRAEA members.

**OVERSEAS DIVISION, NIAE**

The Overseas Division of NIAE has a staff of thirteen professional engineers and one economist. Members of staff may be seconded overseas. Currently two are on long term assignments in Mexico and one in Egypt. The Division provides services to overseas governments and organisations in agricultural mechanisation and engineering, usually on behalf of the Overseas Development Administration under the British Aid Programme. The resources and experience of the Overseas Division, NIAE are also available for contracts on a consultancy basis.

Requests under the British Aid Programme should be made to the appropriate British Embassy or High Commission for submission to the Overseas Development Administration of the Foreign and Commonwealth Office. Information about consultancy services should be obtained directly from the Overseas Division of NIAE. Informal direct contact with the Overseas Division is welcomed.



**OVERSEAS PROJECTS**

The Overseas Division is assisting projects in over 20 countries; it is also collaborating with international organisations in the development of equipment especially suited to the less developed countries. Current and recent programmes include:

**ADVISORY SERVICES**

Overseas Division has seconded engineers to act as advisers to the Agricultural Credit Bank of the Yemen Arab Republic and to the Government of Mexico.

**MECHANISATION**

In Sierra Leone, Kenya, Sudan, Pakistan, Swaziland and Jordan the main concern is the improvement of management, servicing and repair of equipment in hire schemes.

**NATIONAL CENTRES**

India, Yemen Arab Republic, Ecuador, Brazil and Costa Rica have received assistance for national agricultural engineering centres.

**LAND DEVELOPMENT**

Overseas Division advised on farm mechanisation and heavy equipment in land development projects in Belize, Dominican Republic, Egypt, Iraq, Kenya, Pakistan and Sri Lanka.

**RESEARCH**

Applied research involving cultivation methods and equipment, often as part of other projects. The results of the dryland farming research project in Botswana have applications in other semi-arid countries.

## OTHER ACTIVITIES

### ANIMAL POWER

A new multi-purpose animal drawn toolcarrier has been developed in collaboration with the International Crops Research Institute for the Semi-Arid Tropics. The new implement is well suited to both traditional and improved cultivation practices. Manufacture has commenced in England and in India. Expert support is being provided to the International Livestock Centre for Africa in a programme comparing native oxen with more powerful cross-bred draught cattle.

### DEVELOPMENT OF EQUIPMENT

A variety of power driven equipment, accessories and instruments has and is being developed for a number of countries. These include a whole crop cereal harvester/thresher (*Egypt*); a new pull-along sprayer (*Zimbabwe, Swaziland, Mexico, Sri Lanka, Costa Rica*); a fuel servicing pack (*Sierra Leone*); well-pointing and drainage equipment for domestic water supply and salinity control (*Sri Lanka, Pakistan*).

### INDUSTRIAL COLLABORATION

The expertise of Overseas Division is being used to assist British manufacturers in the design, development and export of equipment suitable for less developed countries. These include hand tools, animal and tractor drawn equipment and small self powered machines.

## OVERSEAS SERVICES

**ADVICE** and consultancy services concerning agricultural engineering and farm mechanisation, including animal draught.

**INFORMATION and SUPPORT** for overseas staff.

**DEVELOPMENT and EVALUATION** of agricultural equipment for use overseas.

**TRAINING** programmes can be arranged for the special requirements of overseas agricultural engineers.

**COLLABORATION** with British manufacturers in the development of equipment for use overseas.

**PROJECT PREPARATION** and

**PROJECT MANAGEMENT** for agricultural mechanisation programmes.

The underlying principles to the work of the Overseas Division are:

**EXPERT ADVICE** to countries and bodies serving overseas agriculture.

**SELECTION** of the most appropriate types of equipment for overseas conditions.

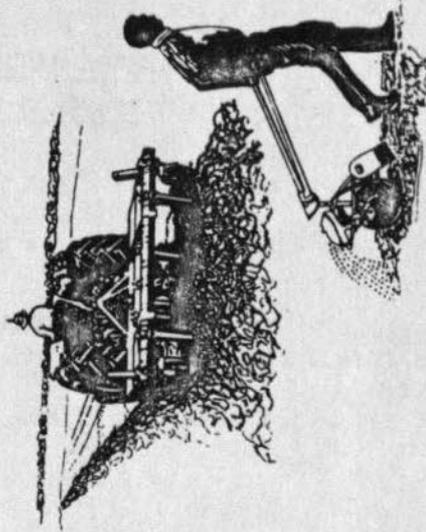
**MANAGEMENT** of that equipment to ensure its optimum use.

**ECONOMIC and FINANCIAL** evaluation of developments in agricultural mechanisation

**FEEDBACK** to British manufacturers on equipment needs overseas.

# The British NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

## OVERSEAS SERVICES



*Overseas Division*

National Institute of Agricultural Engineering  
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1950s by the 2000s. Despite the fact that  
the program has been a success in many ways,  
it has also been a source of controversy.

Dr. Robert G. Anderson



AMERICAN  
OVERSIGHT

CONSTITUTION

OF THE UNITED STATES  
OF AMERICA

THE BUREAU

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of America

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AMERICAN OVERSIGHT

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## AGRICULTURAL ANNEX

### INTRODUCTION

The objectives of this supporting annex on agriculture are:

- To provide more detailed information and data to support certain conclusions and recommendations made in the Main Report
- To clarify specific issues which have a direct relation on resource conservation and agricultural aspects of AMSB's work
- To supply additional facts and material which will assist the AMSB in their role of providing mechanisation services to the agricultural sector in Kenya

Part 1 of this annex explains the land classification system in each area where the AMSB is represented. This section also details present and anticipated land use trends where this information is available.

Part 2 covers some key aspects of crop production and mechanised farming within the AMSB area of operations and assesses the physical impact of this organisation's activities on the agricultural sector as a whole.

In Part 3 the crucially important subject of soil and water conservation (SWC) is discussed in relation to the AMSB's current, and possible future, role in this sphere.

Part 4 presents a Case Study on AMSB's SWC efforts at Nyakach in Kisumu District. The objective of this exercise is to examine some of the main problems which are hindering any successful outcome of the project and to outline some ways of overcoming these problems. The Study Team stress here that the aim is to be as constructive as possible, within the natural and human limits imposed, regarding the current difficult situation and likely solutions for the future.

## 1. LAND USE AND DEVELOPMENT

### 1.1 Land Classification and Resource Availability

Some system of land classification is necessary to assess the availability of land resources and evaluate their potential for agricultural development. A popular approach for classifying land is to devise a system of land capability or suitability for this purpose.

Whereas the land capability classification system is based on defining a set of factors which limit the use of land (e.g. erosion, drainage) land suitability classification works on a system of dividing the land according to similar characteristics such as topography, soil, climate, hydrology and vegetation. In a macro system of land classification, these areas of similar attributes are known as agro-ecological zones (AEZ) or Natural Regions.

The classification of land for development purposes is not an easy task in a country like Kenya. The country has a very wide diversity of natural resources and conditions ranging from tropical Alpine through high rainfall forest to arid desert. Taking into account the local differences in land qualities, the Kenyan MoA has classified land into agro-ecological zones using the FAO system of zonation as a basis (Farm Management Handbook of Kenya, Vol. IIA, 82).

The new classification system divides the agro-ecological zones into temperature belts ranging from Tropical Alpine through Upper and Lower Highlands and Midlands to Lowland. These belts are defined according to temperature limits within which the main crops thrive in Kenya. The annual mean temperature range is largely dependent on altitude ranges. The main zones are numbered according to a combination of precipitation/evaporation indices and seasonal distribution of rainfall. The AEZs can be printed onto soil maps to show fertility status and natural constraints (slope, drainage, salinity, etc). The main zones themselves are based on their probability of meeting both temperature and water requirements of the main crops. The main AEZs are shown in Table A1 with the names of the zones referring to potentially leading crops which could be grown there. The zones in which the AMSB has been active are:

TABLE A1 Main Agro-Ecological Zones in Kenya<sup>1)</sup> and AMSB Areas in 1983

Zonal Belts	1 (humid 80%+)	2 (subhumid 65-80)	3 (semi-humid 50-65)	4 (transitional 40-50)	5 (semi-arid 25-40)	6 (arid 15-25)	7 (perarid 1%-)
UH							
Upper Highland Zones MT10-15°C Seasonal night frosts	Sheep- Dairy Zone	Pyrethrum- Wheat Zone (Eg Nakuru)	Wheat- Barley Zone (Eg Nakuru)	Upper Highland Ranching Zone	Upper Highland Nomadism Zone <sup>5</sup>		
LH							
Lower Highland Zones MT 15-18°C Mean Min Temp 11°C Normally No Frost	Tea Dairy Zone	Wheat/ Maize) Pyrethrum Zone (eg Kipkelion)	Wheat/(Maize) Barley Zone (eg Eldoret, Nyahururu)	Cattle- Sheep- Barley Zone (eg Narok, Kajiado )	Lower Highland Ranching Zone (eg Naramoru)	Lower Highland Nomadism Zone <sup>5</sup>	
UM							
Upper Midland Zones Ann. Mean 18-21°C MT 11-14°C	Coffee Tea Zone	Main Coffee Zone (eg Machanga Ruiru)	Marginal Coffee Zone (eg Kitale)	Sunflower Maize <sup>3</sup> Zone (eg Marigat)	Livestock Sorghum Zone (eg Chiaka- riga)	U. Midland Ranching Zone	U. Midland Nomadism Zone <sup>4</sup>
LM							
Lower Midland Zones Ann. Mean 21-24°C MT > 14°C	L. Midland Sugarcane Zone (eg Bumala)Zone	Marginal Sugarcane Zone	L. Midland Cotton Zone (eg Migori)	Marginal Cotton Zone (eg Machanga)	L. Midland Livestock- Millet Zone (eg Makueni Kitui)	L. Midland Ranching Zone	L. Midland Nomadism Zone <sup>4</sup>
Lowland Zones MT > 24°C Mean Max Temp 31°C	Cocoa Oil Palm Zone <sup>5</sup>	Lowland Sugarcane Zone <sup>5</sup>	Coconut Cassava Zone (eg Mariakani)	Cashewnut Cassava Zone	Lowland Livestock Millet Zone (eg Garsen)	Lowland Ranching Zone	Lowland Nomadism Zone <sup>4</sup> (eg Garissa)

1) FAO 1978: MoA (Farm Management Branch and GAT); AMS.

2) Rainfall/Evaporation Indices.

3) Maize also in LH 1, UM 1-3, LM and L 1-4.

4) Nomadism, semi-nomadism and other forms of shifting grazing.

5) Not found in Kenya.

Source: FMH, MoA

### 1.1.1 Upper Highlands Zone (UH)

#### UH2: Pyrethrum - Wheat Zone

This zone totals some 270 sq km. and covers a major part of the high altitude region over 2,700 metres. Annual average precipitation is 65-80% of the potential evaporation (Open Pan Evaporation ie Eo). Much of the country's forest land is found in this zone. Livestock carrying capacity on natural pasture is around two units per hectare. Examples of AMSB stations which cater for areas falling in this zone are Narok and Nyahururu.

### 1.1.2 Lower Highland Zone (LH)

#### LH2: Wheat/Maize - Pyrethrum Zone

About 310 sq km in extent. Sub-humid and moderately cool with mean annual temperatures ranging from 15 to 18°C. Agricultural potential is high in this zone.

#### LH3: Wheat/Maize - Barley Zone

Covering over 540 sq km with rainfall between 50 & 60% of Eo. Although climatic conditions are marginal, this zone encompasses the major high altitude (over 1,800 metres) maize growing areas of Eldoret and also parts of Nyahururu and Naro Moru Districts.

#### LH4: Cattle - Wheat Zone

Some 340 km in total with the main area falling in the Mau Divisions of the Narok District. Livestock production in this area is mainly based on the migratory pastoral system with the natural pasture able to support medium density grazing.

### 1.1.3 Upper Midland Zone (UM)

#### UM2 & 3: Coffee Zones

This zone covers about 510 sq km and is economically very important as it encompasses the main coffee growing areas of the country. AMSs situated in these zones are at Ruiru and Makueni.

#### UM4: Sunflower - Maize Zone

Approximately 720 sq km overall. Although sunflower is recommended by the MOA as an attractive crop for this zone, little is grown at present due to the relatively poor returns realised when compared with maize. Marigat AMS is situated in this zone.

#### UM5: Livestock - Sorghum Zone

Covering some 500 sq. km, this zone has only marginal potential for agriculture. Rainfall is in the region of 25-40% of Eo and the areas situated in this zone are semi-arid. Well managed commercial ranching can support one livestock unit to every two hectares of natural pasture. Chiakariga AMS is in this zone.

### 1.1.4 Lower Midlands Zone (LM)

#### LM 1-2: Sugar-cane Zones

Largely situated in the south-west of the country, this zone encompasses the main sugar-cane growing areas and measures about 620 sq km in total. Annual mean temperatures tend to be higher at around 21-24°C but seasonal rainfall is good with a 60% reliability of first rains. However, the second rainy period in the area near Lake Victoria can be very poor. Climatic conditions are fair to good for maize production. Bumala and Migori AMS are situated in this zone.

#### LM 3-4: Cotton Zones

The zones are about 1160 sq km in extent with conditions tending to differ widely within each zone. Rainfall reliability tends to be lower than LM2 and growing periods are shorter. Nevertheless, maize can grow well provided the rainfall is evenly distributed. AMSs found in these zones are Makueni and Machanga.

#### LM5: Lower Midland Livestock - Millet Zone

The zone covers some 2200 sq km and has very marginal agricultural potential, mainly for moderate rangeland development. Kitui and Kajiado AMS are situated in this zone.

### 1.1.5 Lowland Zones (LM)

#### L3 & 4: Coconut/Cashew - Cassava Zones

About 900 sq km in total, these zones are largely found in the Coast Province. Coconut production is mainly confined to L3 whereas the more

drought tolerant cashew nut tree thrives in L4 where precipitation is below 50% of Eo. Mariakani AMS serves these zones although, like many other stations, it also covers areas in other zones including the following ones:

#### L5: Lowland Livestock - Millet Zone

This zone covers some 950 sq km. Potential for crop production is minimal and the risk of crop failure is very high. Although Garsen AMS caters for the northern part of this zone, it also serves the coastal area around Malindi which falls into L4.

#### L6: Lowland Ranching Zone

The zone, which covers an extensive area of some 2370 sq km, is arid (less than 25% available moisture) and hot (mean maximum temperature approximately 31°C) for most of the year. Garissa AMS is situated in this zone.

Table A2 shows the estimated amount of land available for agricultural production in Kenya. Of the total land mass in Kenya of 575,000 sq km, only some 13.2% (i.e. about 7.4M ha) is estimated by the MoA to have reasonable to good potential for sustained agricultural production. This area would include the zones UH2, LH2, 3 and 4, UM and LM 2, 3 and 4, and L2 and 3 already mentioned. The remainder of the land falls in the semi-arid, and arid regions which cover large tracts of the country.

A previous estimate of agricultural potential in the country put the total amount of land available for agriculture in 1976 at about 7.5 Mha excluding forest land of 1.2 Mha (Government Sessional Paper No. 4 1981). Estimates of high and medium potential land have previously been thought to be about 17%. Even at this figure land suitable for sustained agriculture is very limited in Kenya.

## 1.2 Present Land Use and Development Potential

Quite substantial areas of high potential land in south-western Kenya are under cultivation (Photo 11). Table A3 shows the estimated intensity of land usage in the various provinces in 1976. In the



relatively heavily populated provinces such as Western, Central and Eastern, most available agricultural land is being cropped at least once a year. This is the case even where soil fertility is poor and other physical constraints, such as broken terrain and poor drainage, are present.

Land usage is relatively light in some areas of the Coast and Rift Valley Provinces. However, major parts of these provinces are unsuitable for sustained crop production. As well as the climatic limitations mentioned in 1.2, much of the soil is largely deficient in plant nutrients and organic matter (e.g. Acrisols) and some soil types, such as Luvisols, are highly prone to erosion. Traditional measures to improve soil productivity are limited. Until recently the population pressure on much of the high potential land was relatively light and the general necessity for improved land use practices was not as urgent (Photo 12).

Kenya has one of the fastest growing populations in the world with an estimated increase of 3.9% per annum. At this rate of growth the national population would reach 23.35 million by the end of 1990, a 52% increase over the 12 years since the 1979 census. The estimated 1983 population of Kenya is 17.87 million giving an average density of 31 people per square kilometre. The majority of people live in either the Lake Victoria area, the south-western highlands, or the coastal belt.

As long ago as 1976 the intensity of land use was high as indicated in Table A2. During the seven years that have passed since then the country's population is estimated to have grown by over one third. With the increased population pressure, land use is certain to have risen significantly. In parts of Nyanza, Western and Central Provinces the average amount of available agricultural land per person has dropped below 0.33 ha per person as shown in Table A4. Correspondingly, population density has risen in certain divisions to over 700 people per square kilometre (CBS, 1979).

Even in districts with high population densities, such as South Nyanza and Busia, some potential still exists for agricultural development through bringing new land under cultivation. There is also potential for horizontal development in both northern and southern parts of the



PHOTO 11 Intensive land use on family farms in marginal sugarcane zone about 15 km N of Migori



PHOTO 12 Well established contour terraces ploughed out in Kipkelion area of Kericho District

Coast and Rift Valley Provinces. However, the ratio of pasture and fallow land which is desirable under a stable system of long-term agricultural production in the marginal zones (AEZs UM5, LM 4-5 and L5) precludes intensive dry-land crop production on much of the cultivatable land in these two provinces.

The conclusion is that any significant increase in agricultural production must take place by increasing the productivity of land which is already within the current cultivation cycle.

This can be achieved by a number of measures, or combination of measures:

- by increasing crop input-output coefficients through new or different technology (e.g. introducing hybrid seed, changes in crop husbandry, etc.)
- by raising the level of inputs (e.g. increasing the marginal productivity of labour, increasing fertilizer inputs, etc.)
- by minimising the risk of loss of output (e.g. chemical control of pests and diseases)
- by improving the marketing of crops (eg transport, handling and storage, etc)
- and by the protection and conservation of factors of production (e.g. soil conservation and water retention measures).

This study has addressed itself largely to the latter.

Estimates of cultivatable land resource are listed by district in Table A4. Relevant districts which still have potential for land development are the south-eastern region of South Nyanja (under Migori AMS), the western part of Baringo (Marigat AMS), Transmara and Eastern divisions of Narok, and parts of Taita-Taveta in the Coast Provinces (Mariakani AMS). Population pressure is relatively light in these areas and agricultural development, largely uncontrolled by Government, is taking place. Some demand for plant and tractor hire services is likely to continue at Migori, Narok and Mariakani AMSB Stations.

TABLE A4 Land Availability in Agricultural Areas of Kenya

PROVINCE	DISTRICT(S)	TOTAL RURAL AREA (km <sup>2</sup> ) (Census 1979)	TOTAL NON-AGRICULTURAL LAND (km <sup>2</sup> )	AGRICULTURAL LAND (ha)		
				Total (km <sup>2</sup> )	per household (ha)	per person (ha)
Nyanza	Kisii	2,152	227	1,925	1.50	0.26
	South Nyanza (Migori)	5,685	1,153	4,532	3.38	0.56
	Kisumu	1,926	354	1,573	2.42	0.48
	Siaya	2,517	319	2,098	2.14	0.39
Western	Busia (Bumala)	1,579	230	1,349	2.74	0.57
	Bungoma	2,347	355	1,992	2.86	0.46
	Kakamega	3,111	563	2,548	1.33	0.26
Rift Valley	Nandi	2,339	413	1,926	3.39	0.65
	Kericho (Kipkelion)	3,842	467	3,375	2.88	0.56
	Trans Nzoia <sup>3</sup> (Kitale)	1,997	438	1,559	3.67	0.67
	Uasin Gishu (Eldoret)	3,418	637	2,781	5.94	1.11
	West Pokot <sup>4</sup>	6,072	1,141	4,931	19.11	3.64
	(8,983) <sup>2</sup>					
	Eiyeo Marakwet <sup>5</sup>	2,272	694	1,578	4.69	1.06
	Baringo (Marigat)	9,875	2,689	7,185	18.46	3.81
	Laikipia	9,715	628	8,087	33.68	7.09
	Nakuru (CWS)	5,762	833	4,829	4.63	1.00
	Narok (Narok)	16,101	3,185	11,916	33.55	5.93
South East Kajiado (Kajiado) <sup>6</sup>	4,400	1,067	3,332	n/a		
Central	Nyandarua (Nyahururu)	2,672	587	2,085	5.33	0.95
	Kiambu (Ruiru)	1,935	513	1,422	1.13	0.23
	Muranga	2,216	408	1,808	1.46	0.29
	Nyeri (Naromoru)	2,010	421	1,589	1.8	0.35
	Kirinyaga	1,127	172	955	1.86	0.34
Eastern	Embu (Machanga)	2,562	548	2,014	4.44	0.82
	Meru <sup>7</sup> (Chiakariya)	n/a				
	Machakos (Makueni)	13,115	1,842	11,273	6.79	1.32
	Kitui (Kitui)	22,803	2,739	20,064	23.94	4.43
Coast	Taita-Taveta	6,339	497	5,842	20.26	4.23
	Kwale	7,942	629	7,313	14.76	2.65
	Kilifi (Mariakani)	11,264	4,851	7,113	10.43	1.81
	Southern Tana River (Garsen)	9,184	637	8,550	158.22	27.63
	Lamu (Gurissa)	6,500	518	5,517	79.59	16.27
TOTAL		175,479	32,402	143,061	-	-

Source: Farm Management Handbook, MoA.

Note: 1) Includes excessively broken land, forests, water and rivers, roads, residential land, etc.

2) Main parts of Northern area (2911 km<sup>2</sup>) not suitable for agriculture.

3) An additional 14700 ha in LH<sub>4</sub> - LH<sub>3</sub>; 4500 ha in LH<sub>2</sub>; and 136 ha in LH<sub>3</sub> - LH<sub>1</sub>.

4) An additional 1200 ha in TA<sub>1</sub> - LH<sub>2</sub>; 110 ha in LH<sub>3</sub> - LH<sub>1</sub>.

5) An additional 6100 ha in TA<sub>1</sub> - LH<sub>2</sub>-3; 1400 ha in TA<sub>1</sub> - LH<sub>2</sub>-3.

6) An additional 1500 ha in LH<sub>4</sub> - LH<sub>4</sub>.

7) Data not available.

## 2 AGRICULTURAL PRACTICES

### 2.1 Crop Production in AMSB's main areas of operation

Together with coffee and tea, maize is one of the three most important commodities in Kenya today. It is the most widely produced and consumed crop and forms the basis of the rural population's diet. By far the largest proportion of the crop is grown on smallholdings. Although no reliable estimates of national output exist, an estimated 2 million tonnes or more was produced in 1980/81 and 1981/82.

The National Cereals and Produce Board (NCPB), a parastatal organisation, has a legal monopoly over nearly all maize purchases except for minor local sales and it enforces fixed producer and consumer prices. The annual intake of the Board over the past decade has fluctuated between 236,000 and 533,000 tonnes (NCPB 1981). This level of purchases is considered indicative of the long-term rising trend in national production, in response to both favourable producer prices and to the increased adoption of maize hybrids. However, these fluctuations in production levels occur not only because of climatic variations but also because of erratic marketing policies. MoA officials believe that the yield increases generated by the introduction of hybrid maize seed are unlikely to be sustained and that further increases in national production must be achieved through better farming practises, especially on family farms. The large farm sector produces only a small part of the national output and although most of its crop is sold rather than consumed on the farm, this sector has delivered an annual average of less than 20% of the NCPB's total intake in recent years.

The national output of maize has never been reliably estimated. In the mid-1970s the NCPB was reportedly handling some 40% of the crop. More recently, the Board estimated that the proportion purchased was about 30%. Total production in 1980-81 was estimated to be about 2.1 million tonnes with 473,000 tonnes being purchased by the NCPB (CBS 1982). The bulk of this surplus production came from the Rift Valley Province.

Some crop production estimates were obtained from the PDA's offices in three provinces. These were Nyanza, Rift Valley, and Coast which were identified in Part 1.2 as being the three regions which have some potential for the development of new land for agricultural production. Furthermore, two-thirds of the AMSB/THS stations are to be found in these three provinces. It was not possible, in the time available, to obtain data from the other provinces in the country.

Approximately 350,000 ha were planted to maize in the province during the long rainy season of 1982 as shown in Table A5. This area produced an estimated 10 million (90 kg) bags with over half this amount coming from four districts - Trans Nzoia, Uasin Gishu, Kericho and Nakuru. Each of these districts has an AMS operating in it (Kitale, Eldoret, Kipkelion and Nakuru respectively). The first two named districts, together with Laikipia, provided over half the estimated maize surplus produced in the province during 1982. In districts where family farm production predominates, such as Kericho and Nandi, about two-thirds of the total production is consumed within the immediate area. Relatively small amounts of maize are grown in two districts where THSs are located (Marigat AMS in Baringo District, and Kajiado AMS).

Kenya is not self-sufficient in wheat, having to import about 118,000 tonnes in 1981. This figure amounted to more than half the total consumption in that year. With more favourable climatic and marketing conditions during 1982 the NCPB estimated total purchases of around 200,000 tonnes of wheat from the Rift Valley Province, the region in which nearly all the crop is grown. This estimate could be optimistic as annual production ranged between 139,000 and 177,000 tonnes during the 1970s. The last year that more than 200,000 tonnes of wheat were produced was 1969. Domestic consumption, which totalled 101,000 tonnes in that year, has more than doubled since then. Approximately 80% of the total amount of wheat produced each year comes from the large farm sector. This situation is unlikely to change as the former scheduled areas are agronomically well suited to wheat production and wheat is generally regarded as a crop which should be grown under large scale systems of production. It is Government policy to encourage wheat production and to attain self-sufficiency. Recent trends in production and consumption indicate that these goals are



unlikely to be achieved.

Table A5 shows the estimated production of wheat in the Rift Valley Province in 1982. Three districts, Uashin Gishu, Nakuru and Narok, produced more than two-thirds of the total crop in that year.

Although the THS was established during the 1960s to develop smallholder wheat production in the Narok District (see Main Report, Section 3.1.3), the crop has become relatively unimportant within the AMSB's sphere of activities today.

Estimated crop production levels of the main industrial crops in Nyanza and Coast Provinces are shown in Table A6. The importance of the maize crop to farmers in these provinces is evident in that the combined total area under principal industrial crops in each province during 1982 was less than the total maize area. No data was available for the Rift Valley Province for the 1982 production season.

Important industrial crops in this province include coffee, tea, sisal and pyrethrum. There are two strategically important industrial crops which the THS could possibly assist in developing if this body was in a position to provide an efficient service to farmers. These are sugar cane and cotton. Sugar production is growing steadily and Kenya is now exporting this commodity. In 1980 there was a surplus of 150,000 tonnes after domestic demand of 275,000 tonnes had been met. The estimated surplus in 1981 was 100,000 tonnes with local consumption continuing to rise steadily. Raw cane is sold to the sugar companies by family farmers and production co-operatives. The AMS at Kipkelion, in the Kericho District, could provide tractor hire services to family farmers growing sugar near Kisumu. However, the station would have to be relocated closer to Kisumu as mentioned in the Main Report (Section 4.2).

Cotton production has also been growing at a steady rate during recent years. The Government's aim is to reduce the imports of cotton for local textile mills and, eventually, to have a surplus for export. Marigat AMS in Baringo District serves cotton growers in the Kerio Valley with about two-thirds of the total of around 600 ha ploughed in 1982 in this region. The valley is very remote and the problems of providing an efficient service to cotton growers are considerable. Furthermore, little or no work is carried out by the Marigat AMS on soil conservation measures on newly opened land in the Kerio Valley.

TABLE A6 Industrial Crop Production Estimates for Nyanza and Coast Provinces, 1982

CROP:- PROVINCE	DISTRICT	COTTON		PYRETHRUM (i) (ii)	SUGAR CANE (i) (ii)	BANANA		COFFEE (i) (ii)	TEA (i) (ii)
		(i)Area (ha)	(ii)Pro- duction (tonne)			(i) (ii)	(i) (ii)		
Nyanza	Kisumu	12,000	1,700		28,000	980,000	n/a (350 in 1981)	63	189
	Siaya	17,950	1,900		420	12,600	n/a (77 in 1981)	44	110
	Kisii 1 S.Nyanza	26,160	3,925	12,000	n/a (About 1400 in 1981)	20,800	1,300 n/a (605 ha in 1981)	9,000 (1,012 ha in 1981)	7,500
	TOTAL	56,090	7,525	12,000	(42,400)		(2,000+)	(8,000+)	10.960
Coast		CASHEW NUT		COCONUT	MANGOS				
	TOTAL	36,060	n/a	37,000	12,210	n/a			

Note 1) Some tobacco also grown (1618 tonnes off 1745 ha in 1981).

The station serves little purpose with farmers now relying more on their own resources. Thus the purchase of tractors by some of the cotton growers there makes the THS at Marigat largely redundant and the Study Team recommends that the station should be closed down (see Main Report, Section 4.3).

There are three AMSB stations which are located in the semi-arid area of Eastern District viz. Chiakariga AMS (Meru District), Machanga AMS (Embu District) and Makueni AMS (Machakos District). Crops grown in these districts are basically for home consumption with the main ones being sorghum, millet and cowpea (S. Wiggins, 1981). Yields are generally low and many crop harvests are partial or complete failures due to lack of sufficient rain. Cotton is an important cash crop in parts of Embu and Meru Districts. However, yields are reportedly mediocre and net cash income from the crop has been modest.

## 2.2 Farm Size and Agricultural Employment

The size of a farmer's holding, as well as the economic viability of his farm, has a close correlation with the level of mechanisation of the unit. Available data on farm sizes in Kenya varies considerably. This kind of information is difficult to collect due to the fragmentary nature of family farm holdings and the dynamic situation regarding land tenure. Table A7 shows that small farms predominated in both numbers and total land area by the late 1970s. An indication of farm size distribution is given in Table A8. With the ongoing government programme of land registration and resettlement, the proportion of small farms will continue to grow and the family farm sector become even more predominant in the agricultural economy.

As can be seen from Table A7 and A8, historical influences on land ownership have resulted in a diverse range in types of ownership and sizes of holdings. Farming systems have also been influenced by these forces which encouraged different patterns of production. Examples are the large scale cereal farms and the company owned plantations in the highlands, and the pastoral system of livestock production in Narok District. Thus there are relatively few family farms in the Rift Valley Province compared with the other main farming areas in the country. As indicated in Table A8, the average farm size in the

TABLE A7 The Extent of Land Holdings and Farm Employment 1977/78

CROP FARMS	Approx. Av. Size (ha)	Number of farms	Total Area (hectares)	Percentage Distribution	Employment /100ha	
					Total	
Small Farms <sup>1</sup>	2	1,704,000	3,500,000	44	2,236,000	64
Intermediate <sup>2</sup> ('gap') Farms	25	40,000	1,000,000	13	80,000	8
Mixed Farms	500	1,800	900,000 <sup>3</sup>	11	200,000 <sup>4</sup>	22
Large Farms	1,000	2,460	2,500,000	32	371,000	15
SUB TOTAL		+/-1,748,000	+/-7,900,000	100		
OTHER FARMS						
Irrigation Schemes	2	4,744	8,728		5,000	60
Plantations	390	475	185,000 <sup>5</sup>		129,000	70 <sup>5</sup>
Non-Govt. Ranches	6,500	100	650,000		-	-
TOTAL		+/-1,750,000	+/-8,750,000		3,021,000	34

Source: IBRD 'Growth and Structural Changes in Kenya: A Basic Economic Report'

- Note: 1 Production off these farms accounted for nearly 80% of agricultural GDP in 1978.  
 2 Gap farms 'slot in' between large and small farms.  
 3 By 1978 up to 35% of this area had been subdivided into smallholdings.  
 4 Total includes around 144,000 squatters in large farm areas.  
 5 Cropped area only.

TABLE A8 The Percentage Distribution of Family Farms by Size and Province 1978

Size Group	Central Province	Coast Province	Eastern Province	Nyanza Province	Rift Valley Province	Western Province	1974/1978 % Total
1. Below 0.5 hectares	6.74	20.37	9.55	15.72	22.99	21.53	13.91
2. 0.5 - 0.9 "	10.50	18.46	17.35	26.18	12.11	17.67	17.92
3. 1.0 - 1.9 "	36.96	22.52	33.39	22.03	17.59	17.27	26.99
4. 2.0 - 2.9 "	16.47	11.42	14.82	15.23	14.78	14.68	15.11
5. 3.0 - 3.9 "	11.86	7.68	8.57	6.79	10.11	8.60	8.89
6. 4.0 - 4.9 "	5.92	8.15	9.68	8.13	5.72	4.36	7.22
7. 5.0 - 7.9 "	7.63	5.87	5.43	4.09	6.87	10.22	6.50
8. 8.0 hectares & over	3.92	5.53	1.22	1.83	9.83	5.68	3.47
Number of holdings	329,530	69,861	353,159	386,431	89,823	254,618	1,483,422

Source: G Muchiri - Agricultural Machinery Production and Use, 1981.

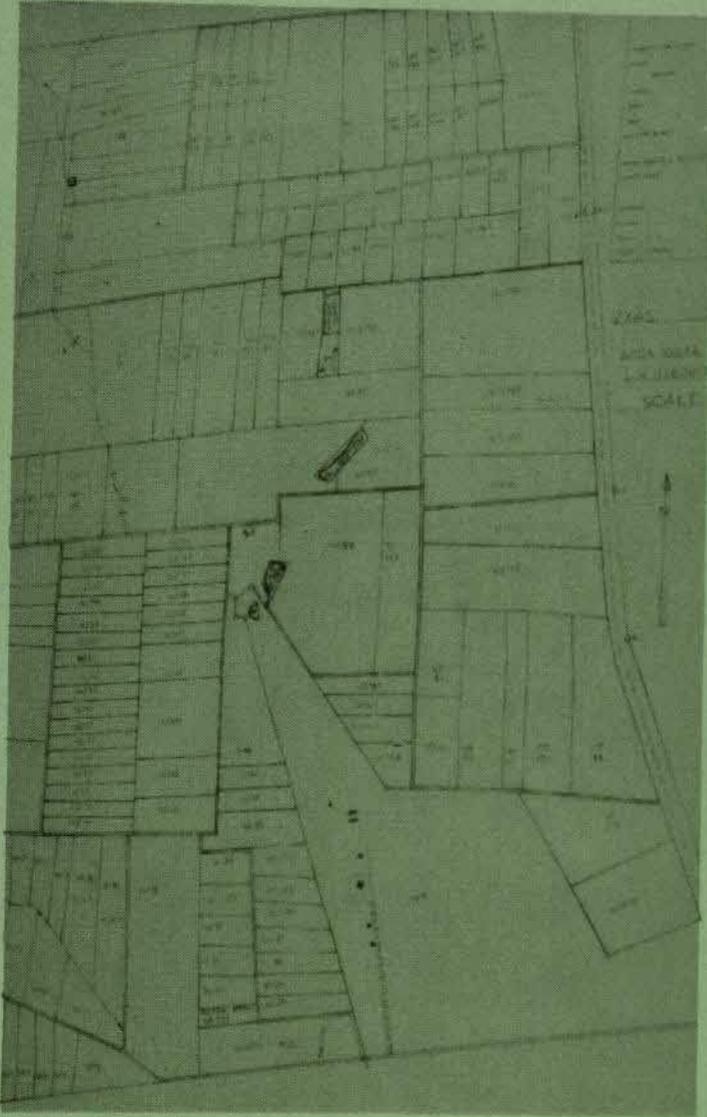
family farm sector tends to be larger in the Rift Valley. This trend is apparently being perpetuated through the unequal subdivision of large farms into family farm units (see Photo 13 and Section 3.5.1 in Main Report). The implications for mechanisation of key activities on family farms are far-reaching and complex.

It is unlikely that farm units in Kenya below two hectares in size will justify any standardised tractor mechanisation for production systems. On the other hand, a third of all family farms existing in the Rift Valley Province during the mid 1970s measured 3 ha or more. The majority of very small farms in the Province are in the west where the population density is highest (Kericho, Nandi and Trans Nzoia Districts - see Table A4). Most cultivation practises on these farms will be undertaken by hand. On the larger family farms, animal traction is used in areas where the people are familiar with this technique. This aspect is discussed in the following section.

In areas where the population density is high and land is used intensively, labour employment opportunities are greater on small farm units. Table A7 indicated the estimated level of farm employment on Kenyan farms in 1977/78 with the family farm sector gainfully employing over four times the amount of labour per unit area compared with the relatively highly mechanised large farms. Farm productivity per hectare is comparable in both sectors provided the level of inputs, other than farm power, are similar. Maize yields on large farms in the Rift Valley averaged 3 to 4 tonnes per ha in the mid 1970s (HTS 1977) compared with 2.5 to 3.5 tonnes per ha on family farms. The average yield per hectare in 1982 long rains season was estimated by local MOA officials to be about 2.6 tonnes per ha (see Table A5).

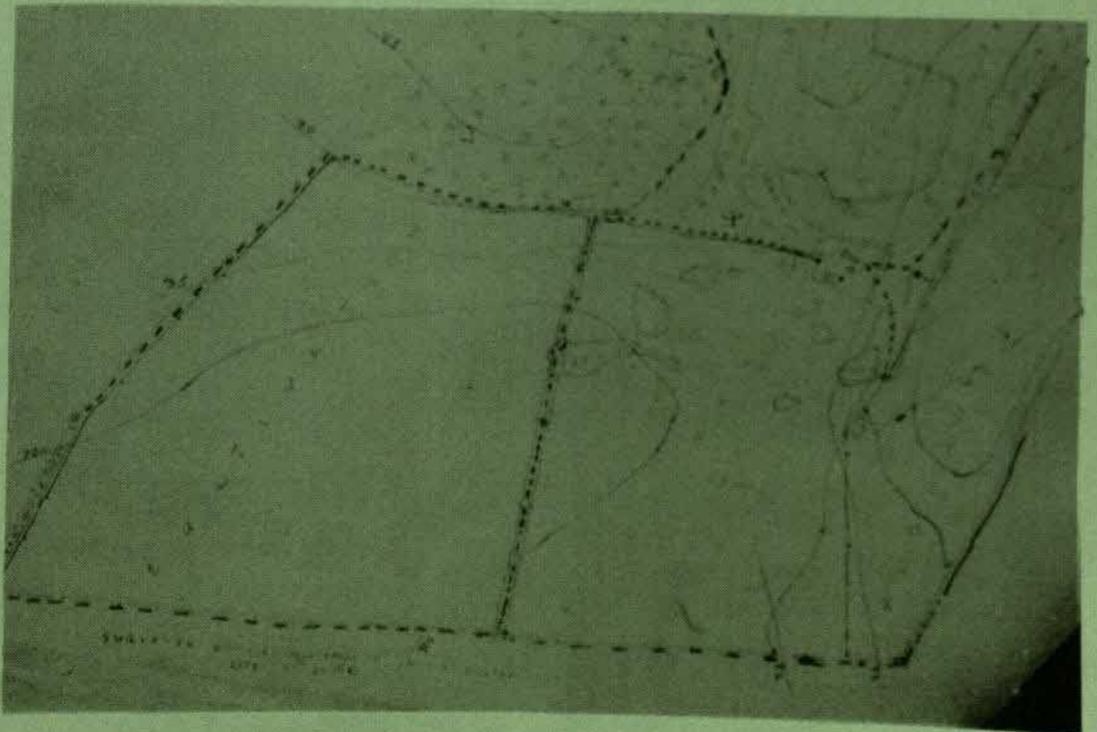
### 2.3 Farm Mechanisation in AMSB areas of Operation

As outlined in Section 1.1 of the Main Report, GOK policy in agriculture is to develop the family farm sector to a level where rural areas become self sufficient in basic foodstuffs (MEPD, 1982). The THS originally formed part of this policy, being organised 'to fill the gap where private contractors did not (currently) meet local demands and to stimulate agricultural development'. Initially the THS concentrated on the Masai Wheat Scheme with 4,200 ha being ploughed



a) (left) Plan of large farm in Eldoret District (about 960 ha) subdivided for family farm resettlement. Note gridiron pattern of plot demarcation with no provision for soil or water conservation.

b) (below) Plan of contour survey for land development (Vlei drainage) on large farm 20 km NW of Eldoret.



during the first year of operations 1966-67 (MOA, 1967).

However, as the service expanded into other areas, its management became more complex and its operations less effective (see Main Report, Sections 3). The service competed directly with private contractors in areas such as Narok, Migori and Kipkelion (Main Report Section 2.2). These private contractors, by virtue of their enterprise, were more efficient - and more effective - commercially than the AMSB. Thus, although the THS has increased its tractor fleet fourfold and its scope of operations nearly twentyfold, it has not achieved the output expected of it. The service ploughed less than 4,000 ha in 1982, harrowing and seeding a further 3,500 ha (14,400 ha were harrowed and seeded in the nine months of operations in 1966-67).

The THS was primarily established to provide small family farms with the opportunity to mechanise part of their cultivation practices where this operation could be afforded. In a recent estimate only 0.3% of rural households could afford to own their own tractors (S. Pollard 1982). In Kenya today, alternatives to tractor power are animal traction and hand cultivation techniques. The Agricultural Economics Unit (AEU) of the LRDD estimates that approximately 270,000 (i.e. 12% of the national total) of rural households own their own oxen (S. Pollard 1982). There are only two main areas in the country where oxen are used for draught purposes to any great extent. These are the regions occupied by the Luo (in Nyanza Province) and the Kamba people (in Eastern Province) who, together with smaller social groupings (e.g. Luya), have a historical tradition for using animals for traction purposes. Areas in which the AMSB has THS stations located where animal traction techniques are relatively popular include Machakos (Makueni AMS), Embu (Machanga AMS), Kajiado and Narok, South Nyanza (Migori AMS), and Kipkelion (Kericho AMS). In all these cases, except possibly the last one, adequate land, albeit often of low quality, is available on which to graze draught animals (see Table A4). The farming systems in these regions has been studied and adequately described in detail elsewhere (e.g. FMH Volume 2, 1983; S. Pollard, 1980 and 1981). Data collected on the various systems found in the high and medium potential areas include crop rotations and calendars and cropping intensities. A summary of the basic information collected on agricultural development in AMS regions is

located in Table A9.

Although the technique is only popular in two main regions of the country, animal traction is almost as important a component in the provision of power on Kenyan farms as tractors are. Using the data available, a rough calculation can be made of the relative importance of the three main methods of primary cultivation used in the agricultural sector. From the information contained in Table A3, the assumption can be made that approximately three million hectares of land are currently being cultivated each year in Kenya. Using data collected by the AEU of the LRDD (S. Pollard, 1982) Magariri Land Settlement Scheme (1981) and GTZ (1982), the following assumptions can be made:

- A pair of oxen plough an average of 0.25 ha per day for 10 full working days at the start of the rains.
- With an estimated national total of nearly 700,000 oxen, approximately 435,000 ha is currently being ox ploughed, assuming 170,000 active pairs (i.e. half the total population) plough 2.5 ha each per season.
- Assuming each privately owned tractor ploughs 90 ha per year (H. Schmidt, 1982, i.e. double the average of the THS units in recent years), 6,000 tractors annually ploughed an area of about 540,000 ha during the past three to four years.

From the above, an estimated total of about 1 million hectares is ploughed by mechanical means in Kenya each year with just under half this total being dependent on oxen for draught purposes. The AMSB cultivated a total of nearly 7,000 ha in 1982, of which about 3,850 ha (i.e. 55%) was ploughed with the remainder consisting of secondary cultivation and ploughing. This indicates that of the total area ploughed by tractors, 0.7% was done by the THS AMSB (i.e. 1 ha in every 150).

Looking at the overall position about two thirds of all primary cultivation in 1982 was done solely by hand, about 15% by oxen and the remaining area by tractor. In the family farm sector, around 80% of the land was hand cultivated with only 3% ploughed by tractors,

TABLE A9 Summary of Agricultural Information on Family Farms in AHMB Areas

AHMS	DISTRICT-PROVINCE	3.1. ACZ	3.2. AEZ	MAIN SOIL TYPE	LAND USE CROP %	AGRICULTURAL LAND/HOUSEHOLD	APPROX. POPULATION	CROP INTENSITY	MAIN ENTERPRISE	FARM POWER OWNERSHIP OXEN <sup>4</sup>	TRACTORS
1 Bumala	Busia-Western	I3	LM1-3	Upland Ferrasols <sup>1,2</sup>	55%	2.72ha	171/km <sup>2</sup>	0.9	Maize, Cotton, Sugar-cane	34% own Oxen	Very few tractors
2 Chiakariga	Meru-Eastern	IV1	LM5	Upland Luvisol <sup>1</sup>	56%	1.80ha	32/km <sup>2</sup>	1.4	Livestock, Millet, Sorghum		Few tractors
3 Eldoret	Uasin Gishu-R.Valley	III5-6	LH3	Plateau Ferrasols <sup>1,2</sup>	n/a	5.94ha	n/a	-	Maize, Wheat		Some private contractors in District
4 Garsen	Tana River-Coast	VII1	L5	Sed. Plain Solonetz <sup>3</sup> & Luvisols	n/a	-	n/a	-	Livestock, Ranching		Little cultivation
5 Garissa	Garissa-N.Eastern	VIII1	L7	Upland Cambisols & Fluvisols <sup>3</sup>	n/a	-	n/a	-	Nomadism		Little cultivation
6 Kajjindo	Kajiado-R.Valley	V3-4	UH <sub>2</sub> , LH2-4	Upland Luvisol <sup>1</sup>	n/a	5	n/a	-	Maize, Livestock	20% own Oxen	Few private contractors
7 Kipkelion	Kericho-R.Valley	II4-6	LH1-2	Volcanic F Ridge Nitosol	n/a	2.88ha	n/a	-	Tea, maize beans	26% own Oxen	No local private contractors
8 Kitale	Trans-Nzoia-R.Valley	III5	UM4	Upland Ferrasols <sup>1,2</sup>	n/a	3.67ha	n/a	-	Barley, Maize		No THS
9 Kitui	Kitui-Eastern	VI-2	LM5	Upland Acrisol <sup>2</sup>	n/a	23.94ha	n/a	-	Livestock, Millet	14% own Oxen	No THS
10 Machanga	Embu-Eastern	IV1-2	LM5	Hilly Cambisol Plateau Vertisols	44%	4.44ha	46/km <sup>2</sup>	1.5	Livestock, Millet, Cotton	18% own Oxen	Very few tractors
11 Makueni	Machakos-Eastern	IV2-4	LM4-5	Upland Acrisols <sup>2</sup> & Vertisols <sup>3</sup>	n/a	6.79ha	n/a	-	Livestock, Millet	30% own Oxen	Few tractors
12 Mariakani	Kilifi-Coast	IV1	L4-5	Upland Cambisols & Luvisols <sup>1</sup>	66%	4.40ha	140/km <sup>2</sup>	1.3	Maize, Cassava, Cashew, Coconut	Little Ox drawn cultivation	Few private contractors
13 Marigat	Baringo-R.Valley	III	UM3/UM5	Footslope Luvisol <sup>1</sup>	32%	9.70ha	18/km <sup>2</sup>	0.9	Livestock, millet, cotton	Little Ox drawn cultivation	Very Few Tractors
14 Migori	S.Nyanza-Nyanza	III3-4	LM2-3	Upland Cambisols & Luvisols <sup>1</sup>	46%	5.90ha	149/km <sup>2</sup>	0.9	Sugar-cane, Cotton, Cassava	34% own Oxen	Few tractors
15 Nakuru	Nakuru-R.Valley	III4-5	UH <sub>2</sub> UM4-6	Upland Cambisols	33%	4.63ha	n/a	1.0	Wheat, Maize	None	Some private contractors no THS
16 Narok	Narok-R.Valley	III5-7	UM4-5	Plateau Phaeozems	25%	33.55ha	0.5/km <sup>2</sup>	0.7	Beans, Livestock	20% own Oxen	Some private contractors
17 Naromoru	Nyeri-Central	III5-6	LH4-5 UM2	Volc F ridge Phaeozems	n/a	1.88ha	n/a	-	Wheat, beans, Coffee, wheat, Livestock	Some Oxen	Some private contractors
18 Nyatururu	Nyandarua-Central	II5-6	UH2-3	Volc F ridge Phaeozems	23%	5.33ha	66/km <sup>2</sup>	1.1	Wheat, potatoes, Pyrethrum	Very few Oxen	Some private contractors
19 Ruiru	Kiambu-Central	III4-5	LH2-3UM2-5	Volc F ridge Phaeozems	72%	1.13ha	157/km <sup>2</sup>	1.4	Maize, beans, Potatoes	Very few Oxen	No THS

Main Sources:- MoA Farm Management Handbook, K55 (1981) and S Pollard (1981)

Note:- 1 These soils can be prone to erosion and require soil and water conservation measures.

2 Low inherent fertility.

3 Difficult to plough.

4 Estimated ownership of oxen among rural householders.

5 Similar to Northern District of Narok.

assuming that no more than 500,000 ha of total cropped land was in the large farm sector (G. Muchiri 1981). These estimates compare favourably with those of CEBECO (1981) which indicated that in the family farm sector about 84% of cropped land was hand cultivated, 12% ox-ploughed and the remainder done by tractor.

In summary, tractor power plays a very small part in land preparation on family farms, with the THS contribution being virtually negligible.

The question as to which form of draught power, tractor or animal, should receive the greatest emphasis or priority by GOK is an issue which is still being studied in depth. Ideally a comparison of both forms should be made on technical, economic and social grounds and a balanced case presented for one or the other. In some instances, in certain areas, a case could justifiably be made for both where it can be demonstrated that there are conditions to which each are particularly suited or where one form of mechanisation cannot satisfy all the demand.

### 3. SOIL AND WATER CONSERVATION (SWC)

#### 3.1 Present Policy and Practices

The main cause of soil erosion in Kenya is the escalating removal of protective vegetation from the land. Subsequent accelerated water runoff leads to excessive loss of this resource as well. Erosion losses mainly affect the fragile layer of topsoil, together with its nutrient and organic content, resulting in decreased soil fertility or total loss of the topsoil. Once good fertile soil is lost natural processes can take several thousand years to replace it (UNEP, Nairobi; 1983). Productive farming land is scarce in Kenya (see Part 1) and every effort should be made to preserve it.

The Kenyan Government is fully aware of the need for conserving the country's soil and water resources. The present policy of the GoK on resource conservation is well thought out and sound. The problem is to put this policy into practice. The MoA is directly responsible for implementing the soil conservation aspects of government policy and the MWD for executing the policy on water conservation. Of necessity, there is considerable overlap of responsibilities between these two ministries and with other government bodies. The MoA Working Party (WP) which was set up in May 1980 to examine the major aspects of SWC in Kenya listed eight other government organisations which are directly involved in natural resource conservation of one kind or another (MoA 1981). Indeed this WP mentions 18 different public and private organisations, with 27 subdivisions between them, which are all concerned in some way with soil and water conservation.

It is not within the scope of this study to report on the deliberations and findings of this WP, or the PPCSCA which was subsequently established to implement approved recommendations of the WP (Cabinet memorandum on establishment of PPCSCA 1981). Nonetheless, the multiplicity of organisations working on natural resource conservation and the lack of co-ordinated policy and effort between these bodies has a direct bearing on the operation and effectiveness of the AMSB. In fact co-ordination is lacking between departments within this division of the ministry, let alone between ministries (see next paragraph). Within the limited resources at its disposal,

the PPCSCA has done well to publicise the importance of the resource conservation cause throughout the country. This has mainly been achieved through the vehicle of a national resource conservation week (see Table A10). The Commission alone cannot achieve its objective of identifying unsound land use practices and ensuring sound planning and implementation of SWC projects. Government organisations such as the AMSB are in a position to assist the PPCSCA in achieving these objectives as well as providing services to farmers.

The failure of widespread adoption of SWC measures throughout the country is not due so much to technical constraints as to extension problems (Zobisch M.A., 1982). The mechanisms of soils erosion are well understood (J.K. Mitchell, 1982; R.P.C. Morgan, 1982) and the technical approach to soil conservation in Kenya is covered in detail in the Soil Conservation Handbook (C.G. Wenner, 1981). The handbook is issued free of charge to technical officers in Government service by the Soil and Conservation Extension Unit (SCEU) of the LRDD. Yet this publication is apparently not used by the AMSB in the field. Although both the SCEU and the Board are within the same division in the MoA. The handbook is aimed specifically at family farmers in the high potential areas. Nevertheless, the contents apply just as well to the large farm sector in which the AMSB undertakes much of its work.

The SCEU handbook also advises technical officers on how to approach a farmer (and his wife) who needs conservation measures implemented on his farm. Furthermore, it shows how to plan and sub-divide a farm into separate units to obtain the best use from the land. This advice is invaluable to the AMSB in the work it has to carry out in demarcating and sub-dividing large farms into small family farm units (Photo 13). Good advice, in less detailed form, is also contained in the FMH Volume 2 (Jaetzold and Schmidt, 1982) and in the SIDA/MOA Soil Conservation Project 1980 review.

However, even with a high degree of technical skill, government officers cannot implement worthwhile SWC measures on land belonging to farmers who are unwilling, or unconvinced of the need, to have such benefits. This problem of extending advice on SWC requirements - and what the AMSB can do about it - is covered in the next section.

TABLE A10 Reported Achievements during National Soil and Water Conservation Weeks, 1981 and 1982

Achievement (in km)	Central 1981 1982	Coast 1981 1982	Eastern 1981 1982	R. Valley 1981 1982	Western 1981 1982	Nyanza 1981 1982	N.Eastern 1981 1982	TOTAL1) 1981 1982
Cut off drains	374.7 1586.6	27.5 90.9	50.5 650.8	77.9 128.5	28.1 337.2	355.9 116.6	1.9 -	918.5 2912.6
Fanya Juu terraces	917.6 2563.3	13.5 19.6	56.2 1169.4	36.8 76.9	14.9 236.4	886.0 19.6	1.5 -	1926.9 3089.7
Bench terraces	341.6 300.8	1.0 15.3	31.5 677.3	21.2 422.0	8.3 91.0	256.7 115.6	- -	660.2 1662.0
Narrow base terraces	68.7 189.7	- 7.8	21.7 246.5	2.2 56.4	1.1 52.5	665.0 3.0	- -	758.7 555.9
Stone terraces	11.4 5.4	1.0 2.2	12.8 197.1	13.7 31.1	5.2 39.1	405.5 8.4	0.5 -	444.4 283.3
Number of Gullies Controlled	92 49	20 346 <sup>2)</sup>	98 179	69 79	108 1230	464 90	3 -	854 1964
Number of water dams repaired	24 10	5 6	159 13	6 68	2 -	74 2	2 1	272 100
Gabions/Check dams	88.8 157.0	19.9 186.0	15.3 526.0	69.3 318.0	25.8 23.0	16.0 25.0	12.0 6.0	247.1 1241.0
Planted Grass Strips	86.3 141.9	4.0 18.6	- 1668.0	2.0 646.9	- 247.7	367.0 209.2	1.0 -	460.3 2808.5
Artificial Waterways	- .04	- 0.7	- 33.1	- 15.7	- 13.6	- 17.8	- -	- 80.9

Source: PPCSCA, Office of the President, Nairobi.

Note 1) Total includes Nairobi area.

2) Corrected figure

Some AMSB stations still retain a capability for planning and implementing sound SWC measures. Of the stations that the Study Team visited this was certainly the case with Ruiru and Mariakani AMS. These stations have some staff who have had 25 or more years experience in surveying, planning and designing soil and water conservation structures. However, the Study Team found that younger members of staff were not being trained by the experienced technicians in the art of surveying and planning in the field. AMS managers stated that university and college graduates and diplomates were not getting the opportunity to benefit from the accumulated experience of older staff due to the current staffing structure in the government service. Newly graduated staff are being placed in senior administrative or management positions on stations for which they have little or no training. This approach is naturally resented by less qualified, but highly experienced, older staff. Thus the benefit of accumulated experience was not being passed on. This state of affairs is a tragedy for a newly developing nation like Kenya.

### 3.2 Future role of the AMSB

The Main Report contains detailed recommendations regarding the possible future objectives and role of the AMSB (Section 4). Only those aspects requiring further elaboration are commented on in this supporting document. The Study Team envisages that future emphasis will be more on providing mechanical services for resource conservation than land cultivation as the latter can be effectively catered for by the private sector. In order to provide an efficient service to farmers, the organisation of the AMSB needs strengthening and restructuring, staff must be trained in advanced skills, and the activities of the various AMS need to be managed and co-ordinated in an effective manner.

Improvements in the organisation of the AMSB are recommended in Section 4.2 of the Main Report. Suggestions include the establishment of a planning and design unit and an in-service training programme for staff. Both of these innovations will have a direct bearing on the effectiveness of the AMSB to plan and implement sound soil and water conservation practices. The setting up of a Survey and Planning Unit (SPU) will enable the PHS to use its scarce resources to greatest

effect. In-service training courses are considered by the Study Team to be of just as much importance as academic training elsewhere. Kenya needs to use the expertise it has accumulated during the past three decades and experienced technical staff should be encouraged to pass on their skills. To do this, these staff (such as the TAs in the Survey Sections) need to be in a position of seniority. Provision should be made for promoting suitably experienced staff to positions where they can impart knowledge to newly graduated staff, even if the latter are at Agricultural Officer level. If this is not done, there is a danger that younger staff will be promoted to senior administrative positions with little or no practical experience in soil and water conservation techniques. This has already happened at some stations (e.g. Eldoret and Migori AMS).

In view of the fact that most problems in SWC work stem from extension rather than technical aspects, the AMSB should have a much closer working relationship with other organisations which are also involved in this field. This includes the Extension and Training Section of the SWCB within the LRDD. Although the latter's responsibility is exclusively in the family farm sector, much of its work is just as applicable to the large farm sector (e.g. Soil Conservation handbook for field technical officers). Kenya faces a mammoth task in educating the present generation of land users in the urgent necessity of conserving the nation's natural resources. The AMSB is in frequent contact with large scale farmers. Merely informing farmers of the AMSB's capability to plan and implement standard soil conservation measures is a step in the right direction.

Many large scale farmers are still unaware of the need for conserving soil and water resources on their farms, or of the benefits that will accrue from the implementation of effective conservation measures. However, there appears to be a growing awareness among leading farmers of the necessity for, and the advantage to be derived from, such measures. These are the people who will show the way provided they are assisted in building approved structures on their farms. The PHS has the mechanical resources; the proposed SPU would ensure that the planning and design of all work was technically sound.

The Study Team does not recommend that the AMSB contemplate the

setting up of its own resource conservation extension unit. What is envisaged is that there should be a strengthening of the capability of technical officers to advise farmers on the correct approach to resource conservation and the AMSB's capacity to implement such measures.

Apart from improving communications between itself and other relevant bodies, the AMSB can do little about co-ordinating its efforts in the field without help from the provincial administration. The District Commissioners have wide powers including those of enforcing good land use practices if they feel that this is necessary. However, most of the responsibility for encouraging resource conservation and protection in the rural areas falls on the District Agricultural Officer (DAO). The DAO plays a crucial role in this work. He must be keen, interested in his work, and able to motivate the staff under him. The Study Team met men of this calibre in the field (eg Migori).

In many instances the DAO, or one of his staff, will probably be the first contact between any 'potential customer' and the local AMS. Thus there needs to be a closer working relationship between the DAO's office and the stations, backed up strongly by the DC's office as well as the PDA's. This would encourage a more disciplined attitude towards the planning and implementation of government directed efforts in resource conservation at district level.

#### 4.1 Introduction

At the specific request of HQ staff of the AMSB, members of the study team visited the Nyakach area in Nyando Division, Kisumu District, on April 22nd 1983. The purpose of the visit was to inspect gully erosion in the eastern half of the division and appraise the work being carried out by the PHS's field unit which has been attempting to control the gullies since 1980.

#### 4.2. Description of Area

4.2.1 Agro-Climatic Zone (ACZ): Nyando Division falls within ACZ III 3 which indicates that annual average precipitation is 65-80% of the potential evaporation with the mean annual temperature being about 21°C at 1,350 m (4,500 ft). Average annual rainfall is about 1,200 mm with a 60% reliability of receiving 600 mm in the long first rains and 400 mm during the second rains (FMH, MoA, 1983).

4.2.2 Soil Type: (Arenosols with Luvisols) Dark yellowish brown gravelly soils developed on collivium from undifferentiated Basement Complex Rocks. The land forms in the area are hill footslope and piedmont, the former being situated on the east side of the Kano plain. Inclines on the piedmont are approximately 4 to 8%. Well drained and coarse in texture, the soils are very deep (up to 0.7 m) but generally have only low to moderate fertility. The luvisols have a tendency to cap on the surface leading to low water infiltration rates and resultant high runoff (KSS 1981). "These soils are easily eroded ..... erosion can be severe and therefore soil conservation is a necessity" (KSS 1982).

4.2.3 Agro Ecological Zone: Most of the Division is situated in the cotton zone (LM3) with good potential for growing the crop. Another crop with high potential is sisal. Yield potential is fair for maize (Hybrid 511-513), cassava and pigeon pea. The stocking rate on natural pasture ranges from 0.9 - 1.2 ha per livestock unit (FMH

Volume IIA 1982 - unimproved stock: 1 cow = 0.65 livestock units). 75% of the area in Kisumu District is reckoned to be unsuitable for economically successful small scale crop production (MOA 1981). The three main crops actually produced by Nyakach farmers during the period 1979-82, in order of importance, were maize, cotton and sorghum (MOA 1982). No data is available on sisal production; little of this crop was seen during the team's visit to the area.

4.2.4 Population: The population in Nyando Division in the 1979 census totalled 155,700 with a density of 181 people per square kilometre. The available agricultural land per person was 0.42 ha giving an average of 2.23 ha per household of five people. The population density has been relatively high for at least the last two decades (National Atlas of Kenya 1963).

4.2.5 Present Land Use: Quite substantial areas of the eastern part of Kisumu District are under cultivation. The majority of the people live on the piedmont between the hill footslopes and the lake shore. Nearer Kisumu town 57% of farm land was estimated to be under crops in 1977. Average farm size was 2.2 ha. However, comparatively large areas of commonly owned land were still available for livestock grazing. The average herd size per farm was 18 head. The hill slopes to the east of the study area appeared to be heavily grazed and the land in the vicinity of the footslopes was partially denuded due to overgrazing in the latter half of the dry season. Further signs of the intensive usage of land in the area were the cropping of natural waterways, where these were situated near homesteads, and the spread of noxious weeds such as Lantana camara and Calitropis spp.

4.2.6 Soil Erosion: Small gullies reportedly started forming in 1979 up to one kilometre down from the hill footslopes. Excessive run-off, following storms during the early part of the first rains, led to scouring of the natural waterway and gully formation. The initial gully was allegedly relatively shallow (less than 2 metres deep) during the first season when it was first reported by villagers to the local Agricultural Officer. A survey team from Kipkelion AMS was sent to assess the area in late 1979. No confirmation could be obtained as to whether any of the area under study was surveyed at that time or later. No survey maps of any kind were to be found at either this

station, the site itself, or Migori AMS at the time of the study team's visit. The latter station took over responsibility for controlling gully erosion in the area in 1980. By the end of the second rains in that year, the initial gully had reportedly grown by several metres in both depth and width. The seriousness of the situation was appreciated by officials in the PDA's office in Kisumu, and substantial sums of money were allegedly made available through the local District Development Committee. The Nairobi office of the Canadian International Development Agency (CIDA) contributed K.Sh 5 million towards the cost of the Nyakach Gully Control Project, as it had become known (SWCB, LRDD personal communication May 1983).

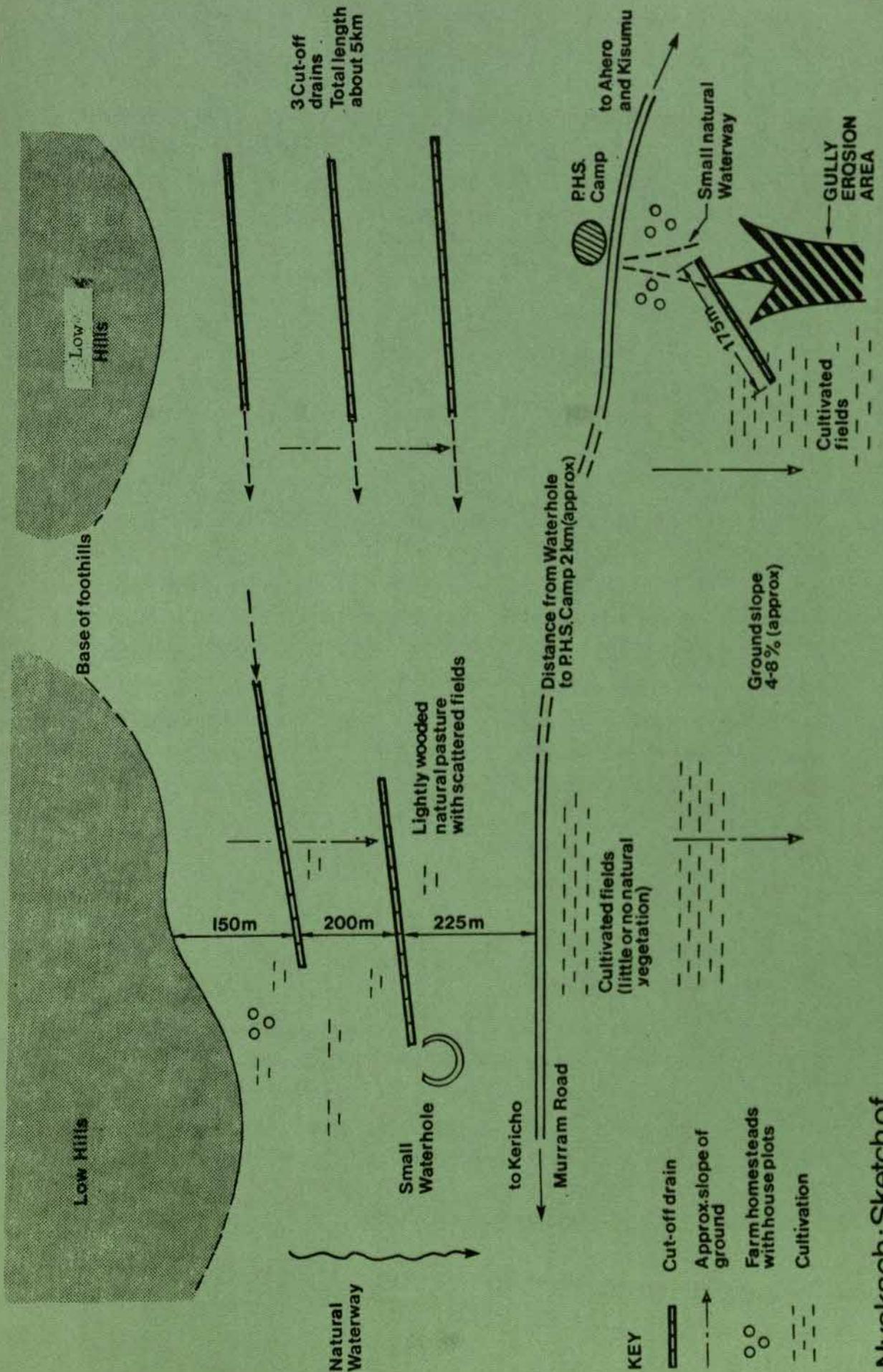
#### 4.3 AMSB Gully Control Measures

A PHS field team from Migori AMS commenced work on gully erosion control measures in late 1980. Two crawler tractors and a dam-scoop were stationed at the site and over the following two years three cut-off drains, totalling approximately 5 kilometres in length, were constructed between the hill foot-slope and the head of the initial gully. The cut-off drains, which run in a straight line due north, were designed to spill into a small water hole approximately 2 kilometres north east of the original gully (see Figure 5). The water-hole was constructed in 1982/83, in compliance with the wishes of the local people, to provide water for consumption purposes. In the period 1980-1982, the eroded area expanded considerably with the head of the new gully reportedly moving 20 metres up the slope and the gully's depth increasing to over 6 metres.

Machinery operating problems (mainly fuel shoretages) brought PHS activities to a virtual standstill in late 1982. However, prior to the onset of the main rains in 1983, a shallow cut-off drain some 175 metres in length was made across the natural contour in a straight line about 30 metres above the head of the main spur of the gully (see Photo. 14 in the main report). This drain had broken at the time of the Team's visit to the site on 22nd April, 1983.

#### 4.4 Recommendations

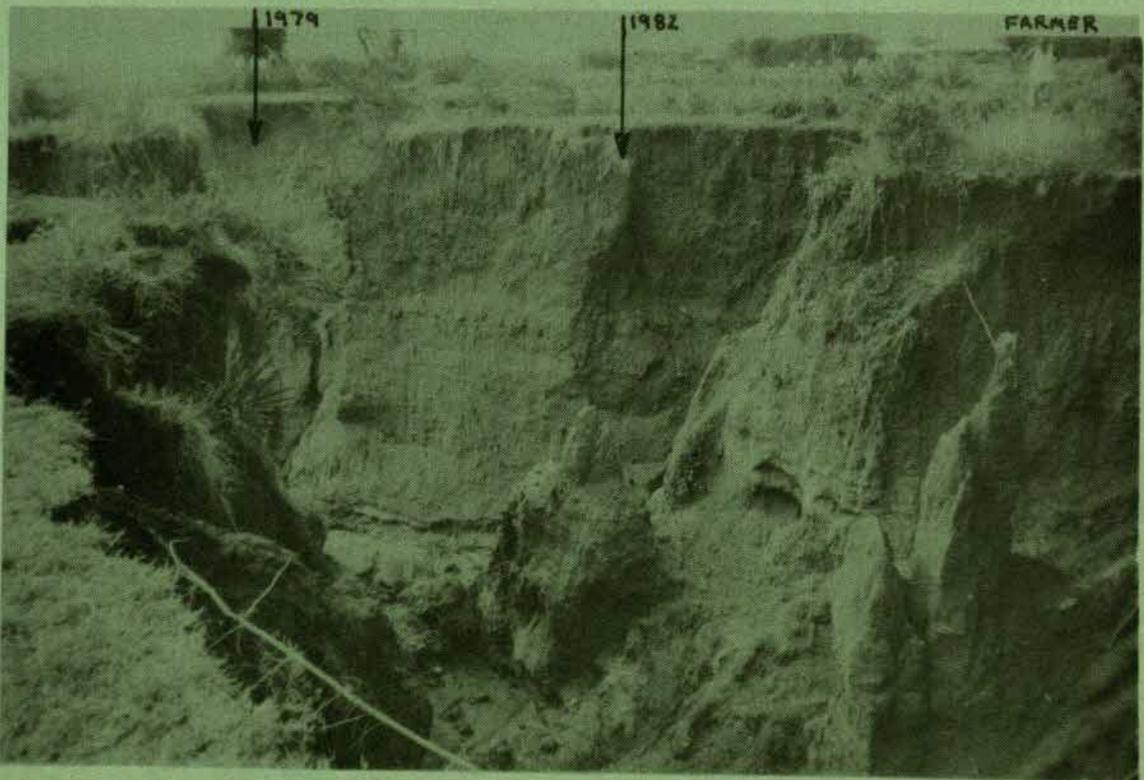
Urgent solutions need to be found to improve the situation at Nyakach. The perceived priorities are:



Nyakach: Sketch of Gully Erosion Control Area



a) Head of gully erosion accelerated by incorrect siting of cut-off drain at Nyakach South, Kisumu District.



b) The deterioration during four years of work on the control of gully erosion, adjacent to a). Arrows show head of gully at various stages.

- To arrest the present level of gully erosion as quickly as possible;
- To then stabilize the gullies which have been formed;
- To reclaim lost land where possible;
- To promote a long-term self-sustaining system of land use in the area.

In achieving these aims all aspects of land use, including crop production and livestock grazing, must be improved and made more protective. The prime objective should be to maximise the amount of surface cover on all pasture and cultivated land whilst at the same time at least maintaining the Nyakach peoples' present standard of living.

Several different, but inter-related, approaches can be made towards solving the problems connected with resource conservation at Nyakach. These are separated here into immediate and longer term solutions and technical and social approaches. Little can be done in the way of physical activity by the AMSB until the end of the wet season (in fact it would be positively harmful to undertake any soil conservation works until the end of the year even if erosion levels continue to accelerate). However, much can be done in the way of planning and preparation. Information must be gathered on some basic aspects of the situation before any further work is done in the area. Firstly, a topographical survey should be done of the immediate catchment area. This survey area should include the land up to the hill footslope to the east of the eroded area and the natural pasture land spreading northwards to the main waterway.

A detailed study should also be made of the latest aerial photographs taken of the area (1980) to compare present land use with the past (1948), and to subsequently assess possible trends in the future. If possible, a short study should also be made of both natural resources (other than landforms) and human resources in the affected area. Among the aspects studied would be population levels and movements, current land use practices, including stocking rates and land tenure, and farm economics. People's attitudes towards

the very real problem in their midst would also need to be examined.

Once sufficient data was collected, the planning and design of effective conservation measures must be made. These would have to be both technically sound and socially acceptable to the local people. Factors which would need to be considered include the possibilities of decreasing the stocking rate of cattle in the catchment area and the construction of proper conservation structures. The latter would entail the realignment of water diversion channels along the contour line and the construction of cut-off drains along the foot of the hills to the east of the eroded area. Natural waterways could be marked out and protected with locally available material before the end of the wet season with the same being done for the gully areas themselves. (See Soil Conservation in Kenya, 1981 and FMH 1982 - both publications available to DAOFS).

Accepted designs and programmes should be implemented as soon as the rains end. Work needs to be started on gully stabilisation measures using standard practices. However, technical solutions are not sufficient in themselves and social approaches to the problem should also be pursued at the same time as an integral part of the overall resource conservation programme. These social aspects would include informing and educating the local people of efforts which were being made on their behalf to improve the situation and to obtain their active co-operation (both physical and moral). Without human commitment, any technical solutions will be to no avail in the long run. The control of livestock grazing, the protection of waterways and eroded areas, and better farming practices (including early ploughing and contour terracing of fields) should all be among the aspects covered in the long-term social approach to the overall problem.

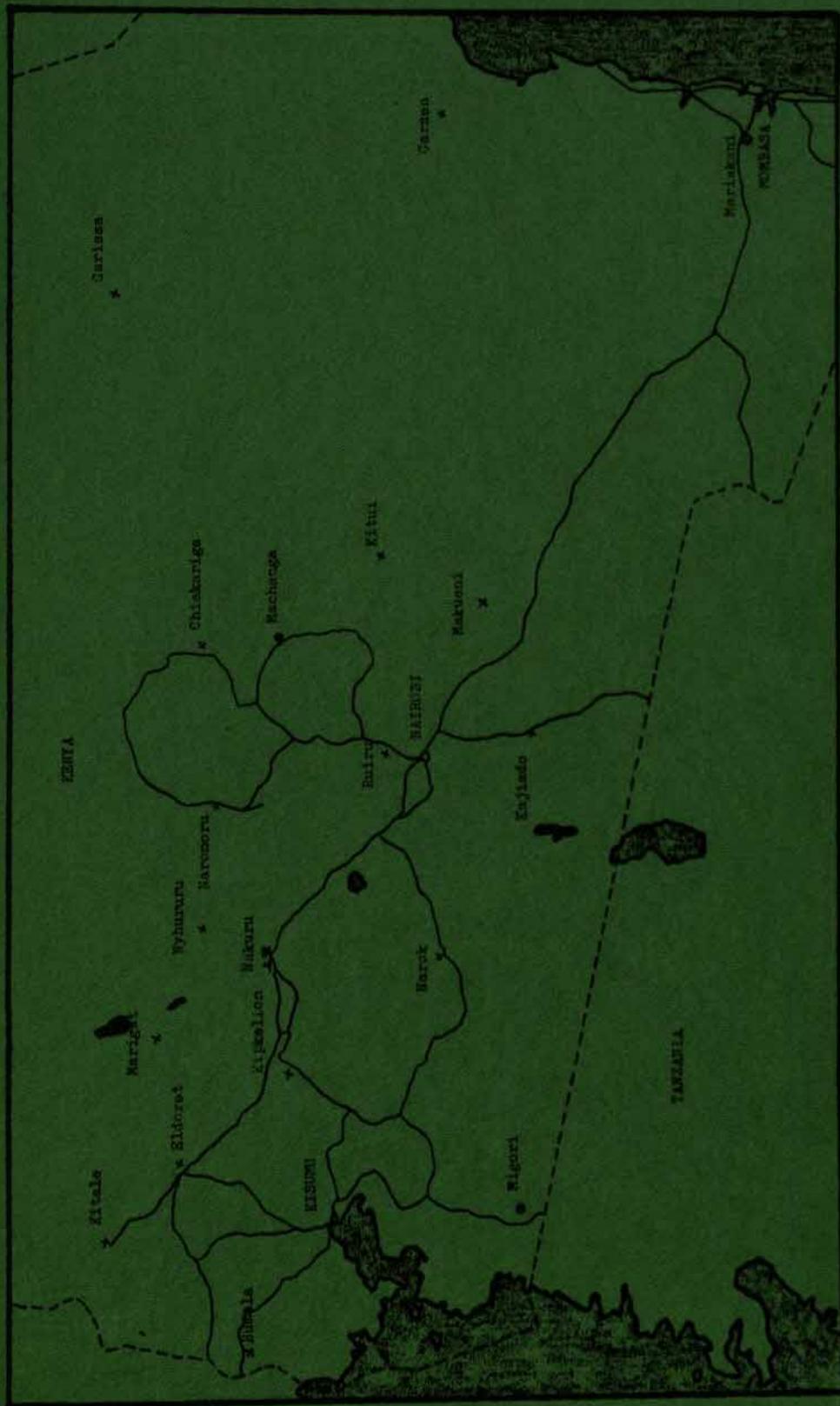
The successful execution of some of these measures will only be achieved through long-term co-ordinated effort. The Government sponsored team, working through the PDA's office, needs to operate closely with representatives of the local community including the District Development Committee and the local council. This approach is of even more paramount importance if finance is to come through

these sources, as well as from central government, as has been the case up until now.

Considerable funds have already been expended on trying to solve 'the Nyakach problem' during the past four years. The Study Team consider it essential that a properly planned and co-ordinated programme be fully costed and controlled if there is to be any hope of a successful solution to the problems (see Main Report Section 4). The PHS staff at Migori AMS and HQ staff in Nairobi could possibly assist the DAO, Kisumu, in this exercise. This type of work would be of the kind that the recommended Survey and Planning Unit of the AMSB, together with the Accounting and Information Section, would be ideally suited to undertake once these bodies have been formed. At present neither the AMSB, nor other organisations in the Province, have any capability for planning and implementing a programme such as that envisaged for the control of the gully erosion at Nyakach. This type of expertise is needed urgently if Kenya is to avoid further disasters similar to the one at Nyakach.

MAP OF KENYA SHOWING AGRICULTURAL MECHANISATION STATIONS

(SCALE 1:5 million)



- KEY
- - - National frontier
  - Major Road
  - X Agricultural Mechanisation Station, X With PMS Services only.
  - ⊗ Regional Workshop
  - \* Central Workshop

