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WASAARADDA BEERAHA
SOMALI DEMOCRATIC REPUBLIC
MINISTRY OF AGRICULTURE

GENALE-BULO MARERTA PROJECT

ANNEX VI

Potential for Agricultural Development

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PROJECT AREA AND STUDY AREA

This study contained two elements, a Master Plan covering 67 400 hectares and a feasibility study of 5 000 hectares.

Throughout the reports the term Study Area refers to the area covered by the Master Plan studies and the term Project Area is used for the feasibility study area.

ABBREVIATIONS USED IN THE REPORTS

ADB	African Development Bank
ADC	Agricultural Development Corporation
CARS	Central Agricultural Research Station - Afgooye
DAP	Diammonium phosphate
EDF	European Development Fund
ENB	National Banana Board
FAO	Food and Agriculture Organisation
FAO/PP	FAO Pilot Project (Afgooye - Mordiile Project)
HASA	Hides and Skins Agency
HTS	Hunting Technical Services Limited
HV	High volume (crop sprayer)
IBRD	International Bank for Reconstruction and Development (the World Bank)
IRRI	International Rice Research Institute
ITCZ	Inter-tropical convergence zone
ITDG	Intermediate Technology Development Group (London)
JOSR	Jowhar Offstream Storage Reservoir
LDA	Livestock Development Agency
Libsoma	Libya-Somalia Agricultural Development Company
LSU	Livestock unit
LV	Low volume (crop sprayer)
MLFR	Ministry of Livestock, Forestry and Range
MMP	Sir M. MacDonald & Partners
NCA	Net cultivable area
NCB	National Commercial and Savings Bank (formerly National Commercial Bank)
ONAT	National Farm Machinery and Agricultural Supply Service
PLO	Palestine Liberation Organisation
SDB	Somali Development Bank
SNAI	Jowhar Sugar Estate
TDN	Total digestible nutrients
TDP	Total digestible protein
ULV	Ultra-low volume (crop sprayer)
UNDP	United Nations Development Programme
USBR	United States Bureau of Reclamation
USDA SCS	United States Department of Agriculture, Soil Conservation Service
WHO	World Health Organisation

SPELLINGS OF PLACE NAMES

Throughout the report Somali spellings have been used for place names with the exception of Mogadishu where the English spelling has been used. To avoid misunderstanding, we give below a selected list of Somali, English and Italian spellings where these differ.

Somali	English	Italian
Afgooye	Afgoi	Afgoi
Awdheegle	-	Audegle
Balcad	Balad	Balad
Baraawe	Brava	Brava
Buulo Mareerta	Bulo Marerta	Bulo Mererta
Falkeerow	-	Falcheiro
Gayweerow	-	Gaivero
Golweyn	-	Goluen
Hawaay	Avai	Avai
Hargeysa	Hargeisa	-
Janaale	Genale	Genale
Jelib	Gelib	Gelib
Jowhar	Johar	Giohar
Kismaayo	Kisimaio	Chisimaio
Marka	Merca	Merca
Muqdisho	Mogadishu	Mogadiscio
Qoryooley	-	Coriolei
Shabeelle	Shebelli	Scebeli
Shalambood	Shalambot	Scialambot

GLOSSARY OF SOMALI TERMS

Cambuulo	-	Traditional dish of chopped boiled maize with cowpeas or green grams.
Chiko	-	Chewing tobacco
Der	-	Rainy season from October to December
Dharab	-	Five jibals or approximately 0.31 ha
Gu	-	Rainy season in April and May
Hafir	-	Large reservoir on farms for storing water for use in dry periods
Hagai	-	Climatic season June to September characterised by light scattered showers
Jibal	-	Area of land approximately 25 m by 25 m or 0.0625 ha
Jilal	-	Dry season from January to April
Kawawa	-	Two man implement for forming irrigation ditches
Moos	-	Measurement of land area equal to a quarter of a jibal
Quintal	-	Unit of weight measurement equivalent to 100 kg
Uar	-	See hafir
Yambo	-	Small short-handled hoe
Zareebas	-	Thorn cattle pen

PART I

GENERAL

CHAPTER 1

INTRODUCTION

1.1 Existing Situation

Location, climate, water resources, soils, population and agricultural significance of the Study Area have been summarised in Annex IV, Chapter 1.

Description and discussion of present crop production are contained in Annex IV and, in relation to proposed recommendations, include:-

(a) present land use

(b) farming systems and methods, cropping systems and production inputs

(c) production problems affecting the major annual and perennial crops

(d) labour usage and availability.

Infrastructural services applicable to crop production are discussed in Annex III, Chapter 3 and include institutions both inside and outside the Study Area which affect production within the area. Information on Study Area population and land tenure is also given in Annex III (Chapters 4 and 5), both of which must be considered as part of any development proposals.

Present crop production is dominated by maize and sesame, grown mainly as subsistence crops, as well as bananas, which are grown mainly for export to Italy and the Middle East. The area under cultivation is widespread, occupying an estimated 74% of the Study Area, with virtually all production being under some form of irrigation. However, land use intensity is generally low. Although annual crop production occupies 63% of the Study Area (as gross areas), average land use intensity is only 39%. Consequently the net cultivated area under annual crops of 16 590 ha represents only 25% of the gross Study Area of 67 410 ha. A wide range of other crops is also cultivated, but on a small scale. These include upland rice, pulses, groundnuts, tomatoes, tobacco, grapefruit and coconuts. Previously, cotton, castor and groundnuts had been grown extensively. There are, basically, two farming systems in the Study Area. Annual crop production is dominated by smallholder farming and by commercial growing of bananas, both of which utilise hand labour for nearly all field operations. Land preparation for bananas represents the only extensive use of machinery, with the small area (400 ha net) of upland rice being the only form of truly mechanised farming. However, labour availability studies indicate that with few exceptions the necessity to mechanise farming is limited.

Crop management is poor. Annual crop production, in general, is dependent upon erratic rainfall and poor water supplies along inefficient canals. Fertiliser usage and pest control measures are effectively nil. As the main problems are weed control, irrigation supplies, poor land levelling, pests and poor crop nutrition, yields are therefore low. Bananas have declined in productivity over the last ten years due to many inter-related agronomic and economic problems. Present net returns are very low and, as a result, overall crop management is minimal. This is seen as insufficient nematode control, fertiliser usage, drainage, weed control and poor irrigation. Seasonal labour shortages are experienced, and the continued seasonal usage of moderately saline groundwater must also be contributing to this decline.

Infrastructural services serving the agricultural sector are inadequate even though the regional headquarters of the Ministry of Agriculture and semi-autonomous agencies are situated in the Study Area. On top of this, national institutions dealing with agricultural training and research as well as seed multiplication are situated at Afgooye, only 65 km upstream of the Study Area in an area with similar physical and climatic conditions. The present situation and problems are summarised below.

(a) The shortage of sufficient and qualified staff within the Ministry of Agriculture is such that, apart from limited development of co-operatives, virtually no impact has been made by extension services on the farming community.

(b) The lack of properly organised long term research programmes since the establishment of CARS, Afgooye in 1964 has resulted in few valid recommendations for improved methods of crop production. Coupled with this, the lack of properly supervised seed multiplication and inspection has also resulted in the total lack of pure stocks of any recommended annual crop variety.

(c) Agrochemical and fertiliser supplies are generally adequate with shortfalls reflecting demand more than supply.

(d) Export marketing of bananas, organised by the ENB, is erratic and, along with high FOB costs and technical charges, is another major reason for poor productivity.

(e) Tractor hire, maintenance facilities and spare part availability are inadequate, due to concentration on the servicing of state farms.

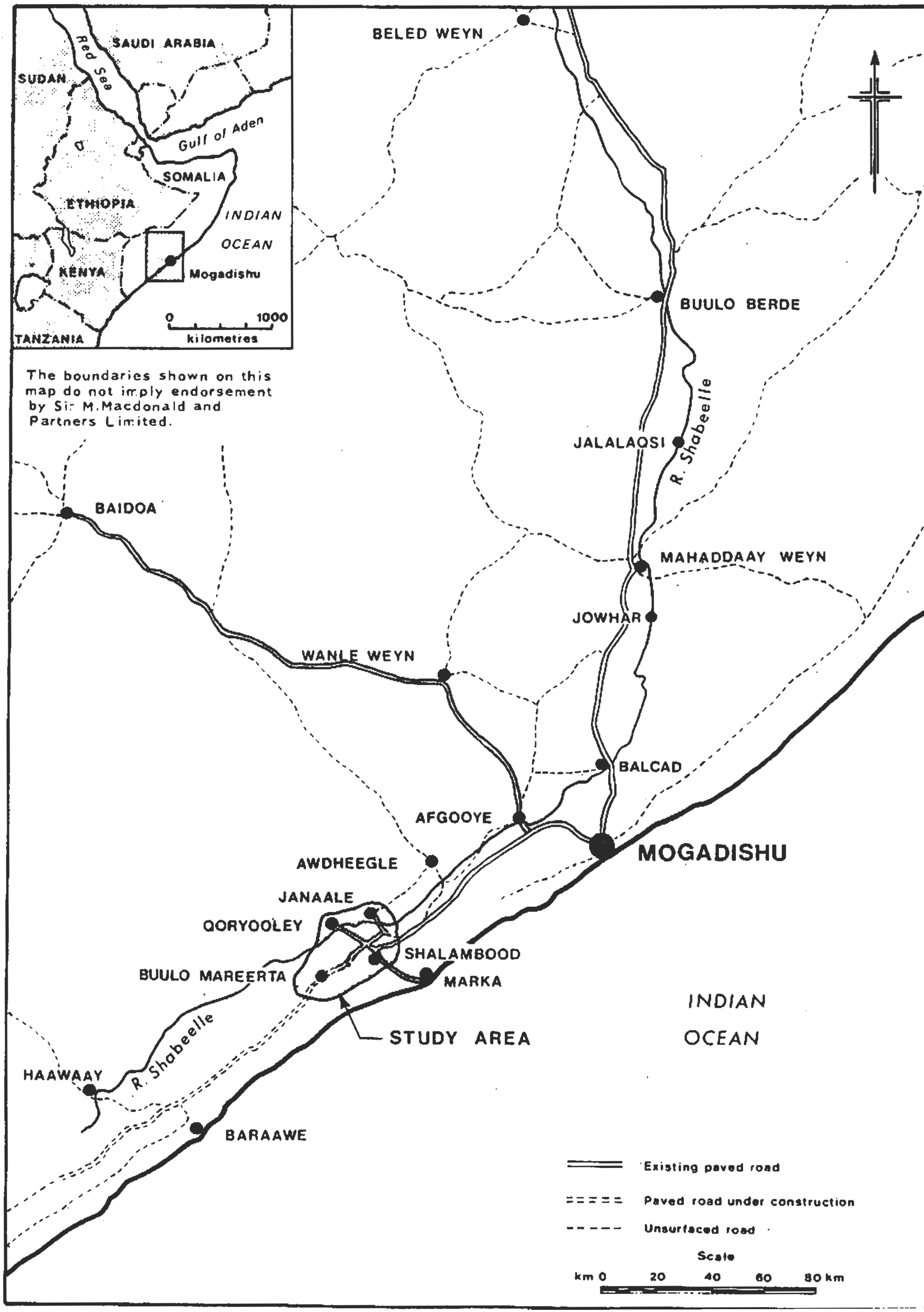
(f) Marketing organisations (private and state) for surplus produce, particularly grain crops, are good. ADC operations in the study area are a reasonable model for other institutions to follow.

(g) The first students from the new agricultural school and university faculty of agriculture graduated during 1977. Consequently, present shortages of qualified manpower should lessen provided graduates are effectively absorbed into development projects.

1.2 Development Proposals - Data Sources

Crop recommendations for the Study Area to be discussed in Annex VI, were based on technical data collected from various sources during 1977 and are outlined below. All information was correlated with existing problems and production methods reported fully in Annex IV.

LOCATION OF THE STUDY AREA



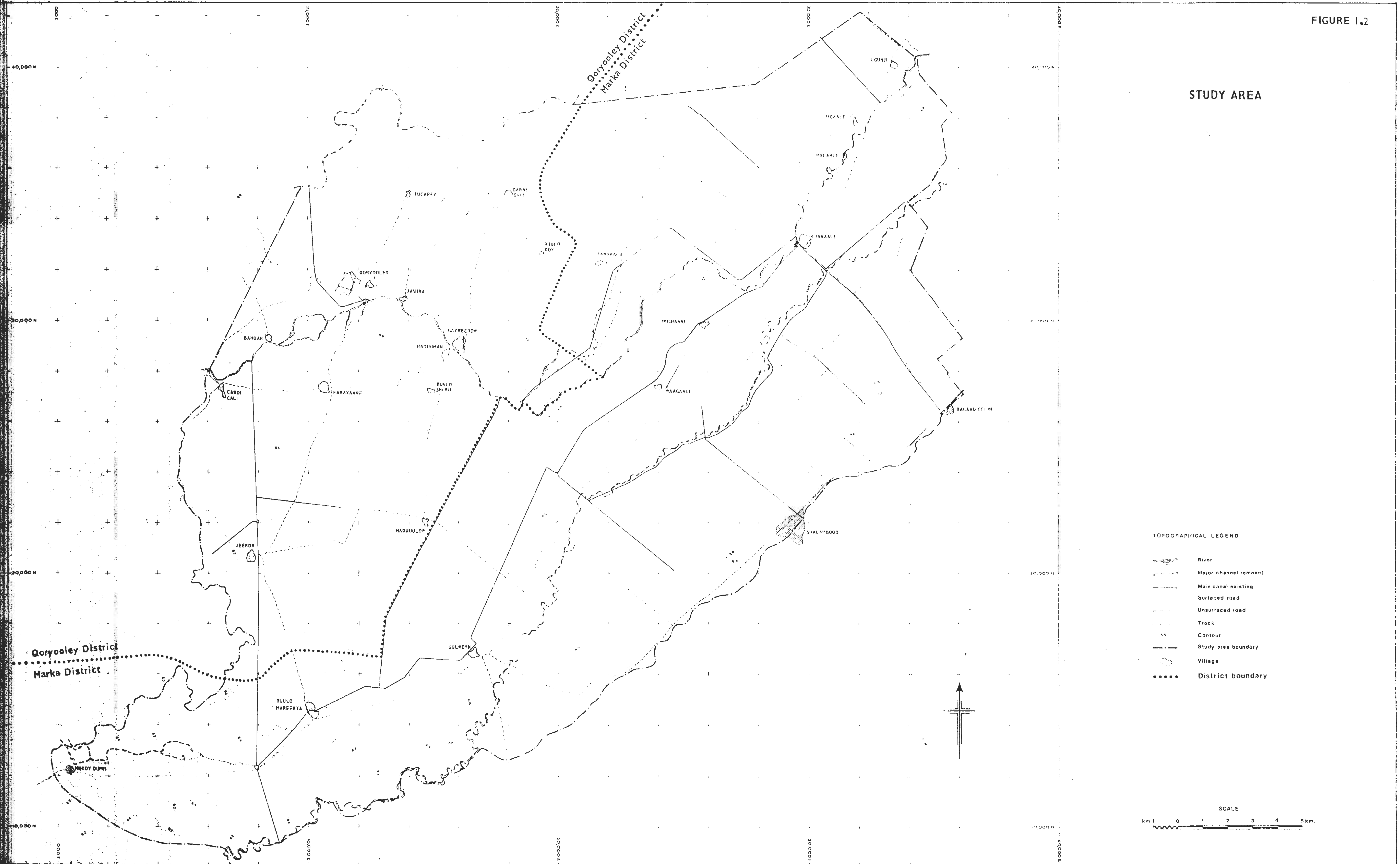


FIGURE 1.2

STUDY AREA

(i) Agriculture Projects

Regular visits were made to the following projects outside the Study Area in order to monitor growing crops, assess production problems and collect production information:-

Project	Crops
Haaway Crash Programme farm	Paddy rice (500 ha direct-drilled)
Afgooye - Mordiile project and pilot farm (Libsoma Farm)	Maize, upland rice, groundnuts and sesame (approx. 1 000 ha)
Experimental tobacco farm (People's Republic of China Technical Aid Project), Afgooye	Tobacco (30 ha)
Seed Multiplication Centre, Afgooye	Maize, upland rice and groundnuts
Central Agricultural Research Station, Afgooye (CARS)	All annual crops
ITOP processing factory, Afgooye	Canning tomatoes (120 ha)
Balcad irrigation project	Cotton (720 ha)
Chinese Technical Aid Experimental Farm, Jowhar (People's Republic of China)	Paddy rice (40 ha)
Ciba-Geigy crop protection fieldwork	Cotton, maize, upland rice and bananas (at Balcad, Libsoma, CARS and Study Area banana farms)

Ciba-Geigy technical staff were an invaluable source of general agronomic information pertinent to the Study Area as well as specific information relating to chemical application methods and problems.

(ii) Infrastructure

Expanding crop production can be limited by post-harvest processing facilities. Capacity data and quality requirements were collected from the following sources:-

Process	Source
Oil milling	National Oil Mill, Mogadishu (Ministry of Industry)
Cotton ginning and weaving	Somaltex factory, Balcad
Tomato canning	ITOP factory, Afgooye
Cigarette manufacture	National Cigarette and Match Factory, Mogadishu
Rice milling	Crash Programme and ONAT mills, (Shalambood).

(iii) Technical Reports

Technical information in the form of reported data has been drawn from a wide range of sources. However, availability of reported technical information from within Somalia and drawn from development work carried out along the Shabeelle river is limited.

Main sources used are:-

(a) Semi-annual reports, CARS, 1965-1974

(b) Pilot project for irrigated agricultural development on the Shabeelle river, FAO, 1975

(c) Ciba-Geigy crop protection recommendations for Somalia in 1977 (unpublished).

One of the major limiting factors to crop development in the Study Area is the present overall lack of basic proven recommendations, and, with a few exceptions, improved varieties selected under local conditions. Although visits were made to many projects, management practices in all but a few were poor, markedly reducing the amount of valid information that could be utilised. On top of this, as has been fully discussed in Annex III, Chapter 3, research data from CARS, Afgooye are, in general, inadequate. Although the FAO pilot project

(FAO/PP) carried out an extensive research programme, it was effectively for one year only and therefore information must be used with a certain degree of caution. The Ciba-Geigy recommendations were also introduced after one year's experimental field work and are currently being modified as the result of certain problems experienced in 1977.

Therefore, in order to establish the recommendations required for this study, substantial reference (as outlined above in Section 1.2 (c)) is made to reported information from outside as well as to standard agronomic text books. Consequently, as will be repeatedly pointed out in this annex, further work is essential in order to verify and/or modify most of these technical recommendations.

1.3 Development Proposals - Annual Crop Production

As the result of Government policy to limit expansion of perennial crops to present proposals (see Annex IV, Chapters 4, 11 and 13), the most important agricultural development in the Study Area will be improvement of existing irrigated annual crop production. The existing area under annual crops is already extensive and dominated by smallholder agriculture within the highly populated Study Area. Current Government policy towards development of smallholder agriculture is the formation of either co-operative societies (multi-purpose societies) or actual co-operative farms (group farms). Development proposals given in this annex will be based on the improvement of the present irrigated farming system in two ways along these same lines. These are the identification of specific projects and, elsewhere, the general improvement of technical services to the present agricultural community within particular development zones. Two methods of irrigation are also being proposed.

1.3.1 Development Projects

In these projects, provision is made for full farm management and technical supervision, machinery availability, the organisation of input supplies (seed, chemicals, fertilisers etc.) and marketing of surplus produce. Projects will be provided with an adequate system of main canals, secondary canals and field channels (watercourses) as either the extension of existing systems or as completely new systems. Surface drainage systems will also be introduced.

The main project proposed is the Qoryooley project, for which a full feasibility study and design has been undertaken. Most of the remaining projects will be based on development proposals given in Annex VII (Engineering) as in most cases engineering restrictions or requirements are the main criteria involved with project identification. Management and implementation of these projects are discussed in Annex IX. Farming systems will be based on either co-operative (communal) farming by smallholders or the existing system.

1.3.2 Development Zones

Remaining areas within the Study Area have been demarcated as development zones. Within each zone, development proposals will be based on upgrading existing services in the form of improving existing agricultural infrastructure, particularly extension services, and canal maintenance. Therefore, no change in existing farming systems will be proposed; this means that technical inputs to these zones will be less than in development projects.

1.3.3 Irrigation Methods

Full discussion on methods of irrigation recommended for the study area is given in Annex VII. Two methods are being proposed:-

(a) basin irrigation (as already practised) with modifications to include flood irrigation, and

(b) furrow irrigation

Crop recommendations will be based on the use of either irrigation method.

1.4 Presentation of Data and Recommendations

Recommendations, proposals and requirements for improved crop production will be discussed in four parts of this annex. General recommendations will be given in Part I including crop water requirements, mechanisation and labour utilisation. In Part II, recommendations for the improved management of crops under consideration are given based on smallholder farming systems (see Section 1.3) and the degree of mechanisation discussed in Part I. Specific proposals for the Qoryooley project feasibility study are given in Part III, which will tie together recommendations given in Parts I and II as well as relevant information extracted from Annexes III and IV (Existing Agriculture and Related Infrastructure). Cropping patterns, water requirements, inputs, services and marketing will be the main subjects covered in Part III. Part IV deals with Master Plan proposals for development projects and development zones. Modification to selected cropping patterns and projected yields given for the Qoryooley project will be discussed to cover variation in proposed technical inputs and services, as well as in existing land use of each project area or zone. Improvement of general infrastructural services will also be discussed in Part IV.

Development proposals for perennial crops will be considered individually. Banana production will be discussed in Part II, Chapter 15. Grapefruit production, which will be in direct reference to the EDF scheme near Golweyn (see Annex IV, Chapter 13), is discussed in Part II, Chapter 16.

CHAPTER 2

IRRIGATION AND CROP WATER REQUIREMENTS

2.1 Method of Calculation

2.1.1 Crop Water Requirements

Calculations have been made using the guidelines given in FAO Irrigation and Drainage Paper No. 24, Crop Water Requirements (J. Doorenbos and W.O. Pruitt, 1975 and 1977). These calculations are based on the monthly reference crop evapotranspiration rate (ET_0) which is defined as:-

"The rate of evapotranspiration from an extended surface of 80 to 150 mm tall grass cover of uniform height, actively growing, completely shading the ground and not short of water".

Several methods are available for calculating ET_0, but it is considered that with the amount of climatic data available for Janaale, the Penman method will give the most satisfactory results (Annex II, Chapter 1). Table 2.1 gives monthly values of ET_0 for Janaale and, until new climatic records of sufficient length are collected for other areas, these values may be applied to the entire Study Area.

TABLE 2.1

Reference Crop Evapotranspiration and Rainfall Data (Janaale)

Month	ET_0 (mm/day)	Mean monthly rainfall (mm)	75% reliable rainfall (mm)
January	5.53	1.5	1.1
February	5.98	0.1	0.1
March	6.22	3.9	2.8
April	5.57	75.9	55.4
May	5.13	73.9	54.0
June	4.69	80.5	58.8
July	4.63	54.8	40.0
August	5.01	47.4	34.6
September	5.62	21.5	15.7
October	5.25	32.7	23.9
November	4.69	52.6	38.4
December	4.99	26.2	19.1
Total	-	471.0	343.9

Source: Annex II, Chapter 1

To determine the quantity of evapotranspiration for a particular combination of month and crop, ET_0 must be multiplied by a crop coefficient (kc) which varies between crops, between growth stages, with the length of growing season and prevailing climatic conditions. The product of ET_0 and kc is the daily consumptive use of that crop (ET_c). This is then converted into a monthly consumptive use by multiplying by the days in that month (n).

Not all of this water needs to be provided by irrigation due to the contribution made by rainfall. Table 2.1 gives mean monthly rainfall and 75% reliable rainfall for Janaale. Some rainfall will be lost due to run-off, leaving only a certain proportion as effective. Effective rainfall (r, measured in mm) has been calculated using the USDA Soil Conservation Service Method (Dastane, 1974). The net irrigation requirement (I_n mm) can now be expressed as:-

$$I_n = n.ET_0.kc - r$$

The gross irrigation requirement (I) at field outlet can only be determined for a particular project once the water application efficiency (ε_a) and the field distribution efficiency (ε_f) are known. Water application efficiency makes allowances for losses due to deep percolation, often determined by the leaching requirement needed to prevent build up of soil salinity, and to surface run-off of irrigation water. Field distribution efficiency adjusts for seepage losses from field distribution channels. The final expression for gross irrigation requirement at field inlet is:-

$$I = \frac{n.ET_0 . kx - r}{\varepsilon_a . \varepsilon_f}$$

2.1.2 Irrigation Intervals

The basic irrigation interval, i, for a particular period can be calculated as follows:-

$$i = \frac{d\ b\ a}{I_n} = \frac{RAM}{I_n}$$

where d = effective rooting depth of the crop (mm)

a = the fraction of the soil water which can be extracted as available moisture. This is usually defined as the extractable moisture lying between soil suction limits of 0.05 bar and 15 bar. For the vertisols of the Study Area, the upper limit has been taken as 0.00 bar (see Annex I)

b = the fraction of the available moisture that any particular crop can successfully utilise. For most crops this will be between 50 and 60%

I_n = net irrigation requirement (mm/day)

RAM = readily available moisture in the root zone (mm)

However, with heavy clay soils, the total infiltration and terminal infiltration rates may be insufficient to accommodate the total amount of water applied at long irrigation intervals (equal to $i.I_n$ (mm) if the effects of deep percolation losses are ignored). Consequently, the irrigation interval must be reduced so that applied water can infiltrate within an acceptable period. Therefore, infiltration characteristics of the soil, rather than moisture holding ability, now determine irrigation intervals. This situation has been encountered with the montmorillonitic clays of the Study Area and is discussed fully in Section 2.11 of this chapter.

2.2 Crop Coefficients

Coefficient values for a particular crop vary with each stage of crop growth. The method used is as described by Doorenbos and Pruitt (1975 and 1977) which divides crop development into four stages:-

(a) Initial - germination and early growth when the soil surface is not or hardly covered by the crop.

(b) Crop development - from the end of the initial stage to attainment of effective full ground cover.

(c) Mid-season - from attainment of full ground cover until onset of maturation.

(d) Late season - from onset of maturation until full maturity or harvest.

Figure 2.1 shows the crop coefficient curve for a gu season maize crop. The information required to plot this curve is the planting date, the length of each development (growth) stage and three particular crop coefficients as follows:-

kc_1 = initial stage coefficient

kc_3 = mid-season coefficient

kc_4 = coefficient at the end of the late season stage.

The crop development stage coefficient, kc_2, is derived by interpolation between kc_1 and kc_3 as seen in Figure 2.1. Table 2.2 summarises the data required to plot crop coefficient curves for the annual crops considered for development in the Study Area. Planting dates and crop development stage lengths were determined from data collected from crop monitoring studies carried out in the Lower Shabeelle region during 1977 and are fully explained in the following chapters of this annex. Crop coefficients were derived from Doorenbos and Pruitt (1975 and 1977) using the average climatic data for Janaale reported in Annex II and summarised in Annex IV, Chapter 1. Both upland rice and paddy rice are treated similarly. Doorenbos and Pruitt maintain that only in early stages is there a need to reduce the kc values for upland rice by 15 to 20% compared with paddy rice. They also assume no difference in kc values for either direct-sown or transplanted paddy rice. In the context of the Study Area, both paddy and upland rice will be direct-drilled and managed in the same way during early crop growth where the upper soil layer will be at, or close to, saturation.

TABLE 2.2

Crop Coefficients, Planting Dates and Development Stages (Annual Crops)

Crop	Planting date [1]	Development stage length (days) Initial	Devel-opment	Mid-season	Late season	TOTAL	Crop coefficients [2] kc_1	kc_2	kc_3	kc_4
Maize	April 15th	20	30	35	20	105	0.60	-	1.05	0.55
	September 15th	20	30	35	20	105	0.25	-	1.05	0.55
Upland rice	May 1st	25	25	40	15	105	0.90	1.10	1.10	0.95
	September 1st	25	25	40	15	105	0.90	1.10	1.10	0.95
Paddy rice	May 1st	25	25	40	15	105	0.90	1.10	1.10	0.95
	September 1st	25	25	40	15	105	0.90	1.10	1.10	0.95
Cotton	August 15th	30	40	65	45	180	0.25	-	1.05	0.65
Sesame [5]	November 1st	25	20	35	10	90	0.25	-	1.05	0.25
Groundnuts	September 1st	20	35	45	20	120	0.25	-	0.95	0.55
Sunflower	April 15th	20	25	30	20	95	0.60	-	1.05	0.40
	September 15th	30	25	30	20	95	0.25	-	1.05	0.40
Tobacco [6]	August 15th	55[3]	50	50	20	175	0.25[4]	-	1.05	0.60
Tomatoes	August 15th	30[3]	40	45	25	140	0.25[4]	-	1.05	0.60
Forage	April 15th	20	30	10[8]	-	60[8]	0.60	-	1.05	-
Pulses	April 15th	15	25	35	20	95	0.60	-	1.05	0.30
Castor [7]	September 1st	15	30	45	30	120	0.25	-	1.05	0.50
Safflower [7]	April 15th	15	25	35	15	90	0.60	-	1.05	0.25
	November 1st	15	25	35	15	90	0.25	-	1.05	0.25

Notes:
(1) Median or optimum planting date.
(2) By interpolation, except for rice.
(3) In nursery; development stage starts at transplanting in field.
(4) Applies only at start of development stage. Nursery water requirements minimal and assumed as nil requirements.
(5) Assumed kc values as for safflower.
(6) Assumed kc values as for tomatoes.
(7) Estimated development-stage lengths based on known total growing seasons and crop behaviour.
(8) Forage cut at 50-70 days; average length of 60 days assumed.

Source: Doorenbos and Pruitt (1975 and 1977), Agronomic survey data (1977)

The data given in Table 2.2 and presented in the form of Figure 2.1 for each crop and growing season, can therefore be used directly to calculate the mean monthly crop coefficients. These are given in Table 2.3 for all annual crops under consideration together with two perennial crops, bananas and citrus.

2.3 Crop Consumptive Use

The gross monthly consumptive use for each crop is determined by multiplying the mean monthly crop coefficient (Table 2.3), the corresponding reference crop evapotranspiration rate (Table 2.1) and the number of the days in that month. Gross consumptive use figures are given in Table 2.4.

2.4 Effective Rainfall

The proportion of rainfall that can be utilised by a crop is a complex function of rainfall amount and intensity, soil intake rates, surface evaporation, moisture holding capacities, topography, land use and management, and the state of the crop itself. In an attempt to assess correctly the influence of as many of these factors as is possible, the USDA Soil Conservation Service (USDA, SCS) method has been adopted in order to calculate effective rainfall (Dastane, 1974). Effective rainfall figures are given in Table 2.5, and relate monthly crop consumptive use to monthly rainfall. In addition, a correction factor must be applied to any figure taken from Table 2.5 to allow for net depths of irrigation application differences (d) that are different from the standard application of 75 mm assumed when deriving Table 2.5. Correction factors are given below:-

d (mm)	Multiplication factor
50	0.930
55	0.947
60	0.963
65	0.977
70	0.990
75	1.000
80	1.004
85	1.008
90	1.012
95	1.016
100	1.020
125	1.040
150	1.060
175	1.070

For soils in the Study Area, the net irrigation application, after deep percolation losses, is limited by the infiltration rate to 60 mm (see Section 2.10). The multiplication factor is therefore taken as 0.963. The data required to calculate effective rainfall are given in Table 2.1 (monthly rainfall) and Table 2.4 (crop consumptive use). The 75% reliable monthly rainfalls have been used in accordance with river flow reliability calculations. Monthly effective rainfall for each crop is given in Table 2.6.

TABLE 2.3

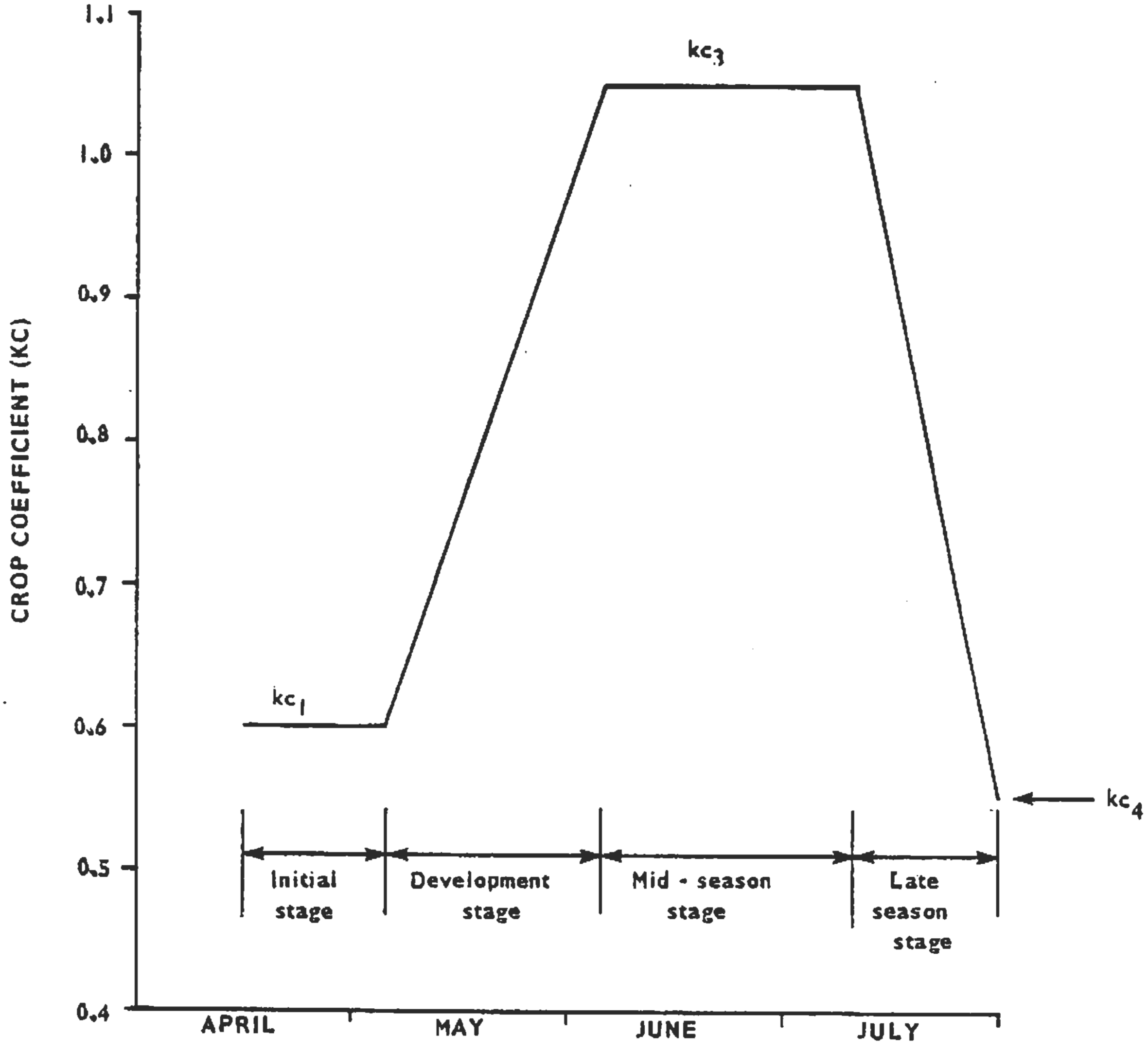
Mean Monthly Crop Coefficients

Season	Crop	Planting date	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Gu	Maize	April 15th	-	0.30	0.75	1.05	0.90	-	-	-	-	-	-	-
	Rice[1]	May 1st	-	-	0.95	1.10	1.10	0.50						
	Forage	April 15th	-	0.30	0.75	0.50	-	-	-	-	-	-	-	-
	Sunflower	April 15th	-	0.30	0.80	1.05	0.50	-	-	-	-	-	-	-
	Pulses	April 15th	-	0.30	0.85	1.05	0.45	-	-	-	-	-	-	-
	Safflower	April 15th	-	0.30	0.85	1.05	0.35	-	-	-	-	-	-	-
Der	Maize	September 15th	-	-	-	-	-	-	0.15	0.55	1.05	0.90	-	-
	Rice[1]	September 1st	-	-	-	-	-	-	0.95	1.10	1.10	0.50	-	-
	Cotton	August 15th	-	-	-	-	-	0.15	0.35	0.85	1.05	1.05	0.90	0.35
	Sesame	November 1st	-	-	-	-	-	-	-	-	0.25	0.90	0.90	-
	Groundnuts	September 1st	-	-	-	-	-	-	0.30	0.75	0.95	0.80	-	-
	Sunflower	September 15th	-	-	-	-	-	-	0.15	0.60	1.05	0.50	-	-
	Tobacco	August 15th[2]	-	-	-	-	-	0.20	0.75	1.05	1.05	0.40	-	-
	Tomato	August 15th[2]	-	-	-	-	-	0.20	0.85	1.05	0.95	0.10	-	-
	Safflower	November 1st	-	-	-	-	-	-	-	-	0.40	1.00	0.85	-
	Castor	September 1st	-	-	-	-	-	-	0.35	0.95	1.05	0.80	-	-
	Bananas[3]	-	-	-	-	-	-	1.0	-	-	-	-	-	-
	Citrus [4]	-	-	-	-	-	-	0.55	-	-	-	-	-	-
	Miscellaneous crops [5]	May 1st - December 1st	-	-	-	-	-	0.80	-	-	-	-	0.40	-

Notes:-
(1) Both upland and paddy rice as direct-drilled crops
(2) Transplanting date
(3) kc derived assuming a mature crop with 80% ground cover
(4) kc derived assuming large mature trees providing more than 70% cover with clean cultivated ground
(5) Vegetables, etc.

FIGURE 2.1

CROP COEFFICIENT CURVE: GU SEASON MAIZE



kc_1 = 0.60
kc_2 = by interpolation
kc_3 = 1.05
kc_4 = 0.55

TABLE 2.4

Gross Monthly Crop Consumptive Use (mm)

Season	Crop	Planting date	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
		ET_o (1)	6.22	5.57	5.13	4.69	4.63	5.01	5.62	5.25	4.69	4.99	5.53	5.98	
Gu	Maize	April 15th	-	50	119	148	129	-	-	-	-	-	-	-	446
	Rice(2)	May 1st	-	-	151	155	158	75	-	-	-	-	-	-	539
	Forage	April 15th	-	50	119	70	-	-	-	-	-	-	-	-	239
	Sunflower	April 15th	-	50	127	148	72	-	-	-	-	-	-	-	397
	Pulses	April 15th	-	50	135	148	65	-	-	-	-	-	-	-	398
	Safflower	April 15th	-	50	135	148	50	-	-	-	-	-	-	-	383
Der	Maize	September 15th	-	-	-	-	-	-	25	90	148	139	-	-	402
	Rice(2)	September 1st	-	-	-	-	-	-	160	179	155	77	-	-	571
	Cotton	August 15th	-	-	-	-	-	23	59	138	148	162	154	59	743
	Sesame	November 1st	-	-	-	-	-	-	-	-	35	139	154	-	328
	Groundnuts	September 1st	-	-	-	-	-	-	51	122	134	124	-	-	431
	Sunflower	September 15th	-	-	-	-	-	-	25	98	148	77	-	-	348
	Tobacco	August 15th(3)	-	-	-	-	-	31	126	171	148	62	-	-	538
	Tomato	August 15th(3)	-	-	-	-	-	31	143	171	134	15	-	-	494
	Safflower	November 1st	-	-	-	-	-	-	-	-	56	155	146	-	357
	Castor	September 1st	-	-	-	-	-	-	59	155	148	124	-	-	486
Der	Bananas	-	193	167	159	141	144	155	169	163	141	155	171	167	1 925
	Citrus	-	106	92	87	77	79	85	93	90	78	85	94	92	1 058
	Miscellaneous crops	May 1st - December 1st			127	113	115	124	135	130	113	124	69	-	1 050

Notes:-
(1) mm/day
(2) Upland and paddy rice
(3) Transplanting date; nursery consumption estimated at 0.7% maximum field consumption per transplanted hectare and therefore assumed as nil.

TABLE 2.5

Monthly Effective Rainfall Related to Monthly Rainfall and Consumptive Use

Monthly rainfall (mm)	MONTHLY CONSUMPTIVE USE (mm) 25	50	75	100	125	150	175	200	225	250	275	300	325	350
	MONTHLY EFFECTIVE RAINFALL (mm)													
12.5	7.5	8.0	8.7	9.0	9.2	10.0	10.5	11.2	11.7	12.5	12.5	12.5	12.5	12.5
25.0	15.0	16.2	17.5	18.0	18.5	19.7	20.0	20.0	24.5	25.0	25.0	25.0	25.0	25.0
37.5	22.5	24.0	26.2	27.5	28.2	29.2	30.5	33.0	36.2	37.5	37.5	37.5	37.5	37.5
50.0	25.0	32.2	34.5	35.7	36.7	39.0	40.5	43.7	47.0	50.0	50.0	50.0	50.0	50.0
62.5	at 41.7	39.7	42.5	44.5	46.0	48.5	50.5	53.7	57.5	62.5	62.5	62.5	62.5	62.5
75.0		46.2	49.7	52.7	55.0	57.5	60.2	63.7	67.5	73.7	75.0	75.0	75.0	75.0
87.5		50.0	56.7	60.2	63.7	66.0	69.7	73.7	77.7	84.5	87.5	87.5	87.5	87.5
100.0		at 80.7	63.7	67.7	72.0	74.2	78.7	83.0	87.7	95.0	100	100	100	100
112.5			70.5	75.0	80.2	82.5	87.2	92.7	98.0	105	111	112	112	112
125.0			75.0	81.5	87.7	90.5	95.7	102	108	115	121	125	125	125
137.5			at 122	88.7	95.2	98.7	104	111	118	126	132	137	137	137
150.0				95.2	102	106	112	120	127	136	143	150	150	150
162.5				100	109	113	120	128	135	145	153	160	162	162
175.0				at 160	115	120	127	135	143	154	164	170	175	175
187.5					121	126	134	142	151	161	170	179	185	187
200.0					125	133	140	148	158	168	178	188	196	200
225					at 197	144	151	160	171	182				
250						150	161	170	183	194				
275						at 240	171	181	194	205				
300							175	190	203	215				
325							at 287	198	213	224				
350								200	220	232				
375								at 331	225	240				
400									at 372	247				
425										250				
										at 412				
450	25	50	75	100	125	150	175	200	225	250				

Source: Extracted from USDA, Soil Conservation Service (Dastane, 1974).

TABLE 2.6

Monthly Effective Rainfall (mm)

Season	Crop	Planting date	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
		Month:	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
		Rainfall (1)	2.8	55.4	54.0	58.8	40.0	34.6	15.7	23.9	38.4	19.1	1.1	0.1	
Gu	Maize	April 15th	-	50	38	44	29	-	-	-	-	-	-	-	161
	Rice (2)	May 1st	-	-	41	44	30	23	-	-	-	-	-	-	138
	Forage	April 15th	-	50	38	38	-	-	-	-	-	-	-	-	126
	Sunflower	April 15th	-	50	38	44	27	-	-	-	-	-	-	-	159
	Pulses	April 15th	-	50	39	44	26	-	-	-	-	-	-	-	159
	Safflower	April 15th	-	50	39	44	25	-	-	-	-	-	-	-	158
Der	Maize	September 15th	-	-	-	-	-	-	9	16	29	14	-	-	68
	Rice (2)	September 1st	-	-	-	-	-	-	13	20	29	13	-	-	75
	Cotton	August 15th	-	-	-	-	-	20	10	18	29	15	1	-	93
	Sesame	November 1st	-	-	-	-	-	-	-	-	23	14	1	-	38
	Groundnuts	September 1st	-	-	-	-	-	-	10	17	28	14	-	-	69
	Sunflower	September 15th	-	-	-	-	-	-	9	17	29	13	-	-	68
	Tobacco	August 15th (3)	-	-	-	-	-	20	11	19	29	12	-	-	91
	Tomato	August 15th (3)	-	-	-	-	-	20	12	19	28	10	-	-	89
	Safflower	November 1st	-	-	-	-	-	-	-	-	24	15	1	-	40
	Castor	September 1st	-	-	-	-	-	-	10	18	29	14	-	-	71
	Bananas	-	2	43	41	43	30	26	13	19	28	15	1	-	261
	Citrus	-	2	37	36	39	27	24	11	16	26	13	1	-	232
	Miscellaneous crops	May 1st - December 1st	-	-	38	41	29	25	11	17	27	14	1	-	203

Notes:-
(1) Mean monthly rainfall at 75% reliability (mm)
(2) Upland and paddy rice
(3) Transplanting date

An exception to the use of the USDA, SCS method has been made for the beginning of gu rains in April when being utilised for annual crop production. To make full use of available rainfall, land preparation methods are required to minimise losses from the field. These are discussed in Chapter 3 of this annex. This means that with the 75% reliable April rainfall (55.4 mm) falling onto dry soil that can easily absorb this amount, run-off can effectively be treated as zero. Similarly, despite soil cracking, no deep percolation losses will occur as capillary forces will retain moisture in, at the most, the top 250 mm of soil. This has been shown to occur on deep heavy alkaline cracking clays in the Sudan (Lea, 1961) and confirmed by reported information collected from experienced banana farmers in the Study Area. It is considered, therefore, that full use of the early gu rains can be made and complete effectiveness of the 75% reliable April rainfall can be accepted.

2.5 Net Irrigation Requirements

Net irrigation requirements (I_n) in mm per month for each crop are given in Table 2.8 and are calculated by subtracting the appropriate effective rainfall figure from gross consumptive use (Table 2.4).

2.6 Peak Irrigation Requirements

Calculation of normal water requirements is based on a monthly interval. Within each month, hot cloudless periods will occur that give rise to increased evapotranspiration rates above the calculated mean monthly rate. Allowance, therefore, must be made in any canal system to accommodate these peak periods. Doorenbos and Pruitt (1977) give a correction ratio for semi-arid climates with predominantly clear weather conditions during the month of peak evapotranspiration rates, and this is reproduced in Table 2.7.

TABLE 2.7

Peak Evapotranspiration Rates

Net depth of irrigation application (mm)	Peak evapotranspiration rate/ mean monthly rate
40	1.125
60	1.105
80	1.085
100	1.070
120	1.060
140	1.050
160	1.040

Source: Doorenbos and Pruitt (1977)

TABLE 2.8

Monthly Net Irrigation Requirements (mm)

Season	Crop	Planting date	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Gu	Maize	April 15th	-	0	81	104	100	-	-	-	-	-	-	-	285
	Rice (1)	May 1st	-	-	110	111	128	52	-	-	-	-	-	-	401
	Forage	April 15th	-	0	81	32	-	-	-	-	-	-	-	-	113
	Sunflower	April 15th	-	0	89	104	45	-	-	-	-	-	-	-	238
	Pulses	April 15th	-	0	96	104	39	-	-	-	-	-	-	-	239
	Safflower	April 15th	-	0	96	104	25	-	-	-	-	-	-	-	225
Der	Maize	September 15th	-	-	-	-	-	-	16	74	119	125	-	-	334
	Rice (1)	September 1st	-	-	-	-	-	-	147	159	126	64	-	-	496
	Cotton	August 15th	-	-	-	-	-	3	49	120	119	147	153	59	650
	Sesame	November 1st	-	-	-	-	-	-	-	-	12	125	153	-	290
	Groundnuts	September 1st	-	-	-	-	-	-	41	105	106	110	-	-	362
	Sunflower	September 15th	-	-	-	-	-	-	16	81	119	64	-	-	280
	Tobacco	August 15th (2)	-	-	-	-	-	11	115	152	119	50	-	-	447
	Tomato	August 15th (2)	-	-	-	-	-	11	131	152	106	5	-	-	405
	Safflower	November 1st	-	-	-	-	-	-	-	-	32	140	145	-	317
	Castor	September 1st	-	-	-	-	-	-	49	137	119	110	-	-	415
	Bananas	-	191	124	118	98	114	129	156	144	113	140	170	167	664
	Citrus	-	104	55	51	38	52	61	82	74	52	72	93	92	326
	Miscellaneous crops	May 1st - December 1st	-	-	89	72	86	99	124	113	86	110	68	-	847

Notes:
(1) Upland and paddy rice
(2) Transplanting date; nursery irrigation requirements assumed as nil (see Table 2.4).
(3) This table is based on consumptive use less effective rainfall

2.7 Field Application Efficiency and Farm Conveyance Efficiency

At each irrigation, considerably more water than the net irrigation requirement is needed at the feed inlet. This is because of unavoidable losses in field distribution through seepage from channels and, at application, due to deep percolation and surface run-off. For a well-designed layout with well-levelled fields and which has been operating under good irrigation management for several years, soil condition becomes the dominant factor in controlling the quantity of irrigation water losses. Table 2.9 indicates the approximate losses for different soil textures, assuming the above conditions. However, further variation occurs with the actual method of irrigation used.

TABLE 2.9

Irrigation Water Application Losses

	Soil texture		
	Light	Medium	Heavy
Farm channel losses (%)	15	10	5
Farm conveyance efficiency (%)	85	90	95
Surface run-off losses (%)	5	10	25
Deep percolation losses (%)	35	15	10
Overall field irrigation efficiency (%)	45	65	60

Source: Doorenbos and Pruitt (1975)

Table 2.10 outlines the expected ranges of field application efficiency for different methods.

TABLE 2.10

Irrigation Methods: Field Application Efficiency

Irrigation method	Field application efficiency (%)
Graded borders	60 - 75
Basin and level borders	60 - 80
Contour ditches	50 - 55
Furrows	55 - 70
Corrugations	50 - 70
Sub-surface	up to 80
Sprinkler	60 - 80

Source: Doorenbos and Pruitt (1975) after USDA, SCS.

Study Area soils are all medium to heavy textured and therefore farm channel losses are likely to be less than 5 to 10% of the gross water supply. Similarly, surface run-off losses will amount to between 10 and 25%, although this will be influenced by the actual irrigation method. Using small basin irrigatin, zero run-off is theoretically possible. However, this requires exact water control and a high level of field management skills. Consequently, it is considered that an average figure of 15% losses due to run-off is applicable to the surface irrigation methods to be used in the area. Allowances for deep percolation, also given in Table 2.9, are the unavoidable losses to groundwater as a result of soil structure. For the heavy clay soils of the Study Area, the lowest value of 10% for deep percolation losses can be taken as a result of low natural permeability characteristics of heavy soils. This low figure, which represents the maximum rate of deep water movement in these soils, may be insufficient to provide for adequate downward movement to leach out salts that enter the soil in irrigation water. This problem is discussed in Section 2.8.5. Therefore, farm losses, which have been used for calculating gross irrigation requirements, are as summarised below:-

	Percentage of gross water supply at field inlet
Watercourse and farm channel seepage	5
Surface run-off	15
Deep percolation	10
Inefficient management	10
TOTAL	40

Losses attributable to inefficient management are discussed further in Annex VII. Consequently, the overall allowance of 40% farm losses gives a field application efficiency of 60% from the field inlet.

2.8 Leaching Requirements

A salinity problem related to water quality occurs if the total quantity of salts in irrigation water is sufficient for salts to accumulate in the root zone to the extent that growth and yields are affected. If this accumulation occurs, crops have increasing difficulty in extracting sufficient water from a more concentrated soil solution. The build-up and increased uptake of certain ions (for example, sodium and chloride) also induces toxicity and, in the case of calcium, suppresses uptake of other nutrients. Consequently, increasing salinity retards crop growth and is often visible, at high levels, as symptoms similar to those caused by drought. The effects of salinity not only vary between crops but also with different growth stages. Early growth stages are generally more sensitive. Often, increasing salinity is only seen at lower levels as decreased yields, similar to "hidden hunger" symptoms of nutrient deficiencies.

Therefore, to control salinity, it is essential that salts leaving the root zone in drainage water should equal those entering in irrigation water. By balancing inputs and outputs, the leaching requirement to achieve this equilibrium is represented as Equation 8.1:-

$$R = \frac{I_n \cdot EC_{iw}}{f(EC_{dw} - EC_{iw})}$$

where	R	=	leaching requirement (mm/day)
	I_n	=	net irrigation requirement (mm/day)
	EC_{iw}	=	electrical conductivity of irrigation water (mmhos/cm)
	EC_{dw}	=	electrical conductivity of drainage water (mmhos/cm)
	f	=	leaching efficiency.

2.8.1 Irrigation Water Quality (EC_{iw})

Where irrigation supplies are solely from the river (i.e. no contribution is made from groundwater), supply quality is directly related to river water quality. Mean monthly conductivities of the Shabeelle river are given in Table 2.11. Average conductivities of river water received by annual crops in the Study Area are therefore as follows:-

Gu season (April - July)	0.92 mmho/cm
Der season (Sept - Dec)	0.63 mmho/cm

An annual weighted average can then be calculated as, for the same crop, net irrigation requirements in the gu season are only about 75% to 85% of the der season requirements. This is due to the contribution of effective rainfall (see Table 2.6). For example, the net irrigation requirements for maize are:-

Gu season	285 mm
Der season	334 mm

The annual weighted average conductivity of river water received by annual crops therefore is:-

$$\frac{(100 \times 0.63) + (80 \times 0.92)}{180}$$

$$= 0.75 \text{ mmhos/cm}$$

It must be noted that irrigation water quality should not be 'diluted' by the salt-free rainfall contribution as this effect has already been allowed for in calculating the net irrigation requirement (I_n).

TABLE 2.11

Shabeelle River Mean Monthly Salinity Levels

Month	River water electrical conductivity (mmhos/cm)
January	0.97
February	1.19
March	1.08
April	0.92
May	1.19
June	0.96
July	0.81
August	0.54
September	0.42
October	0.45
November	0.82
December	0.85

Source: Annex II, Chapter 4

The annual weighted average salinity value of 0.75 mmhos/cm can now be used with Equation 8.1 to produce Figure 2.2. Figure 2.2 shows the leaching requirement (expressed as a percentage of the net irrigation requirement) for a range of drainage water salinities (EC_{dw}) and various leaching efficiencies (f).

2.8.2 Leaching Efficiency

The leaching efficiency factor, f, is necessary because not all deep percolating water passes through the soil matrix itself. Therefore, as some water passes directly through the root zone without actively leaching out any salts, only a certain percentage of the leaching water is effective in removing salts. The leaching efficiency is higher in light textured soils than in heavy clays, due probably to the degree of cracking found in heavy clay soils. The value of f also appears to depend on irrigation methods used. With basin or border-strip irrigation, leaching efficiency is greater than with furrow irrigation. Highest efficiencies are found if the soil is leached by rain or low intensity sprinkling. Van der Molen (1973) gives the following tentative values for f:-

silty loam, sandy loam	$f = 0.5 - 0.6$
silty clay loam, sandy clay loam	$f = 0.4 - 0.5$
clay	$f = 0.2 - 0.3$

A figure of 0.3 would therefore seem applicable for the Study Area clay soils. However, whenever possible, f should be determined from leaching experiments or by analysis of field leaching data. It may be possible to show that with expanding lattice montmorillonitic clays, as long as soil moisture content is high enough to close all the soil cracks, leaching efficiency is much higher than 0.3.

2.8.3 Permissible Salt Levels

The appropriate value for EC_{dw} can be determined from the allowable salt level in the root zone that permits satisfactory crop production. Permissible salt levels for selected crops are given in Table 2.12, which also indicates estimated yield reductions with increased soil salinity. Ayers and Westcot (1976) recommend that, where possible, EC_e values for 10% yield reduction are used since, in most cases, factors other than salinity cause greater yield reductions.

In general, soil under field conditions contains substantially less water than in a saturated paste. Comparisons of moisture holding capacities and saturation percentages have shown that EC_{sw} $2.EC_e$, where EC_{sw} is the average salinity of soil water taken up by the crop (MMP, 1975; Ayers and Westcot, 1976). Consequently, EC_{sw} must be related to salinity of drainage water (EC_{dw}) passing out of the base of the root zone. In order to do this, both a crop water uptake pattern and a soil salinity profile in the root zone are required. These are given in Figure 2.3. It is assumed that 40% of water uptake is in the top 25% of the root zone, with decreased uptake proportional to depth in the root zone. Soil water salinity is assumed to increase linearly with depth from EC_{iw} at the soil surface to EC_{dw} at the root zone base. This is a conservative estimate as a

FIGURE 2.2

LEACHING REQUIREMENTS

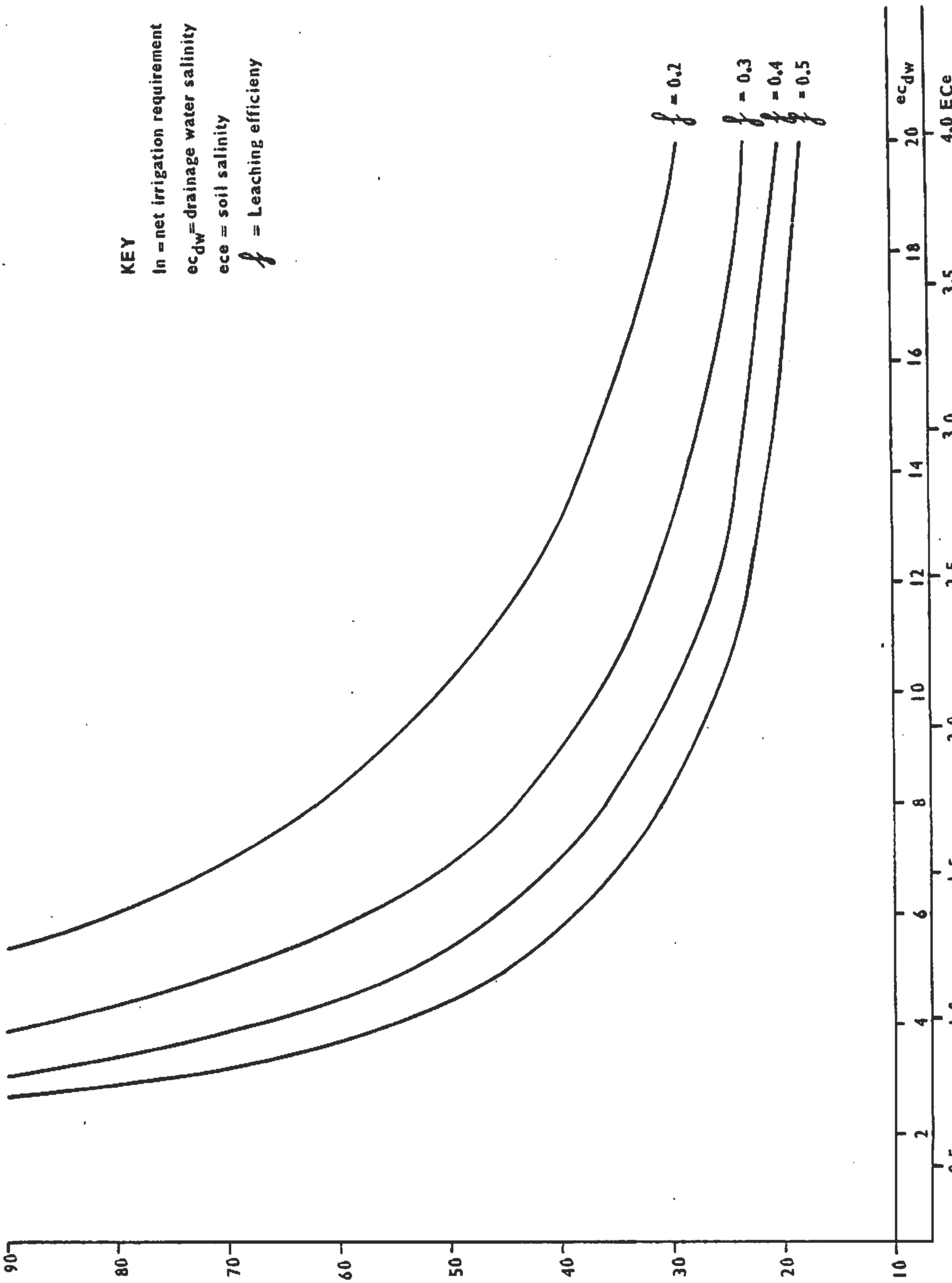
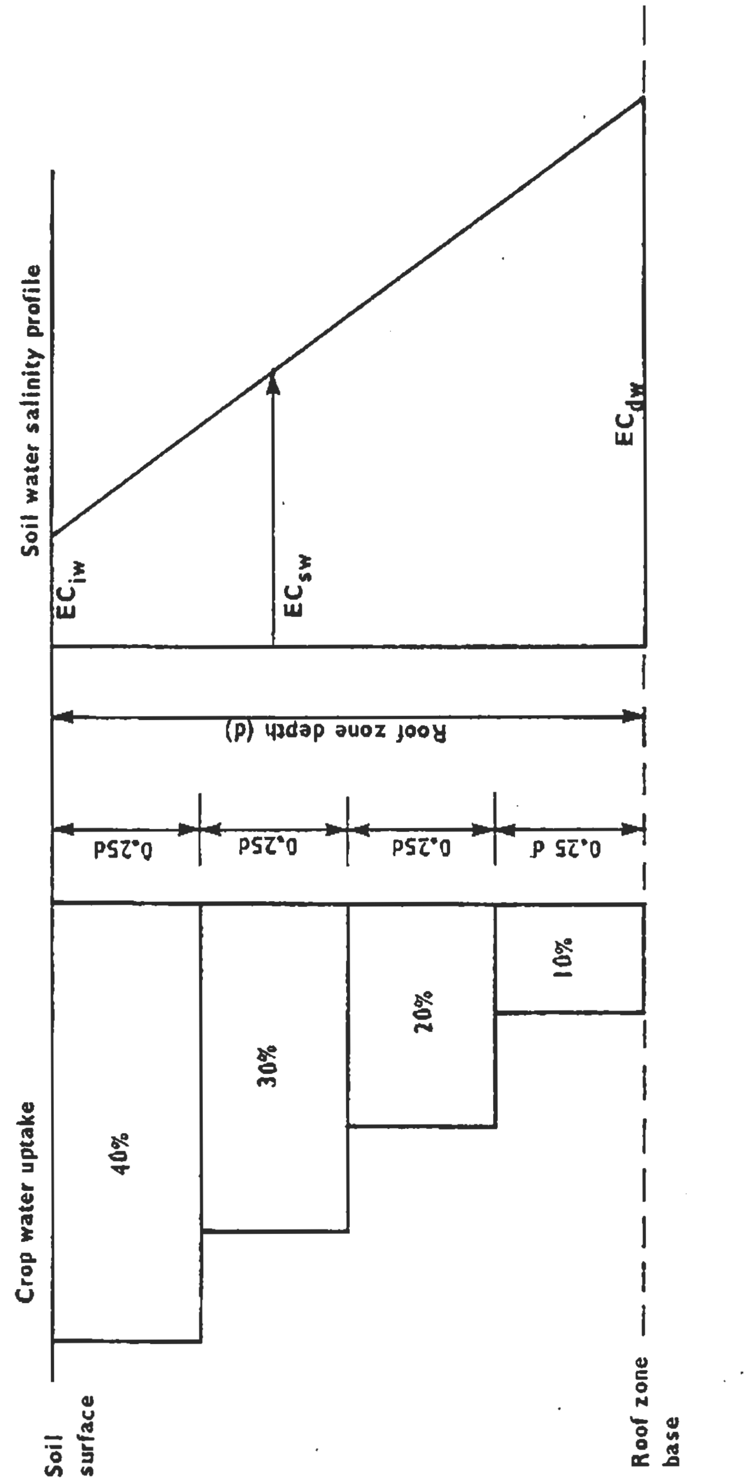


FIGURE 2.3

WATER UPTAKE AND SOIL SALINITY PROFILES IN RELATION TO ROOT DEPTH



true profile would probably remain less saline in the upper half of the root zone where 70% of crop water uptake is assumed to occur. Combining both factors given in Figure 2.3 gives the following expression:-

$$EC_{sw} = 0.625 \, . \, EC_{iw} + 0.375 \, . \, EC_{dw}$$

Rearrangement and substitution for EC_e gives the final expression for EC_{dw} as:-

$$EC_{dw} = 5.333 \, . \, EC_e - 1.667 \, . \, EC_{iw} \qquad \text{(Equation 8.2)}$$

This can now be used to complete the information required to solve Equation 8.1. Using an EC_{iw} value of 0.75 mmhos/cm, the corresponding EC_e values relating to EC_{dw} have been plotted on Figure 2.2. Therefore, the leaching requirement (as a percentage of net irrigation requirement) can be read directly from Figure 2.2, given the permissible EC_e for any crop and the leaching efficiency. The leaching requirements for selected crops have been calculated assuming a leaching efficiency of 0.3 (see Section 2.8.2) and a 10% crop yield reduction, and are given in Table 2.12.

However, although Equations 8.1 and 8.2 will always apply, Figure 2.2 has been derived specifically for gu and der seasonal irrigation from the Shabeelle river only. Consequently, where other circumstances arise, the problem of leaching must be examined in more detail.

Such circumstances are, for example:-

(a) fallow periods when soil dessication will contribute more salts to the root zone;

(b) where high water tables occur and capillary rise will draw salts to the surface;

(c) when irrigation supply is wholly or partly from more saline groundwater.

This examination is best achieved by taking a full salt balance operational study over several years of irrigation in order to see if any build-up of salt levels will occur.

2.8.4 The Use of Saline Groundwater

The problems involved in using saline groundwater in the Study Area may be outlined by assuming the situation of a mixed irrigation supply using river water (average EC_{iw} = 0.75 mmho/cm) and groundwater (average EC_{iw} = 2.50 mmhos/cm). If both supplies are applied equally, the average irrigation water salinity will be 1.625 mmhos/cm. If this is used, a greater leaching requirement is necessary. For example, with a medium tolerance crop such as rice (permissible EC_e at 10% yield reduction = 3.8 mmhos/cm), the resultant leaching requirement, calculated as for Table 2.12, is 34% of the net irrigation requirement. This is equivalent to a downward movement of water of 1.7 mm/day (assuming I_n = 5 mm/day) that must pass through and out of the root zone base. By comparison, only 0.7 mm/day must pass through if only river water is used.

Therefore, through the partial use of groundwater, the amount of water that must be forced downwards through the root zone to prevent a build-up of salinity has more than doubled. This will have two possible consequences:-

TABLE 2.12

Crop Salinity Tolerances and Leaching Requirements

Crop	Yield decrement(%) (1) 0	10	25	50	Max.(2)	Leaching requirement (% I_n)(3)	Yield reduction (%) at max. leaching (4)
Cotton	7.7	9.6	13.0	17.0	27.0	5.1	0
Safflower	5.3	6.2	7.6	9.9	14.5	8.0	0
Forage (Sorghum)	4.0	5.1	7.2	11.0	18.0	9.9	0
Rice	3.0	3.8	5.1	7.2	11.5	13.7	3
Tomato	2.5	3.5	5.0	7.6	12.5	15.0	6
Maize	1.7	2.5	3.8	5.9	10.0	22.1	18
Groundnut	3.2	3.5	4.1	4.9	6.5	15.0	0
Pulses (Cowpea)	1.3	2.0	3.1	4.9	8.5	28.8	26
Grapefruit	1.8	2.4	3.4	4.9	8.0	23.1	22

Note:

(1) Soil salinity levels (EC_e) inducing yield reductions. Salinity expressed as electrical conductivity of a saturated paste extract (mmhos/cm)

(2) EC_e level at which growth ceases

(3) Leaching requirement as per cent net irrigation requirement (I_n) at 10% yield reduction, with leaching efficiency of 0.3 and EC_{iw} = 0.75 mmhos/cm.

(4) Maximum leaching availability estimated at 16.7% of net irrigation requirement (see Section 2.8.5). Yield reduction calculated assuming leaching efficiency of 0.3, and EC_{iw} = 0.75 mmhos/cm. Calculated EC_e = 3.2 mmhos/cm.

(5) No data available for bananas, sesame, sunflower, tobacco and castor.

Source: FAO Irrigation and Drainage Paper No. 15; Crop Water Quality (FAO, 1976).

(a) groundwater tables will rise quickly and a waterlogging problem develop. This will lead to either abandoning the field or installation of costly in-field deep drainage.

(b) because of the low permeability of the Study Area clay soils, it is likely that 1.7 mm/day cannot physically be passed through the soil. Therefore, on top of the waterlogging problem, will be the continuous build-up of salt levels. This will also lead to reduced yields or either abandoning fields or installing in-field deep drainage.

2.8.5 Practical Limitations and Effects of Leaching in the Study Area

As discussed in Section 2.7, factors affecting field application efficiency applicable to the Study Area have been taken as follows:-

(a) watercourse and farm channel losses

(b) surface run-off losses

(c) deep percolation losses

(d) inefficient management.

Total losses from the field inlet are assumed as 40%, giving a field application efficiency of 60% of gross water supply at the field inlet.

Infiltration rates for the Study Area soils are limited (see Section 2.10). The maximum infiltration per irrigation application has been taken as 70 mm of water. Assuming the above 60% field application efficiency which includes 10% deep percolation losses, this infiltration represents 10 mm of water as deep losses with 60 mm of water available for crop consumption (i.e. the net irrigation application referred to in Section 2.4). Therefore, deep percolation losses represent 16.67% of the net irrigation requirement. As explained in Section 2.7, due to the limited natural permeability of heavy soils, deep percolation is, therefore, the maximum level of leaching available in the Study Area. The leaching requirement figures for each crop given in Table 2.12 show that this estimated maximum leaching (0.166 7 I_n) is adequate for most selected crops, assuming a yield reduction of 10%. However, this leaching is insufficient for maize, pulses and grapefruit.

Using Equations 8.1 and 8.2, and assuming a leaching efficiency of 0.3 and EC_{iw} of 0.75 mmhos/cm, a base EC_e level of 3.2 mmhos/cm is obtained. This can be used, with known crop tolerance levels, to determine estimated yield losses, which are also given in Table 2.12.

No detailed salinity tolerance levels for bananas, sesame, sunflower, tobacco and castor are available. Bananas are known to be susceptible to low levels of salinity, with soil sodium chloride levels of 0.05% representing the upper limit tolerated (Simmonds, 1966). With the known sodium ion/EC_e relationship in the Study Area soils (see Annex I), this represents a maximum tolerance level for bananas of about 4.5 mmhos/cm (EC_e). Yield reductions for bananas can therefore be assumed as similar to grapefruit. Sunflower is considered as a moderately tolerant crop with 50% yield reductions estimated at an EC_e level of 6.5 mmhos/cm, similar to rice (FAO, 1975). Castor is reported to have a low tolerance similar to maize. Therefore, assessment of yield potential for certain crops in the Study Area and given in Part II, takes into consideration the likely yield reductions due to restricted leaching. This is particularly the case with maize and bananas.

2.9 Readily Available Moisture

The total available soil moisture that can be utilised by a crop is normally defined as the percentage by volume of water lying between field capacity and the permanent wilting point (PWP). However, with expanding lattice clays, exact field capacity is undetectable and the upper limit is usually replaced by a total soil suction of 0.05 bar. However, for the Study Area vertisols, the upper limit is taken as 0.00 bar. A full discussion of soil moisture characteristics of Study Area soils and available moisture limits is given in Annex I (Soils).

Moisture retention analyses of the different soil series have all yielded a total available moisture of 20% by volume, as an average figure for a total sampled depth of 1.30 m. For the top 250 mm alone, available moisture can be as high as 30%. Consequently, Study Area soils have a high ability to store water for evapotranspiration purposes, with no water availability problems envisaged.

In order to assess available moisture that can be utilised by any given crop, the effective root zone depth (d) is required. This is the depth of soil from which roots can extract moisture and, for planning purposes, can be taken as the root depth of the mature plant. Estimated rooting depths for selected crops and applicable to the Study Area are given in Table 2.13. These root depths were determined as follows:-

(a) rooting of well-managed plots in the Study Area of maize, rice, sesame and bananas were studied at a total of 24 selected sites.

(b) reported data from CARS, Afgooye (maize, rice) and from the FAO pilot farm (maize, rice, sesame, cotton, groundnuts and sunflower) (FAO pilot project, 1975).

(c) reported data collected from other areas with similar soils under irrigation in Iraq, Ethiopia and Somalia (MMP, 1971; Halcrow, 1975; HTS, 1969).

(d) root depths for castor and safflower were estimated based on their known rooting characteristics being similar to other crops such as sesame and sunflower.

The growing period before this maximum depth is reached is also of importance. Estimated times are given in Table 2.13 with data based on reported information for Somalia (FAO pilot project, 1975), general information on crop rooting characteristics (Arnon, 1972 and Hagan et al, 1967) and related to growing seasons of the crops under consideration (see Table 2.2).

However, not all of the available moisture can be easily utilised by the crop. To avoid development of unacceptable moisture stress with subsequent growth reduction, soil moisture content in the root zone must be restricted to a certain percentage depletion (p) of the available moisture held between soil suctions of 0.05 or 0.00 and 15.0 bar. The following depletion must ensure that critical stress levels are not exceeded during any stage of crop development.

TABLE 2.13

Crop Root Depths, Allowable Moisture Depletions and Readily Available Moisture

Crop	Root depth (mm)	Days to maximum root depth	Average allowable moisture depletion (%) (1)	Average readily available moisture (RAM) (mm)	Minimum moisture depletion (%) (2)	Minimum RAM (mm) (2)
Maize	800	45	50	80	40	64
Upland rice	450	45	40	36	40	36
Sesame	800	40	50	80	40	64
Cotton	1 000	55	50	100	40	80
Groundnuts	600	45	50	60	40	48
Safflower	800(4)	40	50	80	40	64
Sunflower	800	40	50	80	40	64
Pulses	800	40	50	80	40	64
Cereal forage (millet)	800	40	50	80	40	64
Castor	800(4)	50 - 44	50	80	40	64
Tomato	800(4)	-	50	80	40	64
Tobacco						
Bananas	1 000	-	50	100	-	-
Citrus	1 500	-	50	150	-	-

Notes:
(1) Higher depletion (50-60%) allowance at non-critical growth stages. Not lower than 40% for upland rice.
(2) At critical growth stages, e.g. flowering, seed-set.
(3) RAM = root depth x % depletion x 20% (total available moisture in root zone).
(4) Estimated root depths.
(5) Paddy rice excluded due to different irrigation management.

Source: See text (Section 2.9)

Critical periods in crop growth vary between crops but can be summarised as follows:-

(a) germination and seedling stage

(b) tillering (if applicable)

(c) flowering and early stages of seed set and fruiting.

The last stage (flowering, etc.) is often the most critical period in any crop's growth in relation to moisture availability. Prolonged moisture stress at this stage severely reduces yields, whereas at other stages only slight reductions occur. The best example is maize. Moisture stress at tasselling causes poor seed-set as the result of desiccated unreceptive silks or pollen-shedding before silks have become receptive. Consequently, if moisture stress is at tasselling only, vegetative growth at maturity is normal, but yields low. As seen in the Study Area, moisture stress at heading of rice results in empty heads ("whiteheads") and reduced yields (see Annex IV, Chapter 8). With cotton, moisture stress at the period of boll-set induces excessive boll-shedding. However, with cotton, the total lack of moisture stress induces excessive vegetative growth. In general, outside the critical period of flowering and seed-set, soil moisture depletion in the root zone can be as much as 65% for most annual crops without affecting yields, with a general figure of 50 to 60% quoted (Hagan, 1967; Arnon, 1972; FAO pilot project, 1975). At critical stages, depletion should not exceed 40%; for example, Hagan (1967) states a maximum 35% depletion for cotton at critical stages after which yield reduction occurs. For upland rice, stress levels are more critical and should not fall to below 40% depletion even outside critical growth stages. Conversely, depletion levels can increase up to 80% for nearly all crops at the onset of maturation. Allowable depletion levels for crops under consideration are given in Table 2.13. These figures are not applicable in the late season stage (see Section 2.11).

From soil moisture analyses given in Annex I, it can be shown that 40 to 50% of available moisture lies between soil suctions of 0.05 and 0.1 bar. Therefore, by limiting depletion of available moisture to 50%, maximum water stress should be restricted to approximately 0.1 bar. The readily available moisture (RAM) that can be easily utilised by the crop is determined by multiplying root-depth (d), total available moisture (20%) and the available moisture depletion (p). Estimated RAM for each crop is given in Table 2.13.

2.10 Infiltration

Surface infiltration curves (with time) for the two most important soil series in the Study Area (Saruda and Qoryooley) are shown in Figures 2.4 and 2.5. Curves for other series are similar, but with a higher level of variability. Using the mean levels, the six hour cumulative infiltrations are 71 mm for Saruda soils and 76 mm for Qoryooley soils. At the end of this period, infiltration rates have dropped to less than 2.0 mm/h for Saruda soils and 3.5 mm/h for Qoryooley soils.

The implications of these low terminal rates are clear. Infiltration of applications greater than 70 mm (net and including deep losses) will take much longer, as can be seen in Table 2.14. These times are very long, particularly for Saruda soils, and it is recommended that infiltration per application is limited to a maximum of 70 mm, keeping the duration of an irrigation application

FIGURE 2.4

SURFACE INFILTRATION OF SARUDA SOILS

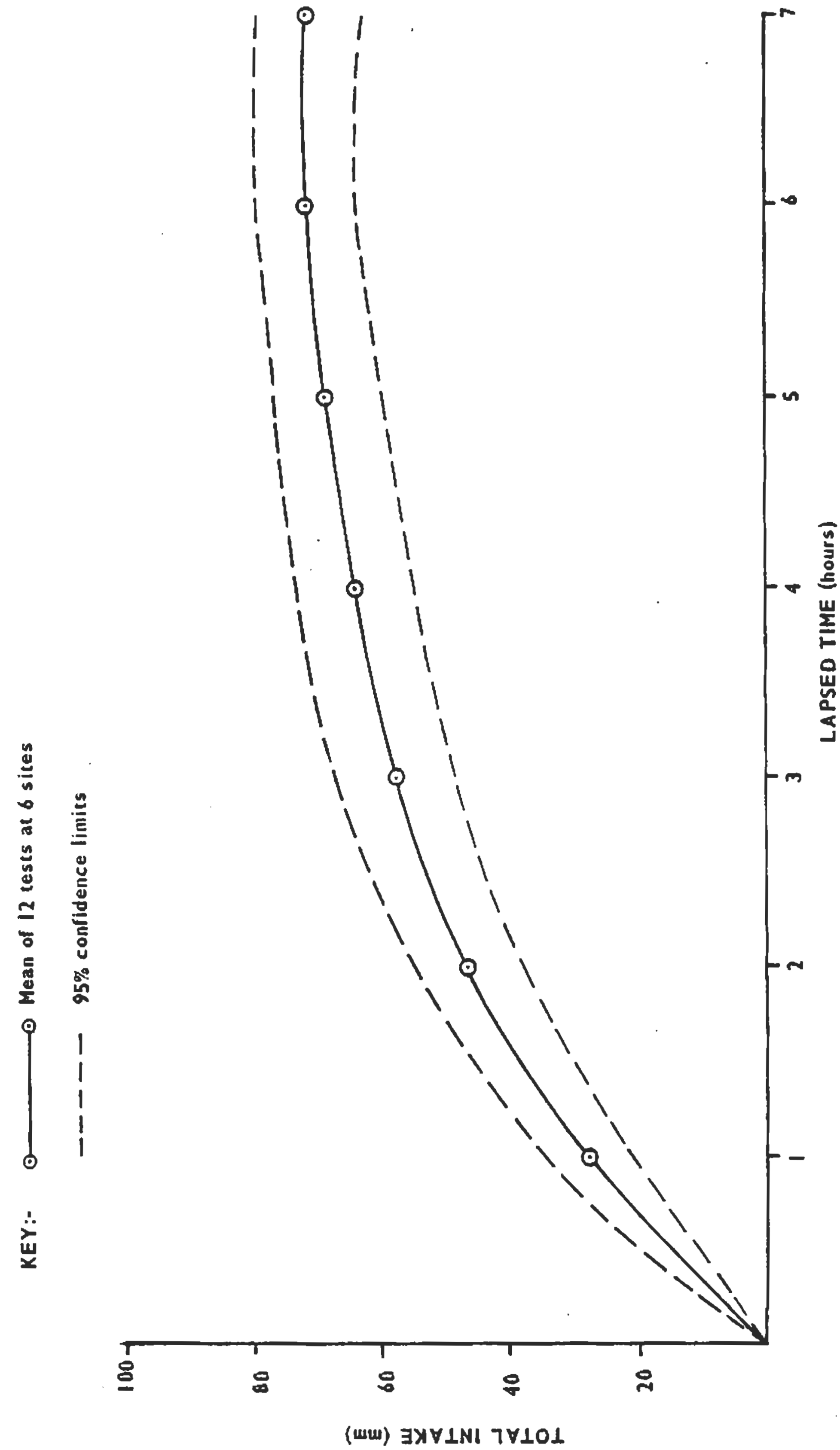
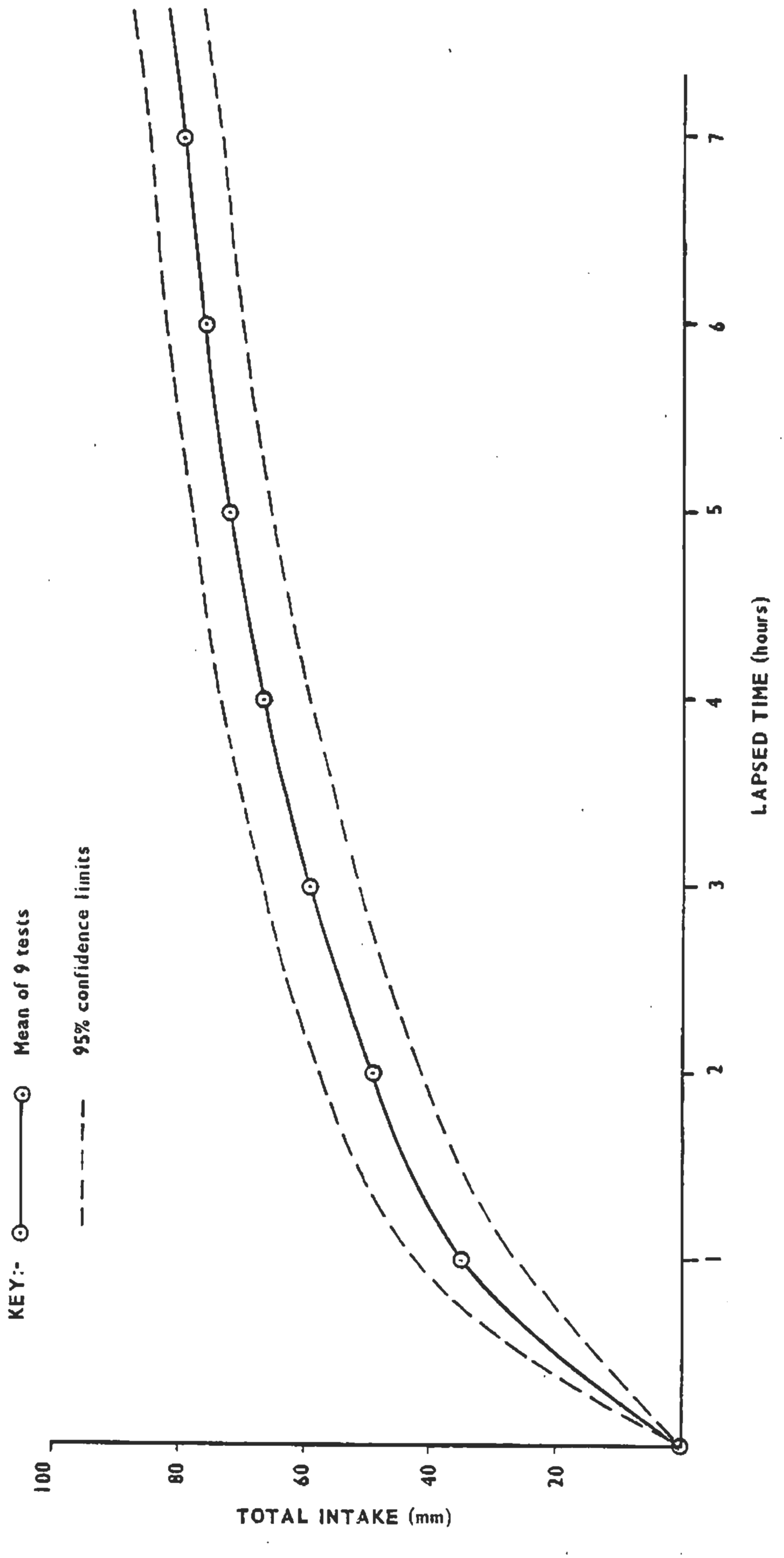


FIGURE 2.5

SURFACE INFILTRATION OF QORYOOLEY SOILS



to six hours. Assuming 60% field application efficiency and 10% deep percolation losses, if the total amount of infiltrated water is limited to 70 mm, only 60 mm is available to satisfy net irrigation requirements.

TABLE 2.14

Total Infiltration Times for Selected Study Area Soils

Total required infiltration (mm)	Infiltration time (hours)	
	Qoryooley soils	Saruda soils
70	4.7	5.5
80	7.0	11.0
100	13.0	21.0
120	19.0	31.0
150	27.0	-

2.11 Irrigation Intervals

For any given crop, the irrigation interval can be calculated by dividing RAM by the daily net irrigation requirement for any given month. The minimum interval is therefore obtained when using the maximum daily net irrigation requirement. However, as can be seen in Table 2.13, for most crops under consideration, RAM is 80 mm of water. Therefore, the total net application per irrigation (80 mm or more) would be greater than the maximum infiltration limit set at 70 mm (Section 2.10). Consequently, irrigation intervals must be determined by dividing the permissible net application depth (60 mm) by the net irrigation requirement. Irrigation intervals for crops under consideration are given in Table 2.15, which shows that rice is the one exception, as RAM for rice (36 mm) is less than the permissible net application level of 60 mm. For all other crops, infiltration limitations are critical in determining irrigation intervals. Except for rice and groundnuts, this is also the case even during the critical growth stage of flowering when permissible moisture depletion is less (see Table 2.15).

The irrigation intervals given in Table 2.15 were calculated from the maximum net irrigation requirement. Consequently, the figures represent the minimum expected intervals at any one time during the growing season. This generally applies to the critical stage of flowering and early seed development. At other times, the net irrigation requirements are less. Therefore, either the time between irrigations can be extended or the total depth of water applied at each irrigation reduced. This can be seen, for example, for irrigation during crop maturation when a far greater depletion of available moisture can occur without loss of yield. As demand for water is decreasing, even with a limited infiltration per irrigation application, final irrigation will be at a correspondingly longer interval before crop maturity is reached. This is seen, as will be discussed in later chapters, as the lack of yield response of crops to irrigation after a certain stage in growth. This is increased or decreased by

The introduction of project charges must ensure that the householder's income does not fall below present average income levels. The following proposed scale of repayments guarantees the family income:

Years of development	1	2	3	4	5	6	7	8
Repayment/ household	0	1 000	2 000	3 000	3 400	3 800	4 200	4 552
Average household income	2 912	3 264	3 774	3 932	4 334	4 352	4 370	4 400

The results of the build-up of these repayments are shown in the cash flow to the project authority (Table 7.19), indicating that the project authority cash flow becomes positive in year 8 and provides an average of So. Shs. 5.7 million surplus over operation and maintenance costs per year to service and repay capital after year 13.

TABLE 7.19

Cash Flow to Project Authority
(So.Shs. million, financial prices)

Year	Net crop revenue	Farm costs	Net revenue	HQ charges	Project costs	Net project cash flow
1	-	-	-	-	19.49	-19.49
2	0.24	0.01	0.23	-	28.80	-28.80
3	0.25	0.01	0.24	-	11.64	-11.64
4	1.49	0.30	1.19	-	19.94	-19.94
5	4.31	0.57	3.74	0.62	15.60	-14.99
6	5.68	0.81	4.88	1.66	11.27	- 9.61
7	8.87	1.06	7.80	3.19	4.60	- 1.41
8	11.24	1.06	10.18	4.78	3.80	0.98
9	13.15	1.06	12.09	6.16	4.05	2.11
10	14.46	1.06	13.40	7.37	3.68	3.69
11	15.54	1.06	14.47	8.26	3.85	4.41
12	16.14	1.06	15.07	8.89	4.09	4.80
13	16.57	1.06	15.50	9.32	3.12	6.19
14	16.78	1.06	15.72	9.51	5.18	4.32
15	16.78	1.06	15.72	9.51	3.90	5.60
16	16.78	1.06	15.72	9.51	4.16	5.35
17	16.78	1.06	15.72	9.51	4.08	5.93
18	16.78	1.06	15.72	9.51	3.31	6.20
19	16.78	1.06	15.72	9.51	3.89	5.62
20	16.78	1.06	15.72	9.51	3.80	5.72
21	16.78	1.06	15.72	9.51	3.79	5.72
22	16.78	1.06	15.72	9.51	3.78	5.73
23	16.78	1.06	15.72	9.51	3.12	6.39
24	16.78	1.06	15.72	9.51	3.90	5.61
25	16.78	1.06	15.72	9.51	4.12	5.49
26	16.78	1.06	15.72	9.51	4.34	5.16
27	16.78	1.06	15.72	9.51	3.92	5.59
28	16.78	1.06	15.72	9.51	3.43	6.08
29	16.78	1.06	15.72	9.51	3.83	5.67
30	16.78	1.06	15.72	9.51	3.49	6.02

crop root intensity within the maximum root zone. Sparsely-rooted crops, for example, castor, will require later irrigations than densely-rooting crops, such as sesame. Consequently, although calculations indicate the necessity for continued irrigation, the use of residual moisture down to levels near or at permanent wilting point obviates the requirement.

The above method must not be applied during early growth stages. Due to shallower root depths, RAM values will be small, indicating that frequent light irrigations are necessary. However, Lea (1961) reported that on heavy clay soils in the Sudan and under rainfed conditions, the rate of root growth reflected the rate of moisture penetration, with roots remaining just above the slow moving moisture/dry soil interface. Therefore, in order to encourage rapid early root growth to maximise water uptake, initial irrigations should be the maximum possible (i.e. 60 mm net irrigation) particularly as the physical structure of the Study Area soils alters markedly with moisture content.

CHAPTER 3

MECHANISATION AND LABOUR UTILISATION

3.1 Introduction

The aim of mechanising field operations is to improve farm operational efficiency, to overcome labour shortages and to carry out tasks where speed is essential. The degree of mechanisation required in the development of crop production is, therefore, a reflection of both the intensity of production required and labour availability. The main problem is deciding the extent to which mechanisation should be introduced and the degree of sophistication of the machinery involved. In the context of developing countries, where manpower shortages are rare and the level of mechanical and operational expertise is generally low, it is essential that introduced equipment should be simple, flexible and of the barest minimum needed. The more specialised and sophisticated the machinery becomes, the greater the risks of breakdown through improper maintenance or operation and uneconomic use as the result of lying idle for long periods when not required for its specific function. Conversely, once machinery is introduced for a necessary operation it then becomes more economical to use at other times and, if adaptable, for other operations for which it was not specifically required. This then leads to over-mechanisation and any existing labour force is relegated to carry out a limited range of often menial tasks. Ultimately, this reduces the feeling of personal involvement of the labour force and their sense of responsibility for overall productivity.

As a result of labour availability problems, an increasing amount of mechanisation is being introduced in several schemes along the Lower Shabeelle river, in order to maintain and increase present production levels. This has been unavoidably accompanied by technical problems resulting from the lack of experience, poor maintenance and incorrect utilisation. Consequently, the net benefits of mechanisation were difficult to observe. The ultimate situation was reached when serious consideration was given to introducing regular aerial spraying of chemicals at these schemes to overcome two major factors currently reducing yields, weeds and pests.

Therefore, before making any recommendations for mechanisation of crop production in the Study Area, the following points must be borne in mind:-

(a) the risks outlined above

(b) the high population density and extensive areas of smallholder agriculture in the Study Area.

Both are far greater than in other areas along the Shabeelle river which are currently under development. Mechanisation requirements must therefore be minimal and geared to farming systems, such as co-operatives, in which the smallholder and family labour will play a dominant role in proposed agricultural development.

(c) Identification of methods to overcome existing problems without recourse to intensive mechanisation. This is of particular relevance where labour shortages exist and can be overcome by, for example, the selective use of chemical weed control and staggered planting dates.

(d) Better utilisation of the present labour force, through the introduction of improved tools and, after suitable testing, other more appropriate hand operated equipment. This should also include introduction of animal drawn implements which will result in a more efficient but still labour based farming system.

(e) The corrosive atmosphere of the Lower Shabeelle area caused by coastal humidity. Equipment life can be significantly reduced by this high humidity if inadequate protection is given to working mechanisms of equipment especially when not in use.

(f) The physical characteristics of the fine-textured vertisol soils of the Study Area alter markedly with moisture content and become highly intractable when wet. Mechanised field operations must be minimised in order to reduce delays and stoppages due to wet land. Under irrigated conditions, soil moisture can be predicted and in-field operations planned accordingly. However, with the erratic Study Area rainfall, some delays will be inevitable. If there is total dependence on mechanisation and without any allowance for the use of labour, other farm operations will also be disrupted. This problem, therefore, enhances the points raised in paragraphs (c) and (d) above.

(g) As basin irrigation is one of the two methods of irrigation included in development proposals, extra labour is needed to repair bunds damaged by in-field tractor movements. With furrow irrigation, turning at headlands will also cause similar damage that will need repair after each opertion. It has been estimated that this damage can cause up to 50% yield losses in headland turning areas.

(h) The effectiveness of mechanising operations such as planting and harvesting is also dependent on other factors. For planting, well-graded pure seed and a higher level of land preparation are needed. Also, pure seed, specific varieties (for example, non-shattering dwarf or determinate types) and a high standard of crop management are necessary to provide the even maturing, sturdy and weed-free crop essential for efficient mechanised harvesting.

The principal objective of mechanisation of crop production in the Study Area must therefore be to improve the efficiency of hand-labour rather than replace it. This objective forms the basis for recommendations discussed in this chapter. Discussion is limited to annual crop production. Mechanisation and labour utilisation for banana production are described separately in Chapter 15.

3.2 Labour Utilisation

Future annual crop production in the Study Area will be based mainly on smallholder agriculture. Therefore, reasonable utilisation of available labour is the most important factor in any development proposals. Labour requirements have been estimated for a wide range of operations for the annual crops under consideration, including requirements for recommended methods of pest and weed control which are discussed in Appendices A and B. Labour requirements per operation are tabulated in Appendix D, and are used for estimating requirements for each crop discussed in Part II of this annex. A miscellaneous labour requirement of 10% is added to cover contingencies as well as small operations that take less than a few manhours per hectare, for example, finishing off bund formation behind tractors.

Labour estimates were based on data collected from the Study Area, from projects in the Lower Shabeelle region and information reported from earlier projects. Data were also used from projects outside Somalia with similar physical conditions and crop production methods.

However, full labour utilisation also involves the introduction of improved hand tools and hand operated equipment in order to replace or modify labour intensive practices, examples of which are discussed below.

(a) Weeding

Mattocks or long-handled hoes to replace the inefficient traditional hoe (yambo). It is estimated that if imported from Tanzania, the price per mattock would be So. Shs. 25, which, in comparison with the present price of So. Shs. 10 for a yambo is not an obstacle to change.

(b) Chemical Application

Ultra low volume (ULV) and low volume (LV) microsprayers represent the most economical, efficient and least time-consuming methods of applying chemicals for smallholder agriculture (see Appendix A). Only in a few circumstances are other methods more applicable. The use of standard knapsack sprayers or granule application are recommended where only small areas are to be treated. The choice of method depends on cost differences betwen standard and ULV formulations of recommended chemicals.

(c) Seed-dressing

Simple rotating drums for treating seed prior to planting or pre-planting storage, can easily be made locally.

(d) General Hand Tools

A wide range of simple tools should be made available for routine work such as slashing, raking handling stover or forage, felling and cutting. As discussed in Annex III, present availability of hand tools is poor (Annex III, Chapter 3; ONAT).

(e) Groundnut Production

Stripping and shelling of groundnuts are very labour-demanding. The introduction of simple hand operated equipment will significantly reduce labour inputs.

(f) Rice Production

Where the selected cropping pattern permits, the use of combine harvesters should be avoided, particularly in development zones. Hand seeders, cutters and threshers which are available from manufacturers in Asia and West Africa must be introduced, but require testing under local conditions before full recommendations can be made. Rice treddle threshers have been operated successfully at the Chinese experimental rice farm, Jowhar.

Estimated operational costs for recommended equipment (except for crop spraying) are given in Appendix C, summarised in Table 3.1, and are also used in Part II as part of production cost estimates. Application costs for crop spraying are given in Appendix A. The low operation costs confirm the suitability of this equipment in the known situation of abundant self-employed labour.

As stated in Annex III (Chapter 3, Agricultural Infrastructure), the present availability of these tools and hand operated equipment is very limited. However, the equipment listed above can be obtained from a variety of sources, a few examples of which are:-

Siscoma, Dakar, Senegal
Ubongo Farm Implements, Dar-es-Salaam, Tanzania
Ce Co Co, Ibaraki City, Japan
Cossul and Co. (PVT) Ltd., Kanpur, India

These recommendations represent only a few examples of many implements available throughout the world covering every facet of small-scale agricultural production where labour is not a constraint. Full details are to be found in the following publication:-

Boyd J., 1976, Intermediate Technology - a buyer's guide to low cost agricultural implements. Intermediate Technology Development Group (ITDG), London.

Most of these implements can easily be imported into Somalia for assessment, recommendation and sale. ITDG also operate a service whereby scale drawings and technical photographs can be obtained for a selected range of equipment, enabling manufacture to be undertaken within the country.

It is absolutely essential that full consideration is given to the provision of this highly suitable equipment for crop production in the Study Area, in preference to continued expansion of high levels of mechanisation. The existing widespread usage of hand operated and diesel powered maize shellers indicates the likely acceptance of any such equipment.

TABLE 3.1

Estimated Capacities and Costs of Selected Hand Operated and Animal Drawn Equipment

Equipment or Implement	Capacity	Estimate annual usage	Estimated capital cost (So.Shs.) (2)	Estimated cost per hectare (So.Shs.) Without labour	Estimated cost per hectare (So.Shs.) With labour (1)
Groundnut sheller	1 q/h	To plant 100 ha	800	2	6
Groundnut stripper	2 q/h	18-29 ha	1 100	13	33
Rice drill (two row)	15-20 h/ha	10 ha	700 - 1 000	8 - 11	38 - 41
Rice thresher	2 q/h	30 ha	2 000 - 4 300	15 - 32	65 - 82
Rice weeder	25 - 30 h/ha	10 - 12 ha	125	2 - 3	27 - 33
Seed dressing drum	15 minutes per 100 kg seed	Up to 500 ha (planted)	1 000	0.50	Less than Shs. 1.00
Animal-drawn implements (bund formers, harrows levellers, etc.)	0.5 ha/5 h	25 ha	200 - 900	3 - 12	25 - 32
Maize shellers					
(a) small	7.5 q/h	500 hours	3 000	12[3]	22[3]
(b) large	30 q/h	500 hours	28 000	61[3]	71[3]
Rice huller	6 q/h (paddy)	500 hours	20 000	42[4]	52[4]

Notes:
(1) Labour costed at So.Shs. 1.00/manhour
(2) Estimated 1977 ONAT retail prices based mainly on 1977 prices FOB at country of origin
(3) At 35 q/ha yield, cost per quintal ranges from So.Shs. 0.35 to So.Shs. 2.00
(4) At 65% milling percentage, cost per milled quintal is So.Shs. 2.60 to So.Shs. 3.25.

Source: Appendix C

3.3 Mechanisation of Field Operations

3.3.1 Objectives

The principal aims of the proposed agricultural development of the Study Area are to increase both yields and farming intensity. Mechanised inputs are therefore required to carry out those field opertions for which hand labour methods would be inadequate. This is considered by this study to apply to only the following operations:-

(a) Land preparation between harvesting and planting of successive crops. This includes ridging in the case of furrow irrigation and bund formation for basin irrigation.

(b) Planting and harvesting of large areas of labour intensive crops such as rice, when these operations must be carried out quickly.

(c) Other specific operations to maximise tractor usage and overcome labour peaks such as grain carting, blading groundnuts, uprooting cotton plants and, occasionally, weeding.

3.3.2 Tractor Requirements

The recommendation of tractors for the Study Area involves three criteria - tractor model, power output and method of drive.

Out of a wide range of makes already in Somalia, the most common models in the Study Area are Fiat and Same. Although the present standard of maintenance of tractors is poor it is recommended that preference is given to these established makes because any mechanic will be more familiar with these types. Similarly spare parts are likely to be more readily available than for other models. In fact, ONAT has recently restricted importation of tractors to three manufacturers (Fiat, Same and Massey Ferguson) in order to rationalise the present fragmented situation. As a result of poor maintenance, operational skills and ill-matched equipment little evidence exists in Somalia upon which to make specific recommendations of tractor type based on performance and reliability. The final decision depends largely on price and availability. Machinery on the European market, including tractors, is becoming increasingly sophisticated to meet the requirements of mechanised farming within developed economies. Consequently, certain manufacturers may find it increasingly uneconomical to continue producing out-dated and more basic models for the relatively small demand from developing countries, although these models are more appropriate and less expensive. With assembly plants in several tropical countries, such as Kenya, Massey Ferguson tractors are likely to remain the more suitable compared with Fiat and Same, which are manufactured only in Europe. At present, there is little price difference between all three makes. Consequently, until differences in price and suitability become apparent, it is recommended that continued use is made of either Fiat or Same tractors.

Within a given range, optimum power output and tractor size varies with field-work to be undertaken. For this study, careful assessment of present tractor usage was necessary because, in many cases, reported criticisms and failings were due mainly to using ill-matched equipment or to bad timing of operations, particularly in relation to soil moisture and the physical condition of the soil. The amount of weed regrowth before ploughing, also limits effectiveness.

At the Libsoma Farm, Afgooye, two-wheel drive 60 hp tractors were inadequate for combined maize-planting and ridging, and were barely sufficient for mouldboard ploughing (triple-furrow) during the dry season. Study Area banana farmers consider the minimum power output for mouldboard ploughing to be 70 hp with 60 to 65 hp for disc-ploughing during the jilal season. At Balcad cotton scheme, 74 hp tractors easily handled disc-ploughing on dry land. Conversely, on moist soil, 50 hp tractors were used for disc-harrowing ploughed land with a 12-disc offset harrow. However, 47 hp tractors at Libsoma are used only for light trailer work and no banana farmer uses 50 to 60 hp tractors for any fieldwork. The FAO pilot project, Afgooye, also considered 60 hp tractors unsuitable for general land preparation (FAO, 1975). In the feasibility studies for the Afgooye-Mordiile (now Libsoma) and Balcad schemes, 70 hp tractors were recommended (HTS, 1969). Likewise, at the Bura scheme in Kenya, 70 hp tractors were also recommended for land preparation on soils similar to those of the Study Area.

Therefore, it is recommended that tractors used for land preparation for annual crops should have a power output of between 60 and 70 hp because most operations will be carried out when the soil is in a dry state. Higher powered tractors would be able to complete field operations more quickly through their capability to draw larger equipment. However, this will result in either longer idle time or, with fewer tractors required, a greater risk of breakdown affecting other field operations. Higher-powered tractors (100 hp) are only required for specialised operations such as deep ploughing, which is not recommended for annual crops. Deep ploughing is discussed in Chapter 15 (Bananas).

Provided wet soil conditions are avoided, two-wheel drive tractors should be adequate. However, due to the erratic nature of rainfall in the Study Area, four-wheel drive is essential for emergency situations. In general, four-wheel drive models are more expensive, but present prices in Somalia reflect variability between manufacturer rather than tractor type, as is seen in the following 1977 ONAT prices:-

MF 165	(60 hp; 2 WD)	So. Shs. 73 900
Fiat 640	(64 hp; 4 WD)	So. Shs. 82 700
Same Corsaro	(65 hp; 4 WD)	So. Shs. 83 100

Consequently until price differentials change, four-wheel drive is recommended at least for some tractors in any fleet or project.

3.3.3 Land Preparation

Land preparation requirements depend mainly on soil characteristics. The soils of the Study Area are vertisols (Annex I). Soil physical conditions in these fine textured soils are strongly influenced by moisture content. As described earlier, the optimum soil moisture content for tillage lies within very narrow limits, the soil being plastic and intractable when wet, hard when dry. However, these adverse tillage properties are to some extent offset by the characteristic swelling and shrinking properties of the soils; in the dry state a shallow friable mulch forms at the surface and cracks develop vertically into the profile. Mulch material falls into the cracks so that when the soil is re-wetted and the clays expand, pressure is created in the lower horizons which results in a churning effect in the whole profile. Providing the soils are allowed to wet and dry sufficiently, these self-mulching, churning and cracking properties largely eliminate the need for cultivation except for weed control. The mulch provides an easily worked surface layer for cultivation, whereas the churning and cracking improve aeration and admixture of surface material into the profile.

Recommended practices are described below for gu and der season crops as well as methods of final land preparation for each of the two irrigation methods under consideration.

(i) Gu Season Cropping

Immediately after harvesting der crops, land must be disc-harrowed to destroy remaining weeds and stubble as well as to work the surface soil layer and flatten ridge or bund remnants. For this operation, scalloped discs are more effective than plain discs. During the jilal season, disced land should be further prepared using a mouldboard plough to bury remaining weeds and residues. It is considered that weed levels at harvest may be too great to allow clean burial by ploughing without the initial discing. A reasonable period of several weeks between discing and ploughing should be left to allow for complete desiccation of weeds.

Land levelling is necessary after every two to three cropped seasons and should also be carried out in the jilal season. Eversman TM3, 329RT or 3212RT levellers are examples of suitable models for the Study Area. Prior to any levelling, a second discing will ne necessary to break down any clods to provide a suitable surface for levelling. This second discing will also provide a suitable tilth for basin irrigation.

Several reports have indicated the risk of wind erosion if full land preparation is carried out during the jilal season. Little evidence of wind erosion in fields was observed and is not expected after any land preparation in the dry season. Natural soil mulching processes provide just as fine a tilth and this is stable even during this high jilal or hagai winds.

(ii) Der Season Crops

There will be insufficient time between gu and der season crops to enable full land preparation as recommended for the jilal season.

As recommended in section (i) above, all gu crops must be disc-harrowed immediately after harvesting. With full land preparation during the jilal season and good weed control in gu season crops, weeds levels should be low at harvesting. Consequently further operations should concentrate on controlling weed regrowth prior to planting der season crops. With furrow irrigation, adequate control will result from ridging at planting time. With basin irrigation, a further cultivation immediately prior to planting will be necessary. For this cultivation, 'ducks-foot' cultivator bodies mounted on a tool-bar will be adequate.

(iii) Furrow Irrigation - Final Land Preparation

Gu season cropping assumes full effectiveness of April rains in order to allow planting prior to the availability of irrigation in May. This is discussed in Chapter 2 (Section 4). However, for furrow irrigation, planting onto pre-formed ridges creates two problems:-

(a) germinating crops obtain a reduced water supply

(b) surface run-off is not prevented.

Better moisture availability is obtained from planting on the flat, followed by ridging up once the crop has become established. However, for tall crops like maize, this is not possible until at least four weeks after planting during which time the first irrigation will be required. A modified border strip method, to allow for this first irrigation, would not be possible due to different levelling requirements and would not prevent surface run-off. Consequently for crops such as maize, ridging will be necessary at planting. It is also essential for dwarf crops such as groundnuts. Therefore, in order to prevent run-off, small tie ridges must be prepared at intervals along the furrow. This can easily and quickly be done by hand using long handled mattocks. At the first irrigation, these tie ridges are removed by irrigation workers as they control flow along the furrow.

For der season crops, and for gu crops when adequate irrigation supplies are available at planting, no modifications to ridges are necessary. The field can be ridged, planted and irrigated immediately. Ridging should be done using non-smearing bodies on a tool-bar. Ridging and planting at the same time should provide weed-free conditions for germination. Hand labour will be required to finish off incomplete ridges in the field watercourse headland.

(iv) Basin Irrigation - Final Land Preparation

This involves bund and field lateral (farm channel) formation. Bunds should be prepared using a simple angled A-frame attachment in order to scrape the soil into a flat bund. Present methods, using double disc ridgers, gouge out soil and leave a sharp bund. The use of an A-frame results in more even irrigation. The flatter bund also minimises problems of any machinery movement at harvest and subsequent land preparation.

For field laterals, a V-ridger body can be used in conjunction with a modified A-frame, in order to prepare a raised channel to obtain sufficient command. V-ridgers used alone cut into the field and reduce efficiency of the resulting channel.

With basin irrigation, no modifications will be required to make effective use of gu rainfall before irrigation starts in May. No surface run-off should occur from basins. Hand labour will be required to complete bunds and laterals at tractor crossing points. With hand planting, bund formation should be carried out before planting. With mechanised planting (e.g. rice drilling) bunding takes place immediately after planting.

(v) General

If effective weed control is carried out during crop growth, weed levels at harvest will be minimal. Consequently, modifications will be possible. After der crops, one heavy discing will be sufficient, eliminating the need for further ploughing and discing. After gu crops only a single operation (ridging or cultivating) when planting der crops will be necessary. Conversely, poor weed control will require slashing before any discing and will necessitate regular and costly deep ploughing.

3.3.4 Miscellaneous Field Operations

Under certain circumstances, further usage of tractors and machinery will be required to replace labour intensive operations other than land preparation.

(a) Rice Production

Both drilling and harvesting demand much labour, even if hand operated seed drills and threshers are introduced. Any large scale rice production therefore requires greater mechanisation. Combined drills and combine harvesters are already used in the Study Area (see Annex IV, Chapter 5). Standard drills such as an MF30 drill are adequate. Also only small basic combines are necessary as the present tendency to import large combines represents the most obvious example of over-mechanisation. The MF307 combine, the smallest of the Massey Ferguson range, would for example, be adequate as only flatland work would be done and no wet crop-handling necessary. The only modification is to fit a standard peg type drum and concave required for rice harvesting.

(b) Cultivations

Cultivations are required for continued weed control before any cropping. With basin irrigation, a light cultivation prior to planting on the flat will control any weed regrowth.

Weed build up will take place on any fallowed land, particularly in the gu season. Regular cultivation at four to five week intervals should be adequate to control these weeds and minimise land preparation requirements for der season crops.

Weed control within crops is discussed in Appendix B. In general, mechanical inter-cultivation of crops is not recommended.

(c) Blading Groundnuts

On heavy soils, considerable assistance will be required during groundnut harvesting. Due to the critical nature of soil moisture during groundnut harvesting on heavy soils, quick lifting is necessary. To assist lifting, blading is recommended as the easiest mechanised operation. The required tool-bar attachments can easily be made, for example, from old vehicle leaf springs. Several rows can be bladed with one pass.

(d) Post-harvest Cotton Operations

The standard practice involves laborious uprooting and burning trash to control pest carry-over. An alternative method is to destroy remaining plants using a heavy duty rotary slasher. This, however, still leaves a stubble that can hinder further land preparation. Also, pest control is generally less effective unless all the trash is burned. Recommended methods are to blade in the same way for groundnuts and rake the trash before burning. This method was reported to be effective at the FAO pilot project, Afgooye as a substitute for hand labour (FAO, 1975).

(e) Field Transport

Increased yields, particularly with any bulky crops such as cotton, will require extra carting to either the village or a farm storage area. This is of relevance only to proposals where communal farming (for example, co-operatives) are involved. As most crops will be hand harvested, only basic trailers are required. For bulky harvests, simple wire or canvas high sides can be made locally and fitted to the trailers. The optimum capacity is about five tonnes.

(f) Grass Slashing

In proposed projects, weed and grass control will be necessary along canal banks, surface drain slopes and non-cultivated areas. Grass cutting will be required several times during rainy periods from April to November and can be easily carried out with a pto driven, rear mounted mower bar. This will be more flexible than heavy duty rotary slashers.

3.3.5 Summary

Recommended mechanised field operations and estimated operation times are given in Table 3.2. All the equipment listed in Table 3.2 can be drawn by 60 or 70 hp tractors. Operating speeds and efficiency factors are based on theoretical values and data collected during field surveys. For all operations, there is a range of speeds and efficiencies related to differing field conditions and operator skills. For conditions in the Study Area it has been necessary to select slower speeds and lower efficiencies than average. However, existing operator skills must be improved to carry out each operation even at these estimated rates.

The relative simplicity of proposed mechanisation is seen in the frequent use of a rear-mounted tool-bar; five operations can be carried out using tool-bar attachments.

TABLE 3.2

Mechanised Field Operations, Assumed Performance and Outputs

Operation	Working width (m)	Operating speed (km/h)	Efficiency factor (%)	Operation time (h/ha)	Recommended machinery
Ploughing (mouldboard)	0.91	5.5	70	2.65	3-furrow
Disk harrowing	2.16	6.5	75	0.95	20 disc, offset
Land levelling	3.60	5.0	75	0.74	e.g. Eversman 3212RT
Ridging:-					
(a) 60 cm rows	3.00	5.0	70	0.95	) Non-smearing bodies;
(b) 80 cm rows	3.20	5.0	70	0.89	) tool-bar mounted
Cultivating(2)	3.00	6.5	75	0.68	Tool-bar mounted
Bund and field lateral formation	12.50(1)	6.0	75	0.18	A-frame and V-ridger; tool-bar mounted
Rice drilling	2.40	5.0	70	1.20	e.g. MF30
Combine harvesting (rice)	3.00	4.5	60	1.23	e.g. MF307
Groundnut blading(3)	1.80	5.0	70	1.59	) Tool-bar mounted
Cotton blading (uprooting)(3)	1.60	6.0	70	1.49	) attachments locally made
Raking cotton trash	3.00	5.0	70	0.95	
Grass cutting (mower bar)	1.80	5.0	70	1.59	e.g. MF60

Notes:
(1) Bunds at 25 m x 25 m spacing
(2) Pre-plant during fallow periods
(3) Groundnuts: 3 rows per pass; Cotton: 2 rows per pass
(4) Data based on 60-70 hp tractors
(5) To include 5 tonne trailers for grain carting

(a) Ridging with non-smearing bodies adjustable to a furrow spacing of 0.6 or 0.8 m.

(b) Cultivating with "ducks foot" cultivator bodies for light weed control.

(c) Forming bunds and field laterals with A-frames and medium size V-ridger attachments.

(d) Blading for either lifting groundnuts or uprooting cotton.

Tool-bar widths should be 3.5 m in order to accommodate ridging or cultivating bodies to cover four 0.8 m ridges in one pass.

Consequently, with the exception of rice production, further equipment requirements are minimal.

Information on machinery operating costs is given in Appendix C. These have been estimated at So. Shs. 70 per tractor hour for all operations except levelling (So. Shs. 84/h) and So. Shs. 190 for combine harvesting.

3.3.6 Implementation of Field Mechanisation

The degree of implementation of these recommendations depends on development proposals for the Study Area. These have been outlined in Chapter 1 and involve either development projects with full farm managerial and technical supervision or development zones with upgraded technical services supplying the existing farming community. Implementation is also dependent upon selected cropping patterns and intensities. Full implementation of these recommendations is, therefore, only possible in project situations exemplified by requirements given in Part III for the Qoryooley project feasibility study. Under these circumstances, reorganisation of existing holdings into blocks is necessary in order to improve access and minimise inefficient tractor usage. In most projects, re-organisation is necessary anyway, as the result of altered or new layouts of main canals, secondaries and field units as well as levelling requirements.

However, in development zones, reduced mechanisation is necessary due mainly to an anticipated lesser degree of organisation possible amongst the farmers and because machinery will be hired from an outside source (ONAT). Scattered holdings without any reorganisation make any mechanisation difficult due to access, cropping and in-field movements unless either re-organisation of land is undertaken or simplified cropping patterns chosen. This plus reduced technical supervision and inevitable cash or credit problems will minimise both the opportunity and likelihood of implementing all given recommendations. As basin irrigation will be the only irrigation method used in development zones, necessary modifications are as follows:-

(a) Post-harvest harrowing replaced by a hand-weeding

(b) Bunds and laterals prepared using the traditional kawawa

(c) Once developed, animal drawn implements to be used for simple levelling and bund formation (see Section 3.4).

Under these circumstances cropping patterns selected for projects must be modified to accommodate the extra labour requirement, particularly if rice is included. Rice harvesting must be quick to minimise losses through bird attack and shattering. The alternative to combine harvesting is hand harvesting with cutters or scythes and treddle threshing, both of which are very labour-demanding.

3.4 Animal Drawn Equipment

Apart from animal carts, the use of animal drawn equipment in the Study Area has been limited to a few isolated examples of ox ploughing (see Annex IV, Chapter 5). It is considered by this study that the introduction of selected implements and training of oxen or even donkeys to perform these few operations will play a vital intermediary role between hand labour and mechanisation. This is of particular importance with the use of basin irrigation in development zones where full mechanisation as recommended in Section 3.3, is not possible. The ability to gain access to scattered holdings and to move within the confined area of a basin are two of the advantages of animal drawn equipment over tractors.

The proposed usage of animal drawn equipment takes account of the heavy soils. Ploughing and the deep ridging needed for furrow irrigation are now recommended due to the heavy nature of the physical work involved. However, the friable easily worked surface mulch which forms naturally in the moist or dry state, will enable certain operations to be easily performed by animal drawn equipment. Recommended examples of animal drawn equipment needed in the Study Area are as given below:-

(a) Cultivators

As already practised in many parts of East Africa, tined cultivators can be used to weed wide row crops such as maize, sesame and cotton.

(b) Bund Formers (A-frames)

As discussed in Section 3.3.6, these can easily replace the more labour intensive kawawa for bund formation.

(c) V-ridgers

Medium sized ridgers can be used either to cultivate wide-row crops or prepare ridges for planting. Under a system of basin irrigation, small ridges reduce the effects of waterlogging, particularly for maize.

(d) Levellers

Simple wooden levellers can be used within basins during land preparation. This single operation will significantly increase yields of crops grown by smallholders in development zones because of the improved irrigation that crops will receive.

(e) Harrows

A wide range of harrows exist (disc, zig-zag, spring-toothed) which can be used for the post-harvest harrowing required to destroy weeds.

All the above equipment, plus a wider selection not considered necessary for the Study Area, are available from the same sources as the improved hand tools (ITDG, 1976). However, full testing will be necessary before any recommendations are made. As with improved hand tools, immediate consideration must be given to the introduction and assessment of the recommended animal drawn implements. Estimated operating costs of selected examples are given in Appendix C and summarised in Table 3.1. As with hand operated equipment, the low operation costs confirm the suitability of instigating development of these implements within the Study Area. For example, the cost to a smallholder for cultivating or harrowing will be less than So. Shs. 12/ha. Using a tractor, these operations would cost So.Shs. 50 to So. Shs. 65/ha (0.68 to 0.95 h/ha at So. Shs. 70/h; see Section 3.3).

3.5 Miscellaneous Equipment

Further requirements for post-harvest treatment of several crops are also necessary. Present availability of maize shellers is inadequate to meet present demand and nneds improvement when proposed development is implemented and production increases. A range of shellers is available, generally driven by either small petrol engines or from a tractor pto. Examples range from the Ransomes "Cobmaster" which can produce 7.5 quintals of shelled grain per hour to the Ransomes "Lion" which is pto driven and with an output of 30 q/h. Other examples are also given in the Intermediate Technology publication (ITDG, 1976). Estimated operation costs of sheller are given in Appendix C and summarised in Table 3.1.

If rice production is increased, there will be an increased requirement for rice hulling. The present Crash Programme mill at Shalambood is virtually at capacity and the new ONAT mill, also at Shalambood, represents the only future spare capacity for the entire Lower Shabeelle area. Within the Study Area, many small diesel-operated, privately owned oil mills and maize mills are found in the large villages. If rice production expands, official encouragement should be made for the establishment of rice hulling equipment to be used in the same way. Small hullers requiring 0.5 to 2 hp engines are available with a handling capacity of up to 6 to 9 q/h of paddy (before milling).

Estimated operation costs of rice hullers are also given in Appendix C and summarised in Table 3.1. Current rice hulling charges at Shalambood, which include polishing, are So. Shs. 20 per quintal of milled rice. Even without polishing, the estimated cost of So. Shs. 3 to 4 per milled quintal represents a far more economic method.

PART II

CROP RECOMMENDATIONS

CHAPTER 4

MAIZE

4.1 Introduction

Maize is the staple food of a large proportion of the population living in southern Somalia and is one of the most important crops grown in the Study Area. In the past few years, regular maize imports into Somalia of about 30 000 tonnes per year have been necessary (see Annex VIII, Chapter 2). Therefore, improvement of the existing extensive but poor maize production in the Study Area will improve supplies for domestic consumption and decrease national import requirements. However, due to the poor rainfall distribution and its drought sensitivity, improved production of maize can only be under improved irrigation methods. Maize production problems in the Study Area have been fully discussed in Annex IV, Chapter 4.

4.2 Varieties

Both the local varieties and the recently developed Somali composite maize are early maturing varieties requiring 100 to 105 days. This is considered the optimum growing season for the following reasons:-

(a) These varieties are short-statured and can withstand the strong seasonal winds. Later, taller varieties would be prone to lodging.

(b) A decreased risk of drought compared to longer season varieties.

(c) Double-cropping. Longer season varieties (120 to 150 days) could not be double-cropped and would also interfere with other crops in a rotation.

(d) Earlier maturing varieties (for example, 90 days) that have been tested at CARS, Afgooye during 1977 appear to have a low yield potential. These varieties were also prone to bird-attack as a result of maturing out of season in relation to the other varieties. Although 100 to 105 day varieties will also have a moderate yield potential compared to later maturing varieties, the advantages given in (a) to (c) would offset this.

The Somali composite variety is the only variety that has been developed for recommendation in Somalia and is known greatly to outyield the local variety in the Study Area (see Annex IV) at other development projects and under research conditions (CARS, unpublished data). However, pure stocks do not exist and because it is a yellow-seeded variety it will not be acceptable for local consumption. It is, therefore, recommended that a new white-seeded composite is developed at CARS as soon as possible in order to replace the Somali composite. Good composites can be produced within several years. The Somali composite was developed in two years by the uncontrolled crossing of 22 selected pure lines that had previously been tested in several variety trials and can therefore be referred to as an "interim" composite. A more organised programme should be able to develop a better 100 to 105 day composite. Hybrid varieties, despite their higher yield potential compared to composites are not recommended for the following reasons:-

(a) The higher level of skills and management required during breeding, multiplication and maintenance of stocks.

(b) Farmers would require new stocks each year which would greatly increase the required seed multiplication facilities. With composites a farmer can retain seed each season to provide planting material and maintain good yields by cob selection at each harvest. This is of particular importance in Somalia given the limited infrastructure and poor communications.

(c) Hybrid varieties could be imported from Kenya but, at present, no low altitude hybrids are available and estimated importation costs (CIF Mogadishu) are nearly So. Shs. 500 per quintal (Kenya Seed Co. Ltd., 1977).

4.3 Land Preparation and Planting Methods

General land preparation requirements have been discussed in Chapter 3. Planting by hand is recommended because it is not a labour-demanding operation and mechanised planting, even on projects, is not necessary. The use of shorter statured early varieties necessitates higher plant populations than the standard 40 000 per hectare planted in 90 cm rows. However, research trials have shown only small yield increases with populations between 40 000 and 60 000 plants per hectare (CARS, 1964/68/74 and FAO, 1975). Therefore, an average of 50 000 plants per hectare is recommended, necessitating a closer row spacing of 80 cm and a seed rate of about 20 kg/ha. All seed should be dressed in Fernasan D at a rate of 1 : 333 w/w.

Two planting methods are recommended and are aimed at minimising labour inputs:-

(a) With basin irrigation

Check row planting with three or four seeds every 80 cm x 80 cm to obtain three plants per hill. Seeds should be spaced apart in a shallow hole made at every planting station.

(b) With furrow irrigation

Row planting along pre-prepared ridges with one or two seeds every 25 to 30 m to obtain one plant per hill.

Any thinning can be carried out during the first weeding.

4.4 Planting Dates

Optimum planting dates depend upon the following factors:-

(a) Maximising use of effective rainfall, particularly in the gu season.

(b) Irrigation is required until 75 to 80 days after planting (see Section 4.8).

(c) Maturation and harvest periods should avoid periods of heavy rainfall.

(d) 100 to 105 day varieties are recommended.

Recommended planting dates, therefore, are as follows:-

(i) Gu Season

From the onset of gu rains (normally mid-April) until early May. Harvesting will, therefore, be in August, when minimal rainfall is expected. Later planting will increase stalkborer incidence, decrease the amount of possible double-cropping and will not have fully utilised gu season rainfall in April and May.

(ii) Der Season

From mid-August to mid-September. Earlier planting will result in maturation during the November der rains, but later planting will decrease the period of irrigation. This assumes the present situation when water supplies are normally available only until early December. However, with full operation of the Jowhar offstream storage reservoir, predicted water supplies will be available until mid-January (see Annex II). Therefore, planting can then be extended until mid-October.

4.5 Fertilisers

Recommendations are based on available fertilisers, estimated nutrient removal by maize and results of 13 trials carried out at CARS and the FAO pilot project between 1965 and 1974. All data used were presented in Appendix E and the results of nine major NPK trials are summarised in Table 4.1. Although all research was carried out at Afgooye, results are considered applicable to the Study Area because of the similarity of soils. Unfortunately, in the absence of improved varieties, the local variety was used in most of these trials. Also, trial work was not co-ordinated from year to year and, apart from the FAO trials, no statistical data were published. Little information was reported on application methods and timing. Consequently, only approximate recommendations can be made.

TABLE 4.1

Maize NPK Fertiliser Trials, Afgooye 1965-1974
Summary of Yield Responses

Year	Site	Number of trials	Number of varieties	Mean yields (q/ha shelled grain) Nil treatment	Most significant(1) response to applied N and P	Optimum treatment (kg/ha) N	P_2O_5
1965	CARS	1	1	15.4	25.4	52	52
1971	CARS	2	3	7.2	18.3 - 22.3	100	0 - 50
1972	CARS	2	2	15.0	27.9 - 34.3	50 - 100	50
1974	FAO/PP	2	1	23.2	38.0 - 41.4	50 - 100	50
1974	CARS	2	1	21.9	33.4 - 38.6	80	0 - 50

Note: (1) Calculated as highest yield increase per kg of applied nutrients.

Source: Appendix E

However, from the trial results, responses to both nitrogen and phosphorus clearly occur. The main response is to applications of about 50 to 100 kg/ha of nitrogen. Responses to phosphorus are not so consistent and only appear to occur at higher levels of nitrogen application, with the most significant yield increases occurring with 50 kg/ha P_2O_5. However, no trial assessed phosphorus application rates lower than 50 kg/ha. On the other hand, nutrient removal data show that for an expected yield of 35 q/ha (see Section 4.11), maize only removes an estimated 98 kg/ha N, 35 kg/ha P_2O_5 and 91 kg/ha K_2O. Therefore, although Study Area soils are deficient in nitrogen and phosphorus, the higher rates of N and P_2O_5 to which yield responses occurred will not be necessary. Recommended fertiliser rates are as follows:-

(a) 50 kg/ha diammonium phosphate (DAP)

(b) 150 kg/ha urea.

This will supply 79 kg/ha N and 25 kg/ha P_2O_5. The DAP should be applied as a basal dressing by broadcasting before ridging and planting or, for check-row planting, by spot applications at planting. The urea should be applied at the onset of rapid shoot growth (20 to 25 days after planting), covered up and followed immediately by an irrigation.

To obtain higher yields (40 q/ha), nutrient removal will increase slightly (see Appendix E) and a possible 60 kg/ha DAP and 160 kg/ha urea will be necessary.

In the research trials, no response to potassium applications occurred. This is typical of many maize growing areas in Eastern and Central Africa and is confirmed by the known moderate potassium status of the Study Area soils (see Annex I). However, because maize is a moderately heavy potassium feeder and all stover is fed to livestock and not ploughed in, regular light applications are recommended to prevent any decline in soil potassium levels. 50 kg/ha of potassium sulphate (25 kg/ha K_2O) every four cropping seasons should be adequate.

However, further research is necessary to confirm all these recommendations, particularly for nitrogen and phosphorus requirements.

4.6 Pest and Disease Control

The only serious pest or disease problem in the Study Area is maize stalkborer (**Chilo partellus**). Attacks commence soon after emergence of the crop and Ciba-Geigy experimental work at the Libsoma Farm (Afgooye) showed that effective control using standard non-systemic insecticides is only obtained with two applications within 20 to 25 days after emergence using either dusts and granules or sprayers. ULV microsprayers are, in general, the most effective and quickest application method suitable for the Study Area (see Appendix A). Therefore, the Ciba-Geigy recommendation for stalkborer control is also recommended for the Study Area and is given below:-

> Two ULV sprays of 2.5 l/ha Nuvacron Combi (Monocrotophos/DDT)
> at 10 and 20 days after planting;
> i.e. 5 l/ha total application. (Ciba-Geigy, 1977).

Observation by the Consultants at the Libsoma Farm during the 1977 gu season showed that this treatment gave very good control, particularly as stalkborer incidence was severe during 1977. It also greatly reduced late infestations on developing cobs which usually occur on unsprayed crops. Cost comparisons also show little difference between standard chemicals and ULV formulations as exemplified in Table 4.3.

Research work at CARS in 1976 and 1977 has shown that the systemic insecticide Carbofuran (Furadan) also gives significantly better stalkborer control and higher yields. Trial results are presented in Table 4.2. However, better control was only seen at application rates of 3 kg/ha a.i. and, as shown in Table 4.3, it is considerably more expensive at these rates than other methods. FMC general recommendations for Furadan are only 0.75 to 1.5 kg/ha a.i. which would only cost between So. Shs. 120 and So. Shs. 240/ha. Therefore, further research is essential to compare ULV formulations and Furadan and confirm the recommendations given for the Study Area. This is because, if economically viable, granular applications of Furadan would be an easier and cheaper method for smallholders to adopt under existing farming systems.

Cutworms can also cause serious but isolated damage. Control methods are discussed in Chapter 8 (Sesame) and on average may be necessary every third year.

TABLE 4.2

Maize Stalkborer Control: Trial Results, CARS, Afgooye 1976-1977

Chemical	Active ingredient	Treatment (kg/ha a.i.)	Number of applications (1)	Stalkborer incidence (2) 1976 Der	1977 Gu	Yield (3) (q/ha shelled) 1976	1977
Control		-	-	- (85)	-	13.9	9.1
Busudin 10G	Diazinon	(a) 0.5	1	- (25)	-	34.4	16.8
		(b) 1.0	2	- (23)	-	35.6	23.8
Sevin 85S	Carbaryl	1.7	2	- (11)	-	33.3	17.7
Furadan 10G	Carbofuran	(a) 0.75	1	15	10	30.0	9.0
		(b) 1.5	1	25	20	32.0	16.1
		(c) 3.0	1	65	45	40.0	26.1

Notes:

(1) Furadan granules applied to the soil at planting. Other chemicals applied down the whorl at 13 and 35 days (second application) after emergence.

(2) As days of control after planting. Trials harvested at 100 to 106 days. Figures in brackets are percentage incidence of stalkborer at 50 days afer planting.

(3) Stalkborer incidence far greater in 1977 gu season.

Source: "Agricultural crop pests and their control in Somalia", Lyon W.F. (CARS, 1977).

TABLE 4.3

Maize Stalkborer Control: Chemical Costs

Chemical	Application rate kg/ha a.i.	Product	1977 ONAT price (So. Shs. per kg or litre)	Cost/ha (So. Shs.)
Basudin 10G[1]	1.0	10 kg/ha	15.00	150
Nuvacron Combi ULV	-	5 l/ha	36.60	183
Furadan 10G	3.0	30 kg/ha	15.85	475

Note: (1) Best standard chemical (see Table 4.2).

4.7 Weed Control

Full discussion on available weed control methods is given in Appendix B. Two methods are recommended for maize as follows:-

(a) Hand Weeding

Three early weedings will be necessary before full crop cover is reached at about 45 days from planting, for example, at 10, 20 and 40 days.

(b) Herbicides

Ciba-Geigy trials at Afgooye have shown good weed control using a pre-emergence application of 5 l/ha of Primextra 500 FW (Atrazine and metolachlor) but with no residual carry over to affect other crops (for example, groundnuts) grown in the der season after treated gu season maize. Application should be by using a Microhandy LV sprayer (see Appendix A) one to three days after the first irrigation. The use of herbicides is only recommended for large scale farmers who may face a regular shortage of labour so that the limited available labour can concentrate on other crops where herbicide recommendations are not available.

4.8 Irrigation

Crop water and irrigation requirements have been fully discussed in Chapter 2. The minimum irrigation interval at full crop development is estimated to be 15 days (see Table 2.15) and calculations of irrigation intervals presented in Appendix F indicate six irrigations are needed. Two maize irrigation trials were carried out at Afgooye and results are summarised in Table 4.4. Although full details were not available these trials indicate that at least five to six irrigations are required and that with 100 to 105 day varieties, the final irrigation will be at about 75 days after planting. These results are confirmed by the calculated data given in Appendix F.

TABLE 4.4

Maize Irrigation Trial Results: Afgooye, 1974

Number of[1] irrigations	Date of[2] final irrigation	Irrigation[3] interval (days)	Yield (q/ha shelled) 1974 Gu[4]	1975 Der
2	40	40	15.6	-
3	40	20	20.3	-
3	50	25	21.1	-
4	60	20	23.8	-
5	80	20	26.1	-
3	56	28	-	36.7
4	63	21	-	40.9
5	63	16	-	45.7
6.	70	14	-	51.0
7	84	14	-	51.0

Notes: (1) Includes irrigation at planting

(2) Days after planting. 100 to 105 day local varieties used in trials

(3) Gu season trial supplemented by rainfall

(4) Mean of two local varieties. Variety mean yields were 24.4 and 18.3 q/ha.

Source: FAO pilot project (FAO, 1975).

However, with the known erratic rainfall, requirements can vary. Therefore, with this known variability and the lack of experimental data, further research is required.

4.9 Harvesting

Harvesting by hand is the only recommended method. It is only moderately labour demanding and mechanical harvesting is not considered practical. Even with good stalkborer control, there are sufficient infestations in maturing crops to cause a certain amount of stem collapse. This is not considered to affect yields but would limit the effectiveness of using combines. Two methods of hand-harvesting can be used:-

(a) Traditional Method

Cutting and stooking with a drying period of one to two weeks before cob picking. This method restricts the rate of final grain drying and encourages rodent damage.

(b) Direct Picking

The crop is allowed to stand for a few more days before cobs are picked directly from the standing crop.

Harvesting will take place in August (gu crops) when rainfall is minimal, and December/January (der crops) when hot dry weather occurs. During both periods, moderate to strong winds also occur. Therefore, the second method of harvesting is recommended as it will allow full grain-drying to take place quickly with virtually no risk of rain damage. Stover, for feeding livestock, can then be cut and either stacked or transported from the field.

4.10 Post-harvest Operations and Storage

Surplus production can then be shelled and bagged, utilising motorised shellers already used in the Study Area. With correct harvesting, in normal years, further grain-drying will not be necessary, particularly after der season crops. Therefore, any bagged maize should be stacked to allow good ventilation. This is because, with the high atmospheric humidity, any well-dried grain, unless ventilated, will re-absorb moisture. Between April and December, any stacks must be covered to avoid rainfall damage.

There is little evidence to indicate any need to change the traditional method of covered pits for storing food maize. However, if storage pests become prevalent, good safe control for six to nine months can be carried out using 1% malathion at the rate of 100 g per 100 kg of seed.

4.11 Yields

Assessment of yield potential in the Study Area is complicated by the overall lack of consistently good maize management on farms and projects along the Shabeelle river. However, it is reported that 36 ha of Somali Composite yielded an average of 23 q/ha at the Libsoma Farm in 1976. At the FAO pilot project, 12 ha of the local variety yielded 23 q/ha in 1973, 50 ha yielded 26 q/ha in 1974, and a further 4 ha yielded 25 q/ha but with poor pest control (FAO, 1975). Average yields of the Somali Composite given in the Study Area were estimated to be 29 q/ha with only moderate management (see Annex IV, Chapter 6). The yield potential of low altitude, short-season composites in Kenya is considered to be 35 q/ha (Kenya Seed Co., 1977), although under similar conditions in Ethiopia a yield of 40 q/ha is considered possible (Halcrow, 1975). At the Bura project in Kenya, where growing conditions and soils are similar to the Study Area, projected yields were estimated at 30 to 40 q/ha (MMP, 1977). Under research conditions at the FAO pilot project and CARS, Afgooye, yields of 40 to 55 q/ha were obtained with, occasionally, 60 to 70 q/ha reported (CARS, 1964-1975; FAO, 1975).

Therefore, there is sufficient evidence to suggest a yield potential in the Study Area of 35 to 40 q/ha under good management. However, these yields will not only depend on full implementation of recommendations and full irrigation, but on the continued research into developing varieties, fertilisers, pest control and irrigation requirements. Details of projected yields are given in Table 4.5. Higher yields are not considered possible due to the use of short season varieties, the effects of soil salinity and high soil pH.

From data given in Chapter 2 (Table 2.12), it is estimated that with the predicted restriction on leaching, about 18% yield reductions can be expected. However, because only moderate yields are expected, crop management problems will have a more significant effect. Therefore, these theoretical yield reductions can be ignored.

TABLE 4.5

Maize: Projected Yields

	Yield (q/ha)			
	Year 0(1)	Year 1	Year 4(2)	Year 8(3)
Development projects(4)	6 - 10	18	35	40
Smallholders (5)	6 - 10	14	20	25

Notes:
(1) Existing situation
(2) With present recommendations and composite varieties
(3) Following further research and varietal development
(4) Full management situation including improved land levelling and irrigation methods
(5) With existing farming systems.

4.12 Labour Requirements

Estimated labour requirements under full management are based on data given in Appendix D and are given in Table 4.6. At 4 manhours per day, between 107 and 111 mandays per hectare are required.

TABLE 4.6

Maize Labour Requirements[1]

Operation	Manhours/ha	Notes
Basal dressing fertiliser	5	Broadcasted before ridging
Planting	25	
Pest control	2	2 ULV sprays at 10 and 20 days after planting
Top dressing	25	At 20 to 25 days after planting
Weed control	150	3 weedings before 45 days after planting
Irrigation	100-117[2]	6 to 7 irrigations
Harvesting	25	At 105 days
Carting and shelling	16	
Stover cutting and carting	40	
Sub-total	388-405	
Miscellaneous (10%)	39	
TOTAL	427-444	

Notes: (1) For development project situation

(2) For furrow irrigation and variation between seasons.

Source: Appendix D.

CHAPTER 5

UPLAND RICE

5.1 Introduction

Rice is a crop ideally suited for cultivation on the heavy Study Area soils and its inclusion in crop development proposals is also necessary for economic and financial reasons. In 1977, Somalia imported about 28 000 tonnes of milled rice and in previous years, annual imports averaged 20 000 tonnes (see Annex VIII). The Government is also encouraging rice production and is currently offering high prices to producers of So. Shs. 285 per quintal (milled) for paddy rice (flooded rice) and So. Shs. 350 per quintal for upland rice.

Upland rice production is more suitable in the Study Area because its required method of irrigation is similar to that of other annual crops. Therefore, it can be more easily introduced into present farming systems. Recommendations for upland rice are given in this chapter and for paddy rice in Chapter 6. Upland rice is already grown in the Study Area and production methods and problems are discussed in Annex IV, Chapter 8.

5.2 Varieties

Two 120-day varieties (Dawn and Saturn) and one 105-day variety (Vista) are presently available. Vista was recently released following several years of trials at Afgooye, during which it outyielded the standard recommended varieties Dawn and Saturn. Summarised trial results are given in Table 5.1. It is therefore recommended that Vista is used to replace the other varieties for the following reasons:-

(a) Higher yield potential

(b) A shorter growing season will allow greater flexibility in any rotation as well as reducing the risk of drought.

However, present seed stocks of Vista under multiplication at Afgooye are not pure and selection work or the introduction of new stocks from the USA will be necessary. Varietal characteristics of Vista are summarised in Table 5.2.

TABLE 5.1

Upland Rice Research Trials, CARS, Afgooye 1972-74: Yields of Three Selected Varieties

Yield (q/ha unmilled)

Variety	1972	1973	1973	1974	1974	Mean
Vista	31.8	30.9	17.5	39.1	33.4	30.5
Saturn	25.6	19.5	21.7	24.7	19.4	22.2
Dawn	19.6	18.4	13.2	-	13.5(1)	16.2

Note: (1) Affected by drought at heading

Source: CARS annual reports, 1973-1975

5.3 Planting Methods

Land preparation requirements are given in Chapter 3, and it is essential that level fields are prepared. For smallholder production, if land cannot be levelled properly, it is necessary that animal drawn levellers are available for use in prepared basins prior to planting (see Chapter 3).

TABLE 5.2

Vista; Varietal Characteristics

Origin	USA
Seed type	Short with cream-coloured husk
Height at maturity	1.0 - 1.2 m

Growth stage	Days after planting
Onset of tillering	10
Onset of shoot elongation	20 - 25
Boot stage	65 - 70
Heading	75
Maturity	105

Source: CARS, Afgooye (1977).

Rice should be drilled in rows 15 to 20 cm apart using either a tractor-drawn combined drill for large scale production or hand operated drills for smallholders. CARS trials have shown optimum seed rates to be 90 to 100 kg/ha (CARS, 1975). All seed should be dressed with Fernasan-D. If tractor-drawn drills are used, bunds and field channels are prepared after drilling.

5.4 Planting Dates

The main restrictions on growing seasons are water availability and bird attack. Recommended planting dates for Vista are:-

(a) Gu Season

At the onset of water availability in May. Planting should be completed within a few weeks to minimise bird attacks that will start from mid-July onwards. Harvesting will be in August when rainfall is minimal.

(b) Der Season

Mid-August to mid-September for crops to be harvested in December. Earlier planting will cause crops to mature during November der rains. Later planting will increase risk of bird damage because of increased bird populations reported in January and February (see Appendix H).

5.5 Fertilisers

Results of fertiliser trials carried out at CARS and the FAO pilot project between 1968 and 1974 are presented in Appendix E. Trial results, however, are not consistent and, although not reported, it is considered that most trials were affected by bird attack and poor irrigation. The most significant response is to applications of 50 to 100 kg/ha N, and only if applied during the first month of growth. Responses to applications of phosphorus only occurred when applied with nitrogen and, despite some conflicting data, optimum applications appear to be 25 to 50 kg/ha P_2O_5. No response to potassium occurred. Therefore, with estimated nutrient removal (see Appendix E) at expected yields of 25 to 30 q/ha of paddy (see Section 5.11), the recommended fertiliser rates are:-

(a) 50 kg/ha DAP at planting

(b) 140 kg/ha urea as a top dressing 25 days after planting at the onset of rapid shoot elongation.

This will apply 74 kg/ha N and 25 kg/ha P_2O_5. The DAP can be applied either in the seed-drill or by broadcasting and harrowed in before planting. Top dressing is by broadcasting prior to an irrigation. The requirement of nitrogen and phosphorus is confirmed by observations at several rice production farms where applications of only urea (1 to 3 q/ha) produced good vegetative growth but small heads and low yields. No potassium fertilisers will be required because most of the potassium uptake remains in the straw which will either be burnt or directly ploughed in.

5.6 Weed Control

Observations at several projects have shown that present Ciba-Geigy recommendations, if carried out correctly, will provide good weed control. These recommendations are:-

(a) Post-emergence spray of Stam F34/Preforan (propanil/Fluorodifen) at 12 l/ha about 10 days after crop emergence. This gives good weed control for five to six weeks.

(b) Two hand weedings will also be required from five to six weeks until 60 days after planting when full crop cover is reached.

Without the use of herbicides, it is considered that weed control in upland rice will be very difficult in any large scale production. However, for smallholder production (i.e. crops of less than 0.4 ha), six or seven hand weedings should also give good weed control if improved tools are used (see Chapter 3).

5.7 Pest and Disease Control

The only pest or disease problems requiring control measures are rice stemborer (**Chilo partellus**) and birds (mainly **Quelea quelea**).

5.7.1 Rice Stemborer

Although only moderate infestations occur in the Study Area, crops should be sprayed at the most susceptible growth stages (tillering and heading) to control stemborer. Recommended control measures are ULV sprays of 2.5 l/ha Carbicron (Dicrotophos) at tillering and 2.5 l/ha Nuvacron (Monocrotophos) at heading (Ciba-Geigy, 1977). Both chemicals gave good stemborer control at the Libsoma Farm, Afgooye. However, further research is necessary to determine more specific requirements and to compare ULV control methods with granular applications of Carbofuran (Furadan). As with maize, Furadan is reported to give good stemborer control in rice and would be easier for smallholders to use.

5.7.2 Quelea Quelea (Sudan Dioch)

The problem of **Quelea quelea** and other seed-eating bird species on rice is discussed in Appendix H. In most years, at least three people per hectare will be required for bird scaring, every day, from the onset of heading until harvesting. For Vista, heading occurs at about 75 days after planting. For gu season crops, this will occur after the first **Quelea** flocks arrive. Therefore, bird scaring will be necessary for a 35-day period for crops grown in both seasons. It is also important that minimal damage is done to crops by bird scarers. Control is possible by walking along the bunds and without entering the crop. Cracking whips and slinging mud pellets are adequate methods.

5.8 Irrigation

Because of its high water demand and shallow rooting, upland rice will require frequent light irrigations. Water requirements are discussed in Chapter 2 and from Table 2.15 the minimum irrigation interval is estimated to be 5 days. Theoretical requirements presented in Appendix F for Vista (105 days) show that irrigation intervals from 4 to 10 days will be needed until about 90 days after planting. This is confirmed by results from one trial carried out at the FAO pilot project, which are summarised in Table 5.3. The large yield differences clearly indicate the need for irrigation intervals of no longer than 10 days and that irrigation should continue to within 15 to 20 days of harvesting. However, because this is the only reported trial that has investigated rice irrigation requirements along the Shabeeelle river, further research is essential. Poor irrigation, particularly during early growth stages and at heading, is a major problem affecting upland rice yields in this region.

TABLE 5.3

Rice Irrigation Trial, FAO Pilot Project 1974

Variety:- Dawn (120 days)

Irrigation interval (days)	Irrigation period (days) (1)	Yield (q/ha paddy)
20	80	8.9
20	100	12.6
15	105	17.1
12	105	21.3
8	90	25.3
8	105	30.2

Note: (1) Days from planting. First irrigation at planting.

Source: FAO, 1975.

5.9 Harvesting

Although Vista, like the two other cultivated varieties, is not prone to shattering, quick harvesting is essential, mainly to minimise losses due to bird attack. Therefore, for large scale production, combine harvesters are necessary and requirements are discussed in Chapter 3. However, for smallholders, it is recommended that hand harvesting and the introduction of hand-operated threshers is undertaken, which will be more appropriate and more practical.

Harvesting will take place at the end of August for gu crops and in December for der season crops when rainfall will be minimal.

5.10 Post-harvest Operations

All harvested rice will need to be transported to the two rice mills at Shalambood. No further grain drying should be necessary. However, in abnormally wet years, gu season crops may require drying. This can be carried out using the Bentall driers being established at Qoryooley and Janaale (see Annex III, Chapter 3) before onward shipment to the rice mills.

5.11 Yields

Present management of upland rice at farms and projects along the Shabeelle river is poor. Average yields are about 16 q/ha (unmilled) although the highest average yield reported for a single field was 22 q/ha. However, at the FAO pilot project, 8 ha yielded 30 q/ha in 1973 and 29.5 q/ha in 1974 (FAO, 1975). These results were obtained using the varieties Dawn and Saturn. Both these varieties have been outyielded by Vista under research conditions (see Table 5.1), and although the yields in Table 5.1 are not high, Vista has produced over 40 q/ha in other trials (CARS, 1975). Therefore, average yields of 25 to 30 q/ha of unmilled paddy should be attainable. At a 65% milling out-turn, this represents 16.3 to 19.5 q/ha of milled rice. Details of projected yields are given in Table 5.4. Land levelling and irrigation management are the major problems that will limit yields and if not practised properly, final yields will be lower than those projected. Year 4 yields (25 q/ha) are considered possible with the given recommendations. Year 8 yields (30 q/ha) will depend mainly on selection of better varieties. In several trials, at CARS, other short season varieties out-yielded Vista and further testing should easily produce higher yielding varieties than Vista. Already, six short season (85-100 days) drought-tolerant upland rice varieties have been obtained from IRRI and are to be tested at the Libsoma Farm in 1978.

TABLE 5.4

Upland Rice: Projected Yields

	Yield (q/ha) (1)			
	Year 0	Year 1	Year 4	Year 8
Development project	16	16	25	30
Smallholders (2)	-	15	15	20

Notes: (1) Unmilled paddy. Milling percentage = 65%

(2) Lower average yields due to poorer land levelling and irrigation management.

5.12 Labour Requirements

Estimated labour requirements are based on data given in Appendix D and are presented in Table 5.5. Bird scaring will require the greatest amount of labour and, apart from the cost involved, adult labour cannot be considered for this task. They will be required for other field operations, and, when required, bird scaring will be necessary from dawn to dusk. Therefore, bird scaring must be carried out by children, which is the normal method already practised in the Study Area. The average family has three to four children of which only one or two will be of suitable age to carry out bird scaring. At the given requirement of three persons per hectare per day, this represents 0.3 ha to 0.6 ha per family i.e. for every 100 ha under rice, labour from 170 to 330 families will be necessary for bird scaring.

TABLE 5.5

Upland Rice Labour Requirements

Operation	Manhours/ha	Notes
Basal dressing	5	Smallholders only
Drilling	30	Smallholders only
Pest control	2	2 ULV sprays at tillering and heading
Top dressing	5	At 25 days
Weed control	121	Herbicide application and 2 hand weedings
Irrigation	90 (1)	10 irrigations
Harvesting and threshing	200	Smallholders only
Carting	6	
Minor operations	26	
Sub-total	250 480	Mechanised production Smallholders
Miscellaneous (10%)	25-49	
Total (2) (3)	275 534	Mechanised production Smallholders

Notes:
(1) Basin irrigation

(2) Excludes bird scaring by 3 children per day for 35 days = 105 child-days/ha.

(3) At 4 manhours per day total labour requirement is 69 or 134 mandays/ha.

Source: Appendix D

5.13 Intensive Production Restrictions

Proposals for a 5 000 ha intensive rice production project to be established in the Study Area have been described in Annex IV, Chapter 13. At full development, 3 500 ha (net) would be cultivated in the gu season and 2 500 ha in the der season. However, for reasons given below, intensive large scale production in the Study Area is not considered feasible.

As stated in Section 5.4, rice crops can only be grown between May and December. This means that gu season crops will be harvested in late August and der season crops must be planted before mid-December. Therefore, to enable two rice crops each year, the maximum cropping in each season can only be 50%. Gu season cropping will also be restricted as the result of predicted water shortages (see Annex II). The project proposals had considered extending cropping seasons by using groundwater in March to enable earlier planting. Groundwater quality in the Project Area (near Shalambood) is poor (EC = 2.5 mmhos/cm) and would seriously inhibit germination and early growth stages as well as increase soil salinity levels. The use of groundwater in the Study Area is not recommended for annual crops (see Annex II).

However, the greatest obstacle to a large scale intensive rice production will be providing labour for bird scaring. The proposed maximum net area of rice (3 500 ha) will require labour from 5 000 to 7 000 families for bird scaring. The Study Area population is about 18 900 families but this labour must be drawn from 25 to 40% of the Study Area. This is totally impractical. Rice production within any part of the Study Area must be limited to the resident population within that area.

CHAPTER 6

PADDY RICE

6.1 Introduction

Paddy rice has been successfully cultivated at two projects on the Shabeelle river. An experimental farm was started in 1967 at Jowhar by a Chinese Technical Aid Team and, in 1975, the Hawaay Crash Programme farm (100 km south-west of the Study Area) started paddy rice production. The Chinese team also carried out a small extension programme in the Study Area and obtained promising yields (see Annex IV). However, development of paddy rice production in the Study Area is restricted to suitable areas (see Section 6.2 below) and to development projects or farms. It is considered that smallholder paddy rice production within the existing farming system and irrigation network will not be possible without extensive reorganisation of holdings. This is necessary to enable an area of land to be continually supplied with water to maintain the required flood. Recommendations given below are based mainly on information collected at Jowhar and Hawaay.

6.2 Land Suitability

Land suitability is a major restriction to the area of paddy rice that could be cultivated in the Study Area. Two factors are involved:-

(a) Soils

Only soils with slow deep percolation and infiltration rates are suitable in order to maintain the required flood without the wastage of scarce water supplies. It is considered that only the old alluvial soils such as the Saruda soils are suitable.

(b) Topography

The required flat basins could be prepared in any area of suitable soils. However, unless these areas are topographically suitable, it will be uneconomical to prepare these basins in comparison with levelling costs to prepare fields for upland costs to prepare fields for upland rice. Therefore, topographic surveys will be necessary in any area chosen for development to ascertain whether it would be feasibile or not to prepare rice paddies.

6.3 Varieties

Two 120-day Chinese varieties are presently available (Kendo and Shendo), having been recommended by the Chinese Technical Aid Team following several years research at Jowhar. Varietal charateristics of these varieties are given in Table 6.1. Both are reported to have the same yield potential, but Shendo is prone to shattering and is not as suitable as Kendo. However, because these varieties take 120 days to mature, earlier maturing varieties are more practical for the same reasons given for upland rice i.e. cropping seasons, rotational restraints and drought risks due to water shortages. Although further research is needed to select high yielding early varieties of paddy rice, there are certain varieties that can grow under upland rice conditions as well as under flooded paddy conditions. The variety Vista is considered physiologically adaptable to both methods and therefore is recommended as an interim short season variety.

TABLE 6.1

Paddy Rice: Varietal Characteristics

	Variety	
	Kendo	Shendo
Origin	China	China
Seed type	Short	Short
Height at maturity	1.0 m	1.0 m
Tillering	Few	Heavy
Shattering	Normal	Susceptible
Onset of tillering	12-15 days (1)	
Onset of rapid shoot growth	30 days	
Boot stage	75 days	
Heading	80-85 days	
Maturity	120 days (2)	

Notes:- (1) Days after planting
(2) Shendo to be harvested at 115 days to avoid losses due to shattering.

6.4 Planting Methods

Direct drilling is recommended. At the Jowhar experimental farm, no yield differences occurred between transplanted and direct drilled crops. All crops at Jowhar and Hawaay are now direct drilled mainly because of the very high labour requirements necessary for transplanting. A similar difficulty will also occur in the Study Area if a reasonable area of paddy rice is to be developed. Therefore, planting methods and seed rates for all three varieties are as given for upland rice.

6.5 Fertilisers

Fertiliser recommendations for production of the two Chinese varieties are high (250 kg/ha urea and 120 kg/ha calcium phosphate) and are necessary for the high yields (60 to 70 q/ha paddy) obtained at the Jowhar experimental farm. However, for the moderate yields expected in the Study Area (see Section 6.8), less is required. Good yields (30 to 35 q/ha) were achieved at Hawaay with only 150 kg/ha urea. With the estimated nutrient uptake of rice (see Appendix E) and expected yields as well as data given for upland rice, estimated requirements are as follows:-

Yield	Fertilisers
35 q/ha (paddy)	50 kg/ha DAP 140 kg/ha urea
45 q/ha	65 kg/ha DAP 175 kg/ha urea

However, further research is necessary to confirm these requirements.

6.6 Other Operations

No alterations to recommendations given in Chapter 5 are required for pest control requirements, harvesting and milling.

Less weed control is necessary. Full flooding of crops which effectively suppresses weeds is required from 25 to 30 days after planting. This was seen at both Jowhar and Hawaay. Therefore, the single post-emergence herbicide application will be sufficient (see Chapter 5). Good weed control using only Stam F34 (propanil) was achieved this way at Hawaay.

Bird scaring requirements are also the same as given for upland rice.

6.7 Irrigation

Crop water requirements for dirct-drilled paddy rice are considered to be the same as for upland rice (see Chapter 2), although a greater field requirement is necessary to maintain the required flood. Irrigation requirements for paddy rice are as follows:-

(a) Regular short interval irrigations until about 25 days after planting, i.e. at the onset of rapid shoot growth.

(b) Flooding from 25 days to 90 days for Vista and to 100 days for the Chinese varieties. A flood depth of 10 to 15 cm is considered adequate. Top dressing should be applied prior to flooding.

(c) A low level of infiltration will occur, necessitating regular applications of water every few days to maintain an optimum flood depth.

6.8 Yields

In 1976, 50 ha grown in the Study Area yielded an average of 30 q/ha (unmilled). At Hawaay, average yields of 30 q/ha have been obtained after two years of production. At the Jowhar experimental farm, 40 ha produced an average of 50 q/ha and the Chinese Aid team considered 30 q/ha to be the minimum expected yield under large scale production. Therefore, projected yields for the Study Area are as follows:-

(a)	Year 4	35 q/ha (unmilled)
(b)	Year 8	45 q/ha (unmilled)

At 65% milling, these yields represent 22.8 to 29 q/ha of milled rice. Estimated yields are given for development project situations only.

6.9 Labour Requirements

Estimated labour requirements are given in Table 6.2. Compared to upland rice, less labour is required mainly due to the lower requirement for hand weeding. At 4 manhours per manday, about 42 mandays per hectare are needed, or 107 mandays per hectare if hand planted and hand harvested, excluding bird scaring.

TABLE 6.2

Paddy Rice Labour Requirements

Operation	Manhours/ha	Notes
Basal dressing and drilling	35	Smallholders only
Pest control	2	
Top dressing	5	
Weed control	1	Herbicide application only
Irrigation	113	
Harvest and threshing	200	Smallholders only
Carting	6	
Minor operations	26	
Sub-total	153	Mechanised production
	388	Smallholders
Miscellaneous (10%)	16-39	
Total (1)	169	Mechanised production
	427	Smallholders

Note: (1) Excludes bird scaring by 3 children per day for 35 days = 105 child-days/ha.

Source: Appendix D

CHAPTER 7

COTTON

7.1 Introduction

There has been a long history of partially successful cotton production along the Shabeelle river since the mid-1930s (see Annex IV), although present production is limited to about 700 ha at the Balcad cotton project. With its similar soil and growing conditions to the Sudan Gezira, the Study Area is considered most suitable for the development of cotton. Coupled with this, there is a high demand for cotton fabric in Somalia and the Balcad textile mill is currently operating well below capacity (see Annex VIII). Also, most of the raw material used by the mill is imported.

However, the poor yields presently obtained at Balcad (9 to 10 q/ha seed cotton) and in production trials at the FAO pilot project, indicate that considerable care and good management are essential in order to produce good yields.

7.2 Varieties

Medium staple upland cotton (**G. hirsutum**) is the most suitable type for development in the Study Area. The prolonged rainfall period from April to November and the predicted gu season water shortages necessitate shorter-season cotton varieties that can be fully irrigated within the der season and enable picking to be completed during the dry jilal season. No recommended varieties exist in Somalia, but Acala 15, Acala 4-42 and, recently, Barac have been grown at Balcad, and Acala 4-42 at the FAO pilot project. Yield data have shown the suitability of Acala 4-42 and its continued use is recommended until further research produces a better adapted variety. Growth data of Acala 4-42 and similar upland varieties grown at CARS, Afgooye, during 1977, are given below:-

Growth stage	Days from planting
First square	40
First flower	50 - 55
Full crop cover	70
First boll open	110 - 115
First pick	130 - 135
Final (third) pick	170 - 180

7.3 Planting Methods

Land preparation is discussed in Chapter 3 and requirements are as for maize. Hand planting using the same methods as maize is also recommended. About 60 000 plants per hectare is considered optimal for Acala varieties (Halcrow, 1975; FAO, 1975) which represents a row spacing of 80 cm x 20 cm or four plants per hill at an 80 cm check-row spacing. This will require a seed rate of about 30 kg/ha of undelinted seed and all seed should be dressed with Fernasan D. Thinning can be carried out during the first weeding.

7.4 Planting Dates

To enable picking in dry weather, cotton can only be planted in the der season. Acala varieties will also require about four months irrigation. Therefore, as irrigation availability is expected to extend to early January, all cotton must be planted in August. Picking can then commence from mid-December after the der rains and be completed at the end of February and before the next gu rains.

7.5 Fertilisers

Reported research into fertiliser requirements of cotton is limited to a single trial from which little can be concluded (Appendix E). The low nitrogen and phosphorus status of the Study Area soils indicate that responses to applications of both nutrients should occur. Therefore, based on estimated nutrient removal for a projected yield of 20 q/ha (seed cotton), 50 kg/ha DAP and 150 kg/ha of urea to provide 78 kg/ha N and 25 kg/ha P_2O_5 should be sufficient. The urea is applied as a top dressing about 35 to 40 days after planting prior to the onset of flowering. Slightly higher application rates will be necessary to obtain the maximum yield potential of 25 q/ha and are estimated to be 80 kg/ha DAP and 180 kg/ha urea. However, further research is essential in order to provide valid recommendations.

7.6 Weed Control

Four hand weedings will be necessary during the first 65 to 70 days after planting in order to obtain effective weed control. No effective safe herbicide recommendations are available in Somalia to replace hand weeding, due mainly to phytoxicity problems encountered during recent research programmes.

7.7 Pest and Disease Control

The main pests on cotton crops at Afgooye and Balcad are American bollworm (**Heliothis**), spiny bollworm (**Herias**), jassids and, to a certain extent, stainers (**Dysdercus**). It can be assumed that these pests will also occur in the Study Area. Present control recommendations require a continuous spray programme at 8 to 10 day intervals from first flower bud formation, i.e. from about 40 days after planting (Ciba-Geigy, 1977). This necessitates 8 to 10 ULV sprays at a rate of 2.5 l/ha of Nuvacron Combi (monocrotophos/DDT). Research trials at the FAO pilot project proved these recommendations successful, whereas fewer sprays or the use of conventional high volume formulations gave inadequate control and greatly reduced yields (FAO, 1975). Observations during 1977 at Afgooye and Balcad showed that bollworm damage during the first two months of flowering was the major cause of present low yields. No serious diseases were seen at Balcad and are not expected in the Study Area.

7.8 Irrigation

Theoretical calculations presented in Appendix F indicate that cotton will require between 8 to 10 irrigations at intervals of between 12 and 15 days. However, the results of one trial at the FAO pilot project using Acala 4-42 (Table 7.1) indicate that only 6 to 7 irrigations at 15 to 20 day intervals are necessary. This difference is probably due to larger application rates possible at Afgooye compared with the low rate (60 mm) assumed in Appendix F. From observations at Balcad, the irrigation period should not exceed four months to avoid over-vegetative growth and delayed fruiting.

TABLE 7.1

Cotton Irrigation Trial Results: Afgooye 1974

Irrigation interval (days)	Irrigation period (1) (days)	Yield q/ha seed cotton
30	90	15.3
20 - 30	110	20.2
20	110	31.0
15 - 20	110	28.9
15	110	26.9
10 - 15	110	28.3

Note: (1) Days from planting

Source: FAO, 1975

7.9 Harvesting

For August-planted crops, picking will start in mid-December and finish at the end of February. Three picks at 20 day intervals are considered necessary with about 50% of the crop harvested during the second picking. The risk of late rains in December makes it necessary to carry out a preliminary picking before the bulk of the crop is harvested in the second pick.

7.10 Post-harvest Operations

Methods of destroying crop residues have been discussed in Chapter 3. It is recommended that after the final picking, cotton plants be uprooted and burnt in order to facilitate land preparation and prevent the carry-over of pests. The best method of uprooting cotton at the FAO pilot project was by using a tractor-drawn groundnut lifter normally used for blading groundnuts (FAO, 1975). However, smallholders will need to uproot by hand.

7.11 Yields

There is little yield information available concerning well-managed cotton crops in Somalia. Several trials in 1966 and 1974-75 gave yields of 22 to 31 q/ha of seed cotton (CARS, 1966; FAO, 1975). Few other trials have been undertaken. However, the FAO pilot project considered the high yield of 25 q/ha was possible under field conditions in Somalia. This yield potential has also been projected for cotton to be grown in areas of Kenya and Ethiopia with similar growing conditions to the Shabeelle river (Halcrow, 1975; MMP, 1977). Projected yields for the Study Area are given in Table 7.2, but the higher yields (20 q/ha) will not be attained without good irrigation management and pest control measures.

TABLE 7.2

Cotton Projected Yields

	Yield (q/ha seed cotton)			
	Year 0	Year 1	Year 4	Year 8
Development projects	-	10	20	25
Smallholders[(1)]	-	10	15	18

Note: (1) Lower yields due to less efficient irrigation management and pest control.

7.12 Labour Requirements

Estimated labour requirements are given in Table 7.3. The highest labour demand is during picking and labour availability during this period will determine the intensity of cotton in any cropping pattern. At 4 manhours per day, 214 to 139 mandays/ha are required.

TABLE 7.3

Cotton Labour Requirements

Operation	Manhours/ha	Notes
Basal dressing	5	Before ridging
Planting	25	
Top dressing	25	At 35-40 days
Weeding	200	4 weedings before 65-70 days
Pest control	8	9 ULV sprays
Irrigation	116	7 irrigations[(1)]
Picking	390	3 picks
Carting	5	
Uprooting	90	Smallholders only
Burning trash	3	
Sub-total	777-867	
Miscellaneous	78-87	
TOTAL	855	Development projects
	954	Smallholders

Note: (1) Furrow irrigation

Source: Appendix D

CHAPTER 8

SESAME

8.1 Introduction

Sesame is another important annual food crop grown extensively in the Study Area and, therefore, must be included in development proposals. Increased production will also help to offset imports of vegetable oils into Somalia which presently vary between 5 000 and 9 000 tonnes per year (see Annex VIII).

Sesame is ideally suited for cultivation along the Shabeelle river but, despite its importance, little agronomic research into improving production has been carried out. In addition, studies tended to misunderstand its fairly specific requirements by growing crops in the wrong season and attempting to mechanise harvesting. Present production methods and problems are discussed in Annex IV and recommendations given below are mainly based on modifying traditional methods.

8.2 Varieties

Only the local 90-day variety is available. Some improvement may be possible by selecting out pure lines. Further improvement will only be possible after testing varieties from other countries. However, trials in 1974 showed that over 20 introductions yielded poorly compared to the local variety (CARS, 1975; FAO, 1975). The problem was probably due to introducing late-maturing varieties with unsuitable photoperiodic requirements and poorly adapted to heavy alkaline clay soils. Weiss (1971) reports that sesame varieties are often difficult to introduce into new environments due to their narrow range of adaptability.

8.3 Planting Methods

Land preparation methods are discussed in Chapter 3. Sesame is able to compensate for quite wide variabilities in plant populations and accurate spacing requirements are not necessary. Therefore, check-row planting with a pinch of seeds every 50 to 60 cm and a seed rate of 8 kg/ha will provide a good stand. Planting can be either on the flat or on ridges. All seed should be dressed with Fernasan D.

8.4 Planting Dates

Sesame production is only recommended for the der season. Good yields can only be regularly achieved from crops planted in October and November. This allows flowering to take place after the der rains and in the hot dry jilal season in order to maximise pod-set. It also allows supplementary irrigation to be applied in December. Good yields can be achieved at other planting dates but only in unusual years (FAO, 1975). Climatic conditions between April and November are too unpredictable and, on average, poor yields will result.

8.5 Fertilisers

Sesame does not respond to fertiliser applications (Arnon, 1972) and although two trials at Afgooye obtained significant yield increases, in was only with heavy applications of nitrogen and phosphorus (see Appendix E). However, sesame crops remove only small amounts of N and P from the soil and, therefore, in the absence of specific recommendations, only light applications of N and P are necessary. Estimated requirements for expected yields of 8 to 10 q/ha are 25 kg/ha DAP and 40 kg/ha urea which will provide 23 kg/ha N and 13 kg/ha P_2O_5. A single dressing before a pre-planting irrigation will be sufficient. With furrow irrigation, the fertiliser can be applied prior to ridging.

8.6 Weed Control

Sesame is susceptible to weeds during early stages and two hand weedings are necessary during the first 35 days. Fewer weeds are expected in sesame because it is mainly grown on a pre-planting flood irrigation. Any thinning can be carried out during either weeding.

8.7 Pest and Disease Control

Sporadic outbreaks of cutworm (**Agrotis**) and chafer bug attacks are the only pest or disease problems that will affect sesame planted at the correct time. No specific recommendations are available in Somalia but it is considered that a cheap, effective and easily undertaken method will be the application of Furadan granules (1% a.i. per 100 kg seed) with the seed at planting (FMC, 1977). Attacks are only during seedling stages and it is estimated that attacks requiring control will occur every two to three years. Therefore, applications of Furadan can either be carried out when every crop is planted or during replanting of affected areas within a field. These recommendations can also be applied to maize and other crops which are also sporadically attacked by these soil pests.

8.8 Irrigation

Sesame is susceptible to waterlogging such that irrigation during early growth stages should be avoided. Data given in Appendix F show that if 160 mm is applied before planting, only two or three extra irrigations during flowering will be necessary. If a net application rate of more than 60 mm is possible, only one or two extra irrigations will be necessary. This confirms general information reported by Weiss (1971), observations made from well-managed smallholder crops in the Study Area, and moderate results reported by the FAO pilot project (FAO, 1975). This method can, therefore, be used for both furrow and basin irrigation.

8.9 Harvesting

The local variety is a dehiscent type prone to shattering. Therefore, only traditional harvesting and threshing methods are recommended (see Annex IV, Chapter 7).

8.10 Yields

Although present yields in the Study Area are low (2.5 to 4 q/ha), mainly as the result of poor irrigation, yields of 6 to 8 q/ha are reported to be obtained by several farmers.

Observations of well-managed crops confirmed that these yields are attainable. Yields of 7 to 8 q/ha have also been obtained at Afgooye (FAO, 1975; CARS, 1975) although under research conditions. Projected yields for the Study Area are given in Table 8.1. Little difference in yields of smallholders and those of fully developed projects is envisaged, mainly because sesame has minimal management requirements compared to other annual crops.

TABLE 8.1

Sesame Projected Yields

	Yield (q/ha)			
	Year 0	Year 1	Year 4	Year 8
Development projects	2.5 - 4	5	8	10
Smallholders	2.5 - 4	5	6	8

8.11 Labour Requirements

Estimated labour requirements are given in Table 8.2. At 4 manhours per day, 92 mandays per hectare are required.

TABLE 8.2

Sesame Labour Requirements

Operation	Manhours/ha	Notes
Basal dressing	5	
Planting	20	Check-row
Weeding	100	2 weedings before 35 days
Irrigation	67(1)	4 irrigations (2 during flowering)
Harvesting	90	
Threshing	50	2 weeks after harvesting
Carting	2	
Sub-total	334	
Miscellaneous (10%)	34	
TOTAL	368	

Note: (1) Furrow irrigation.

Source: Appendix D.

CHAPTER 9

GROUNDNUTS

9.1 Introduction

Although groundnuts prefer light, well drained soils, successful production is possible on heavy clays as exemplified by the Sudan Gezira. Groundnuts were grown on a moderate scale in the Study Area until the 1960s, producing yields of 13 to 14 q/ha (unshelled) (see Annex IV, Chapter 3). High yields have also been achieved under research conditions. Therefore, given the need to reduce vegetable oil imports, groundnuts must also be considered as an alternative oil crop. However, the low yields presently obtained at several projects along the Shabeelle river indicate the high level of management that groundnuts require on heavy soils in order to achieve good yields. The physical characteristics of the Study Area soils alter markedly with moisture content such that pegging, pod development and lifting can easily be affected if the soils are too wet or too dry. The high labour requirement of groundnuts also necessitates good crop management in order to make it an economically worthwhile crop. Production problems in the Study Area have been discussed in Annex IV.

9.2 Varieties

Because of the production problems associated with heavy soils, particularly for irrigation and harvesting, and also the risk of water shortages and drought, only the short-season Spanish-Valencia bunch types are recommended. After several variety trials at Afgooye between 1966 and 1972, a few 115 to 120 day varieties were released, including Florigiant, Sudan I and Sudan II. These varieties were further tested at the FAO pilot project in 1974. From trial results, Florigiant and Sudan I are the highest yielding varieties, (FAO, 1975; CARS, 1966-1975). Growth stage of these varieties are as follows:-

Onset of flowering	40	days (after planting)
Onset of pegging	50	days
Full crop cover	60-65	days (60 cm rows)
Final flowering	90-95	days
Maturity	115-120	days

However, pure stocks of either variety do not exist. Either a selection programme or the introduction of new stocks must be undertaken.

9.3 Land Preparation and Planting Methods

Land preparation requirements are given in Chapter 3 and are as for maize. Because of the heavy clay soils, groundnuts can only be grown on ridges using furrow irrigation in order to maintain optimum soil conditions for pod development. Spacing trials at Afgooye have shown row spacings of 40 cm to give the best yields but these are not practical under field conditions. Groundnuts should therefore be planted as single rows on 60 cm ridges or double rows on 80 cm ridges, with a seed-rate of 90 kg/ha. Groundnuts should be shelled before planting and drilled by hand to obtain quicker germination and a more even stand. This is compared to the present practice of planting pods at slightly wider spacings along the row. The introduction of hand-operated planters is recommended.

9.4 Planting Dates

Although groundnuts have been grown in both the gu and der seasons, gu season cropping is not recommended. Isolated storms during the hagai harvesting period will affect lifting and, if conditions are sufficiently wet, germination of the mature pods will occur. Groundnuts must only be planted from mid-August to mid-September. This will allow maturation to take place after the der rains and lifting to be carried out in December. During December, a light irrigation can be applied prior to lifting in order to obtain ideal working conditions. This will not be possible with later planting and the hard ground will badly affect harvesting.

9.5 Fertilisers

In general, groundnuts do not respond consistently to fertiliser applications and this is confirmed by the results of four trials carried out at the FAO pilot project (see Appendix E). Responses to phosphorus are variable and applications greater than 50 kg/ha P_2O_5 cannot be recommended. Responses to low levels of nitrogen also occurred occasionally. Very little nitrogen should be necessary because observations at Afgooye and in the Study Area showed crops to nodulate heavily. Therefore, with the known ability of groundnuts to utilise residual nutrients and for yields of 20 to 25 q/ha (unshelled), a single dressing of 75 kg/ha DAP at planting should be adequate. This will provide 15 kg/ha N and 37 kg/ha P_2O_5. However, further research into fertiliser requirements is necessary.

9.6 Weed Control

Good weed control is essential. The low yields presently obtained at several production farms are attributable mainly to poor weed control. Hand weeding is the only recommended method. No herbicide recommendations are available and mechanical cultivations should not be carried out once flowering has started. At least four early weedings are necessary until 60 to 65 days after planting and full crop cover is reached. The final cultivation should also earth up the groundnut plants to encourage pod development. The friable surface mulch that the Study Area soils develop should also allow easy peg penetration.

9.7 Pest and Disease Control

Apart from isolated cutworm attacks, no pest or disease control is required. Cutworm control is discussed in Chapter 7.

9.8 Iron Deficiency

All crops grown along the Shabeelle river are chlorotic as the result of iron deficiency caused by the high soil pH. Trials at Afgooye using foliar sprays and chelating agents have proved unsuccessful. However, several varieties under test in 1977 at Afgooye have shown reasonable tolerance and it is recommended that further screening of tolerant varieties is carried out.

9.9 Irrigation

Groundnuts should receive regular irrigation. Data given in Chapter 2 (Table 2.15) showed that irrigation intervals of 14 to 17 days are required. The results of a single irrigation trial at Afgooye (Table 9.1) indicate fortnightly irrigations until 90 days after planting are adequate for satisfactory yields.

TABLE 9.1

Groundnut Irrigation Trial Results: Afgooye 1974

Irrigation interval (days)	Irrigation[1] period (days)	Yield (q/ha pods)
20 - 30	80	21.1
20	80	24.6
20	100	30.3
15	•90	34.1

Note: [1] Days after planting. Variety used was Sudan I (120 days)

Source: FAO, 1975.

9.10 Harvesting

Although a labour-demanding operation, fully mechanised harvesting is not considered a practical alternative unless at very high levels of crop management. It is recommended that a partial lifting is carried out by tool-bar mounted blades (see Chapter 3) such that final lifting and gleaning is by hand. Correct soil moisture at harvesting is essential to avoid losses. Harvested plants can then be stacked and air-dried for several days before stripping using hand-operated strippers (see Chapter 3). Shelling is not required. Only unshelled nuts are purchased by ADC. Retained seed for planting can also be better stored unshelled. The remaining hay can be fed to livestock.

9.11 Yields

Limited yield information is available. In general, yields of less than 16 q/ha of unshelled nuts have been frequently reported, mainly as the result of crop management problems. However, several research trials have yielded 40 to 49 q/ha and field production trials averaged 23 to 25 q/ha although for a limited acreage (CARS, 1967 and 1977; FAO, 1975). Reported shelling percentages varied from 64 to 81%. In areas of Kenya and Ethiopia with similar growing conditions to the Shabeelle river area, yields of 20 to 25 q/ha are considered possible (Halcrow, 1975; HTS, 1977). Although these yields will also be possible in the Study Area, they can only be attained as the result of high standards of management. Projected yields for the Study Area are given in Table 9.2.

TABLE 9.2

Groundnut Projected Yields

	Yields (q/ha unshelled nuts)(1)			
	Year 0	Year 1	Year 4	Year 8
Development projects	8 (5.6)	12 (8.4)	20 (14)	25 (17.5)
Smallholders	8 (5.6)	10 (7)	12 (8.4)	15 (10.5)

Note: (1) Shelling percentage = 70%. Shelled yields in brackets.

9.12 Labour Requirements

Estimated labour requirements are given in Table 9.3. At four manhours per day, 148 mandays/ha are required.

TABLE 9.3

Groundnut: Labour Requirements

Operation	Manhours/ha	Notes
Shelling seed	4	
Basal dressing	5	Before ridging
Planting	40	
Weeding	200	4 weedings before 65 days
Irrigation	134	8 irrigations until 90 to 95 days
Lifting/gleaning	130	
Carting	6	
Stripping	20	
Sub-total	539	
Miscellaneous (10%)	54	
TOTAL	593	

Source: Appendix D.

CHAPTER 10

SUNFLOWER

10.1 Introduction

Research trials at CARS, Afgooye and the FAO pilot project have shown that, despite the heavy alkaline soils, sunflower is well adapted to growing conditions in the Shabeelle river area. However, its introduction as a commercial crop in 1975 was unsuccessful due mainly to severe damage by birds during maturation. Bird populations along the Shabeelle river were unusually high in 1975 because of a severe drought and there is sufficient evidence to suggest that in most years sunflower will be unaffected by birds (see Appendix H).

Despite the limited experience of sunflower cultivation, there is sufficient information available to provide basic recommendations, particularly as management requirements of sunflower are similar to maize. Also, given the problems of water shortages, weed control and heavy soils, it is a more suitable oil crop than groundnuts.

10.2 Varieties

Short season varieties are recommended in order to minimise the risk of drought, avoid wind damage and enable early cropping to avoid possible bird damage. Two dwarf 95 day Russian varieties, VN 11 MK 8931, and Predovic, have yielded well in several variety trials (CARS, 1971; FAO, 1975). From observations made at CARS in 1977, growth stages of these varieties are as follows:-

Onset of stem elongation	20 days (after planting)
Bud stage	50 days
Crop cover	50 days (crop height 1.25 m)
Flowering	60 days
Milk stage	75 days
Maturity	95 days

10.3 Planting Dates

Like maize, gu season crops should be planted at the onset of rains in April to maximise the use of rainfall and limited irrigation availability. Also, bird damage will be minimised as harvesting of early varieties will be completed in late July. Der season crops must be planted in early September to allow maturation after November rains and harvesting to be completed before the end of December. Later planted crops are normally heavily attacked by birds (CARS, 1971 and 1975).

10.4 Crop Management

Land preparation and planting methods are as given for maize. Dwarf sunflower varieties require slightly higher plant populations. Highest yields have been achieved at 65 000 plants per hectare which represents an 80 cm x 20 cm spacing for row planting (FAO, 1975). An optimum seed rate is 8 kg/ha.

Fertiliser trials at Afgooye have shown responses to both nitrogen and phosphorus applications, although economic responses were only at low application rates (see Appendix E). Heavy dressings of nitrogen generally lead to over-vegetative growth and lodging.

Therefore, for expected yields of 15 to 20 q/ha, a single application at planting of 100 to 140 kg/ha DAP should be adequate for the Study Area although further research is required.

Three hand weedings are required during the first 45 days of growth and before full crop cover is reached.

No serious pests have been reported but leaf damage to 1977 trials at CARS indicates a possible requirement for one or two sprays before flowering. No spraying should be carried out after flowering since it would restrict insect pollination.

In normal years bird scaring may not be required (see Appendix H) but during dry years labour must be available for bird scaring during the last 20 days before harvesting.

Careful irrigation is required to avoid waterlogging. Irrigation trial results (Table 10.1) indicate that sunflower yields well with quite variable irrigation periods. Optimum requirements appear to be four or five irrigations every 15 to 20 days for a period of 75 to 80 days. However, good yields are possible with a shorter irrigation period of only 60 days, which still provides adequate water supplies at the crucial stage of flowering. With the predicted June and July water shortages (see Annex II), this indicates that sunflower is well adapted for cultivation in the gu season under restricted irrigation.

TABLE 10.1

Sunflower Irrigation Trial Results: Afgooye 1974

Irrigations	Irrigation interval (days)	Irrigation period (days) (1)	Yield (q/ha)	
			Gu	Der
2	30	30	-	13.4
3	15 + 30	50	18.5	-
3	30	60	-	15.6
4	15 + 20	60	23.5	-
3	30 + 50	80	-	15.7
4	15 + 30	80	23.4	-
5	20 + 25	80	-	17.3
5	15 + 20	80	27.6	-
5	20 + 25	90	-	18.4
6	15 + 20	100	25.5	-

Note: (1) Days from planting. No data available on variety used but probably 100 day maturity.

Source: FAO, 1975

Harvesting by hand will be during July or December when rainfall is minimal. Heads are cut and, if necessary, dried further before shelling. Estimated labour requirements are given in Table 10.2.

TABLE 10.2

Sunflower Labour Requirements

Operation	Manhours/ha
Fertiliser application	5
Planting	25
Weeding	150
Pest control (ULV)	1
Irrigation	100
Harvesting	25
Threshing	7
Carting	5
Sub-total	318
Miscellaneous (10%)	32
TOTAL	350 (1)
Mandays/ha (2)	88

Notes: (1) Excludes bird scaring with possible requirement of 3 children/day/ha for 20 days (equivalent of 240 manhours/ha).

(2) 4 manhours/day.

Source: Appendix D

10.5 Yields

At the FAO pilot project, yields of 20 to 28 q/ha have been achieved in research trials although only 13 q/ha was obtained from production trials. Other reported yield data vary from 10 to 18 q/ha and it was noted that these lower yields were due mainly to insufficient bird scaring in trials that would otherwise have given good yields (CARS, 1971 and 1975; FAO, 1975).

Therefore, following further research, field production yields of 15 to 20 g/ha can be expected. Details of projected yields are given in Table 10.3.

TABLE 10.3

Sunflower: Projected Yields (q/ha)

Year 1	Year 4	Year 8
10	15	20

From observations at Afgooye, sufficient numbers of bees are present in the riverine areas to enable full pollination and examination of heads in one trial showed almost 100% seed set. Traditional bee hives and the manufacture of honey are common in the Study Area (see Annex V).

CHAPTER 11

CASTOR AND SAFFLOWER

11.1 Introduction

Several alternative oil crops are also considered suitable for development in the Study Area, although technical information concerning their production requirements in Somalia is limited. However, because of the generally low level of agronomic data available for other major annual crops, the inclusion of estimated requirements and provisional recommendations for these oil crops is necessary in order to indicate their practicality.

11.2 Castor

Castor has already been grown commercially in the Study Area during the 1940s and 1950s. The reported average yields of 15 to 20 q/ha (hulled seed) clearly indicate the suitability of the Study Area for castor production (Annex IV, Table 3.3). During the 1950s variety trials at the Janaale research station yielded up to 30 q/ha with the highest yields produced by American dwarf varieties.

There is considerable interest in renewed development of castor production in Somalia. A European oil consortium is currently appraising the establishment of castor production farms. This consortium has stated that there is now a market in Europe for 100 000 tonnes per year following the decrease in exports from Brazil (personal communication, 1978). As a result of this, world market prices are high and this company is now offering an FOB price of US $400 per tonne for castor grown in Somalia. Since the main reason for production declining in the 1950s was low market prices, the current high price now indicates that castor should be a profitable crop to develop.

However, there is almost no up-to-date technical information on castor production in Somalia. Consequently, only provisional recommendations can be made to indicate the feasibility of renewing castor production in the Study Area. Research into basic agronomic requirements is therefore essential.

11.2.1 Varieties and Planting Dates

Short-season dwarf varieties are recommended in order to facilitate hand harvesting and avoid the risk of drought to which castor is susceptible. Varieties maturing in 120 days are reported to be available in India (Yadava, 1976).

Cultivation of castor is possible in the gu and der season but gu season cropping is not recommended because of the reported risk of pest attack and the known problem of gu season water shortages. Der season crops must be planted in August and early September in order to obtain sufficient irrigation.

11.2.2 Crop Management

Apart from land preparation and hulling harvested capsules, all field operations require only hand labour. Planting requires a seed rate of about 15 to 20 kg/ha and at spacings slightly wider than those for maize.

Castor responds to both nitrogen and phosphorus. Therefore, with the known fertility level of Study Area soils and an estimated nutrient removal for yields of 15 to 20 q/ha (Appendix E), provisional recommendations are to apply 35 to 45 kg/ha DAP at planting and a top dressing of 85 to 110 kg/ha of urea.

Castor requires good weed control during its susceptible slow early growth stages. Three weedings during the first 50 days should be adequate.

Pest control requirements are not known. It is reported that castor is attacked by leaf-eating pests (CARS, 1966). Therefore, with the common occurrence of wild castor in the Study Area, crops will probably require several sprays.

Irrigation requirements are not exacting, but castor has a sparse rooting system and is known to be susceptible to drought. Therefore regular irrigation is necessary for about 100 days. Estimated irrigation data presented in Chapter 2 indicate that irrigation intervals of about two weeks are needed, i.e. about eight irrigations for a 100 day irrigation period.

Dwarf varieties are easily harvested by hand using simple stripping cups. Two harvests are needed to prevent losses through shattering. Harvested capsules will require hulling and it is estimated that machinery costs will be similar to those for shelling maize. A wide range of hand-operated or power-driven hullers is available in castor-producing countries.

Harvested capsules and hulled seed must be handled and stored separately from all other produce due to the poisonous nature of castor seeds. Estimated labour requirements are given in Table 11.1.

TABLE 11.1

Minor Oil Crops: Labour Requirements

Operation	Manhours/ha Safflower (1)	Manhours/ha Castor
Basal dressing	5	5
Planting	25	25
Weeding	100	150
Top dressing	-	25
Pest control (ULV)	-	2
Irrigation	67	134
Harvesting	-	60
Carting	2	4
Threshing, hulling	-	10
Sub-total	199	415
Miscellaneous (10%)	20	42
TOTAL	219	457
Mandays/ha (2)	55	114

Notes: (1) Combine harvested crop. With hand harvesting, total labour requirement = 300 to 350 manhours/ha.
(2) 4 manhours per man day.

Source: Appendix D

11.2.3 Yields

Until further research is carried out, there is little evidence to suggest that production yields of higher than 15 to 20 q/ha of hulled seed can be reached. Expected yields are given in Table 11.2.

TABLE 11.2

Minor Oil Crops: Projected Yields

Crop	Yields (q/ha) (1) Year 1	Year 4	Year 8
Castor	10	15	20
Safflower	6	10	15

Note: (1) Threshed or hulled seed

11.3 Safflower

11.3.1 Introduction

Despite reported poor management, variety trials in 1967 produced 15 to 20 q/ha (CARS, 1967). The highest yielding variety was Frio which matured in 90 days. Also, although safflower is sensitive to waterlogging, a large multiplication plot at CARS in 1977 showed only isolated effects of over-irrigation and, in general, produced a well established pest and disease-free crop. Safflower, like sesame, can be grown well on heavy soils under a system of pre-planting irrigation (Weiss, 1971; Arnon, 1972). Therefore, with 90 day varieties, production methods for safflower production in the Study Area are similar to those for sesame (Chapter 8). Modifications are discussed briefly in Section 11.3.2. Consequently, safflower, being drought-tolerant, is another oil crop well suited to restricted irrigation supplies and, with its known higher yield potential, it is recommended that further research into its production is undertaken. Experimental dryland production has already been started near Afgooye in 1977 and serious consideration has been given by the Ministry of Agriculture to its production as an alternative to groundnuts.

11.3.2 Crop Management and Yields

Provisional recommendations are as given for sesame management with the following modifications:-

(a) Safflower can be grown in both the gu and der seasons although der season cropping allows better harvesting.

(b) Safflower crops must also be rotated due to susceptibility to soil-borne diseases.

(c) Less nitrogen should be applied to avoid over-vegetative growth (Arnon, 1972). An estimated fertiliser requirement of 70 kg/ha DAP at planting should be adequate.

(d) Mechanical harvesting will be necessary. Like sesame, safflower will be a good crop in rotation with rice. Therefore, as der crops will be harvested after rice, better use of costly combine harvesters is possible. It is also reported that thornless varieties are available. These varieties are more suitable because they can be harvested by hand and should be included in future research programmes. Thornless varieties will then allow production by smallholders who do not have access to expensive machinery.

Estimated yields considered attainable with the given recommendations are given in Table 11.2, but higher yields should be possible after the necessary research.

Estimated labour requirements are given in Table 11.1.

CHAPTER 12

TOMATOES AND TOBACCO

12.1 Tomatoes

12.1.1 Introduction

The ITOP tomato processing factory at Afgooye is currently operating below capacity due to the lack of tomato production in the Lower Shabeelle area. During 1976 and 1977, production varied between 20 and 40% of the maximum processing capacity of 160 t/day. With the high price (So.Shs. 45 per quintal) offered by ITOP to encourage production, tomatoes represent another cash crop suitable for development in the Study Area. However, due to the limited market and the high level of crop management required, it is recommended that any proposed production must be limited to small co-operative or private farms within the development zones. Production problems have been discussed in Annex IV.

12.1.2 Varieties and Planting Dates

The currently recommended variety is Roma. This variety consistently out-yielded other varieties in trials held at Afgooye (Table 12.1) and of the varieties tested, was considered the most suitable for processing (Miner, 1968). Imported certified seed is readily available from ITOP and ONAT.

TABLE 12.1

Tomato Variety Trials: Afgooye 1964-1966

Trial	Entries	Yields (t/ha fresh fruit) Trial range	Var. Roma(1)
1964 der	23	4.5 - 24.5	24.5
1964 der	22	3.7 - 26.8	26.8
1965 gu	24	11.7 - 30.7	28.0
1965 der	33	11.7 - 23.9	18.0
1966 der	5	21.6 - 29.6	23.0

Note: Roma average yield = 24.0 t/ha.
Highest average yield of any other variety = 20.0 t/ha.

Source: CARS, 1966; Miner, 1968.

On average, Roma requires 30 days in the nursery and a further 110 days after transplanting. Growth stages are as follows:-

Onset of flowering	45-50 days after transplanting
First harvest	75 days after transplanting
Final harvest	110 days after transplanting
Harvesting period	35 days

Tomatoes must be planted after the gu season to avoid heavy pest and disease attacks. Because of the predicted gu season water shortages, transplanting can only start in August and must be completed by the end of September to enable full irrigation to be carried out. Therefore, nurseries must be planted in July and August.

12.1.3 Crop Management

Little research investigating crop management has been carried out. Recommendations have been mainly based on observations made at the PLO farm (Shalambood) and the ITOP farm (Afgooye).

Standard nursery management is required. One hectare should transplant to 80 to 110 ha and approximately one kilo of seed is needed for four transplanted hectares. Small amounts of fertiliser are required. Also, three to four sprays of a systemic insecticide would be essential in order to control whitefly (**Bemisia**) and prevent early infection of curly top virus disease. This disease is one of the main reasons for the present low yields (see Annex IV, Chapter 9).

Land preparation recommendations are the same as for other annual crops. Seedlings should be transplanted, preferably onto ridges to avoid risk of waterlogging, to a spacing of 80 cm x 50 cm although accurate spacing does not appear essential. Consequently, weed control is more important and at least five weedings are necessary during the first 60 days after transplanting. No proven herbicide recommendations are available nor fertiliser recommendations, but both nitrogen and phosphorus applications are necessary. From nutrient removal data given in Appendix E and assuming a yield of 20 t/ha, about 35 kg/ha DAP at transplanting and a top dressing of 100 kg/ha urea 30 days later should be adequate.

In order to obtain the even growth and fruit development necessary for good yields, regular irrigation is required for a 120 day period after transplanting. Data presented in Chapter 2 (Table 2.15) indicate a minimum irrigation interval of 12 days. Therefore, on average, nine irrigations at fortnightly intervals should be sufficient.

Normally crops are not staked and no pinching out of side shoots is undertaken. Both are considered impractical and not particularly necessary.

Good whitefly control is essential. Observations have shown that regular spraying of systemic insecticides at 8 to 10 day intervals is required. Eight sprays will probably be needed over a period of 65 to 70 days after transplanting. ULV formulations of standard chemicals can be used (e.g. Dimecon) but because harvesting starts at 75 days, non-persistent chemicals must be used from 50 to 55 days after transplanting. Nogos (dichlorvos) is currently recommended for use in Somalia by Ciba-Geigy and must be applied with conventional sprayers. These recommendations will also control any fruitworm (**Heliothis**) which is also known to attack tomatoes grown in the Study Area. As an alternative, carbofuran granules at a rate of 3.6 kg/ha a.i. can be used (FMC, 1977) and represent a safer, easier and less expensive method of whitefly control. However, due to its specific translocation within the plant, carbofuran will not control fruitworm.

Three or four pickings are necessary. Once harvested, fruit must be transported directly to the ITOP factory to avoid deterioration of fruit quality.

Estimated labour requirements are given in Table 12.2.

In order to avoid the build-up of soil pests and diseases, tomato crops must be rotated such that crops are only planted on the same land once every three years. This represents a maximum cropping intensity of 30%.

TABLE 12.2

Tobacco and Tomato Labour Requirements

Operation	Manhours/ha Tomatoes	Tobacco
Nursery(1)	30	30
Transplanting	65	65
Gapping	16	16
Applying fertilisers	30	30
Pest control	7	4
Weeding	250	200
Irrigation	120	102
Topping and desuckering	-	80
Harvesting(2)	400	400
Grading	-	240
Packing and loading	20	25
Sub-total	938	1 192
Miscellaneous (10%)	94	119
TOTAL	1 032	1 311
Mandays/ha(3)	258	328

Notes: (1) Manhours per transplanted hectare
(2) Assumes full yield (Table 12.3)
(3) At 4 manhours per manday

Source: Appendix D

12.1.4 Yields

With moderate management, maximum yields obtained by the ITOP and PLO farms were reported to be 12 to 15 t/ha of fresh fruit, although lower yields were more common due mainly to poor pest control. With yields under research conditions reaching 30 t/ha and with good control of curly top virus disease, yields of 20 t/ha are attainable. Details are given in Table 12.3.

TABLE 12.3

Tobacco and Tomato: Projected Yields

Crop	Product	Yields (q/ha)(1) Year 0	Year 1	Year 4	Year 8
Tobacco	Cured leaf	4	7	12	15
Tomatoes	Fresh fruit	40	70	150	200

Note: (1) Small production farms only

12.2 Tobacco

12.2.1 Introduction

In general, tobacco is not a suitable crop for production on heavy alkaline soils. However, experimental production carried out by the Chinese Technical Aid Team at Jowhar and in 1977 at Afgooye, has shown that tobacco can grow well on these soils. Few management problems have been experienced. The development of tobacco production has been made feasible by the establishment of a cigarette factory in Mogadishu. This factory currently imports nearly all of its tobacco from Tanzania and China, and the demand for cigarettes in Somalia is high.

However, although basic crop management recommendations have been developed by the Chinese team which are applicable to the Lower Shabeelle river area, leaf of a suitable quality cannot be produced in all parts of this area. The experimental farm at Jowhar was transferred to Afgooye because leaf produced at Jowhar had poor combustibility. Quality analysis showed that the chloride content of leaf from Jowhar was too high. However, leaf produced at Afgooye has a lower chloride content and good combustibility. The flavour of Afgooye leaf is also reported to be acceptable, although most of the leaf is blended with the imported tobacco. Therefore, a small experimental programme in the Study Area is necessary before production plans can be undertaken. It is considered by the Chinese agronomists that soil chloride levels will dictate the suitability of the Study Area for tobacco production. If a leaf of suitable quality can be produced, tobacco represents another cash crop that can be grown on small scale farms and co-operatives within development zones.

Crop management recommendations discussed briefly in the following sub-sections are based mainly on data collected from, and observations made at, the Afgooye tobacco farm. Both Virginia and Burley tobacco are grown but Burley tobacco production is more suitable for the Study Area. As an air-cured tobacco, it obviates the necessity of constructing expensive curing barns and the known problem of obtaining sufficient firewood.

It is recommended that if tobacco production is to be established, the Chinese experimental farm is used for training farmers in improved tobacco management, particularly for harvesting, curing and grading.

12.2.2 Varieties and Planting Dates

The only variety of Burley tobacco recommended by the Chinese team is Lin Yi Hao. It requires 55 to 60 days in the nursery and a further 120 days after transplanting before the final picking is carried out.

Recommended planting dates are restricted by both the period of water availability and when water quality is suitable. It is considered by the Chinese agronomists that irrigation of transplanted crops can only be carried out between July and October in order to obtain river water with the lowest possible chloride content. With the predicted gu season water shortages, transplanting can, therefore, only be carried out in August if all crops are to receive a full irrigation.

12.2.3 Crop Management

Standard nursery management is required including the necessary preventative measures against tobacco mosaic virus disease and the avoidance of soil pests and diseases. Light applications of fertiliser are necessary as well as one or two ULV sprays against budworm (**Heliothis**) which is known to occur in the Study Area.

Land preparation recommendations are as given for other annual crops, but tobacco should be planted on ridges and furrow irrigated due to its susceptibility to waterlogging. Seedlings should be transplanted every 25 to 30 cm along rows 120 cm apart. At least four weedings are necessary during the first 45 to 50 days after transplanting and until full crop cover is reached.

At Afgooye, as the result of developing new land, no fertilisers are applied, mainly to avoid high nitrogen levels in the leaf. However, both nitrogen and phosphorus applications will be necessary in the Study Area due to low soil fertility. Provisional recommendations are to apply 50 kg/ha DAP at planting and top dress 30 days later with 100 kg/ha urea. Tobacco is also a heavy potassium feeder (see Appendix E) and even though Study Area soils contain moderate amounts of potassium, 50 kg/ha potassium sulphate should also be necessary.

Irrigation is required for a 75 day period after transplanting and six irrigations at 15 day intervals are considered adequate by the Chinese team, although at peak periods, 12 day irrigation intervals may be necessary (see Table 2.15).

In order to control budworm, three or four ULV sprays of standard insecticides (e.g. Nuvacron) should be applied. Anthracnose (**Colletotrichum tabacum**) was the only prevalent disease seen at Afgooye, but because no diseases were seen on traditional crops in the Study Area, provision for control measures is not necessary.

Topping is necessary from 55 to 60 days after transplanting and desuckering must be carried out for a further 30 to 35 days.

Picking starts shortly after topping has been carried out and eight weekly picks are needed during the harvesting period of about 60 days. Standard harvesting and handling methods are used and strings should be hung in simple ventilated barns that can easily be constructed from local materials. Air-curing then takes about 30 days to complete before grading, packing and transporting to Mogadishu.

Estimated labour requirements are given in Table 12.2.

Like tomatoes, tobacco crops must be rotated and therefore the maximum cropping intensity is only 30%.

12.2.4 Yields

Projected yields are given in Table 12.3. Production at the experimental farm averages about 10 to 12 q/ha of cured leaf and the Chinese team considers yields of 12 to 15 q/ha are attainable.

CHAPTER 13

FORAGE CROPS AND PULSES

13.1 Forage Crops

13.1.1 Introduction

Livestock play an important role in present farming systems and therefore must not be excluded from development proposals. The overall shortage of grazing and forage supplies in the Study Area is described in Annex V, indicating the necessity of increasing forage availability. The predicted water shortages in June and July will limit annual crop production in the gu season to present net cultivated areas. Therefore, the inclusion of proposals for a short-season drought-tolerant forage crop in the gu season will help increase forage availability. A mixed cereal/legume forage crop is recommended in order to provide high-quality fodder.

13.1.2 Selected Species

In order that forage production does not interfere with management of other crops, it is important to select crops that will require minimal management and can be cut early. Bulrush millet appears to be the most suitable and practical cereal crop for the following reasons:-

(a) It can be cut at the onset of heading from 50 days after planting.

(b) It is more drought-tolerant than maize and sorghum.

(c) Observations at Afgooye showed it to have much greater field resistance to stalkborer than either sorghum or maize, such that control measures are not necessary.

(d) Average dry weight yields achieved at the FAO pilot project were higher than for maize (see Table 13.1).

(e) Seed is easily obtained from within Somalia.

The most suitable legume crop is the bonavist bean (Lablab niger, syn. Dolichos lablab). Observations of various legume trials at CARS during 1977 showed this legume quickly produces profuse vegetative growth and is the most resistant to foliar pests prevalent on other crops such as cowpeas. Bonavist beans are grown locally and seed is easily available.

TABLE 13.1

Forage Yield Trials: Afgooye 1974

Trial(2)	Yields (q/ha dry straw)(1) Maize	Millet
1	123	247
2	164	142
3	95	141
4	133	154
Mean	129	171

Notes: (1) Mean yields of two varieties per crop

(2) Irrigation and cutting trials

Source: FAO, 1975

13.1.3 Production Methods

Both crops should be planted simultaneously at a combined seed rate of 25 kg/ha. Planting should be at the onset of rains in April. Nitrogen applications are necessary and 120 to 160 kg/ha of urea at planting should be adequate. One or two early weedings during the first month should be carried out before the spreading legume crop provides a good cover. No pest control or top dressing is necessary.

From information presented in Appendix F, two or three irrigations during May will provide adequate water for good yields. However, moderate yields will also be possible if grown purely as a rainfed crop.

Cutting should start about 50 days after planting and can continue for a further 20 days before forage quality declines. This also enables labour inputs to be staggered. The cut forage can then be chopped and ensiled, dried and preserved as hay and/or fed directly to livestock. Utilisation of this forage is discussed in Annex V. All operations will then be completed by mid July and at least two or to three weeks before the start of harvesting other gu season crops.

Estimated labour requirements are given in Table 13.2.

13.1.4 Yields

Trial results at the FAO pilot project averaged 17 t/ha of dry straw (Table 13.1) and, assuming dry weights to be 20% of fresh weights, this is the equivalent of 85 t/ha (fresh). Under good management in the gu season, yields were above 25 t/ha (dry weight) or 125 t/ha fresh weight. These results are for millet only. Therefore, because of the minimal management required and the inclusion of a legume intercrop, a fresh weight yield of 80 t/ha should be possible under full irrigation and under poor irrigation 40 t/ha can be expected. At the predicted probability of partial or full irrigation availability for extra gu season cropping, it is estimated that the average fresh weight yield will be 65 t/ha.

TABLE 13.2

Short Season Forage Labour Requirements

Operation	Manhours/ha(1)
Fertiliser application	5
Planting	40
Weeding	100
Irrigation	50
Harvesting + carting	120
Chopping	25
Sub-total	340
Miscellaneous	34
TOTAL	374
Mandays/ha	94

Note: (1) Assumes for silage production

Source: Appendix D

13.2 Pulses

Although pulses, particularly cowpeas and green grams, are widely cultivated as intercrops and used as a staple food, recommendations for improved production are not considered necessary. The market for pulses is small and prices are low. In 1977, local market prices were less than So. Shs. 100 per quintal. Also, yield potential is low. Research trials have produced average yields of about 10 q/ha. Consequently, it is recommended that pulse production is limited to domestic requirements. Basic crop management recommendations given for other crops are applicable to pulse intercrops. However, if tested higher yielding varieties are available, their production should be encouraged.

CHAPTER 14

ANNUAL CROP PRODUCTION COSTS AND RETURNS

14.1 Introduction

Estimated production costs presented in this chapter are for crop production using the full management practices recommended in Chapters 3 to 13. This corresponds to a development project situation. In development zones where improvement of existing services using the present farming systems is planned, certain inputs will, on average, be less (for example, tractor operations, fertilisers, chemicals). This and the poorer management that will, in general, be given to crops is reflected in the lower expected yields. It is therefore assumed that under these circumstances, production costs will be 65% of the full costs given in the following sections.

Estimated machinery costs are given in Appendix C and summarised in Chapter 3. Equipment costs are given in Appendices B and C and labour is costed at So.Shs. 1.00/manhour (Appendix D). Chemical and fertiliser costs are based on 1977 ONAT prices. Unless stated, seed costs are taken as ADC purchasing prices. In most cases, farmers will retain seed from one harvest to plant the next crop such that seed costs represent lost sales.

Transport costs, where necessary, are 1977 ADC charges. In general, ADC does not charge for transport from large farms to its depots. However, transport to Afgooye and Mogadishu will be necessary for crops to be sold in Mogadishu (for example, tobacco).

Production costs are divided into general and specific costs. General costs cover crop management inputs that are independent of the crop to be grown. Specific costs cover the individual inputs for each crop.

14.2 General Production Costs

14.2.1 Land Preparation

General land preparation constitutes ploughing, harrowing and land levelling to be carried out in the jilal season as well as cultivating any gu season fallow to control weeds. Estimated costs are presented in Table 14.1. The final cost per hectare per year depends on the intensity of gu season cropping. Two examples are given in Table 14.1: 40% gu cropping (60% fallow) and 60% gu cropping (40% fallow). It is assumed that full cropping (100%) will be carried out in the der season. Because of availability of irrigation water, the der season is the most important cropping season. General land preparation costs, therefore, vary from So.Shs. 165 to So.Shs. 170/ha/year.

14.2.2 Potassium Fertiliser

As stated in Chapter 4 (Maize), there is a general requirement for potassium applications in order to maintain soil potassium levels. It is estimated that 50 kg/ha of potassium sulphate (25 kg/ha K_2O) should be applied every two years. At a cost of So.Shs. 153/q this represents a cost of So.Shs. 38/q/year.

TABLE 14.1

Production Costs: General Land Preparation

Season	Operation	Tractor-hours/ha (1)	Full cost(2)	Cost/ha (So.Shs.) 40% gu cropping	60% gu cropping
Jilal	(a) Ploughing	2.65	186	74	112
	(b) Harrowing	0.95	66	27	40
	(c) Land levelling	0.72	62	25	37
Gu	Fallow cultivation (4 operations)	2.72	190	114	76
			Cost/ha	240	265
			Cost/ha/year(3)	170	165

Notes: (1) From Chapter 3
(2) Machinery costs from Appendix C
(3) 140 to 160% annual cropping intensity

14.2.3 Cutworm Control

Cutworm control recommendations are described in Chapter 8 (Sesame). Control measures are required, on average, every two to three years for most crops, particularly sesame. Chemical costs vary for each crop (So.Shs. 12 to 19/ha/year). An estimated 20 manhours/ha/year is required to effect cutworm control such that the maximum cost per hectare per year is So.Shs. 32 to 39.

14.2.4 Summary

General production costs, therefore, vary between So.Shs. 235 and 247/ha/year.

14.3 Specific Production Costs

Tractor costs are given in Table 14.2 and cover the following operations:-

(a) Pre-planting and planting operations, such as ridging, cultivating, drilling, bund formation, blading, uprooting, etc.

(b) Post-harvest cultivation (harrowing)

(c) Carting of harvested produce from the field to a central farm or village storage area.

Fertilisers costs are given in Appendix E and vary from So.Shs. 131 to 153 for recommended fertilisers. Chemical costs are as follows:-

(a) Seed dressing - So.Shs. 49.70/kg

(b) Insecticides (ULV formulations) - So.Shs. 34 to 37/l

(c) Herbicides - So.Shs. 35/l.

TABLE 14.2

Field Machinery Costs

Crop	Land preparation(1)	Carting(2)	Total	Cost/ha(3) (So.Shs.)
	Hours/ha			
Maize	1.84	2.60(4)	4.44	311
Upland rice	4.17	0.67	4.84	339
Paddy rice	4.17	0.94	5.11	358
Cotton	4.28	1.60	5.88	412
Sesame	1.90	0.24	2.14	150
Groundnuts	3.49	0.85	4.34	304
Sunflower	1.84	0.65	2.49	174
Safflower	1.90	0.24	2.14	150
Castor	1.84	0.52	2.36	165
Forage	1.84	11.05	12.89	902
Tobacco	1.84	-	1.84	129
Tomatoes	1.84	-	1.84	129

Notes: (1) From Chapter 3

(2) Assumes cycle time of 1.2 hours. Carting time per hectare will vary with yield per hectare. Not applicable to tobacco and tomatoes.

(3) So.Shs. 70/h

(4) Includes carting stover

Seed costs are based on ADC purchasing prices (see Section 14.1) except for:

(a) Cotton - Somaltex (Balcad) price used

(b) Castor - Based on FOB producer price (see Table 14.5)

(c) Tobacco - Import price based on imformation obtained from Tobbaco Board of Zambia

(d) Tomatoes - ONAT price

Drying costs are based on an estimated cost of So.Shs. 1.40/q using the new Bentall's driers. It is assumed that gu season crops will require drying although, in general, it should not be necessary.

Transport costs are necessary for rice, castor, tomatoes and tobacco. Rice is only purchased by ADC after milling and from the Shalambood rice mill. Castor, tomatoes and tobacco are not bought by ADC. All other crops are bought by ADC at the farm. Transport charges are taken as So.Shs. 2.50/q to Shalambood, So.Shs. 5.00/q to Afgooye and So.Shs. 7.00/q to Mogadishu. For rice, milling costs are So.Shs. 20/q of milled rice, which is the present charge levied at the Shalambood mill. These charges are high and, as indicated in Chapter 3 (Section 3.5), milling charges of less than So.Shs. 10/q are possible using small village-based equipment. For castor, customs duties and dock handling charges are assumed to be as for bananas (ENB, 1977) and include a cost for sacks of So.Shs. 6.00 each (ADC, 1977).

Specific production costs are given in Tables 14.3 and 14.4 and should be added to general costs (Section 14.2) to obtain total production costs. The specific costs given in Tables 14.3 and 14.4 are based on management and inputs required to achieve Year 4 yields. Production costs for tobacco exclude costs for simple drying barns.

TABLE 14.3

Major Annual Crops: Specific Production Costs

	Cost/ha (So.Shs.)					
Cost factor	Maize	Upland rice	Paddy rice	Cotton	Sesame	Groundnuts
Tractors(1)	311	339	358	412	150	304
Combine harvesting(2)	-	234	234	-	-	-
Sprayers	5	9	9	24	-	-
Miscellaneous equipment (3)	12	-	-	-	-	15
Seed	15	227	185	15	20	156
Fertilisers	270	257	257	270	89	109
Chemicals	186	625	625	830	2	13
Drying(4)	25	18	25	-	-	-
Transport (Shalambood)	-	62	87	-	-	-
Milling	-	325	455	-	-	-
Cost without labour	824	2 096	2 235	1 551	261	597
Labour cost:						
(a) general(5)	427	275	169	855	368	593
(b) bird scaring(6)	-	420	420	-	-	-
Cost with labour	1 251	2 791	2 824	2 406	629	1 190

Notes:
(1) From Table 14.2
(2) 1.23 hours at So.Shs.190/h
(3) Shelling and stripping
(4) Gu season, maize and rice only and assumes 50% annual production in gu season
(5) So.Shs. 1.00/manhour
(6) 105 child-days/ha at So.Shs. 4.00/day

TABLE 14.4

Major Annual Crops: Specific Production Costs

Cost factor[1]	Cost/ha (So.Shs.) Sunflower	Safflower	Castor	Forage	Tobacco	Tomatoes
Tractors	174	150	165	902	129	129
Combine harvesting	-	234	-	-	-	-
Sprayers	3	-	5	-	11	22
Miscellaneous machinery	12	-	12	-	-	-
Seed	10	24	35	40	15	50
Fertilisers	146	102	163	216	271	183
Chemicals	94	3	186	4	336	672
Drying	10	7	-	-	-	-
Transport[2]	-	-	105	-	105	750
Customs, etc.[3]	-	-	233	-	-	-
Nursery costs[4]	-	-	-	-	7	10
Cost without labour	449	520	904	1 162	874	1 816
Labour cost						
(a) general	374	219	567	374	1 311	1 032
(b) bird scaring[5]	240	-	-	-	-	-
Cost with labour	1 063	739	1 361	1 536	2 185	2 848

Notes: (1) See Table 14.3 footnotes
(2) To Afgooye or Mogadishu
(3) Customs and dock handling charges
(4) Extra land preparation, chemicals and fertiliser only
(5) 60 child-days/ha at So.Shs. 4.00/day

14.4 Gross Returns

Gross returns, based on Year 4 yields and 1977 producer prices are given in Table 14.5. The purchasing price for safflower is assumed to be only So.Shs. 120/q. If the same price as sesame is offered in order to encourage production, gross returns would double to So.Shs. 2 400/ha.

TABLE 14.5

Annual Crops: Gross Returns

Crop	Year 4 yield (q/ha)(1)	Producer price (So.Shs./q)(2)	Gross return (So.Shs./ha)
Maize	35	75	2 625
Upland rice	16.25(3)	350	5 688
Paddy rice	22.75(3)	285	6 484
Cotton	20	250	5 000
Sesame	8	240	1 920
Groundnuts	20	120	2 400
Sunflower	15	120	1 800
Safflower	10	120(4)	1 200
Castor	15	249(5)	3 735
Tobacco	12	600(6)	7 200
Tomatoes	150	45(7)	6 750

Notes:
(1) From Chapters 3 to 12
(2) 1977 ADC producer prices unless stated
(3) Milled rice
(4) Assumed ADC prices
(5) Based on FOB price $400 per tonne (So.Shs. 2 490/t)
(6) Mogadishu cigarette factory purchasing price
(7) 1977 ITOP, Afgooye, purchasing price

14.5 Gross Margins

Gross margins for annual crops are presented in Table 14.6 and are based on production costs and gross returns for Year 4 yields. No gross margins can be presented for the short-season forage crop since it will be fed to livestock belonging to the farmer. Therefore, at an average fresh weight yield of 68 t/ha it represents a production cost of So.Shs. 18 to 24/t.

TABLE 14.6

Annual Crops: Gross Margins

	Estimated[1] production costs (So.Shs./ha)		Gross returns (So.Shs./ha)[2]	Gross margins (So.Shs./ha)	
	With labour	Without labour		With labour	Without labour
Paddy rice	2 824	2 235	6 484	3 660	4 249
Upland rice	2 791	2 096	5 688	2 897	3 592
Cotton	2 406	1 551	5 000	2 594	3 449
Castor	1 361	904	3 735	2 374	2 834
Maize	1 251	824	2 625	1 374	1 801
Groundnuts	1 190	597	2 400	1 210	1 803
Sesame	629	261	1 920	1 291	1 659
Sunflower	1 063	449	1 800	737	1 351
Safflower	739	520	1 200	461[4]	680[4]
Tobacco[3]	2 185	874	7 200	5 015	6 326
Tomatoes	2 848	1 816	6 750	3 902	4 934

Notes: (1) Tables 14.3 and 14.4

(2) Table 14.5

(3) Excludes costs for simple drying barns

(4) So.Shs. 1 661 to 1 880/ha if gross return of So.Shs. 2 400/ha assumed (see Section 14.4)

TABLE 15.1

Bananas: Projected Yields (q/ha/year)

	Year 0 [1]	Year 5	Year 10
Gross	200	250	300
Exportable	130	175	240

Note: (1) Present situation

However, without the implementation of the given recommendations, yields will continue to decline due to the gradual build-up of nematode levels, soil salinity and decreased management (in order to reduce costs further). It is estimated that yields will decline during the following ten years to 150 q/ha/year (gross) of which only 100 q/ha/year will be of exportable quality.

The introduction of drainage and improved management will result in increased crop longevity. Both FMC and the SIATSA agronomists considered an increase to seven years per crop was possible, but it is assumed that, in the absence of further information, six years will be the average crop life.

15.4 Field Production Costs

Because of the different input requirements between the first year of production and subsequent years, production costs must be divided accordingly. It is therefore assumed that harvesting starts at the end of the first year and continues for five years i.e. a total crop life of six years. Field production costs exclude packing costs as this is handled by ENB.

15.4.1 Tractor Costs

Land preparation requires 16 h/ha using heavy duty tractors and 1.5 h/ha using a standard tractor (see Annex IV, Chapter 11). Once harvesting is started it is estimated that carting bananas from the field to the packing station will require 15 to 16 h/ha using light duty tractors. Estimated tractor costs are given in Table 15.2.

TABLE 15.2

Banana Production: Tractor Costs

Operation		Tractor	Time (h/ha)	Cost per hour (1) (So. Shs.)	Cost/ha (So.Shs.)	
					Year 1	Years 2 to 6
Land preparation	(a)	100 hp	16	100	1 600	-
	(b)	70 hp	1.5	74	100	-
Transport		60 hp	15 - 16	64	-	1 008
				Total	1 710	1 008

Note: (1) from Appendix C

15.4.2 Labour Requirements

Labour requirements and costs are summarised in Table 15.3 and are based on data collected from ten farms in the Study Area as well as data presented in Appendix D. It is estimated that for a six year crop, the average annual labour requirement with full recommendations and maximum projected yields will be 412 mandays/ha. This excludes labour for packing because this is organised by ENB and its cost is included in ENB charges to the farmer.

TABLE 15.3

Banana Production Labour Requirements

		Year 1		Years 2 to 6 (1)	
Operation	Manhours/ ha	Frequency	Manhours/ ha	Frequency	Manhours/ ha
Planting (2)	250	1	250	-	-
Replanting	60	1	60	-	-
Herbicide spraying	1.2	4	5	-	-
Light weeding	30	-	-	6	180
Fertiliser application	25	3	75	4	100
Nematocide application	25	2	50	2	50
Pruning	25	8	200	12	300
Trash clearing	35	4	140	9	315
Irrigation	9	25	225	25	225
Harvesting	20	-	-	35	700
Loading etc.	5	-	-	35	175
Sub-total			1 005		2 045
Misc. (10%)			100		205
TOTAL			1 105		2 250
Mandays/ha (3)			221		450
Cost/ha (So. Shs.) (4)			1 105		2 250

Notes: (1) Excludes labour for packing organised by ENB.
(2) Includes first application of fertiliser and nematocide.
(3) At 5 manhours/day.
(4) At So. Shs. 1.00/manhour.

15.4.3 Chemical and Fertiliser Costs

Nematocide, herbicide and fertiliser costs are given in Table 15.4 and based on 1977 ONAT prices.

TABLE 15.4

Banana Production: Chemical and Fertiliser Costs

Chemical	Rate/ha	Unit	Cost/unit (So.Shs.)	Cost/ha (So. Shs.) Year 1	Years 2 - 6
Furadan 10G	120 kg	kg	15.85	1 902	1 902
Herbicide	16 litres	l	35	560	-
Sprayer cost	-	-	-	14	
Fertilisers	9 q	q	131 - 153	1 219	1 219
		Total cost/ha		3 695	3 121

15.4.4 Summary

Field production costs are summarised in Table 15.5. The average cost is So. Shs. 6 401/ha/year. The average cost per quintal of exported fruit is given below and ranges from So. Shs. 32 to 35 per exportable quintal.

Exportable yield	175 q/ha/year	240 q/ha/year
Average exportable yield per year for 6-year crop life	146 q/ha/year	200 q/ha/year
Average cost/ha/year	So. Shs. 5 121 (1)	So. Shs. 6 401
Average cost per exportable quintal	So. Shs. 35	So. Shs. 32

Note: (1) Assumes 80% of full costs for lower yield.

TABLE 15.5

Bananas: Total Field Production Costs

	Cost/ha (So. Shs.) Year 1		Years 2 to 6
Tractors	1 710		1 008
Chemicals etc.	3 695		3 121
Labour	1 105		2 250
Total	6 510		6 379
Average cost/ha/year		6 401	

Note: (1) For 6 year crop life

Source: Tables 15.2 to 15.4.

15.5 Infrastructure Development

Improvement of infrastructural services requires the improvement and reorganisation of the National Banana Board (ENB). General recommendations are given below:-

(a) Marketing

On average, bananas require harvesting every ten days. ENB must ensure a regular supply of ships. It is considered that this improvement is the first stage in improving production because it will ensure greater returns to the farmer and a greater confidence within the banana sector.

(b) Training

It is essential that technical staff obtain sufficient knowledge and experience of good crop management and packing as the first step to training other members of staff and most of the farmers. This can be done in two ways. Staff can be given a period of practical training in other banana producing countries.

Conversely, experienced expatriate staff can be recruited in order to carry out an extension and training programme. It also must be remembered that several farmers in the Study Area are sufficiently experienced to undertake this work and should be encouraged to do so.

(c) Research

The technical section of ENB must instigate a research programme immediately. It is essential to determine proper fertiliser, nematode control and irrigation requirements as well as screen new varieties. This research can be carried out on ENB farms in the Study Area.

(d) Seed Multiplication

Until qualified and experienced staff are available and proven nematode control methods are determined, the ENB nursery will not be able to provide suitable healthy planting material. Therefore, it is recommended that this service be abandoned until a future date. It may also be necessary to choose a new site for this nursery in order to minimise the risk of renewed nematode infestation.

15.6 Labour Supply

High labour inputs are essential to banana production and, with the exception of weeding, no other labour input given in Table 15.3 can be replaced by less labour intensive methods. Therefore, at an estimated requirement of 412 man-days/ha/year and a planned net area of 4 000 ha, banana production will require about 4 500 workers each day for field operations.

The present labour input for packing is estimated to be 220 people per day (Annex IV, Appendix A). With the increased banana yields, the number required will rise to 300 to 400 people per day. Therefore, the average daily labour requirement will be up to nearly 5 000 people. It is, therefore, essential that development proposals for annual crop production in the Study Area do not conflict with this requirement. This is discussed further in Part IV of this annex. However, one future advantage will be the increasing Study Area population and, inevitably, decreasing land availability which should result in a greater demand for employment.

TABLE 14.6

Annual Crops: Gross Margins

	Estimated[1] production costs (So.Shs./ha)		Gross returns (So.Shs./ha)[2]	Gross margins (So.Shs./ha)	
	With labour	Without labour		With labour	Without labour
Paddy rice	2 824	2 235	6 484	3 660	4 249
Upland rice	2 791	2 096	5 688	2 897	3 592
Cotton	2 406	1 551	5 000	2 594	3 449
Castor	1 361	904	3 735	2 374	2 834
Maize	1 251	824	2 625	1 374	1 801
Groundnuts	1 190	597	2 400	1 210	1 803
Sesame	629	261	1 920	1 291	1 659
Sunflower	1 063	449	1 800	737	1 351
Safflower	739	520	1 200	461[4]	680[4]
Tobacco[3]	2 185	874	7 200	5 015	6 326
Tomatoes	2 848	1 816	6 750	3 902	4 934

Notes: (1) Tables 14.3 and 14.4

(2) Table 14.5

(3) Excludes costs for simple drying barns

(4) So.Shs. 1 661 to 1 880/ha if gross return of So.Shs. 2 400/ha assumed (see Section 14.4)

CHAPTER 15

BANANAS

15.1 Introduction

Production methods and problems of banana farms in the Study Area are fully discussed in Annex IV, Chapter 11 and Annex III, Chapter 3. Present production is declining and any improvement will depend on improving both infrastructural services and crop management methods.

15.2 Production Methods

The most important factors that will improve banana production are the establishment of infield drainage and proper nematode control. Drainage methods and costs are discussed in Annex VII. However, very little specific information is available in Somalia on improved production methods. In general, all that is required is an improvement in the implementation of standard practices already used. It is assumed that, with the necessary encouragement of better credit and marketing and the known potential for increased yields, this improved implementation will be adopted. However, research is still necessary to assess varieties and determine better fertiliser, pest and disease control and irrigation requirements. Provisional recommendations and inputs are discussed below in order to indicate management requirements, costs and returns.

15.2.1 Varieties and Planting Material

Until new varieties have been screened there is little evidence against the continued cultivation of Poyo. However, research is needed to assess dwarf varieties in order to lessen problems caused by high winds. Also, fresh planting material is required in order to maximise the benefits of introducing improved nematode control. Material for multiplication should be introduced through the plant quarantine service operated by EAAFRO in Kenya.

15.2.2 Land Preparation and Planting

There is no evidence to suggest that present land preparation methods need to be altered. If practised properly, good initial weed control results. As discussed in Chapter 3, weed control is the main reason for any land preparation operations.

Planting must follow standard practices and aim to provide 2 000 plants/ha. However, it is suggested that suckers are planted on the ridges and not in the furrows in order to increase effective rooting depth on the heavy soils and lessen irrigation problems. No salinity problems should result through planting on ridges because all furrows eventually silt up and a system of basin irrigation is then used. Also, suckers must be taken from fields where improved nematode control is carried out and the practice of using abandoned fields to obtain planting material must be stopped. As a result of this, abandoned fields can be cleared sooner and allow a longer fallow period or a longer crop rotation with annual crops.

15.2.3 Weed Control

Weed control during the first year of growth involves a high labour input. In order to obtain good weed control and avoid the problem of labour shortage the use of herbicides is recommended. Current Ciba-Geigy recommendations are:-

- (a) Gesapax (ametryne) at 4 l/ha at planting.
- (b) Gesapex/Gepiron at 8 l/ha at three months after planting.
- (c) Gesapex/Gepiron at 4 l/ha at six months after planting.

This will enable good control of weeds until full crop cover is reached at 9 to 10 months after planting, after which only light weeding is required.

15.2.4 Nematode and Banana Weevil Control

During 1977, FMC (East Africa) carried out an appraisal of soil nematode control requirements on several farms on the Juba river where nematode infestations are reported to be as severe as in the Study Area. FMC have drawn up the following control recommendations using granular formulations of the nematocide/insecticide Furadan (carbofuran):-

(a)	First year	-	20 g/plant of Furadan 10G at planting and every 4 months
(b)	Second and following years	-	30 g/plant of Furadan 10G every 6 months.

Assuming 2 000 plants/ha, this represents 120 kg/ha/year of Furadan 10G. This will replace Nemagon (DBCP) with a far safer and easily applied nematocide which has effectively controlled nematodes in other banana producing countries (FMC, 1977: PANS, 1977). FMC have estimated that improved nematode control will extend the average life of banana crops to seven years from the present three years. The use of Furadan will also control the moderate infestations of banana weevil. No other pest or disease control measures are required and it is recommended that the National Banana Board (ENB) discontinues aerial spraying as a prevention against Sigatoka disease. This disease is not prevalent in the Study Area.

15.2.5 Fertilisers

No proper fertiliser trials have been undertaken by CARS or ENB and little information is available beyond a known response to nitrogen. Based on estimated nutrient uptake by bananas at expected yields of 250 to 300 g/ha/year (see Appendix E) and the fact that bananas are heavy nitrogen and potassium feeders, provisional recommendations are as follows:-

Urea	6 q/ha/year
DAP	1 q/ha/year
Potassium sulphate	2 q/ha/year

This will provide 296 kg/ha N, 50 kg/ha P_2O_5 and 100 kg/ha K_2O. Estimated K applications are moderate because most is returned to the soil by ploughing in or burning trash. However, full research into fertiliser requirements is essential.

15.2.6 Irrigation

Based on data presented in Chapter 2, the average net irrigation requirement for bananas is 4.6 mm/day. Assuming a net application per irrigation of 60 mm, irrigation will be necessary, on average, every two weeks. However, the average interval will be longer if higher infiltration rates are possible, but it is essential to avoid over-irrigating. With the implementation of drainage and with proper land levelling, most land presently used for banana production is considered to be suitable for continued irrigated production. However, training farmers in proper irrigation methods is essential. The cultivation of bananas on heavy soils requires very careful irrigation.

With in-field drainage and the improved leaching that this will allow, it is estimated that the effects of using the saline Study Area groundwater during the jilal season will be low. On average, the use of groundwater during the jilal season is necessary every second year. However, it is recommended that the use of groundwater in the Study Area is restricted to only essential irrigation (see Annex II). Therefore, for this reason alone, expansion of banana production above present cultivated areas is not recommended because with the predicted water shortages, it will increase the frequency at which groundwater will be required. Brief discussion on the use of groundwater in the Study Area is given in Chapter 2 but the use of groundwater will lead to a build-up of salts.

15.2.7 Miscellaneous Field Operations

Considerable improvement is necessary in pruning methods, basin clearance and protection of developing bunches by clearing away broken and dead leaves.

15.2.8 Harvesting and Packing

No fundamental alterations in harvesting and packing methods are necessary but it is the implementation of these operations which requires the greatest improvement. On average, harvesting is necessary every ten days.

15.3 Yields and Crop Longevity

Expected yields under improved management are difficult to assess. La Rosa Filippo (1966) considered 360 q/ha/year to be possible of which 300 q/ha/year would be of exportable quality. The SIATSA agronomists considered a net exportable yield of 250 to 280 q/ha/year and reported that good farms on the Juba river were probably currently producing 250 q/ha/year, although accurate figures were not available. In 1972, the average exported yield from the Study Area was 87 q/ha/year (ENB, 1977). A single fertiliser trial carried out by CARS on a farm near Afgooye produced 380 to 540 q/ha/year (CARS, 1968). Present gross yields average 200 q/ha/year. It is, therefore, estimated that yields of 250 to 300 q/ha/year can be obtained with the implementation of drainage, nematode control and full management recommendations. Full yield details are given in Table 15.1.

TABLE 15.1

Bananas: Projected Yields (q/ha/year)

	Year 0 (1)	Year 5	Year 10
Gross	200	250	300
Exportable	130	175	240

Note: (1) Present situation

However, without the implementation of the given recommendations, yields will continue to decline due to the gradual build-up of nematode levels, soil salinity and decreased management (in order to reduce costs further). It is estimated that yields will decline during the following ten years to 150 q/ha/year (gross) of which only 100 q/ha/year will be of exportable quality.

The introduction of drainage and improved management will result in increased crop longevity. Both FMC and the SIATSA agronomists considered an increase to seven years per crop was possible, but it is assumed that, in the absence of further information, six years will be the average crop life.

15.4 Field Production Costs

Because of the different input requirements between the first year of production and subsequent years, production costs must be divided accordingly. It is therefore assumed that harvesting starts at the end of the first year and continues for five years i.e. a total crop life of six years. Field production costs exclude packing costs as this is handled by ENB.

15.4.1 Tractor Costs

Land preparation requires 16 h/ha using heavy duty tractors and 1.5 h/ha using a standard tractor (see Annex IV, Chapter 11). Once harvesting is started it is estimated that carting bananas from the field to the packing station will require 15 to 16 h/ha using light duty tractors. Estimated tractor costs are given in Table 15.2.

TABLE 15.2

Banana Production: Tractor Costs

Operation		Tractor	Time (h/ha)	Cost per hour (1) (So. Shs.)	Cost/ha (So.Shs.) Year 1	Years 2 to 6
Land preparation	(a)	100 hp	16	100	1 600	-
	(b)	70 hp	1.5	74	100	-
Transport		60 hp	15 - 16	64	-	1 008
				Total	1 710	1 008

Note: (1) from Appendix C

15.4.2 Labour Requirements

Labour requirements and costs are summarised in Table 15.3 and are based on data collected from ten farms in the Study Area as well as data presented in Appendix D. It is estimated that for a six year crop, the average annual labour requirement with full recommendations and maximum projected yields will be 412 mandays/ha. This excludes labour for packing because this is organised by ENB and its cost is included in ENB charges to the farmer.

TABLE 15.3

Banana Production Labour Requirements

		Year 1		Years 2 to 6 (1)	
Operation	Manhours/ ha	Frequency	Manhours/ ha	Frequency	Manhours/ ha
Planting (2)	250	1	250	-	-
Replanting	60	1	60	-	-
Herbicide spraying	1.2	4	5	-	-
Light weeding	30	-	-	6	180
Fertiliser application	25	3	75	4	100
Nematocide application	25	2	50	2	50
Pruning	25	8	200	12	300
Trash clearing	35	4	140	9	315
Irrigation	9	25	225	25	225
Harvesting	20	-	-	35	700
Loading etc.	5	-	-	35	175
Sub-total			1 005		2 045
Misc. (10%)			100		205
TOTAL			1 105		2 250
Mandays/ha (3)			221		450
Cost/ha (So. Shs.) (4)			1 105		2 250

Notes:
(1) Excludes labour for packing organised by ENB.
(2) Includes first application of fertiliser and nematocide.
(3) At 5 manhours/day.
(4) At So. Shs. 1.00/manhour.

15.4.3 Chemical and Fertiliser Costs

Nematocide, herbicide and fertiliser costs are given in Table 15.4 and based on 1977 ONAT prices.

TABLE 15.4

Banana Production: Chemical and Fertiliser Costs

Chemical	Rate/ha	Unit	Cost/unit (So.Shs.)	Cost/ha (So. Shs.) Year 1	Years 2 - 6
Furadan 10G	120 kg	kg	15.85	1 902	1 902
Herbicide	16 litres	l	35	560	-
Sprayer cost	-	-	-	14	
Fertilisers	9 q	q	131 - 153	1 219	1 219
		Total cost/ha		3 695	3 121

15.4.4 Summary

Field production costs are summarised in Table 15.5. The average cost is So. Shs. 6 401/ha/year. The average cost per quintal of exported fruit is given below and ranges from So. Shs. 32 to 35 per exportable quintal.

Exportable yield	175 q/ha/year	240 q/ha/year
Average exportable yield per year for 6 year crop life	146 q/ha/year	200 q/ha/year
Average cost/ha/year	So. Shs. 5 121 (1)	So. Shs. 6 401
Average cost per exportable quintal	So. Shs. 35	So. Shs. 32

(1) Assumes 80% of full costs for lower yield.

TABLE 15.5

Bananas: Total Field Production Costs

	Cost/ha (So. Shs.) Year 1		Years 2 to 6
Tractors	1 710		1 008
Chemicals etc.	3 695		3 121
Labour	1 105		2 250
Total	6 510		6 379
Average cost/ha/year		6 401	

Note: (1) For 6 year crop life

Source: Tables 15.2 to 15.4.

15.5 Infrastructure Development

Improvement of infrastructural services requires the improvement and reorganisation of the National Banana Board (ENB). General recommendations are given below:-

(a) Marketing

On average, bananas require harvesting every ten days. ENB must ensure a regular supply of ships. It is considered that this improvement is the first stage in improving production because it will ensure greater returns to the farmer and a greater confidence within the banana sector.

(b) Training

It is essential that technical staff obtain sufficient knowledge and experience of good crop management and packing as the first step to training other members of staff and most of the farmers. This can be done in two ways. Staff can be given a period of practical training in other banana producing countries.

Conversely, experienced expatriate staff can be recruited in order to carry out an extension and training programme. It also must be remembered that several farmers in the Study Area are sufficiently experienced to undertake this work and should be encouraged to do so.

(c) Research

The technical section of ENB must instigate a research programme immediately. It is essential to determine proper fertiliser, nematode control and irrigation requirements as well as screen new varieties. This research can be carried out on ENB farms in the Study Area.

(d) Seed Multiplication

Until qualified and experienced staff are available and proven nematode control methods are determined, the ENB nursery will not be able to provide suitable healthy planting material. Therefore, it is recommended that this service be abandoned until a future date. It may also be necessary to choose a new site for this nursery in order to minimise the risk of renewed nematode infestation.

15.6 Labour Supply

High labour inputs are essential to banana production and, with the exception of weeding, no other labour input given in Table 15.3 can be replaced by less labour intensive methods. Therefore, at an estimated requirement of 412 man-days/ha/year and a planned net area of 4 000 ha, banana production will require about 4 500 workers each day for field operations.

The present labour input for packing is estimated to be 220 people per day (Annex IV, Appendix A). With the increased banana yields, the number required will rise to 300 to 400 people per day. Therefore, the average daily labour requirement will be up to nearly 5 000 people. It is, therefore, essential that development proposals for annual crop production in the Study Area do not conflict with this requirement. This is discussed further in Part IV of this annex. However, one future advantage will be the increasing Study Area population and, inevitably, decreasing land availability which should result in a greater demand for employment.

CHAPTER 16

GRAPEFRUIT

16.1 Introduction

Proposals for a grapefruit production scheme financed by the European Development Fund (EDF), and currently being established in the Study Area, are discussed in Annex IV Chapter 13. At present only Phase I (230 ha net) is being developed. Further development, of Phase II (about 470 ha net) will depend on the progress achieved during Phase I, but money has been voted for this phase. Phase III (700 ha net) will depend on the success of the previous works. The technical problems of grapefruit production in the Study Area are discussed below.

16.2 Envisaged Production Problems

16.2.1 Water Resources

Grapefruit require controlled water supplies in order to regulate flowering and fruiting and to avoid out of season stresses which cause uncontrolled production. Rainfall in the Study Area is unpredictable. Consequently, guaranteed and controllable irrigation is essential in order to avoid any risk of drought. Sufficient irrigation supplies of river water are possible only in the der season. Gu season river flows are unpredictable and increased grapefruit production will increase demand on a limited water resource. It has been shown that in one year out of four there will be insufficient river water to irrigate any cropped area above the existing net cultivated area during June and July (see Annex II). Therefore, in order to supply the required irrigation, groundwater must be used during certain jilal and gu seasons. This supplementary source of water will not be needed every year; for example, in the case of bananas, tubewells were used for irrigation in 1974, 1975 and 1976 but were not required in 1977 and 1978. In the case of grapefruit, groundwater is likely to be used from January to April and in June and July but not necessarily every year. It is estimated that groundwater will be used for an average of two and a half months each year when measured over a long period. Groundwater in the grapefruit project area is saline (EC = 1.2 to 1.5 mmhos/cm) and its use must be restricted particularly for susceptible crops like grapefruit (see Annex II). Even with the use of river water (average EC = 0.75 mmhos/cm), yield reductions of over 20% are predicted for grapefruit (see Table 2.12).

16.2.2 Orchard Management

A high level of management is required to maintain production of quality fruit that will be acceptable on the sophisticated European market with its consumers' quality preferences and prejudices. This management will be at a level that has not been previously practised in Somalia, involving advanced horticultural techniques, intensive pest control, controlled harvesting methods and effective windbreaks in order to produce high yields of blemish-free fruit.

Windbreaks will be a particular problem due to the high monsoon winds in the hagai and jilal seasons. Careful planning of windbreaks is required to ensure reductions of wind speed through orchards.

16.2.3 Marketing

The grapefruit scheme was designed mainly for export production. This is necessary because, like all other fruit and vegetables, the internal market is limited and easily saturated. However, the only market survey for the planning of the scheme relied on data from 1971. Although a new survey of both European and Middle East markets is necessary, it will be difficult for Somali fruit to be marketed in competition with quality fruit already on the European market. Full discussion on marketing grapefruit is given in Annex VIII.

16.3 Discussion

The development of grapefruit for export is difficult because of problems of water supply, horticultural management and marketing in competition with established suppliers. For these reasons Phase I of the project must be regarded as a pilot and the decision to proceed with grapefruit on Phases II and III should only be taken after it has been demonstrated that the initial problems have been overcome. These problems should be investigated by the consultants who are responsible for the grapefruit project.

Because of the long period required before the trees first fruit, it is unlikely that the decision to proceed on Phase II will be delayed to test the markets so it is recommended that a new market survey is made to confirm that the project is feasible. Only after this survey should Phase II be developed under grapefruit but if there are still doubts about the technical problems and the marketing then the possibility of substituting annual crops may have to be considered.

PART III

FEASIBILITY STUDY OF PROJECT AREA

CHAPTER 17

INTRODUCTION AND EXISTING SITUATION

17.1 Location

The Project Area is located on the right hand bank of the River Shabeelle between the Asayle canal outlet and the Qoryooley barrage. To the east, the project boundary is demarcated by the Asayle canal downstream of Tawakal village and in the west by the Qoryooley-Farsooley road. The Project Area extends northwards from the river to the belt of acacia woodland that traverses the northern boundary of the Study Area.

Although the final gross Project Area is 5 154 ha, the area of land affected totals 5 800 ha. This is because there are presently cultivated areas bordering the Project Area which will be affected by the construction of new canals. This can be seen in Figure 17.1. The small number of farmers in these areas will be accommodated within the project. Full discussion on the location of the Qoryooley project is given in Annex VII.

17.2 Present Land Use and Farming Systems

Present land use in the area of land affected by this project is shown in Figure 17.1 and summarised in Table 17.1. These figures are based on data presented in Annex IV, Chapter 4 (Study Area Land Use), where a full discussion of land use categories is given.

TABLE 17.1

Qoryooley Project: Present Land Use

Land use category	Area Gross ha	%	Net cultivated ha	%
1. Uncultivated land				
1a. Open woodland and scrub	120	2	-	-
2. Marginal annual crop production				
2a. Rainfed cropping	333	6	117	5
2b. 10-30% land use intensity	287	5	86	4
2c. 40% land use intensity	2 740	47	1 096	49
Sub-total (2)	3 360	58	1 299	58
3. Irrigated annual crop production				
3b. 40% land use intensity (2)	2 320	40	928	42
4. Irrigated perennial crops	-	-	-	-
TOTAL	5 800	100	2 227(1)	100

Notes: (1) Irrigated NCA is 2 110 ha
(2) Average land use intensity in class 2 and 3 land is 39%.

Source: Survey data (1977).

The most important feature of the Project Area is the extent of existing agriculture. Only an estimated 2% of the gross affected area is totally uncultivated and comprises an area of mainly acacia woodland along the northern boundary. However, although the remaining area is being cultivated, it is at a low intensity of land use (39%). The dividing line between class 2 and class 3 areas of crop production is roughly parallel to the river. This is the result of two factors:-

(a) Poor irrigation supplies along offtakes from the Asayle canal at and beyond Tawakal and feeding the north-western part of the Project Area.

(b) Difficulty in obtaining irrigation supplies beyond a certain point along minor canals that directly offtake from the river.

The small area of rainfed cropping marks the limit of any available irrigation.

The main crops grown in the area are maize and sesame. Existing production is summarised in Table 17.2. Double-cropping of maize and maize/sesame is, therefore, the dominant cropping pattern practised. However, at an average land use intensity of 39%, this represents a cropping intensity of only about 110%, assuming 70% as the maximum possible land use intensity under present irrigation systems.

TABLE 17.2

Qoryooley Project: Existing Maize and Sesame Production

	Maize		Sesame	
	gu	der	gu	der
Production intensity (%)	100	40	-	60
NCA (ha)	2 227	891	-	1 336
Yields (q/ha threshed grain)				
(a) Land use class 2 land	6		2.5	
(b) Land use class 3 land	10		4	

Source: Annex IV (Study Area Existing Agriculture)

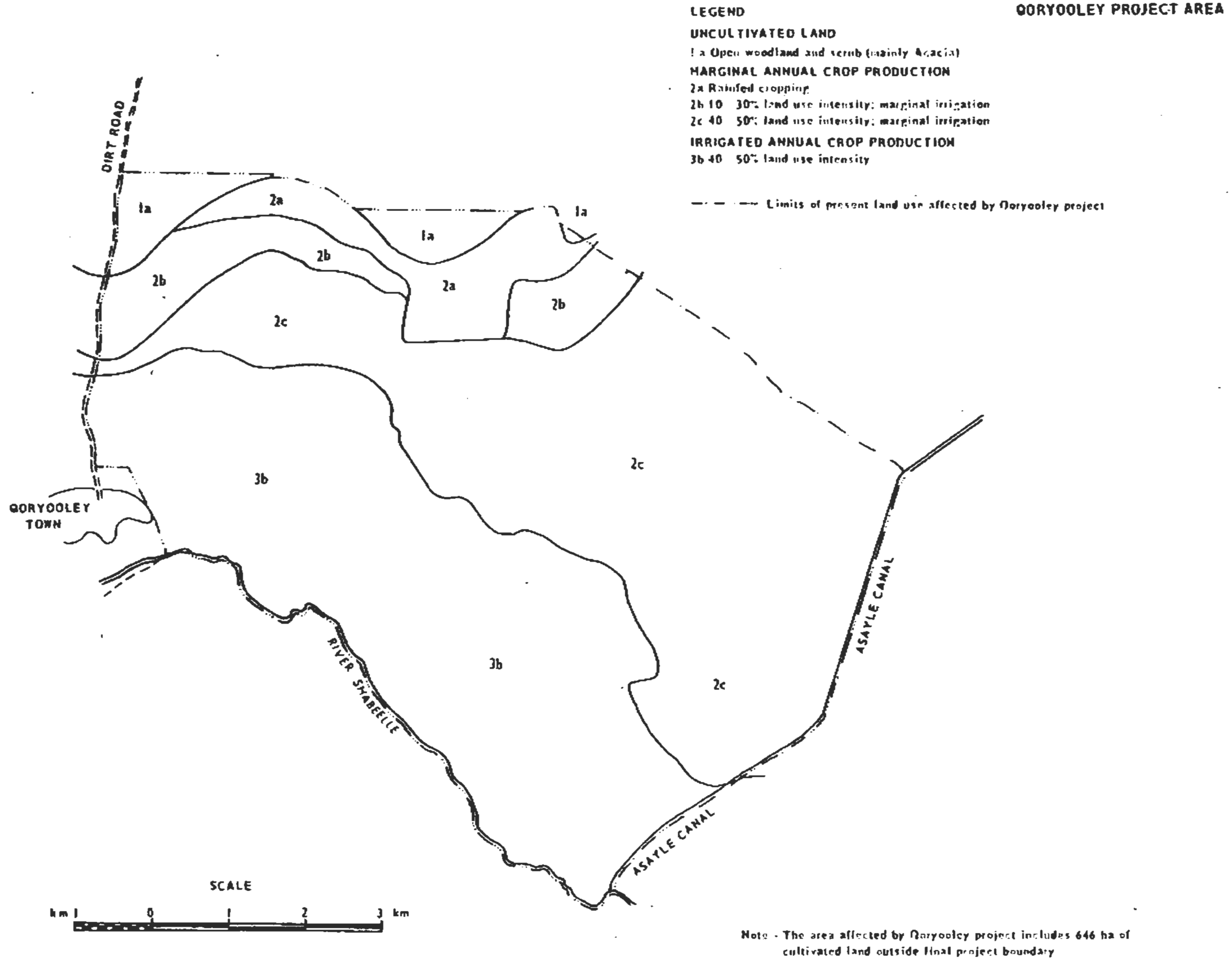
Other crops grown are hagai crops of chewing tobacco, tomatoes and a sesame catch-crop. Inter-cropping in maize crops is also practised, the main inter-crops being cowpeas and green grams. Estimated cultivated areas of these minor crops are as follows:-

Tobacco	50	ha
Tomatoes	35	ha
Sesame catch-cropping	130	ha
Pulse inter-cropping	700	ha of maize crops

A full description of present crop production methods, management and farming systems is given in Annex IV.

FIGURE 17.1

PRESENT LAND USE: QORYOOLEY PROJECT AREA



Note - The area affected by Qoryooley project includes 646 ha of cultivated land outside final project boundary

Crop management is poor and yields low as the result of poor irrigation, the dependence on erratic rainfall, low soil fertility, insufficient weeding, and pests, particularly maize stalkborer. With the exception of two small co-operative group farms, no fertilisers or chemicals are used. Nearly all field operations are by hand labour. A small number of farmers hire privately owned tractors from outside the Project Area.

It is estimated that less than 250 ha (11%) of the present cropped area is prepared by ploughing.

Most of the present crop production is by smallholders i.e. farmers with less than 5 or 6 ha. The average holding size is 1.95 ha per household-family. Apart from smallholders, there are two co-operative group farms at Gayweerow cultivating about 40 ha and two medium scale farmers cultivating about 50 ha.

A detailed breakdown of present land use and yields of major crops is given in Appendix G, being required for the economic analysis of proposed development.

17.3 Population

Full details of estimated population and family sizes are given in Annex III, Chapter 4. There are five villages located within the Project Area, whose members own or farm most of the area. The remaining area is farmed or owned by people who live in three villages adjacent to the Project Area and in the town of Qoryooley. The estimated farming population in the Project Area is given in Table 17.3. This also includes the population affected by the project and which will be absorbed into the project (see Section 17.1).

TABLE 17.3

Qoryooley Project: Present Project Area Population

Village	Population	Household-families (2)	%
Buulo Koy	242	41	2
Garas Guul	545	92	6
Tugarey	423	71	4
Gayweerow	4 634	781	48
Jasiira	1 323	223	14
Nimcooley	300 (1)	51	3
Murale	300 (1)	51	3
Tawakal	1 000 (1)	169	10
Qoryooley	950 (1)	160	10
TOTAL	9 727	1 639	100

Notes: (1) Estimated as only part of these villages farm in or are affected by this project. Estimates based on known sizes of first five villages in the table.

(2) Based on 5.93 members per household-family.

Source: Annex III, Chapter 4 (Study Area Population).

The estimated population for Qoryooley that presently farms in the Project Area is very approximate. The present population of Qoryooley is reported to be 14 614 i.e. 2 460 household-families (see Annex III, Chapter 4). It can be assumed that most of these families are involved in some form of farming. The area of cultivated land that can be farmed from Qoryooley but which is not in the Project Area is limited i.e. the area of class 2 and 3 land up to Bandar and Faraxaane. Consequently, the Project Area farming population living in Qoryooley could be higher. A separate estimation of the Project Area population based on present agriculture can be made. Assuming an average holding size of 1.95 ha per household-family, 5 680 ha (gross) presently under cultivation and 70% as the maximum possible land use intensity, the number of household-families in the area is calculated as follows:-

$$\frac{5\,680 \text{ ha} \times 0.70}{1.95 \text{ ha}} = 2\,038 \text{ household-families.}$$

Consequently, a full population study will be necessary to determine the exact population that will be affected by the project.

17.4 Agricultural Infrastructure

Present infrastructural services within, or affecting, the Study Area are discussed fully in Annex III, Chapter 3. Within the Project Area, however, services are limited. A district office of the Ministry of Agriculture is located in Qoryooley, but only has a small staff of eight inadequately trained and inexperienced technical assistants. Only two co-operatives have been established (at Gayweerow) and there was no evidence of any other extension work or farmer training in the Project Area. Despite requests from other villages, the Plant Protection Service was reported to have visited only the two co-operatives. The nearest ONAT depot for agricultural supplies is at Shalambood, approximately 16 km away. ONAT tractors were reported unavailable and the small area of mechanised land preparation was only through the hire of private tractors. ADC has a sub-depot at Qoryooley and one produce buying station at Gayweerow, although farmers in the area reported no problems in selling surplus produce to ADC. Two of the three Bentall's grain driers presently under construction in the Study Area are located in Qoryooley.

17.5 Project Design and Management

The design and layouts of the project are described in detail in Annex VII, and project management is discussed in the Feasibility Study Report. In order to simplify management, the Project Area has been sub-divided into 8 farm units and a small pilot farm. Each farm unit will have its own farm headquarters and managerial staff in order to provide technical services (e.g. machinery) and supervise farm operations. The final size of each farm unit depends on the net area of land to be irrigated from each of the 15 distributary canals. The distribution of existing villages in and on the edge of the Project Area has also created natural focal points for each farm unit. Farm unit sizes are given in Table 17.4.

TABLE 17.4

Qoryooley Project: Farm Unit Sizes, Cultivated Areas and Family Requirements

Farm unit	Number of distributary canals (1)	NCA (ha) (1)	Required household-families (2)	Net area houseplots (ha) (3)	Net area major crops (ha) (4)
Murale	2	369.5	185	24	345.5
Tawakal	2	533.5	267	34	499.5
Garas Guul	3	529.5	265	34	495.5
Shamaan	2	415	208	26	389
Tugarey	1	482	241	31	451
Nimcooley (5)	1	263	131	17	246
Gayweerow	2	611	306	39	572
Jasiira	2	623	312	39	584
Pilot farm	- (6)	137	70	9	128
TOTAL (7)	15	3 963.5	1 985	253	3 710.5

Notes:
(1) Data from Annex VII (Engineering)
(2) Assumes 2 ha per family
(3) Assumes 0.125 ha per family
(4) By difference (1.875 ha per family)
(5) Excludes 207 ha (NCA) of unsuitable class 6 land
(6) Water supplied via Jasiira farm unit
(7) Gross project area is 5 154 ha with overall total NCA of 4 170.5 ha including unsuitable land in note (5).

Because of the high population already farming in the area, the farming system to be adopted will be based on smallholder agriculture. The number of families required per farm unit is also given in Table 17.4. Data previously presented in Annexes III and IV have shown the present average holding size to be 1.95 ha and an average household-family size to be 5.93 members from which two persons can be considered permanently available for farm work. For study purposes, it is assumed that the average holding per family will be 2 ha and that available labour is two people per family i.e. one person per hectare. However, although present agriculture is fairly evenly distributed throughout the Project Area, over 70% of the affected population live close to the river (Qoryooley, Jasiira and Gayweerow), with 48% in Gayweerow alone (see Table 17.3). Consequently, full project development will require redistribution of the present population.

A certain degree of communal farming will also be required in order to maximise services and benefits provided by each farm unit, for example, mechanised land preparation. The smallest communally farmed area will be at field unit level. Each distributary canal supplies, on average, a series of 20 to 30 ha field units. The establishment of communal farming will only involve the organisation of 10 to 15 families for each field unit.

On each farm unit, a small area of land will be allocated as household plots. This will give smallholders the free choice to continue the cultivation of minor crops without interrupting production of selected major crops. It is considered that an area of two jibals (0.125 ha) per household-family will be sufficient. Therefore, each household-family, on average, will be cultivating 1.875 ha of major crops. The net area of household plots per farm unit is given in Table 17.4.

Provision is to be made for a small pilot farm which will be located near Qoryooley. This farm will provide experimental and training facilities that will be required prior to the establishment of each farm unit. Area details are given in Table 17.4.

A small area of land considered unsuitable for irrigated crop production has been identified in the Nimcooley farm unit. This area requires separate planning compared to the rest of the Project Area. The rest of the Project Area comprises suitable land for irrigation (see Annex I).

CHAPTER 18

CROPPING PATTERNS

18.1 Introduction

Only cropping patterns involving annual crops suited to production in the Qoryooley project are considered. Perennial crops have not been considered for two major reasons:-

(a) It is Government policy to encourage annual crop production in the Study Area and to limit extension of perennial crops to existing plans.

(b) There is neither a groundwater nor surface water resource available in the area to maintain perennial crops during the jilal season (January to March; see Annex II).

Present cropping patterns are dominated by maize and sesame and a small amount of inter-cropping of maize crops is practised. Other minor crops constitute less than 40% of the present cropping area. Several other annual crops besides maize and sesame are considered suitable for cultivation in the area. Because of either their higher value or their contribution to import substitution, these crops also warrant consideration for inclusion in any cropping pattern. These crops are rice, cotton and the oilseeds, groundnuts, sunflower, castor and safflower. Vegetables, mainly tomatoes, pulses and chewing tobacco are presently grown on a limited scale and are unlikely to assume major importance due to their limited markets. However, they are likely to continue in their present role irrespective of the form of development adopted. The provision of household-plots in each farm unit will allow their continued free-choice cultivation.

A number of factors which influence overall cropping intensity in any selection of crops has been considered when formulating cropping patterns. These include:-

soil constraints
water availability
cropping calendars
rotational constraints
crop relative profitability
labour availability.

Although the major emphasis is placed on formulating arable cropping patterns, there is a need to integrate livestock into any development proposals. Livestock are important in the present farming system and an objective of present proposals will be, at minimum, to maintain and improve output from the present livestock population. Specific proposals are given in Annex V and are dependent on forage production in the irrigation areas. This comprises both residues from arable crops and production of forage crops for livestock consumption. Allowance is made for this in the cropping patterns proposed. Although selected cropping patterns are discussed with specific reference to the Qoryooley project, they form the basis for crop development proposals in the whole Study Area. Further discussion is therefore made in Part IV of this annex.

18.2 Soil Constraints

Soils throughout the Project Area are generally consistent with only minor differences in texture, permeability, microrelief and topography. With the exception of about 400 ha, mainly in one area alongside the Asayle canal, all land in the Project Area is considered suitable for irrigation (see Annex I). Soils are, therefore, not considered to constrain cropping patterns. However, they influence the choice between cultivation of either paddy or upland rice. The area of Saruda soils to the north of the Project Area is considered more suitable for paddy rice production because the soils' finer texture reduces infiltration and deep percolation. Suitable topography would also allow construction of flat paddies at a lower than average cost compared with other irrigation systems. However, suitable areas on these Saruda soils are limited to only about 500 ha and have only a minor influence on cropping patterns.

18.3 Water Availability

Water availability is discussed in detail in Annex II. The general rule that has been adopted on availability for crop development is based on the present inefficient utilisation and high wastage of water in present crop production. It is assumed that, with an efficient water distribution system and improved irrigation practices, crop water requirements will be the same as the present extraction rate. Therefore, availability of irrigation water will not constrain cropping in the der season between August and mid-January and a full cropping intensity of 100% can be practised. However, in the gu season (April to July), three years out of four there will be an overall shortage of water in the river in June and July. Consequently, the gu season cropping intensity under full irrigation will be limited to the present net cultivated and irrigated area. This area of 2 110 ha represents about 50% of the total project net cultivable area of 4 170.5 ha (see Tables 17.1 and 17.4), so that under full irrigation no more than 50% cropping intensity can be planned. This limitation and envisaged gu season water shortages are the main reasons for the inclusion of a short season drought tolerant forage crop in gu season cropping. It is also apparent that the der season is the most important of the two cropping seasons.

The predicted June and July water shortages are further evidence for the exclusion of perennial crops.

18.4 Cropping Calendars

The growing seasons for suitable annual crops discussed in Part II of this annex are shown in Figure 18.1, which also gives average monthly rainfall and indicates periods of predicted water shortages. However, for gu season crops, only 15-day planting periods are planned due to the necessity for quick cropping and to maximise utilisation of available water. Short season varieties have also been deliberately selected to fit in with the periods of available water and minimise the risk of crop failure through drought. With rice, this does not appear to result in lower yields. The short season maize varieties, however, have a reduced yield potential compared to standard long season varieties (150 days) grown elsewhere in eastern Africa (see Chapter 4). The main points that arise from the cropping calendar are as shown below:-

(a) 105-day rice vareties (e.g. Vista) can, if necessary, be double-cropped but the period for land preparation before the der season crop will be severely restricted. Der season rice, ideally, should follow a forage crop or a fallow.

(b) 105-day maize varieties can also be double-cropped. Again, land preparation time before the der crop is limited, but to a much lesser extent than for rice. This is due to the greater flexibility in planting dates for der season maize.

(c) Cotton is the longest season crop and can only be grown in the der season. The need to plant cotton in August means that it can only be preceded in the gu season by either a fallow or a forage crop.

(d) Sesame, groundnuts and castor can only be considered as der season crops.

(e) Safflower and sesame can easily follow any gu season due to their later planting date in the der season.

In general, the selection of crops to enable double cropping is based on the following criteria:-

(a) 105-day varieties grown in the gu season can only be followed in the der season by 90 to 120-day varieties which can be planted from September onwards.

(b) Der season crops that must be planted in August (cotton, rice) can only be preceded by gu season crops of less than 90 days or a fallow.

18.5 Rotational Constraints

Within the range of major crops being considered, there are no severe rotational restraints which restrict the area of any one crop each year. In fact, with adequate pest control and fertiliser applications, mono-cropping is possible but not recommended if a rotation can be practised. Therefore, the final area per crop included in any cropping pattern does not depend on specific rotational requirements.

18.6 Crop Relative Profitability

The gross margin (i.e. the gross output less direct costs) is generally accepted as the most useful indicator of crop profitability. However, it can only be taken providing that the fixed costs (development costs, management etc.) involved in production are similar for each crop under consideration. As this is the case with the annual crops that can be included in a cropping pattern for the Qoryooley project, the gross margin methodology is used.

Gross margins are generally related to a unit of land. In a situation of water scarcity, as in the gu season, it can also be expressed in terms of units of water required per hectare of land. However, this is only important when the water requirements of competing crops differ significantly during periods of restricted water availability. There is little difference in the water requirements of proposed gu season crops (see Chapter 19). Therefore, the gross margin expressed in Somali shillings (So.Shs.) per hectare is taken as the most appropriate indicator of financial returns. Estimated gross margins for crops under consideration are summarised in Table 18.1. Market prices, as opposed to economic prices, are used because it is the profitability of crops to the farmer or farming organisation which will influence the choice of crops to be grown. Furthermore, if financial prices differ from economic prices, they reflect Government interference in price structures and a policy of encouraging or discouraging production of different crops.

TABLE 18.1

Annual Crops: Gross Margins

	Gross margins(1) (So.Shs./ha) With labour costed	Without labour costed
Paddy rice	3 660	4 249
Upland rice	2 897	3 592
Cotton	2 594	3 449
Castor	2 374	2 834
Maize	1 374	1 801
Groundnuts	1 210	1 803
Sesame	1 291	1 659
Sunflower	737	1 351
Safflower	461	680

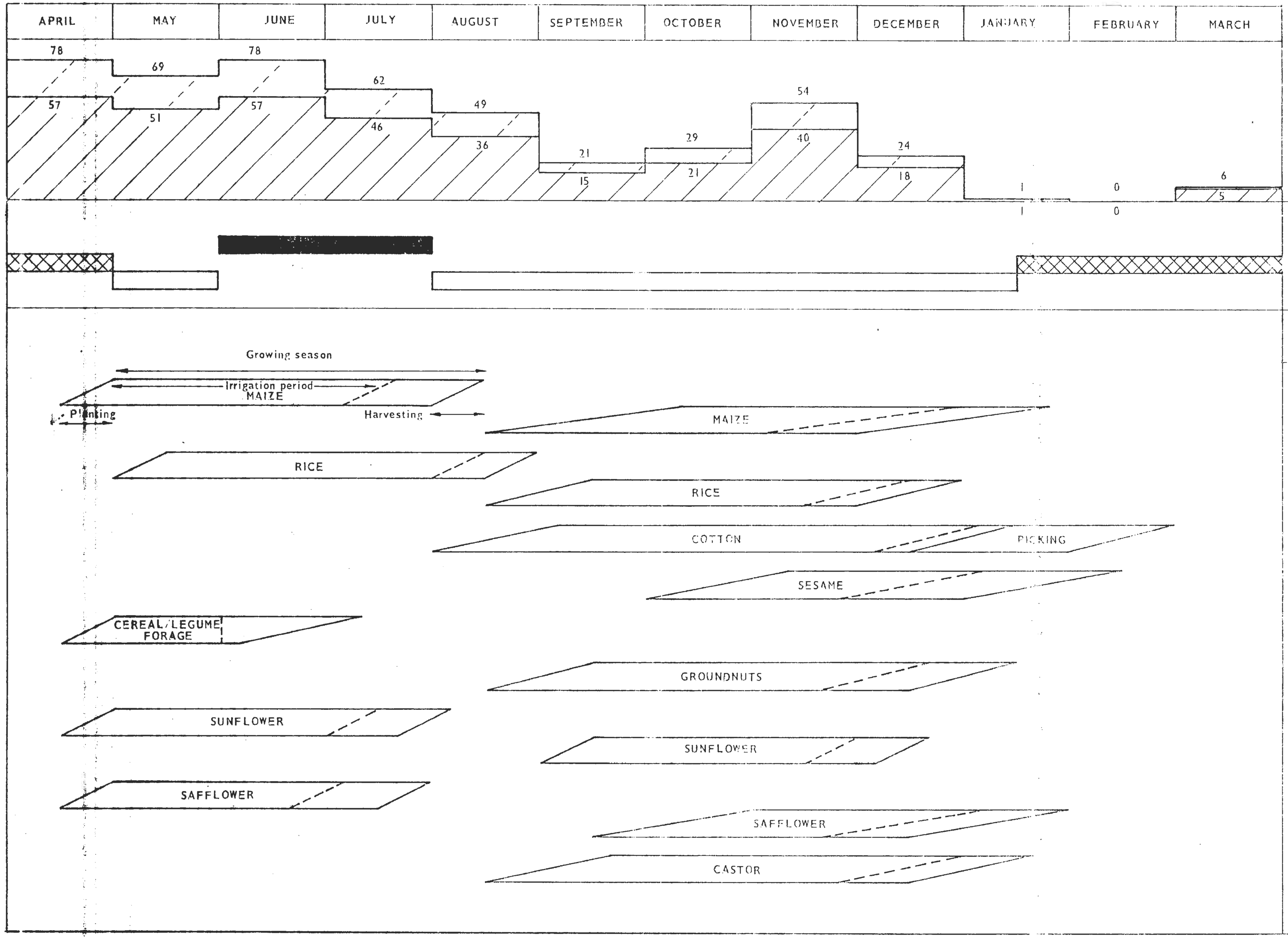
Note: (1) At Year 4 yields
Source: Chapter 14

Table 18.1 indicates that cotton and rice, both upland and direct-drilled paddy rice, are financially the most attractive crops to produce and, therefore, should be included in any pattern to the maximum possible extent. However, despite their lower profitability, maize and sesame must also be included in order to provide at least enough for domestic requirements; of the remaining crops, castor could also be included for financial reasons, but must be excluded due to the lack of available production information applicable to the Study Area. This is also the case for the least profitable crops, safflower and sunflower.

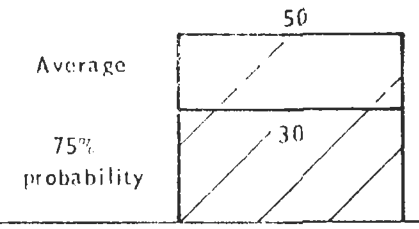
18.7 Crop Labour Requirements

Estimated labour requirements for each crop are given in detail in the relevant chapters of Part II of this annex and are summarised for selected crops in Table 18.2. Given the points raised in Sections 18.2 to 18.6, labour availability is the limiting factor affecting the maximum intensity of any selected crop, particularly in the der season when full cropping will be possible. Therefore, estimated daily labour requirements per crop will also be required. The method of calculation is given in Annex D and requirements for selected crops summarised in Table 18.3. The major peaks in labour requirements coincide with weeding and harvesting, particularly for cotton.

CROPPING CALENDARS



STUDY AREA RAINFALL (mm)



PREDICTED IRRIGATION AVAILABILITY

Restricted to existing N.C.A.

Nil availability

Full availability

CROP	GROWING SEASON (days)	MAXIMUM REQUIRED IRRIGATION PERIOD (days)	PRODUCTION SEASON	LIMITATIONS TO PRODUCTION SEASON
MAIZE	105	75 - 80	Gu	Quick cropping required to maximise rainfall and May irrigation availability
			Der	First harvest after November and final irrigation before January
RICE	105	90	Gu	Quick cropping to maximise May irrigation availability and minimise bird attack December harvest to avoid November rains and increased bird problem after December
COTTON	180	120 - 130	Der	First picking after der rains, final picking before March and final irrigation before January
SESAME	90	55 - 60	Der	Peak flowering after November and final irrigation before January
MIXED FORAGE	50 - 70	45 - 50	Gu	Maximise rainfall and May irrigation availability
GROUNDNUTS	120	95	Der	Lifting after der rains. Final lifting early January after possible light irrigation
SUNFLOWER	90	65	Gu	Maximise rainfall and May irrigation availability
			Der	Maturity after November rains and harvest before increased bird attack after December
SAFFLOWER	90	65	Gu	Maximise rainfall and May irrigation availability
			Der	Harvest after der rains and final irrigation early January
CASTOR	120	95 - 100	Der	As for der safflower

TABLE 18.2

Annual Crops: Labour Requirements

Operation	Labour Requirements (manhours/ha)						
	Maize	Sesame	Upland (1) rice	Paddy (1) rice	Cotton	Forage	Groundnuts
Planting	25	20	-	-	25	40	40
Weeding	150	100	120	-	200	100	200
Irrigation	100 - 117	67	90	113	117	50	134
Top dressing	25	-	5	5	25	-	-
Harvesting	25	90	-	-	390	120	130
Carting	6	2	6	6	5	-	6
Post-harvest (2) operations	50	50	-	-	3	25	20
Minor field (3) operations	7	5	29	29	12	5	9
10% miscellaneous labour	39	34	25	16	78	34	54
TOTAL	427 - 444	368	275	169	855	374	593
Mandays/ha (4)	107 - 111	92	69	42	214	94	148

Notes:
(1) Mechanised production methods and exclude requirements for bird scaring.
(2) e.g. shelling, threshing, plus straw/stover disposal.
(3) e.g. crop spraying.
(4) Based on 4 manhours per working day.
(5) Sunflower (154 mandays/ha), caston (114) and safflower (55) not included (see text).

Source: Annex VI, Part II

TABLE 18.3

Annual Crops: Daily Labour Requirements

Crop	Planting dates	Average daily labour requirement per 100 ha (net) (1)											
(a) Gu season cropping		April		May		June		July		August		September	
Maize	April 15th-30th	-	86	146	130	130	46	46	21	108	28	-	-
Upland rice (2)	May 1st-15th	-	-	31	37	38	121	99	32	31	41	-	-
Mixed forage	April 15th-30th	-	85	135	135	79	114	76	-	-	-	-	-

Crop	Planting dates																
(b) Der season cropping		Aug		Sept		Oct		Nov		Dec		Jan		Feb		Mar	
Maize	Sept 1st-30th	-	-	83	133	136	127	86	44	32	74	74	-	-	-	-	-
Upland rice (2)	Aug 15th-Sept 15th	-	30	33	36	100	131	64	30	38	10	-	-	-	-	-	-
Cotton	Aug 1st-30th	73	114	117	126	98	77	64	35	35	151	217	175	136	64	-	-
Sesame (4)	Oct 15th-Nov 15th	-	-	-	-	20	58	100	107	79	51	27	82	126	51	-	-
Groundnuts	Aug 15th-Sept 15th	-	99	141	100	114	114	86	58	44	144	139	10	-	-	-	-

Notes:
(1) Number of working people required per day per 100 ha (net) for each crop. Data given as half-monthly means.
(2) Bird scaring requirement not included.
(3) Where other planting dates possible (i.e. maize and sesame), labour requirement figure can be shifted in appropriate direction to minimise peak requirements in selected cropping pattern.
(4) Includes labour for pre-planting irrigation.
(5) Paddy rice, safflower, sunflower and castor not included (see text).

Source: Appendix D

The requirement for bird scaring in rice has not been included in the profiles as it will set a limit to the area of rice grown. Up to three people (usually children) per hectare will be required for effective bird scaring during a five week period prior to harvesting. Population statistics presented in Annex III, Chapter 4 have shown that there are between one to two adolescent children in each household-family and it is assumed that only these children are available for bird scaring. Therefore, the area of rice that can be cultivated is limited to a maximum of 0.4 ha per household-family. At an average of two hectares per household-family, this represents a maximum intensity of rice of 20% in any season. Also, rice cultivation should be evenly distributed throughout the Project Area in order that all available children can be utilised. Therefore, upland rice is recommended and not paddy rice as the suitable area for paddy rice (500 ha) is located in one part of the Project Area and would limit paddy rice production to only 100 ha for the entire project.

Although a migratory labour force is reported to enter the Study Area during certain seasons, it is too unpredictable to be relied upon (see Annex III, Chapter 4). Therefore, only the resident population can be regarded as the main source of labour. For planning purposes, it is assumed that each family can provide at least two people as permanent manpower. This has been used, together with estimations of monthly crop labour requirements, in order to determine maximum labour availability. Calculations to formulate cropping patterns have been based on these limits.

18.8 Cropping Patterns

Three cropping patterns applicable to the Project Area have been formulated:-

Cropping pattern A - the basic recommended pattern
Cropping pattern B - an alternative pattern excluding cotton
Cropping pattern C - an alternative pattern excluding rice.

Safflower and castor have not been included because, despite their apparent potential, little is known about their actual performance and management requirements in relation to the Study Area. Sunflower is also excluded. Safflower and sunflower are currently the least profitable annual crops to produce.

18.8.1 Cropping Pattern A

This cropping pattern is regarded as the most attractive financially and is applicable to either large scale or smallholder development. Its composition is as follows:-

	Cropping intensity per season (%)		
Crop	Gu	Der	Total
Maize	20	20	40
Upland rice	20	20	40
Cotton	-	35	35
Sesame	-	25	25
Forage	20	-	20
Total	60	100	160

This pattern is illustrated in Figure 18.2, which shows that despite an overall intensity of 160%, there will be adequate time between crops to allow for land preparation and other farm operations. Also, the pattern can still be achieved within the constraint of water availabilty. The gu season cropping intensity requiring full irrigation is only 40%, which is less than the assumed limit of 50% (see Section 18.3). It comprises a major proportion of the two highest value crops (rice and cotton) but still contains sufficient proportions of maize and sesame required for domestic consumption. The labour requirements for pattern A are given in Figure 18.3, which indicates that available labour will be sufficient to cope with peak demands. Labour requirements for houseplots are not included as these are to be cultivated during spare time or by other family members.

From data presented in Section 18.6, the total gross margin from arable crops (excluding forage) is estimated to be So.Shs. 2 940 to 3 780/ha.

18.8.2 Cropping Pattern B

This pattern has been presented as an alternative if cotton is to be excluded for reasons of Government policy in favour of its development elsewhere in Somalia. Groundnuts are included as labour constraints prevent any expansion of rice production. Composition of pattern B is as follows:-

	Cropping intensity per season (%)		
Crop	Gu	Der	Total
Maize	20	30	50
Rice	20	20	40
Groundnuts	-	25	25
Sesame	-	25	25
Forage	20	-	20
Total	60	100	160

This pattern is illustrated in Figure 18.4, together with estimated labour requirements. Labour requirements are fairly constant for most of the year, apart from a high peak in October, and should be easily met by the estimated available labour.

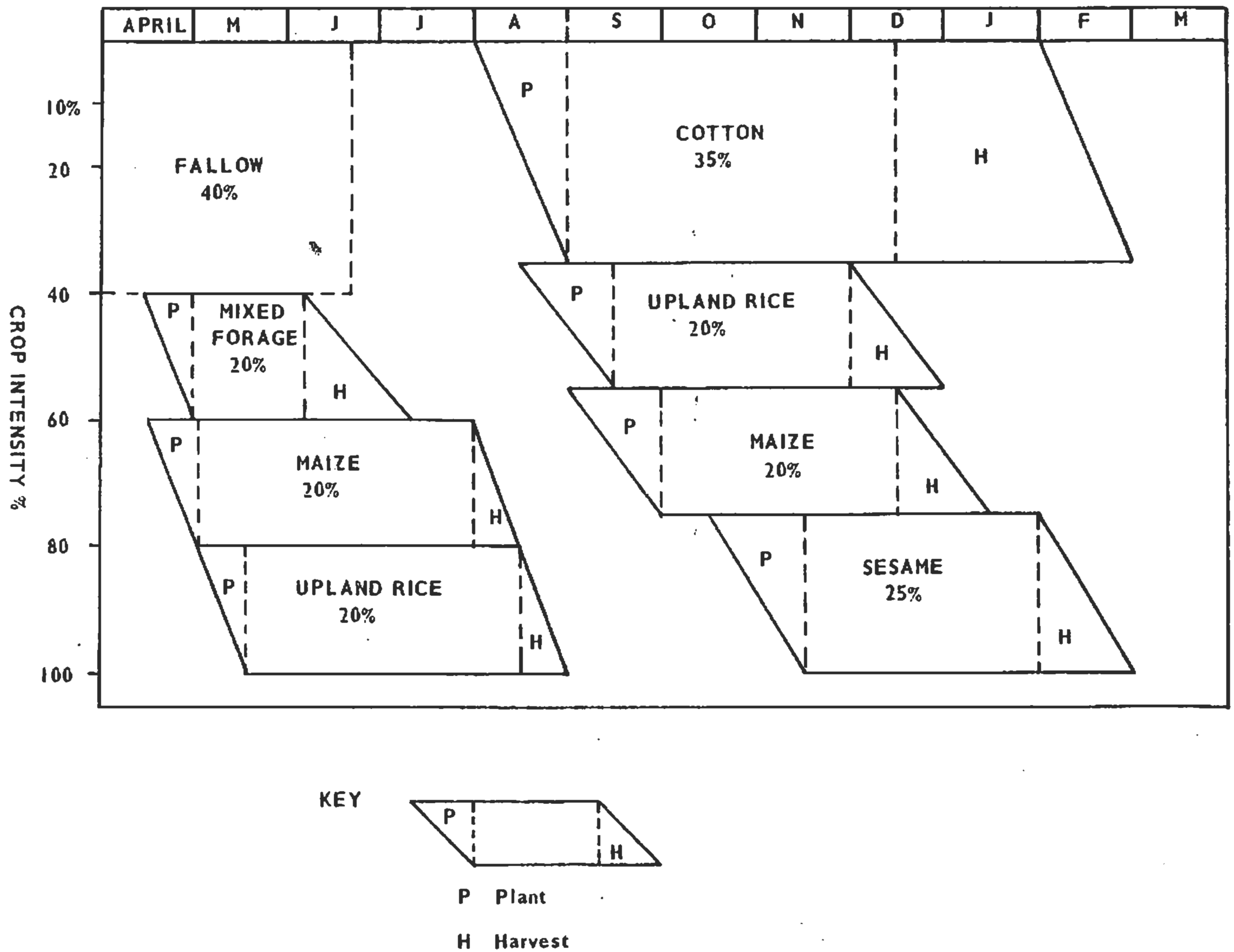
The total gross margin of pattern B, excluding forage, would be approximately So.Shs. 2 470 to 3 200/ha.

18.8.3 Cropping Pattern C

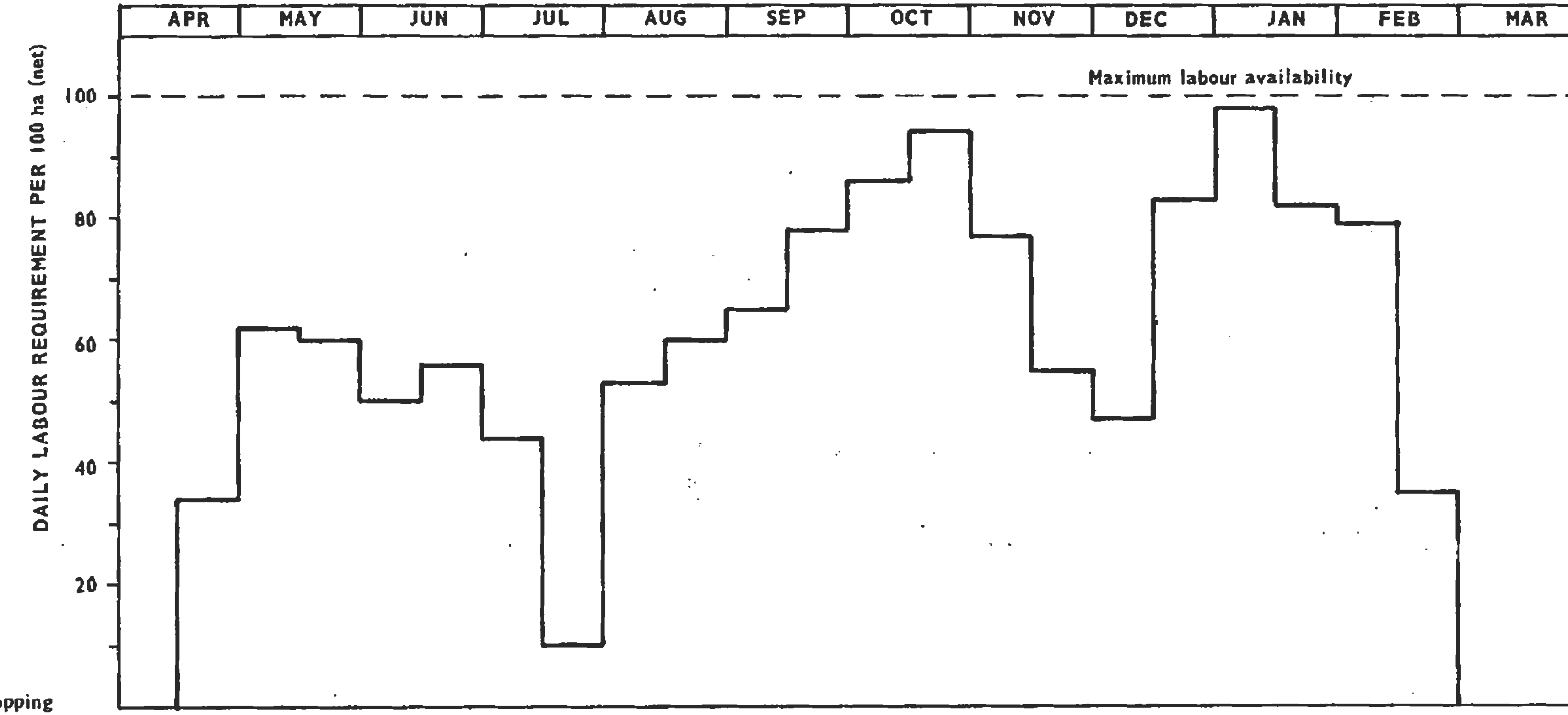
In this pattern, rice is excluded. Therefore cotton, being the only other high value crop, is included to the maximum possible extent given present labour availability. The composition of this pattern is as follows:-

FIGURE 18.2

CROPPING PATTERN A



CROPPING PATTERN A; MONTHLY LABOUR REQUIREMENTS



Daily labour requirements at selected cropping intensity

CROP		Cropping intensity (%)	APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		JAN		FEB		MAR	
MAIZE	GU	20	–	17	29	26	26	9	9	4	22	6	–													
	DER	20										–	17	27	27	26	17	9	6	15	15	–				
RICE	GU	20		–	6	7	8	24	20	6	6	8	–													
	DER	20									–	6	7	7	20	26	13	6	8	2	–					
COTTON	DER	35								–	25	40	41	44	34	27	22	13	13	53	76	61	48	22	–	
FORAGE	GU	20	–	17	27	27	16	23	15	–																
SESAME	DER	25												–	5	15	25	27	20	13	7	21	31	13	–	
TOTAL			–	34	62	60	50	56	44	10	53	60	65	78	86	94	77	55	47	83	98	82	79	35	–	–

Source:- Appendix D, Table 18.3 and Figure 18.2

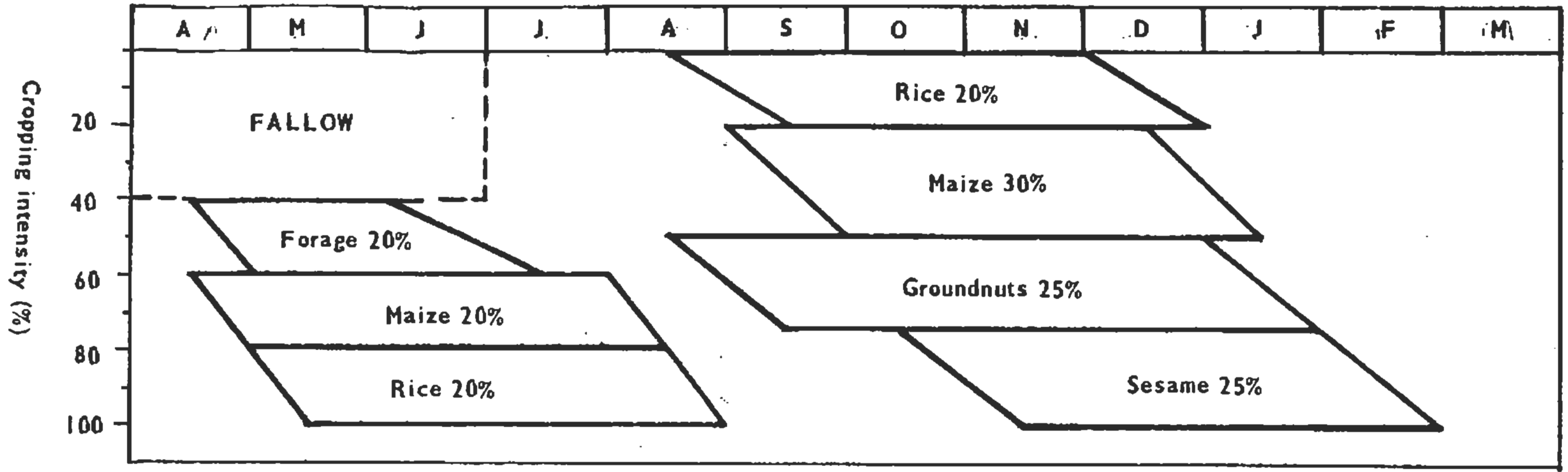
Notes:- Excludes bird - scaring for rice

Maximum labour availability assumes 2 working persons per household family and 2 ha per family i.e. 100 working persons per 100 ha (net)

FIGURE 18.3

FIGURE 18.4

CROPPING PATTERN B: CROPPING CALENDAR AND MONTHLY LABOUR REQUIREMENTS



Daily labour requirements at selected cropping intensity

Crop	Cropping intensity	A		M		J		J		A		S		O		N		D		J		F		M	
Maize	Gu 20	–	17	29	26	26	9	9	4	22	6	–													
	Der 30										–	25	40	41	38	26	13	10	22	22	–				
Rice	Gu 20		–	6	7	8	24	20	6	6	8	–													
	Der 20									–	6	7	7	20	26	13	6	8	2	–					
Forage	Gu 20	–	17	27	27	16	23	15	–																
Groundnuts	Der 25									–	25	35	25	28	28	22	15	11	36	35	3	–			
Sesame	Der 25												–	5	15	25	27	20	13	7	21	31	13	–	
Total requirement per 100 ha (net)		–	34	62	60	50	56	44	10	28	45	67	72	94	107	86	61	49	73	64	24	31	13	–	
Maximum available Labour		← 100 →																							

Source:- Appendix D and Table 18.3
Notes:- See Figure 18.3 foot notes

Crop	Cropping intensity per season (%) Gu	Der	Total
Maize	40	25	65
Cotton	-	50	50
Sesame	-	25	25
Forage	20	-	20
Total	60	100	160

Crop growing seasons and labour requirements are shown in Figure 18.5. Assuming a 6 hour working day for cotton-picking during January, no labour constraints are envisaged. However, with the basic 4 hour working day, assumed throughout this study, requirement does exceed available labour.

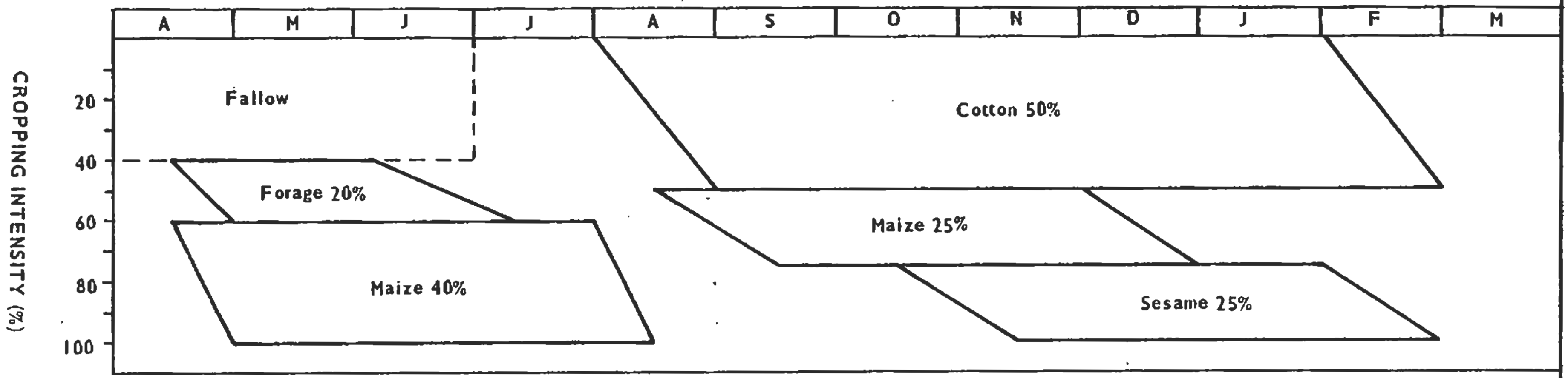
This is not likely to be a serious limitation. Picking can easily be achieved by either the greater use of children, extending the picking period (there is no rainfall risk) or working longer days.

The total gross margin of this pattern, excluding forage, will amount to So.Shs. 2 510 to 3 310/ha.

18.9 Conclusions

All three proposed cropping patterns are considered feasible for the Qoryooley project. Financially, pattern A appears the most attractive and is selected as the basis for farm unit development. Gross margins were determined excluding forage and the final decision to include the recommended intensity of forage production (20%) will depend on the farming co-operatives on each farm unit. This is discussed fully in Annex V (Livestock). However, estimations of project water and equipment requirements presented in the next few chapters includes requirements for forage production in order to cover its full production. Using cropping pattern A, the net areas per crop per farm unit at full development are presented in Table 18.4.

CROPPING PATTERN C;
CROPPING CALENDAR AND DAILY LABOUR REQUIREMENTS



Daily labour requirements at selected cropping intensity

			A		M		J		J		A		S		O		N		D		J		F		M
Maize	Gu	40	–	35	58	52	52	19	18	8	43	11													
	Der	25									–	21	33	34	32	21	11	8	19	19	–				
Cotton	Der	50								–	36	57	59	63	49	39	32	18	18	76	108	88	68	32	–
Forage	Gu	20	–	17	27	27	16	23	15	–															
Sesame	Der	25												–	5	15	25	27	20	13	7	21	31	13	–
Total requirement per 100 ha (net)			–	52	85	79	68	42	34	8	79	89	92	97	86	75	68	53	57	108	115	109	99	45	–
Maximum available labour			100																						

Source: Appendix D and Table 18.3

Notes: See Figure 18.3 foot notes

FIGURE 18.5

TABLE 18.4

Farm Unit Net Cropped Areas: Cropping Pattern A

Crop	Cropping intensity per year (%)	NCA per farm unit per year (ha)							
		Murale	Tawakal	Garas Guul	Shamaan	Tugarey	Nimcooley	Gayweerow	Jasiira
Maize	40	138	200	198	156	180	98	228	234
Rice	40	138	200	198	156	180	98	228	234
Forage	20	69	100	99	78	90	49	114	117
Cotton	35	121	175	174	136	158	86	200	204
Sesame	25	86	125	124	97	113	62	143	146
TOTAL	160	552	800	793	623	721	393	913	935

CHAPTER 19

IRRIGATION REQUIREMENTS

19.1 Introduction

Having selected specific cropping patterns for the project (discussed in the preceding chapter), it is necessary to determine water requirements at full cropping as well as the probable irrigation frequencies for each crop. All data used have been extracted from Chapter 2 (Crop Water Requirements). Three cropping patterns have been put forward and the most suitable (pattern A) selected. Water requirement calculations are based on this pattern. Data presented in Chapter 2 on crop water requirements assumed a median or optimum planting date for each crop and cropping season. In order to obtain a more accurate assessment for project requirements, further data have been calculated to cover the range of plantings proposed for each crop. For example, for the der season, planting of each crop is planned to cover 30 days.

19.2 Net Irrigation Requirements

Mean monthly crop coefficients for the five annual crops and miscellaneous vegetables included in cropping pattern A are given in Table 19.1. Values for miscellaneous crops are used in order to determine water requirements for the proposed houseplots to be established on each farm unit. Crop consumptive use is given in Table 19.2, monthly effective rainfall in Table 19.3 and net irrigation requirements in Table 19.4.

From Table 19.4, it can be seen that, in each season, the irrigation requirements for each crop vary only slightly over the assumed range of planting dates.

Using the net irrigation requirements (Table 19.4) and the cropping intensities given in cropping pattern A, the net water requirements can be calculated. These are given in Table 19.5 for field crops and Table 19.6 for miscellaneous crops (houseplots). From these tables the net water requirements for the whole project may be calculated. This has been done in Table 19.7.

19.3 Irrigation Intervals

Calculation of irrigation intervals is based on the estimated readily available moisture (RAM) in the soil and the net irrigation requirement. RAM is calculated from the total available soil moisture (as a percentage value), the permissible depletion and root depth. However, due to limited infiltration rates, the net application per irrigation (60 mm of water) is substituted for a greater RAM value when calculating irrigation intervals.

This method is also applicable during early growth stages until the maximum root depth is reached. Estimated growth times to maximum root depth for selected crops are given in Table 2.13. However, during these early stages, several other factors must be considered.

TABLE 19.1

Qoryooley Project : Mean Monthly Crop Coefficients

Season	Crop	Planting date	M	A	M	J	J	A	S	O	N	D	J	F
Gu:	Maize	April 15th		0.30	0.75	1.05	0.90	0.40						
		April 30th			0.65	0.95	1.05							
	Forage	April 15th		0.30	0.75	0.05								
		April 30th			0.65	0.95								
	Upland rice	May 1st			0.95	1.10	1.10	0.05						
		May 15th			0.45	1.05	1.10	1.05						
Der:	Maize	Sept. 1st							0.30	0.90	1.05	0.40		
		Sept. 15th							0.15	0.55	1.05	0.90		
		Sept. 30th								0.30	0.90	1.05	0.40	
	Upland rice	Aug. 15th						0.45	1.05	1.10	1.05			
		Sept. 1st							0.95	1.10	1.10	0.50		
		Sept. 15th							0.45	1.05	1.10	1.05		
	Cotton	Aug. 1st						0.25	0.55	1.00	1.05	1.00	0.80	
		Aug. 15th						0.15	0.35	0.85	1.05	1.05	0.90	0.35
		Aug. 30th							0.25	0.55	1.00	1.05	1.00	0.80
	Sesame	Oct. 15th								0.15	0.50	1.05	0.40	
		Oct. 30th									0.25	0.90	0.90	
		Nov. 15th									0.15	0.50	1.05	0.40
	Misc. crops(1)	May 1st-Dec. 1st	-	-	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.40	-

Note: (1) Vegetables and minor crops grown in houseplots

Source: Chapter 2

TABLE 19.2

Qoryooley Project : Monthly Crop Consumptive Use (mm)

Season	Crop	Planting date	M	A	M	J	J	A	S	O	N	D	J	F	Total
		ET_o (1)	6.22	5.57	5.13	4.69	4.63	5.01	5.62	5.25	4.69	4.99	5.53	5.98	
Gu:	Maize	April 15th		50	119	140	129								446
		April 30th			103	134	151	60							448
	Forage	April 15th		50	119	70									239
		April 30th			103	134									237
	Upland rice	May 1st			151	155	158	75							539
		May 15th			72	148	158	158							536
Der:	Maize	Sept. 1st							51	146	148	62			407
		Sept. 15th							25	90	148	139			402
		Sept. 30th								49	127	162	69		407
	Upland rice	Aug. 15th						68	177	179	148				572
		Aug. 30th							160	179	155	77			571
		Sept. 15th							76	171	155	162			564
	Cotton	Aug. 1st						38	93	163	148	155	137		734
		Aug. 15th						23	59	138	148	162	154	59	743
		Aug. 30th							42	90	141	162	171	134	740
	Sesame	Oct. 15th								24	70	162	69		325
		Oct. 30th									35	139	154		328
		Nov. 15th									21	77	180	69	347
	Misc. crop	May 1st-Dec. 1st.			127	113	115	124	135	130	113	124	69	-	1 050

Note: (1) Reference crop evapotranspiration (mm/day)

Source: Chapter 2 and Table 19.1

TABLE 19.3

Qoryooley Project : Monthly Effective Rainfall (mm)

Season	Crop	Planting date	M	A	M	J	J	A	S	O	N	D	J	F	Total
Gu:	Maize	April 15th		50	38	44	29								161
		April 30th			37	43	30	22							132
	Forage	April 15th		50	38	38									126
		April 30th			37	43									80
	Upland rice	May 1st			41	44	30	23							138
		May 15th			36	44	30	26							136
Der:	Maize	Sept. 1st							10	18	29	12			69
		Sept. 15th							9	16	29	14			68
		Sept. 30th								15	28	15	1		59
	Upland rice	Aug. 15th						23	13	20	29				85
		Aug. 30th							13	20	29	13			75
		Sept. 15th							11	19	29	15			74
	Cotton	Aug. 1st						21	11	19	29	15	1		96
		Aug. 15th						20	10	18	29	15	1	0	93
		Aug. 30th							9	16	28	15	1	0	69
	Sesame	Oct. 15th								14	25	15	1		55
		Oct. 30th									23	14	1		38
		Nov. 15th									22	13	1	0	36
	Misc. crops(1)	May 1st- Dec. 1st	-	-	38	41	29	25	11	17	27	14	1	-	203

Note: (1) Mean monthly rainfall (mm) at 75% probability

TABLE 19.4

Qoryooley Project : Monthly Net Irrigation Requirements (mm) (1)

Season	Crop	Planting date	M	A	M	J	J	A	S	O	N	D	J	F	Total
Gu:	Maize	April 15th		0	81	104	100								285
		April 30th			66	91	121	38							316
	Forage	April 15th		0	81	32									113
		April 30th			66	91									157
	Upland rice	May 1st			110	111	128	52							401
		May 15th			36	104	128	132							400
Der:	Maize	Sept. 1st							41	128	119	50			338
		Sept. 15th							16	74	119	125			334
		Sept. 30th								34	99	147	68		348
	Upland rice	Aug. 15th						45	164	159	119				487
		Aug. 30th							147	159	126	64			496
		Sept. 15th							65	152	126	147			490
	Cotton	Aug. 1st						17	82	144	119	140	136		638
		Aug. 15th						3	49	120	119	147	153	59	650
		Aug. 30th							33	74	113	147	170	134	671
	Sesame	Oct. 15th								10	45	147	68		270
		Oct. 30th									12	125	153		290
		Nov. 15th									0	64	179	69	312
	Misc.	May 1st-Dec. 1st		-	89	72	86	99	124	113	86	110	68	-	847

Note: (1) The net irrigation requirements are the gross crop water requirements in mm less effective rainfall. The monthly requirement is weighted to allow for the spread of the planting season.

Source: Tables 19.2 and 19.3

TABLE 19.5

Goryooley Project Water Requirements:

Monthly Net Water Requirement for Cropping Pattern A(1)

Season	Crop	Cropping Intensity (%)	Planting date	NCA (ha)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total(1)
Gu:	Maize	20	April 15th	1.0		0	0.81	1.04	1.00								2.85
			April 30th	1.0			0.66	0.91	1.21	0.38							3.16
	Forage	20	April 15th	1.0		0	0.81	0.32									1.13
			April 30th	1.0			0.66	0.91									1.57
	Upland rice	20	May 1st	1.0			1.10	1.11	1.20	0.52							4.01
			May 15th	1.0			0.36	1.04	1.28	1.32							4.00
Sub-total		60		6.0			4.40	5.33	4.77	2.22							16.72
Der:	Maize	20	Sept 1st	0.67							0.27	0.85	0.79	0.33			2.24
			Sept 15th	0.67							0.11	0.49	0.79	0.83			2.22
			Sept 30th	0.67								0.23	0.66	0.98	0.45		2.32
	Upland rice	20	Aug 15th	0.67						0.30	1.09	1.06	0.79				3.24
			Aug 30th	0.67							0.98	1.06	0.84	0.43			3.31
			Sept 1st	0.67							0.43	1.01	0.84	0.98			3.26
	Cotton	35	Aug 1st	1.17						0.20	0.96	1.68	1.39	1.63	1.59		7.45
			Aug 15th	1.17						0.03	0.57	1.40	1.39	1.71	1.78	0.69	7.57
			Aug 30th	1.17							0.38	0.86	1.32	1.71	1.98	1.56	7.81
	Sesame	25	Oct 15th	0.83								0.08	0.38	1.23	0.57		2.26
			Oct 30th	0.83									0.10	1.04	1.28		2.42
			Nov 15th	0.83									0	0.53	1.49	0.58	2.60
Sub-total		100		10.0						0.53	4.79	8.72	9.29	11.40	9.14	2.83	46.70
TOTAL		160		16.0			4.40	5.33	4.77	2.75	4.79	8.72	9.29	11.40	9.14	2.83	6:.42

Notes: (1) $\frac{\text{Net irrigation requirement} \times \text{NCA per crop}}{100}$ = net water requirement (10^3 m^3 per month) per 10 ha net with cropping pattern A.

(2) Does not include field application efficiency

(3) For irrigation requirements see Annex VII, Table 5.5

Source: Figure 18.2 and Table 19.4

TABLE 19.6

Qoryooley Project: Monthly Net Water Requirements for Houseplots(1)

Season	Crop	Planting date	NCA (ha)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total(1)
Gu and Der	Misc. crops	May 1st - Dec 1st	10	-	-	8.90	7.20	8.60	9.90	12.40	11.30	8.60	11.00	6.80	-	84.70

Note: (1) Net requirement for 10 ha of houseplots

Source: Table 19.4

TABLE 19.7

Qoryooley Project: Monthly Net Water Requirements per 100 ha

Cropping	NCA(1) (ha)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Field crops	93.6	-	-	41.20	49.90	44.66	25.75	44.85	81.65	86.98	106.74	85.78	26.50	594.01
Houseplots	6.4	-	-	5.67	4.59	5.48	6.31	7.90	7.20	5.48	7.01	4.33	-	53.97
TOTAL	100.0	-	-	46.87	54.49	50.14	32.06	52.75	88.85	92.46	113.75	90.11	26.50	647.98

Note: (1) Based on project NCA (3 963.5 ha) and total net area of houseplots (253 ha) given in Table 17.4; i.e. 93.6% field crops and 6.4% houseplots per farm unit.

Source: Tables 19.5 and 19.6

(a) Irrigation during early stages must be more frequent than theoretically required in order to bring the soil up to field capacity at the maximum root depth. This is necessary to enable full leaching to take place as only limited deep percolation in the heavy soils will be possible. Also, once field capacity is reached and re-established at each subsequent irrigation, the final irrigation can be made earlier as maturing crops are allowed a greater depletion of soil moisture.

(b) Assumed rooting depths during early growth are greater than actual root depth. During early stages, the net irrigation requirement is largely a measure of surface evaporation rather than crop transpiration. Consequently, a certain amount of unavoidable capillary rise will occur drawing water from a greater depth back into the actual root zone of the developing crop, thereby creating a greater "effective" root depth.

(c) During the first few weeks of growth, when assumed rooting depths are less than 300 mm, a higher value for total available moisture has been used. Results given in Annex II for selected Project Area soils (e.g. Qoryooley, Saruda soils) indicate an average total available moisture for the first 250 mm to be about 25%. For full root depths, the average 20% value is taken.

For most of the RAM calculations, permissible soil moisture depletion, which will not affect final yields, is assumed to be 50% of the total available moisture at the assumed root depth. Exceptions are as follows:-

(a) For upland rice, a lower value of 40% is taken until onset of maturation because of this crop's greater susceptibility to drought.

(b) For maize, only 40% per cent depletion is taken during the crucial stage of tasselling and seed set.

(c) During late growth stages and final maturation, permissible moisture depletion can increase gradually up to 80%. During the final 7 to 10 days, available moisture is not critical.

Estimated irrigation intervals for the crops included in cropping pattern A, and data used to calculate these intervals, are given in Appendix F and summarised in Table 19.8. Median planting dates and full irrigation availability have been assumed. It is also assumed that at the onset of irrigation, the soil is at least at permanent wilting point which is brought about by seasonal rainfall in April, for gu crops, and July to September for der crops. The following conclusions can, therefore, be made:-

(a) Maize requires at least six irrigations but no irrigations after 75 days are necessary.

(b) Forage needs only three quick irrigations within a period of 25 days. Assuming a planting date of mid-April, these irrigations will be in May which is the only month when full irrigation availability is predicted in the gu season.

TABLE 19.8

Cropping Pattern A: Irrigation Intervals - Gu Season

(a) Maize

Planting date = April 15th
Total available moisture at full root depth (AWC) = 160 mm

Irrigation	1		2		3		4		5		6	
Days from planting	15		25		35		45		60		75	
Net application (mm)	60		60		60		58		52		52	
Consumption (mm)		26		26		26		52		52		96
Residual moisture (mm) (2)		34		68		102		108		108		64
AWC (mm)	60		94		128		160		160		160	
RAM (mm) (1)		50		60		60		60		60		128

(b) Upland Rice

Planting date = May 1st
Maximum AWC = 90 mm

Irrigation	1		2		3		4		5		6		7		8		9		10		11	
Days from planting	0		6		12		19		28		37		47		57		66		75		84	
Net application (mm)	60		51		21		25		32		33		37		37		36		37		37	
Consumption (mm)		21		21		25		32		33		37		37		36		37		37		74
Residual moisture (mm) (2)		39		69		65		58		57		53		53		54		54		54		16
AWC (mm)	60		90		90		90		90		90		90		90		90		90		90	
RAM (mm) (1)		20		20		24		32		32		36		36		36		36		36		72

(c) Mixed Forage

Planting date = April 15th
Maximum AWC = 150 mm

Irrigation	1		2		3	
Days from planting	15		25		40	
Net application (mm)	60		60		60	
Consumption (mm)		26		44		45
Residual moisture (mm) (2)		34		50		65
AWC (mm)	60		94		110	
RAM (mm) (1)		50		70		80

TABLE 19.8 (cont.)

Cropping Pattern A: Irrigation Intervals - Der Season

(a) Maize

Planting date = September 15th
Maximum AWC = 160 mm

Irrigation	1		2		3		4		5		6	
Days from planting	0		10		20		40		55		70	
Net application (mm)	60		60		60		57		46		60	
Consumption (mm)		11		18		48		46		60		140
Residual moisture (mm) (2)		49		91		103		114		100		20
AWC (mm)	60		109		151		160		160		601	
RAM (mm) (1)		25		40		60		60		60		128

(b) Upland Rice

Planting date = September 1st
Maximum AWC = 90 mm

Irrigation	1		2		3		4		5		6		7		8		9		10		11		12		13		14		15	
Days from planting	0		4		8		12		17		22		29		36		43		50		57		65		74		83		90	
Net application (mm)	60		50		20		20		25		25		34		37		37		37		37		36		38		38		29	
Consumption (mm)		20		20		20		25		25		34		37		37		37		37		36		38		38		29		62
Residual moisture (mm)(2)		40		70		70		65		65		56		53		53		53		53		54		52		52		61		28
AWC (mm)	60		90		90		90		90		90		90		90		90		90		90		90		90		90		90	
RAM (mm) (1)		20		20		20		24		24		32		36		36		36		36		36		36		36		36		72

TABLE 19.8 (cont.)

Cropping Pattern A: Irrigation Intervals - Der Season (cont.)

(c) Sesame

Planting date = November 1st
Maximum AWC = 160 mm

Irrigation	Pre-planting		1		2		3		4	
Days from planting	-		0		35		50		64	
Net application (mm)	100		60		44		60		60	
Consumption (mm)		-		44		60		60		127
Residual moisture (mm) (2)		100		116		100		100		33
AWC (mm)	100		160		160		160		160	
RAM (mm) (1)		-		60		60		60		128

(d) Cotton

Planting date = August 15th
Maximum AWC = 200 mm

Irrigation	1		2		3		4		5		6		7		8		9		10	
Days from planting	0		15		30		45		60		75		90		105		118		131	
Net application (mm)	60		60		60		60		60		60		60		60		60		60	
Consumption (mm)		3		24		24		60		60		60		60		62		62		183-222
Residual moisture (mm) (2)		57		103		139		139		139		139		139		137		135		0-12
AWC (mm)	60		127		163		199		199		199		199		199		197		195	
RAM (mm) (1)		30		60		60		60		60		60		60		60		60		160-200

Notes: (1) RAM (readily available moisture in mm) or maximum net irrigation application (60 mm) whichever is the lesser, except after final irrigation.

(2) Residual moisture (mm) as balance between consumption and AWC after preceding irrigation.

Source: Appendix F

(c) Upland rice requires many light irrigations at intervals ranging from 4 to 10 days as a result of its shallow rooting depth.

(d) Sesame requires several irrigations during the period of maximum flowering. However, this assumes the application of 160 mm (net) before and at planting in order to avoid irrigating during susceptible early growth stages.

(e) Cotton requires steady irrigation until approximately 130 days after planting.

However, these estimates, although shown in detail, can only act as an accurate guide. Further field research is necessary for confirmation or modification particularly to assess requirements for upland rice and cotton. Research must investigate:-

(a) Surface infiltration in order to assess if larger net applications per irrigation are possible.

(b) Permissible soil moisture depletion during crop growth. The generally accepted level is 60% and not the assumed 50%.

(c) The effect of rainfall on required irrigation.

19.4 Field Water Requirements

Net water requirements given in Table 19.7 are crop requirements based on calculated crop water consumption. However, net field requirements depend on the irrigation period over which the net water requirement must be applied. Consequently from the information in Appendix F and with the given planting dates for each crop, net field requirements per month will differ slightly from the monthly net water requirements. The greatest difference will be for der season crops. With correct planting dates, final irrigations will be applied in early January. Therefore, the net water requirements for February and most of January will have been applied in the previous months.

CHAPTER 20

FARM EQUIPMENT REQUIREMENTS

20.1 Field Machinery

Mechanisation of proposed crop production in the Study Area is discussed in Chapter 3, which concluded that the degree of mechanisation required depends on labour availability. In Chapter 18, no labour shortages were predicted for any of the three proposed cropping patterns for the Qoryooley project. Consequently, as predicted in Chapter 3, mechanisation is only needed for:-

(a) land preparation

(b) field re-levelling

(c) carting of harvested grain and produce

(d) rice drilling and combine harvesting

(e) post-harvest operations for cotton.

Actual machinery requirements for the project were estimated in the same way that labour requirements were assessed. Using cropping pattern A, requirements per 100 ha (net) are presented in Table 20.1. These also include general land preparation requirements in the jilal season prior to gu season crops (60% intensity) and regular cultivation of the gu fallow (40%) in order to control weeds. With the given cropping calendar for cropping pattern A (Figure 18.2) and the timing of recommended mechanised operations (Chapter 3), an operational calendar can be prepared. This is presented in Figure 20.1, together with estimated daily tractor and combine harvester requirements. All data used are based on 8 hours per day for tractors and 10 hours per day for combine harvesters. With the information given in Figure 20.1, estimated requirements for tractor-drawn implements and combine harvesters can then be made. These are given in Appendix G and summarised in Table 20.2. Unfortunately, on the smaller farm units, some equipment will be under-utilised as they will need at least one implement or set of attachments. This is particularly the case with combine harvesters. Therefore, there is plenty of scope for sharing equipment between two adjacent farm units.

To estimate the number of tractors needed, requirements for carting must also be assessed. This is done for each crop by using the following general equation:-

$$\frac{\text{Farm unit NCA x cropping intensity x yield/ha x cycle time}}{\text{Harvest period x 8 working hours/day x trailer capacity}} = y$$

TABLE 20.1

Machinery Requirements per 100 ha NCA: Field Operations

Operation	Hours/ ha	Hours/ 100 ha	Days/ (1) 100 ha	Operation (2) period	Equipment per day per 100 ha NCA Cropping intensity (3) 20%	25%	35%	40%	60%
Post-harvest cultivation	0.95	95	11.9	15	0.16	-	-	-	-
				30	0.08	0.10	0.14	-	-
				35	0.07	-	-	-	-
Ridging (a) 80 cm	0.89	89	11.1	15	0.15	-	-	-	-
				30	0.08	-	0.13	-	-
(b) 60 cm	0.95	95	11.9	30	-	0.10	-	-	-
Bunds and laterals	0.18	18	2.3	15	0.03	-	-	-	-
				30	0.02	-	-	-	-
Pre-planting cultivation	0.68	68	8.5	15	0.11	-	-	-	-
				30	0.06	-	-	-	-
Drilling rice	1.20	120	15.0	15	0.20	-	-	-	-
				30	0.10	-	-	-	-
Uprooting cotton	1.49	149	18.6	30	-	-	0.22	-	-
Raking cotton trash	0.95	95	11.9	30	-	-	0.14	-	-
General land preparation:									
Ploughing (jilal)	2.65	265	33.1	60	-	-	-	-	0.33
Harrowing	0.95	95	11.9	30	-	-	-	-	0.24
Field re-levelling	0.74	74	9.3	35	-	-	-	-	0.16
Gu fallow cultivation	0.68	68	8.5	20	-	-	-	0.17	-
Combine harvesting	1.23	123	12.3	15	0.16	-	-	-	-
				30	0.8	-	-	-	-

Notes: (1) 8 hours/day (tractors) and 10 hours/day (combines)

(2) 15 days (gu), 30 days (der), 35 days for harvesting forage and 20 to 60 days for general operations

(3) 20 to 35% (crops), 40% (gu fallow), 60% (gu season cropping)

Source: Chapter 3 and Figure 18.2

The actual trailer requirement will be (1 + y) because one unit will be travelling between the field and farm unit HQ whilst harvesting and loading continues in the field. For each farm unit, the average distance to the farm HQ is estimated at 3 km.

With loading and unloading, the cycle time is therefore estimated as 1.2 hours per tractor/trailer unit or 0.85 hour excluding loading in the field. Consequently, tractor requirements for carting do not depend on estimated trailer requirements. For example, if 1.3 trailers are the calculated requirement, only one tractor but two trailers are needed as the tractor will return to the field before the second trailer is fully loaded. However, if 1.8 trailers are needed, two tractors and two trailers are necessary. Several calculated examples are shown in Table 20.3. In general, for all farm units, only one or two tractors and one to three trailers will be required for carting. However, for the gu season forage with an estimated Year 4 yield of 65 t/ha (fresh weight), three to five tractors and four to six trailers are needed for each farm unit. With this information and the cropping calendar used for Figure 20.1 an operational calendar for produce carting can be made. This is given in Figure 20.2 which also gives details of estimated requirements for each farm unit.

TABLE 20.2

Combine Harvester and Tractor-drawn Equipment Requirements

	Maximum daily requirements	Requirement per farm unit[1]
NCA field crops (ha)	100	246 - 584
Combine harvester	0.16	1
Plough, rice drill land levels, rakes	0.14 - 0.20	1
Tool-bars	0.47	1 - 3
Tool-bar attachments	0.03 - 0.33	1 - 2
Disc harrow	0.24	1 - 2

Note: (1) Minimum requirement is one, whereas the theoretical requirement is often less.

Source: Figure 20.1

TABLE 20.3

Carting Requirements for Crop Harvests: Maize and Cotton

Crop	Maize		Cotton	
Produce	Cobs	Stover	Pick 1 or 3	Pick 2
Season	Gu	Gu	Der	Der
Yield/ha (1) (q)	50 (2)	35	4.5	11
Trailer capacity (q)	50	30	15	15
Harvest period (days)	15	20	30	30
Cropping intensity (%) (3)	20	20	35	35
Cycle time (h)	1.2	1.2	1.2	1.2
Trailer requirements per farm unit (246-584 ha NCA field crops)	1.5 - 2.2	1.4 - 2.0	1.1 - 1.3	1.3 - 1.8
Estimated trailer required per farm unit	2 - 3	2	1 - 2	2
Estimated tractor required for carting	1 - 2	1 - 2	1	1 - 2

Notes: (1) Year 4 projected yields

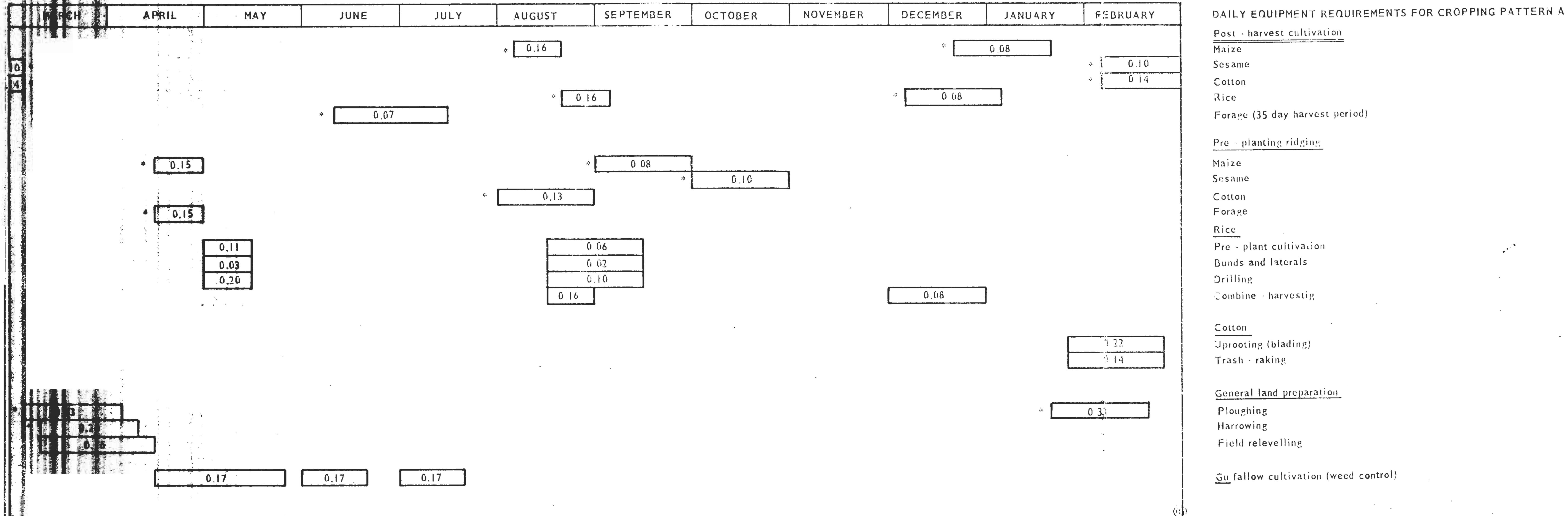
(2) 35 q/ha shelled

(3) Cropping pattern A

By cross-checking data per farm unit to be found in Figures 20.1 and 20.2, full tractor requirements are obtained. Operations to be carried out by 70 hp tractors are also indicated in Figure 20.1 and once farm unit requirements are estimated, the number of 60 hp tractors needed is obtained by difference. Estimated tractor requirements are summarised in Table 20.4, and it can be seen clearly that there will be adequate slack periods during the year to allow plenty of time for servicing and maintenance work. From Figure 20.2, each farm unit also needs six to eight 5 tonne trailers. As all crops, except rice, are to be hand harvested, only basic trailers are needed. Locally made high sides can increase their capacity when handling bulky crops such as cotton. However, at least one trailer should be a tipping model to cover any minor emergencies.

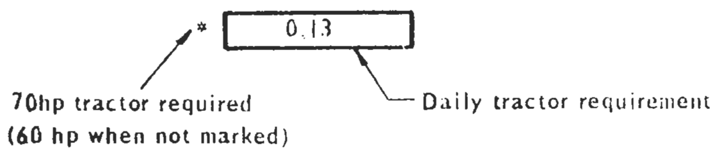
FIGURE [illegible]

MACHINERY OPERATIONAL CALENDAR AND REQUIREMENTS PER 100 ha N.C.A. (field operations)



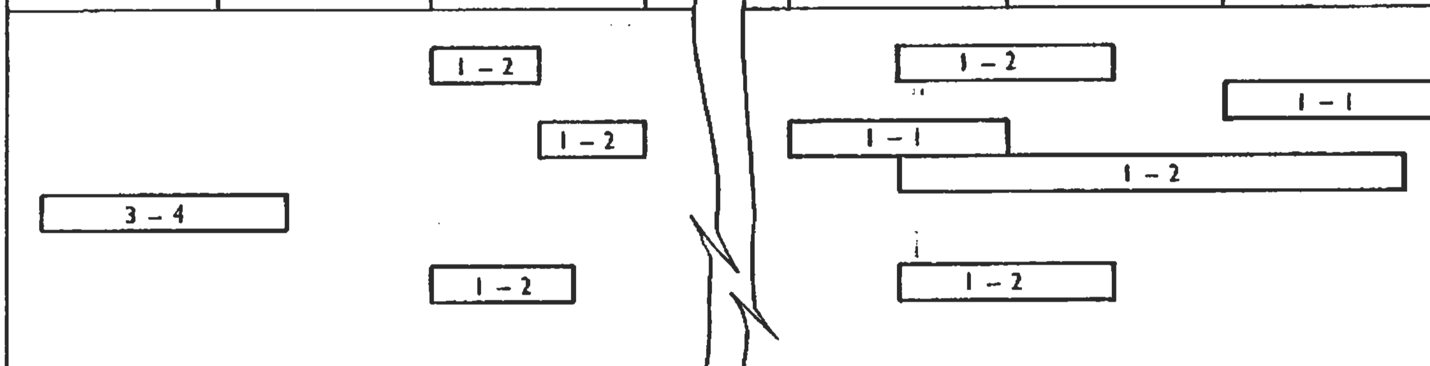
	March		April		May		June		July		August		September		October		November		December		January		February		
	[illegible]	0.73	0.43	0.47	0.56	0.11	0.19	0.13	0.24	0.06	0.24	0.49	0.33	0.08	0.10	0.10	–	–	0.05	0.13	0.11	0.34	0.85	0.59	½ monthly mean daily tractor requirements per 100 ha N.C.A
	[illegible]	–	–	–	–	–	–	–	–	–	–	0.16	–	–	–	–	–	–	0.08	0.08	–	–	–	–	½ monthly mean daily combine harvester requirements per 100 ha N.C.A.
	[illegible]	[illegible]	1 – 3	2 – 3	2 – 4	1	1		1 – 2	1	1 – 2	1 – 3	1 – 2	1	1	1	–	–	1	1	1	1 – 2	2 – 5	2 – 3	Tractor requirement per farm unit (246 - 584 ha N.C.A. field areas)

KEY



OPERATIONAL CALENDAR; FIELD CROP PRODUCE CARTING

Farm units:- Murale (345.5 ha)
Shamaan (389.ha)



	JUNE	JULY		AUGUST			DECEMBER		JANUARY		FEBRUARY	
Total daily requirement Murale and Shamaan farm units	3 – 4	3 – 4	–	2 – 4	2 – 4		1 – 1	4 – 7	3 – 6	1 – 2	2 – 3	
Nimcooley farm unit	3 – 4	3 – 4	–	2 – 4	2 – 4		1 – 1	4 – 5	3 – 6	1 – 2	2 – 3	2 – 2
Tawakal, Garas Guul and Tugarey	4 – 5	4 – 5	–	4 – 4	3 – 4		1 – 1	4 – 7	3 – 6	1 – 2	2 – 3	
Jasiira, Gayweerow	5 – 6	5 – 6	–	4 – 5	3 – 4		1 – 2	4 – 8	3 – 6	1 – 2	2 – 3	

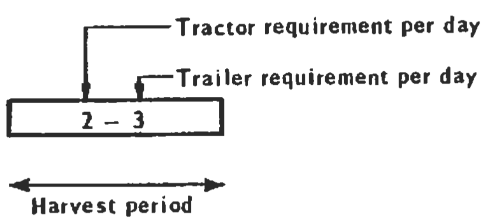


FIGURE 20.2

Estimated costs and field machinery needed for each farm unit are tabulated in Appendix G.

TABLE 20.4

Farm Unit Tractor Requirements

	Tractors		
Farm unit	70 hp	60 hp	Total
Nimcooley	1	3	4
Murale, Shamaan	2	3	5
Tugarey	2	4	6
Tawakal, Garas Guul	3	3	6
Gayweerow, Jasiira	3	4	7

Source: Figures 20.1 and 20.2

20.2 General Equipment

20.2.1 Spraying Equipment

ULVA microsprayers and Microhandy sprayers are needed for pest control in maize, rice and cotton and herbicide application in rice. Peak demand for ULVA microsprayers will be in September and October when three der season crops require spraying. From labour requirement calculations, it is estimated that 1 or 2 microsprayers per day per 100 ha (net) of field crops are needed during this period. This represents between 6 and 12 microsprayers per farm unit, including spares. For Microhandy sprayers, needed only for rice crops, only 3 or 4 sprayers per farm unit are necessary. Details per farm unit are given in Appendix G.

20.2.2 Maize Shellers and Grain Handling Equipment

Maize shelling can be carried out using the combine harvester required for the rice crops. Although normally considered wasteful use of such machinery, maize harvesting will take place outside this rice harvesting period. However, for several weeks during the der season harvests, separate maize shellers are necessary, such as the small Ransomes 'Cobmaster' (see Chapter 3). Assuming a 30 day harvest period, 20 ha of maize per 100 ha (net) of field crops per farm unit, and the Year 4 projected yield of 35 q/ha of shelled maize, a daily shelling capacity of about 25 quintals will be needed. This represents 60 to 150 q/day per farm unit. At an estimated 50 q/day output, only 2 or 3 shellers will be required at each farm unit.

After harvesting and any necessary shelling, threshing or storage, all seed cotton and grain will be handled in sacks. Requirements will be to cover:-

(a) storage of domestic supplies retained by farmers

(b) storing seed retained for planting purposes

(c) bagging surplus produce for sale to ADC.

At an estimated 8 sacks per family per year, approximately 400 sacks per 100 ha (net) per farm unit will be needed. At given seed rates, a further 80 sacks will also be necessary. This represents a requirement of about 1 200 to 3 000 sacks per farm unit and, assuming 10% annual losses, 120 to 300 sacks will be needed each year.

With given Year 4 projected yields, and at full project development, it is estimated that about 4 500 sacks per 100 ha (net) will be needed. With the estimated requirement for retained seed, about 4 000 sacks will be necessary for bagging surplus produce for every 100 ha (net). This means between an extra 10 000 and 24 000 sacks per farm unit will be required. Assuming 10% spare capacity to cover any contingencies, an estimated 190 000 sacks per year will be needed for the entire project to handle surplus produce.

Other grain handling equipment considered necessary is given below:-

(a) a small self-powered sack elevator and several sack trolleys to assist handling bagged grain before sale to ADC

(b) a portable scale to weigh produce, fertilisers, chemicals etc.

(c) a seed dressing drum for treating all planting materials.

Details per farm unit are given in Appendix G.

20.2.3 Miscellaneous Equipment

In order to replace the inefficient yambo, a selection of improved hand tools will be required (see Chapter 3) and numbers are estimated at 300 to 650 per farm unit. This assumes one tool per working person in each family plus a small number of spares.

During cotton harvesting, at the overlap of first and second pickings, an estimated 250 pickers per 100 ha (net) of cotton will be working. Consequently, about 260 to 620 cotton picking bags per farm unit will be necessary with annual replacements of about 30 to 60 bags per farm unit.

In order to supply clean water for spraying purposes or supplying drinking water to people in the field, several donkey-drawn carts should be available. As farm unit HQs will be within easy distance of fields, fuel bowsers are not considered necessary.

Each farm unit will also require a rear-mounted pto-driven cutter-bar mower for general weed control (see Chapter 22).

Details of miscellaneous equipment per farm unit are listed in Appendix G.

CHAPTER 21

FARM BUILDINGS

21.1 Introduction

Each farm unit will be provided with a general farm HQ area for the following purposes:-

(a) administration, records, accounts and management staff accommodation

(b) tractor servicing, maintenance and storage, including fuel

(c) fertiliser, chemical, equipment, and tool storage

(d) temporary grain storage

A typical farm unit HQ area layout is given in Figure 21.1. Details of proposed buildings and houses are given in Annex VII (Engineering).

The houses should, ideally, be situated on the eastern side. Prevailing winds would then prevent dust or smells from the working area reaching the houses. Likewise, the chemical and fertiliser store should be on the western side away from the main part of this area to minimise contamination. The small farm office is attached to the small workshop. This will allow full control over maintenance work and safe storage of spares and tools. Detailed requirements for storage and workshop areas are given below.

21.2 Grain Storage

In order to reduce costs and avoid under-utilisation of large storage buildings, covered storage areas have not been designed to hold the entire surplus production of each farm unit before any transportation off the farm. It is assumed that once harvesting starts in August and December, ADC trucks will make daily trips to each farm unit to transport most of the produce before harvesting is complete. Transport requirements are discussed in Chapter 24 and, on average, only 2 to 4 truck loads per day per farm unit will be necessary. For example, for gu season maize at 20% cropping intensity, a yield of 35 q/ha and harvested over 15 days, estimated daily production will be about 1 800 q for the whole project. Two to three truck loads per day will remove about 1 000 q. This will leave a balance of about 12 000 q of maize at the end of harvesting i.e. 1 500 q per farm unit. This balance will require temporary storage under cover for several weeks until ADC complete transportation to their depots. Assuming 10 q of maize occupies 1.7 m^3 and a stack height of 2 m, 1 800 q or sacks will require a covered area for storage of about 160 m^2.

It is estimated that peak requirements for temporary storage will occur in January and February at the peak cotton picking period. It is further estimated that the maximum covered storage area needed will vary between 180 and 230 m^2 per farm unit, depending on the farm unit size. This assumes sacks will be stacked to a height of 2 m for grain and 3 m for seed cotton. It is considered that reasonable flexibility is still available in case of any temporary problems. Only gu season harvests need covered storage in order to avoid rain damage. Gu season storage requirements are much less than estimated for the der season harvest. During January and February, when there is no expected rainfall, surplus bagged grain or seed cotton can easily be temporarily stored uncovered without risk of damage.

The covered storage area at each farm unit should be designed to maximise ventilation but eliminate any damage from rain, in order to keep grain moisture content as low as possible under the prevailing humidity conditons. Each storage shed should have the features described below:-

(a) A raised floor with at least an aggregate base to prevent any upward movement of moisture.

(b) A wide overhanging roof to intercept wind-blown rain. Guttering should be fitted to minimise splashing and also to collect the rain for drinking purposes.

(c) No side-walls are considered necessary.

Attached to each storage shed, there should be a 100 m^2 uncovered concrete slab. This can be used as a working area for shelling and bagging or occasional grain drying. During August and September, rainfall is only spasmodic and it is considered that with the full ventilation each shed allows and with the strong hagai winds, grain drying requirements will be minimal. During any emergencies, the Bentall grain drier at Qoryooley can be used. As surplus produce for each crop will be fully transported to ADC depots within several weeks from harvesting, the installation of expensive grain drying equipment at each farm unit is not necessary.

21.3 Fertiliser and Chemical Storage

Storage is only necessary for one year's supplies. Stocks will be maintained at Project HQ, such that each farm unit will easily be able to obtain supplies.

For fertilisers, assuming an application rate of 2 q/ha and the 160% annual cropping intensity, each farm unit will require between 1 300 and 1 900 q/year. At a 2 m stack height, covered storage of 70 to 100 m^2 will be necessary. For the small amount of chemicals a further 10 to 20 m^2 of covered storage will be needed for each farm unit.

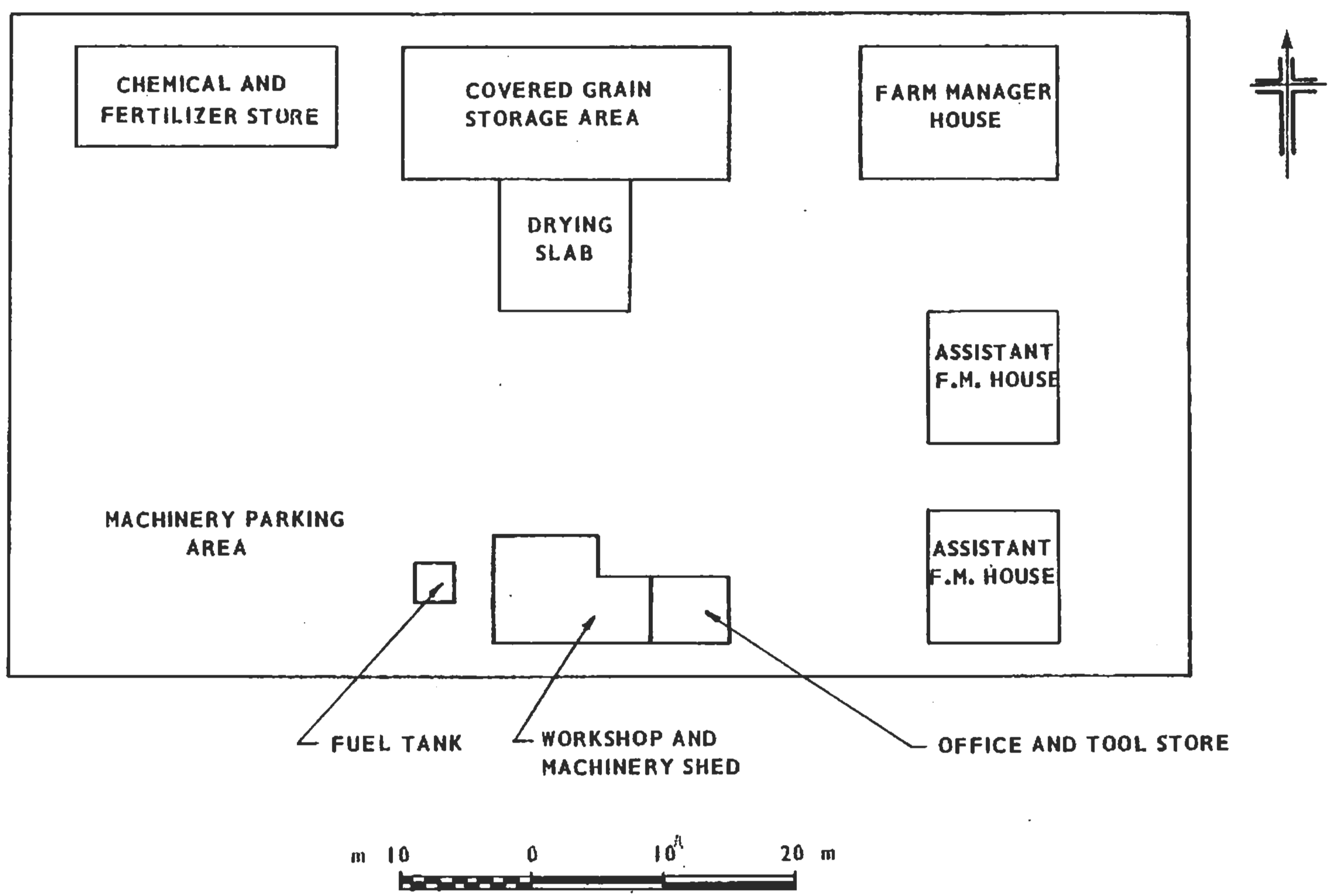
Each store should have a concrete floor to enable effective cleaning after any spillages and to ensure dry storage. Stores must be lockable for safety purposes and, to enable reasonable ventilation, the upper half of each wall should be made of sturdy mesh wire.

21.4 Workshop and Machinery Storage

Each farm unit will be provided with a covered, concrete-floored workshop area of about 80 m^2. This provides adequate space to work on two tractors simultaneously, (60 m^2), as well as a locked store for spares and tools, (20 m^2). Only minimal servicing and maintenance work will be undertaken at the farm unit. More important overhaul work will be done at the Project HQ workshop.

FIGURE 21.1

FARM UNIT H.Q. AREA; TYPICAL LAYOUT



Because of the expense of providing covered areas for all machinery at each farm unit, machinery sheds will be provided only for vital equipment. With the prevailing atmospheric humidity, corrosion and rusting occurs with or without cover. Therefore, the aim of providing cover will be to minimise direct effects of rain on delicate instrumentation and electrical parts, or to prevent moisture being trapped in crucial parts such as grain bins. Therefore, sheds will be provided for tractors and a few implements like rice drills and the cutter-bar mower attachment. Depending on farm unit size, a covered area of 50 to 70 m^2 is considered sufficient, since temporary use can be made of the workshop and grain storage area. Tarpaulins can be used to cover combine harvesters and land levellers. For the remaining equipment (harrows, toolbars, attachments, trailers), covered storage is not necessary. However, all such equipment should be well greased to prevent rusting of moving or adjustable parts.

Each farm unit will also require a separate bulk fuel tank for storing diesel. Tank capacity has been estimated assuming a monthly supply and a daily requirement of 60 litres per farm vehicle. Each farm unit, therefore, will need a fuel tank to hold between 13 000 and 17 000 litres, which includes spare capacity to cover any emergencies.

21.5 Miscellaneous Buildings

A farm office and tool store will also be necessary at each farm unit and should be attached to the workshop and machinery shed. Between 70 and 80 m^2 per farm unit is considered adequate.

Full details of estimated storage areas and farm buildings for each farm unit are given in Appendix G.

CHAPTER 22

MISCELLANEOUS FARM OPERATIONS

22.1 Watercourse and Surface Drain Clearance

Clearance work will be necessary to remove accumulated silt and weed growth and must be carried out once every cropping season. It is estimated that 50 m of watercourse or surface drain can be cleared in about 4 hours, i.e. 50 m/manday. The total length of watercourses on each farm unit will vary from about 9 000 m (Nimcooley) to 21 000 m (Jasiira), with a similar length of surface drains per farm unit (see Annex VII). Therefore, the total labour requirement is estimated to be about 350 to 830 mandays for each farm unit, which represents a requirement of only 12 to 28 men each day over a 30 day period (i.e. 5 men/day for 100 ha NCA). This can easily be fitted into periods of low labour demand for field crop work (see Figure 18.3). As two clearances per year will be necessary, clearance work can be carried out at any time during the gu season, until August, and in the der season between November and December.

22.2 General Weed Control

Constant attention will be necessary to check weed and grass regrowth around each farm unit in the following areas:-

(a) outside canal banks

(b) drain slopes

(c) farm unit HQ areas

(d) un-utilised land, excluding fallowed fields.

The recommended control method is to use a tractor mounted pto-driven cutter-bar mower. In comparison with rotary slashers, a mower will be more flexible for sloping land and awkward areas. The estimated areas to be cut range between about 27 and 58 ha for each farm unit. At an estimated 1.6 h/ha operating time (see Chapter 3), about 45 to 95 tractor-hours will be needed to complete a single cut i.e. 6 to 12 working days per cut, assuming 8 working hours per day. Three cuts during the period of April to December are considered necessary for effective control. Low demand periods for tractors (see Figures 21.1 and 21.2) will enable this work to be carried out in May, July and September to November. The cut grass can then be used as fodder for livestock.

22.3 Seed Supplies

Each farm unit must provide its own planting material by retaining seed from der season harvests for use in the following year. The estimated seed requirements and net areas to provide that seed are given in Table 22.1. Five hectares are considered adequate to provide seed for every 100 ha (net). The main reason for adopting this method of seed supply is because the Afgooye Seed Multiplication Centre has insufficient capacity to provide for the whole project. At full project development, approximately 170 ha must be set aside for seed production each year.

No technical problems are envisaged using this method for the following reasons:-

(a) A composite maize variety will be grown and retained seed will be from selected cobs from a reasonably isolated field.

(b) Only one variety of cotton, sesame or rice will be grown in the whole area and all are self-pollinated crops.

(c) With each crop, one field or part of a field must be selected and obvious off-types rogued out, if necessary. The net area required for seed supplies represents less than 3% of the annual NCA.

(d) Selection from der crops will provide seed with better viability due to a lower moisture content from harvest onwards and a shorter storage period.

TABLE 22.1

Project Seed Requirements

	Maize	Rice	Forage(1)	Cotton	Sesame	Total
Annual cropped area per 100 ha (ha net)	40	40	20	35	25	160
Seed rate (kg/ha)	20	100	25	30	8	-
Seed requirement (2) to plant annual cropped area (q)	10	50	6.25	13 (5)	2.5	-
Yield (q/ha)	35	25	-	20	8	-
NCA to provide annual seed requirements (ha)(3)						
(a) per 100 ha (net)	0.5	2.5	-	1.25	0.5	5
(b) per farm unit (246 ha-584 ha)	1.3 -3.0	6.2 -14.6		3.1 -7.3	1.3 -3.0	12-28(4)

Notes:
(1) Requirement to be bought in each year.
(2) Includes 25% contingencies.
(3) Includes extra area to cover losses and estimates net area per farm unit to provide material for one year using cropping pattern A, excluding forage.
(4) Total project NCA to provide one year's seed requirements, excluding pilot farm, estimated at 170 ha (net) per year.
(5) 13 q/ha cotton seed equivalent to yield of 20 q/ha seed cotton, assuming 35% ginning.

All retained seed should be dressed with Fernasán D and stored separately in marked bags away from other grain. Forage seed (millet and pulses) must be obtained annually through ONAT.

However, it will be necessary to replace seed with pure stocks every 5 or 6 years. As establishment of farm units will be staggered over several years, new stocks will be required by no more than 2 farm units each year i.e. less than 45 ha/year will be necessary for seed supply purposes. This should be obtainable from the Afgooye seed centre and provision will also be made at the pilot farm to assist this supply (see Chapter 23).

For cotton, the harvested seed cotton must be ginned. As the nearest ginnery is Balcad, special care must be taken to avoid any mixing. A small gin can either be installed at project HQ or closely supervised ginning carried out at Balcad for a separate shipment over a pre-arranged period of several days.

22.4 Houseplots

The cultivation of houseplots represents the only other major farm operation on each farm unit which has not been discussed. Houseplots will be allocated to a certain field or part of a field each year. Full water supplies will be available and a free choice of crops and vegetables allowed. Labour inputs will be small and it is considered that cultivation will not interfere with field crop production. When not being used, farm machinery will also be available. However, because tomatoes and tobacco will be the most common 'free choice' crops grown, the houseplot area on each farm unit must be rotated each year to avoid the build up of soil pests. At least three to four years must elapse before that field can be used again for houseplots. Rotation will also minimise fertiliser requirements as 'free choice' crops can utilise residual fertiliser from several years of well-fertilised cropping.

CHAPTER 23

THE PILOT FARM

23.1 Introduction

The proposed pilot farm will be the first agricultural unit of the project to be brought into operation. As a result of the present lack of technical information, trained manpower and other infrastructural services, its establishment will be to carry out the following essential activities:-

(a) Implementation, testing and, if necessary, modification of recommended cropping practices at a farm level

(b) Basic agronomic field research

(c) Agricultural training

(d) Seed supply.

The farm will utilise a total of 137 ha (net) and involve an estimated 70 household-families. With an estimated area of 10 ha to be given over to research, crop production will be as follows:-

Research	10 ha
Houseplots	9 ha
Field crop production	118 ha
Pilot farm NCA	137 ha

Therefore, using cropping pattern A, 47 ha of maize, 47 ha of rice, 24 ha of forage, 41 ha of cotton and 30 ha of sesame will be cultivated annually.

23.2 Field Crop Production

The main role of the pilot farm will be to finalise cropping patterns and recommended practices for the remaining eight farm units. Particular emphasis is needed on land preparation and field re-levelling, irrigation methods and frequencies, weed and pest control. Despite this element of management research, the allocated area of 118 ha (net) is to be run, as closely as possible, in the same way as the planned farm units. Detailed field records must be kept to help identify problems and field management requirements.

23.3 Research

The aim of the research element will not be to replace CARS, Afgooye, but to provide recommendations required immediately and specifically for the project. The most important investigations must include:-

(a) Crop water requirements including application rates, frequencies, soil moisture depletion and rooting depths

(b) Assessment and selection of improved varieties

(c) Fertiliser and pest control trials

(d) Minor crop management trials where specifically required such as spacing trials, herbicide trials etc.

Close co-ordination will be necessary with the field crop production section to identify specific problems requiring further research. Non-specific research (for example, minor crops such as safflower or sunflower) will still be carried out at CARS, which the pilot farm can utilise if and when necessary.

At a later date, the pilot farm will also be used to assist development of the remaining Study Area. Since only limited mechanisation will be feasible for non-project situations, research at the pilot farm should also investigate improved hand tools and selected animal-drawn equipment, the necessity and desirability of which is discussed in Chapter 3. Ten hectares is adequate for the necessary experimental trials, an area to test implements and an area for practical training work.

23.4 Training

Training to be carried out will be for both managerial and farm unit staff as well as for village members who will become field unit supervisors on each farm unit. Training will be entirely practical and will involve identifying agronomic problems as well as learning recommended field management and crop operations. Both the research and field crop production areas will, therefore, be utilised for demonstration work and practical training. Machinery and equipment required for the pilot farm will enable farm operations to continue normally as well as allow their utilisation for training work. Farm machinery will also be used for training farm unit mechanics and drivers.

Farm units are to be brought into operation at a rate of 2 units per year. This will allow from 6 to 12 months training per person beforehand. Training will, therefore, enable previously qualified managerial staff to grasp the complexity and requirements of irrigated crop production as well as obtain a better understanding of machinery and mechanised operations. Field supervisors will also be able to carry out the daily field work competently. The estimated training requirement will be 3 managerial staff, 1 mechanic, from 9 to 12 tractor drivers and 12 to 20 field unit supervisors for each farm unit.

23.5 Seed Supply

The pilot farm will also be needed to provide a limited amount of seed for the farm units. Seed requirements are discussed in Chapter 22 and it is estimated that for cropping pattern A, 5 ha will provide sufficient seed for every 100 ha per farm unit to be cropped in the following year, i.e. approximately 21 to 22 ha is required per farm unit per year. It is considered that, normally, the pilot farm can provide seed for one farm unit every year as necessary replacement stocks. As two farms are planned to be brought into operation every year, the pilot farm should also be able to provide the smaller amount of initial seed stocks for two farm units per year during the establishment period. A further 5 to 6 ha for seed retention will also be needed each year for the pilot farm itself. Each year, the pilot farm should obtain pure seed stocks from the Afgooye Seed Centre. Except for rice, less than 2 q of maize, cotton or sesame will be necessary to plant an area to supply a farm unit of 450 ha. For rice, 11 to 12 quintals will be required. If pure stocks are not available at the Afgooye Seed Centre, supplies must be obtainable from or through CARS and multiplication carried out at the pilot farm before distribution to farm units. It is considered that the qualified staff necessary for the pilot farm (see Feasibility Study Report) will be capable of ensuring this secondary multiplication work is done carefully. However, the constant maintenance of pure base stocks will not be the function of the pilot farm.

23.6 Equipment Requirements

These requirements are based on information presented in Chapter 20 and are listed in Appendix G. As at least one of each item will have to be obtained, nearly all equipment will be badly under-utilised if viewed strictly as a production requirement. However, ample use will be made of all equipment during training programmes and the combine harvester can be shared with an adjacent farm unit in order to minimise expense.

The research section will require extra equipment for trial work, such as hand operated threshers, shellers and drills. Examples and estimated costs are given in Appendix G. These requirements also include selected animal-drawn equipment considered suitable for testing and introduction into the Study Area. For more specialised equipment, use of available facilities is necessary. For example, oil content can be determined by arranging and supervising extraction at local village mills, and cotton fibre quality tests can be carried out at Balcad.

23.7 Farm Buildings

Based on information presented in Chapter 21, the following basic buildings will be required:-

Covered grain store	60 m^2
Grain drying slabs	50 m^2
Chemical, fertiliser and tool store	40 m^2
Machinery shed	60 m^2
Fuel tank	10 000 litres

No separate workshop or office will be required as they can be amalgamated with Project HQ. The grain storage area requirement assumes one truckload (50 q) of grain per day is transported off the pilot farm by ADC during harvesting.

Extra requirements for the research section will involve seed stores and a laboratory (50 m^2), an open covered working area (30 m^2) and a small drying slab (25 m^2).

No specific buildings are considered necessary for the training section as most work will be carried out in the field. Mechanical training can be undertaken in the machinery shed or at the project workshop. However, a small covered area (30 m^2) attached to another building will provide a simple, cool place in which to carry out short lectures.

23.8 Miscellaneous Operations

Watercourse and surface drain clearance will require an estimated 190 mandays per clearance, or under 7 men per day for a 30 day period. General grass and weed control will be necessary for an estimated 6 ha which will take less than 10 tractor hours per cut. Both operations will be easily carried out with available resources for the required frequencies each year.

CHAPTER 24

INFRASTRUCTURE DEVELOPMENT

24.1 Introduction

Present infrastructural services for the Study Area are discussed in Annex III, Chapter 3 and for the Project Area in Chapter 17. As the project and each farm unit will be relatively self-contained, required improvements to infrastructure will be limited to those services upon which they will remain dependent.

24.2 Agricultural Training

As training of field unit supervisors will be carried out at the project, trained manpower requirements will be limited to managerial and technical staff for each farm unit and the pilot farm. All will need to have received full training prior to the period of field training at the pilot farm. Required numbers are given in Table 24.1.

TABLE 24.1

Trained Manpower Requirements

Staff	No. required	Where employed
Farm Manager	8	Farm units
Assistant Farm Manager	16	Farm units
Mechanic	8	Farm units
Assistant Farm Manager (1)	1	Pilot farm
Assistant Agricultural (1) Training Officer	1	Pilot farm
Assistant Irrigation (1) Agronomist	1	Pilot farm
Technical Assistants	8	Pilot farm

Note: (1) During the first few years, expatriate management of the pilot farm is proposed. Further assistant staff are required when the first assistant staff are promoted.

Farm unit management staff should have at least agricultural diploma qualifications. On the pilot farm, with its greater responsibilities in relation to the farm units, both degrees and experience will be necessary for assistant managerial and specialist officer staff. Mechanics will require post-secondary school training and technical assistants required at the pilot farm should be graduates from the Afgooye agricultural secondary school. With the present training programmes in Somalia and abroad, sufficient trained staff will be available during the establishment period.

The project will also require between 90 and 100 tractor drivers at full development at the rate of approximately 20 to 25 drivers per year. With the length of training to be received at the pilot farm before working at a farm unit, only previous experience will be necessary and no extra training needed.

24.3 Agricultural Research

An immediate and vast improvement in the research calibre and output of CARS, Afgooye is essential for any irrigated agricultural development. Although the pilot farm is to carry out a small fundamental research programme, CARS, Afgooye will be needed for the following purposes:-

(a) Production of a suitable composite maize variety, and the maintenance of pure stocks of selected parental material.

(b) Varietal screening, selection and maintenance of pure stocks for a range of important crops.

(c) Continued field trials to investigate fertiliser requirements, irrigation requirements, and weed and pest control methods for selected crops of major economic importance. Programmes should be simple with each trial repeated seasonally and annually to obtain conclusive recommendations which are presently unavailable.

The pilot farm will rely upon CARS for pure stocks of varieties to be tested or multiplied for seed supplies. Other research findings will also be used in conjunction with pilot farm programmes in order to finalise recommendations.

24.4 Seed Multiplication

As stated in Chapter 22, the Afgooye Seed Multiplication Centre will be needed to provide at least 50% of replacement seed stocks required annually, i.e. the equivalent of 20 to 25 ha of land under seed production. Present management at the seed centre needs to be greatly improved to be able to provide pure seed stocks of recommended varieties in the quantities required. This involves the proper isolation of maize varieties, the use of discard rows surrounding all bulk plots, regular monitoring for, and roguing of, off-types and careful separate harvesting. Proper cleaning, grading and seed testing facilities are required. A seed inspection service will also be needed to check multiplication work carried out at the pilot farm and retained seed stocks at each farm unit.

24.5 Agricultural Supplies

Each farm unit will obtain all spare parts, equipment, fertilisers and chemicals from Project HQ. Project management will order directly from ONAT Mogadishu and supplies should be delivered directly to the Project HQ. It will be essential, therefore, to place orders early and maintain good stocks to overcome shortages and delays. For example, fertilisers and chemicals should be ordered annually. ONAT, therefore, will be required to improve its methods of processing orders.

Handling methods also require improvement to avoid dangerous spillage of chemicals.

24.6 Marketing

24.6.1 Transport Requirements

All surplus produce is to be sold to ADC with ADC arranging transportation from each farm unit to its depots in Qoryooley and Shalambood. Grain storage requirements at each farm unit were estimated assuming regular daily transportation of the majority of surplus produce during harvesting periods. During August, this will entail 3 or 5 truck loads (50 q) per day for each farm unit or, on average, about 30 to 35 truck loads per day for the whole project. During harvesting of der season crops (December to February), only 2 to 3 truck loads per day per farm unit will be necessary. However, during the latter half of December, when rice, maize and cotton are being harvested, at least 5 truck loads per day per farm unit will be needed. Assuming 1 truck can transport 2 loads each day, for most of the time fewer than 12 trucks per day will be required for transportation. During peak periods between 20 to 25 trucks per day will be needed. As present transportation of bananas from the Study Area to Marka involves roughly the same number of trucks, no transportation problem is envisaged. As the maximum requirement for cotton at any farm unit is only 2 truck loads per day until the end of February, direct transportation to the Balcad ginnery will also be easily undertaken. These trucks will be required during harvesting and for several weeks afterwards to complete transportation, i.e. August and September (gu crops) and December to March (der crops).

24.6.2 ADC Storage Requirements

At full project development, approximately 3 700 ha will be under field crop production. Using cropping pattern A and assuming Year 4 projected yields, the estimated total production of annual crops is as follows:-

Crop	Season	Cropping intensity (%)	Yield (q/ha)	Total production (q)
Maize	gu	20	35	25 900
	der	20	35	25 900
Rice	gu	20	25	18 500
	der	20	25	18 500
Cotton	der	35	20	25 900
Sesame	der	25	8	7 400

It is estimated that for each family at least 8 q of sesame will be retained for domestic consumption each year. At about 2 000 families involved with the project this represents about 16 000 q of maize and 4 000 q of sesame retained each year. Therefore, surplus produce to be sold to ADC and which will require storage at their depots is estimated as follows:-

	Gu season (q)	Der season (q)
Maize	17 900	17 900
Rice	18 500	18 500
Sesame	-	3 400
TOTAL	36 400	39 800

Cotton has been excluded because, whenever possible, transportation will be directly to Balcad ginnery.

The maximum present production of maize in the Study Area is estimated to be less than 230 000 q/year assuming 23 000 ha cultivated per year and an average yield of 10 q/ha. If the Study Area population of about 18 900 families retains 8 q of maize each year, less than 79 000 q will be sold to ADC annually. Most of this will be sold in the gu season. For sesame, it is estimated that less than 10 000 q will be purchased by ADC each year from the Study Area. Therefore, the maximum storage capacity required is as follows:-

	Gu season (q)	Der season (q)
Qoryooley project	36 400	39 800
Study Area production	57 000	32 000
TOTAL	93 400	71 800

The present maximum storage capacity of ADC depots at Shalambood and Qoryooley is estimated to be 135 000 q of which 65% can be stored under cover (see Annex III, Chapter 3). Present capacity is therefore considered adequate, but it assumes that regular onward shipment to other regions will take place. In case of emergencies, therefore, covered storage for a further 10 000 q will be necessary in the form of slabs and tarpaulins. This will also accommodate any cotton transportation problems and extended storage of rice before milling at Shalambood.

24.7 Grain Drying

Extensive grain drying is considered necessary only in emergencies and only for gu season crops. The two Bentall's drying units have a total capacity of 140 q/h i.e. 1 200 q/day assuming 12 hours operation per day and 75% efficiency. Therefore, in one month, approximately 36 000 q can be dried which will be over 80% of total grain production (maize and rice) to be harvested in August (see Section 24.6). Present capacity will be adequate because full drying will only be necessary for a small proportion of any gu season crop.

24.8 Rice Milling

All rice produced along the Shabeelle river must be transported to Shalambood for milling. Present areas under crop at eight production farms from Jowhar to Hawaay are an estimated 1 250 ha (net) of both upland rice (710 ha) and paddy rice (540 ha) (survey data, 1977). With average yields of 16 q/ha (upland rice) and 30 to 50 q/ha (paddy rice) estimated production is about 28 500 q/year (18 000 to 18 500 q/year milled rice). In the next few years, rice production is likely to expand by a further 800 ha mainly at Hawaay, Kurtenwaarey and Sablaale which are downstream of the Study Area, and will produce a further 20 000 q/year (13 000 q of milled rice). Therefore, future production, excluding the Qoryooley project, will be about 48 500 q/year (31 000 q/year milled rice).

Present annual capacity of the Shalambood mill is about 24 000 q of milled rice, assuming 80 to 100 q/day output, a 6 day week and a 7 week maintenance period. No details concerning the expected capacity of the new ONAT mill were available. This mill is due to open during 1978 and estimated capacity is at least 120 q/day (33 000 q/year of milled rice). Total future capacity (after 1978) will, therefore, be about 57 000 q of milled rice per year with the future production of 31 000 q/year absorbing about 55% of this capacity.

Annual production from the Qoryooley project at Year 4 yields is estimated at about 37 000 q unmilled, or about 24 000 q of milled rice (see Section 24.6.2). Spare future capacity at the two Shalambood mills will be about 26 000 q/year. Therefore, no increase in milling capacity will be required. However, any further rice production will necessitate the construction of another mill if planned ADC mills are not built at other sites along the Shabeelle river (see Annex III, Chapter 3).

CHAPTER 25

NIMCOOLEY FARM UNIT MODIFICATIONS

25.1 Introduction

The position of main canals required for the project has resulted in the inclusion of a small area of land considered unsuitable for irrigated crop production. This area has been nominally attached to the Nimcooley farm unit (263 ha net) and comprises a net cultivable area of 207 ha but this is to be excluded from full development proposals as it would not be economically feasible. The main reason is the salinity hazard of the soils in this excluded area which will significantly reduce the yields of most crops. To minimise costs, no machinery, equipment or facilities will be allocated to this area. Instead, farmers will be able to hire any available equipment from the main part of Nimcooley farm unit. They will also be able to utilise the farm unit's storage and supply facilities in order to market surplus produce and obtain fertilisers or chemicals. Two extension agents will be allocated to the area to train farmers. An estimated 85 household-families will be affected but, despite the construction of new canals, full irrigation availability will be maintained as for the entire project.

25.2 Cropping Pattern

Because of the salinity hazard, only tolerant crops (e.g. cotton) or those needed for domestic consumption (maize, sesame) can be included in any cropping pattern. Therefore, of the crops considered for inclusion in Chapter 18, rice, groundnuts and forage must be excluded. The proposed modified cropping pattern is given below:-

	Cropping intensity (%)			
	Gu	Der	Total	Annual NCA (ha)
Maize	40	-	40	83
Cotton	-	35	35	72
Sesame	-	25	25	52
TOTAL	40	-	100	207

Because of the expected lower inputs of farm machinery, each crop has an increased labour requirement. Consequently, the der season cropping intensity has been reduced to 60% but, if labour is well organised, 80% may be possible. Gu season maize cropping is limited by irrigation availability as predicted for the entire Project Area. Cotton is included as it is the only proposed and suitable cash crop and proposed intensities of maize and sesame should provide adequate domestic requirements, even at expected reduced yields.

25.3 Crop Management and Production Costs

Recommended practices given for the project are still applicable to this area. However, with supervisory work limited to two extension workers, a lower implementation rate of these recommendations can be expected. It is estimated that production costs would represent the equivalent of 65% of the full production costs given for the rest of the project. This is mainly through reduced use of fertilisers, pest control measures and machinery.

25.4 Yields

Projected yields at full development for this area are given below:-

Maize	25	q/ha (shelled)
Cotton	15	q/ha (seed cotton)
Sesame	8	q/ha (threshed)

For maize, the salinity hazard will cause an estimated yield reduction from full yields (35 to 40 q/ha) of at least 25%. Therefore, soil salinity or crop management limitations will prevent yields exceeding 25 q/ha. For cotton, the reduced yields will be the result of poorer management. However, with its low management requirement beyond good irrigation it is expected that good yields of sesame will still be obtainable, although little is known about the salinity tolerance of sesame.

PART IV

MASTER PLAN

CHAPTER 26

INTRODUCTION

26.1 Development Projects

A number of projects have been identified for incorporation in the Master Plan. Selection of the areas for proposed development as projects was based mainly on engineering criteria and this is discussed in full in Part IV of Annex VII. These projects also include the EDF grapefruit scheme which is regarded by this study as a committed project within the Study Area (see Annex IV, Chapter 13). These projects are listed in Table 26.1, together with their gross areas and their locations are shown in Figure 26.1. Development projects will affect 54% of the Study Area.

TABLE 26.1

Master Plan Development Projects

Project	Gross area (1)
Qoryooley	5 800
Asayle	4 170
Faraxaane	5 630
Der flood	1 200
Shalambood	6 255
Mukoy Dumis	4 270 (2)
Golweyn	3 700
EDF grapefruit scheme	2 485
Banana drainage	2 830
TOTAL	36 340 (3)

Notes: (1) Gross project area or gross area affected by project

(2) Phase I = 2 210 ha and Phase II = 2 060 ha

(3) 54% of the Study Area (67 410 ha)

Full discussion on the agricultural development of the Qoryooley project is presented in Part III of this annex and its management is discussed in Annex IX (Implementation and Management). The general development and management of the

Faraxaane, Shalambood, Golweyn, Asayle and Mukoy Dumis projects are based on those given for the Qoryooley project with the following modifications:-

(a) The Asayle project includes eleven large scale farmers who will not be directly controlled by the project authority.

(b) Development of the Mukoy Dumis project will involve a resettlement programme in order to expand the present very small farming community in the area. Development proposals have only been prepared for Phase I of this project (2 210 ha) because, initially, it is necessary to investigate the economics of clearing the large area of bush (1 840 ha) within the project area and opening new land for agricultural development.

The der flood project is designed as a simple, cheap form of expanding irrigated crop production. It is based on flood irrigation (for which sesame production is well-suited) in order to utilise surplus der season river flows. It will therefore require the minimum of management and it is recommended that this is carried out through the Regional Co-ordinator (Janaale) of the Ministry of Agriculture.

The grapefruit project will have its own management structure and is being supervised by independent consultants.

Although this study has expressed doubts about the development of large scale grapefruit production (see Chapter 16 and Annex VIII, Chapter 4), it is assumed that any alternative development of the remaining areas of the EDF scheme (Phases II and III) will be decided between the EDF, the project consultants and the Ministry of Agriculture. Therefore, no further discussion with regard to agricultural development of this project is made in the remaining chapters of this annex.

The banana drainage project should be implemented through the National Banana Board.

For some of these projects, modifications to the cropping pattern selected for the Qoryooley project (pattern A) are necessary. These and the restrictions that determine the final cropping pattern for each project are discussed in Chapter 29.

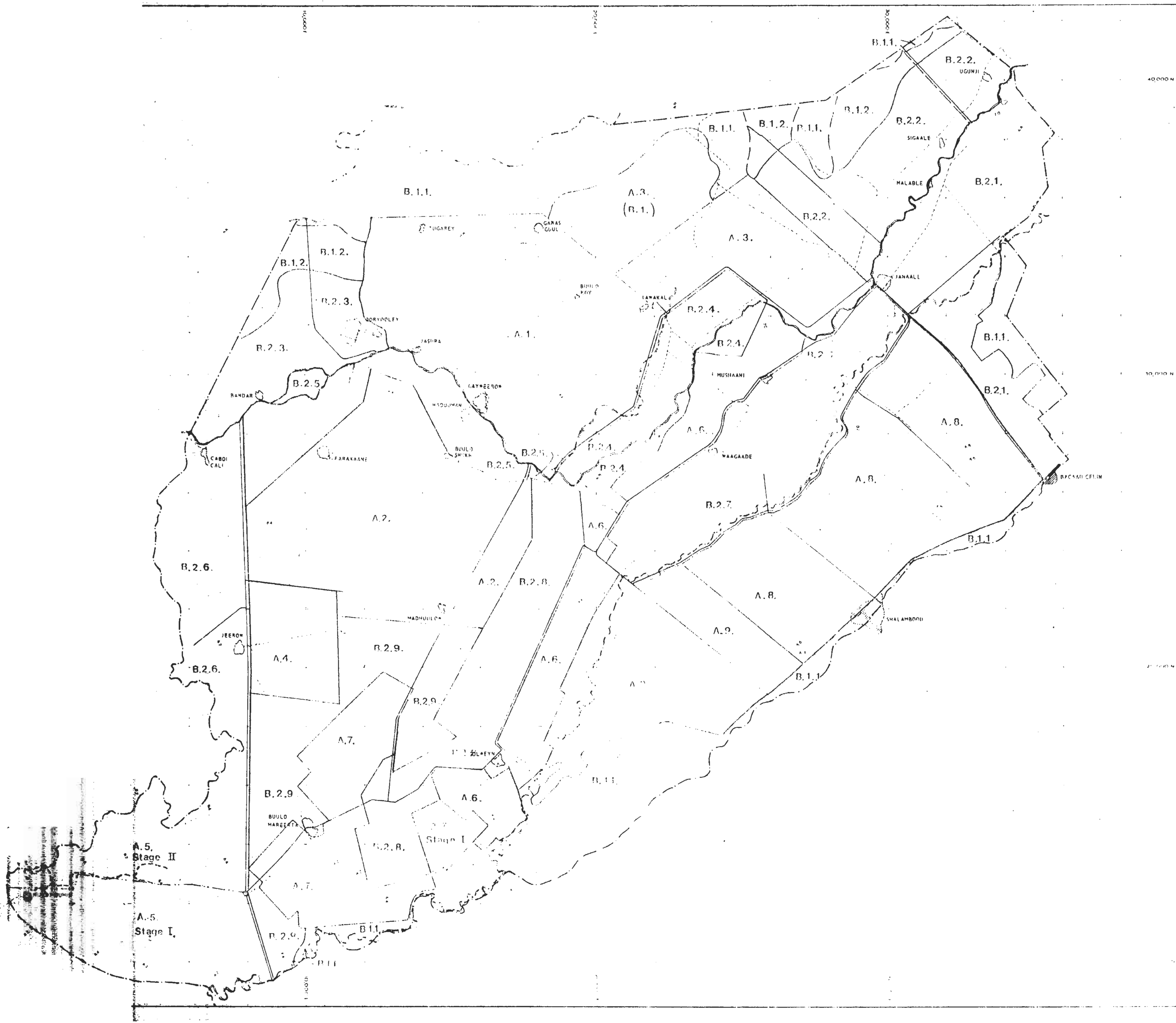
26.2 Development Zones and Non-development Areas

The remaining 46% of the Study Area has been divided into a series of zones where development of irrigated crop production is considered suitable as well as three areas where further development is not considered suitable. Locations are shown in Figure 26.1 and gross areas are given in Table 26.2.

The delineation of development zones was based on the location of the proposed projects and natural boundaries created by major canals or the river. This has created identifiable units of a reasonable size and will assist development planning. Development proposals are discussed in Chapter 30.

FIGURE 26.1

STUDY AREA – PROPOSED DEVELOPMENT



A. PROJECT AREAS

- A.1 Qoryooley project
- A.2 Faraxaane project
- A.3 Asayle project
- A.4 Der flood project
- A.5 Mukoy Dumis project
- A.6 Banana drainage project
- A.7 EDF grapefruit production scheme
- A.8 Shalambood project
- A.9 Golweyn project

B. LAND DEVELOPMENT CLASSIFICATION AND ZONES

- B.1 Non - development zones
  1. Acacia woodland
  2. Marginal agriculture
- B.2 Existing systems with upgraded technical services
  1. Janaale zone
  2. Degwariiri zone
  3. Bandar zone
  4. Majabto zone
  5. Haduuman zone
  6. Jeerow zone
  7. Waagade zone
  8. Primo Secondario Banana zone
  9. Tahliil zone

TOPOGRAPHICAL LEGEND

- River
- Major channel remnant
- Main canal existing
- Surfaced road
- Unsurfaced road
- Track
- Contour
- Study area boundary
- Village

SCALE

0 1 2 3 4 5km

TABLE 26.2

Master Plan Development Zones and Non-development Areas

Development zone:	Gross area (ha)
Janaale	3 165
Degwariiri	2 470
Majabto	1 760
Haduuman	1 940
Jeerow	2 325
Waagade	3 790
Tahliil	3 115
Bandar	1 815
Primo Secondario Canal banana zone	3 020
Sub-total	23 400 (1)
Non-development areas:	
1	4 595
2	2 495
3	580
Sub-total	7 670
TOTAL	31 070

Notes: (1) 35% of the Study Area (67 410 ha)
(2) 11% of the Study Area.

The non-development areas mostly comprise the areas of acacia woodland and scrub that occur along the Study Area boundary. These areas are considered unsuitable for development mainly because it will not be possible to extend improved water supplies into these areas given the existing and proposed network of canals and barrages (see Annex VII). Non-development areas constitute only 11% of the Study Area. Details and proposals for the small area of existing crop production in these areas are given in Chapter 31.

26.3 Banana Production

The banana drainage project is the main development proposed for banana production in the Study Area. This project is considered the largest area (2 830 ha gross) that can be drained by a single open drain line linked to an in-field drainage system (see Annex VII). Agronomic recommendations and expected yields are given in Chapter 15, but figures given in Table 26.3 show that this project will affect less than 50% of present cultivated areas of bananas (3 420 ha) and less than 40% of planned cultivated areas (4 067 ha). However, in-field drainage requirements and general agronomic recommendations will also apply to the other banana farms outside this project. For these farms, the only modification is that alternative methods for the disposal of drainage water are necessary.

TABLE 26.3

Development Projects and Zones:
Present Perennial Crop Production

Project or zone	Net area perennial crops(1)	
	ha	%
Banana drainage project	1 560	36
Other development projects	640	14
Development zones	2 172	50
TOTAL	4 372(2)	100

Notes: (1) 93% bananas; 7% other perennial crops, and assumes even distribution

(2) Includes present cultivated area of bananas (3 420 ha), planned increase in cultivated area (647 ha) and net area of other perennial crops (305 ha).

Source: Land use survey data (Annex IV, Chapter 4).

Therefore, development proposals for crop production covered in Part IV of this annex will only cover annual crops. In each project or zone where bananas are presently cultivated, improved water supplies and services include requirements for banana production.

CHAPTER 27

PRESENT SITUATION

27.1 Crop Production

In order to assess the development potential of each project and zone, it is necessary to determine their present land use, cropping and yields. Data presented are based on information given in Annex IV (Existing Agriculture). Existing net cultivated areas are presented in Table 27.1. Present average yields of cultivated annual crops vary depending on the proportion of marginal annual production (land use class 2 areas) in each project or zone. Therefore, estimated average yields per project or zone vary from 7 to 10 q/ha for maize and from 3 to 4 q/ha for sesame. Average annual production assumes the following cropping intensities in the net cultivated areas within each project or zone:-

Maize	140%	(gu and der seasons)
Sesame (a)	60%	(der season)
(b)	6%	(hagai catch-crop)

Therefore, estimated annual production for each project or zone varies between 10 and 14 q/ha for maize and 2 to 2.6 q/ha for sesame. Production of other annual crops is considered too small to evaluate and it is assumed that maize and sesame constitute 100% of annual crop production.

Average present banana yields are 200 q/ha/year of which 130 q/ha/year is of exportable quality (see Annex IV, Chapter 11).

27.2 Population Distribution

The estimated number of families farming in each project or zone was determined firstly by dividing the total net cultivated area of annual crops (16 590 ha) by the number of families in the Study Area (18 940 families). This provides an average cultivated area of 0.9 ha per family. Secondly, the existing net cultivated area in each project or zone (see Table 27.1) is divided by 0.9 ha to obtain the number of families per project or zone. These are presented in Table 27.2. The Qoryooley project is excluded, having been dealt with in detail in Part III of this annex. In the Asayle project area, there are eleven large scale farms and the smallholder farming community in that area was determined from the net area of land known to be farmed by smallholders (820 ha).

However, the exact number of families farming in some of the areas is greatly influenced by the population of Qoryooley town. The present population of Qoryooley is just over 14 000 inhabitants which represents 32% of the Study Area population living in Qoryooley district. It is not known what proportion of the town population farms land and in what areas. Therefore, estimates of present population in the Faraxaane project area and the Bandar and Haduuman zones may be too high. The same can be said for other large village areas such as Janaale, Shalambood and Golweyn. Consequently, a full study of the farming population in each project area or zone will be necessary before any further development planning is carried out.

TABLE 27.1

Development Projects and Zones: Present Cultivation

Project or zone		Net cultivated areas (ha)			
		Marginal annual crop production (1)	Irrigated annual crop production	Irrigated perennial crops	Gross area (ha)
(a)	Projects				
	Qoryooley	1 299 (1)	928	-	5 800
	Asayle	745 (1)	616	144	4 170
	Faraxaane	-	2 324	-	5 630
	Der flood	5	224	-	1 200
	Shalambood	1 053	690	358	6 255
	Mukoy Dumis (3)	54	148	30	4 270
	Golweyn	543 (1)	203	108	3 700
	EDF grapefruit	137	383	-	2 485
	Banana drainage	-	-	1 560	2 830
(b)	Zones				
	Janaale	85	953	272	3 165
	Degwariiri	287	489	381	2 470
	Majabto	210	360	9	1 760
	Haduuman	-	823	-	1 940
	Jeerow	-	1 028	-	2 325
	Waagade	245	325	333	3 790
	Tahliil	-	943	110	3 115
	Bandar	-	691	-	1 815
	Primo Secondario Canal banana zone	-	384	1 067	3 020
(c)	Non-development areas				
	1	415	-	-	4 595
	2	-	-	-	2 495
	3	-	-	-	580
TOTAL		5 078	11 512	4 372 (2)	67 410

Notes: (1) Includes rainfed cropping in Asayle project (41 ha), Qoryooley project (117 ha), and Golweyn project (40 ha).

(2) 93% bananas (4 067 ha total net present and planned areas).

(3) Phases I and II. For Phase I only, net area of annual crops is 113 ha. Remaining area mainly acacia woodland and scrub.

Source: Land use survey data.

TABLE 27.2

Development Projects and Zones: Present Farming Population

Project or zone		Household-families
(a)	Projects	
	Asayle	930 (+ 11 large scale farmers)
	Faraxaane	2 640 (1)
	Der flood	260
	Shalambood	1 980
	Mukoy Dumis	230 (2)
	Golweyn	850
	Banana drainage	- (3)
(b)	Zones	
	Janaale	1 180
	Degwariiri	880
	Majabto	650
	Haduuman	930 (1)
	Jeerow	1 170
	Waagade	650
	Tahliil	1 070
	Bandar	790 (1)
	Primo Secondario	
	Canal banana zone	440
(c)	Non-development areas	
	1	470
	2	-
	3	-

Notes:
(1) Includes influence of Qoryooley town.
(2) Phase I = 130 families
(3) Does not involve smallholders other than as a source of labour.

CHAPTER 28

GENERAL DEVELOPMENT PROPOSALS:

SMALLHOLDER REQUIREMENTS

28.1 Introduction

Proposals for the Qoryooley project were based on an average allocation of 2 ha per household-family, mainly because the average holding size in that part of the Study Area is slightly less than 2 ha. However, this assumption cannot be made for the other projects or development zones in the Study Area for the following reasons:-

(a) If 2 ha per family was assumed, about 55 000 ha (gross) would be required for annual crop production. The gross area of perennial crops is over 7 000 ha, such that the total gross area for crops would be about 62 000 ha. The total gross area for development projects and zones is only about 59 000 ha (see Tables 26.1 and 26.2) and within each project area and zone there are small areas of land considered unsuitable for irrigated development due to topographic or soil salinity problems (see Annex I). This would further reduce the gross area agriculturally suitable for development.

(b) It is known that in certain areas, average holding sizes are less than 2 ha. The average holding size in each of ten surveyed villages varied from 1.0 to 2.9 ha (see Annex IV, Chapter 5).

(c) If full development at 2 ha per family was possible, the labour availability data presented in Chapter 18 for selected cropping patterns indicate that virtually no labour would be available for banana production. In conjunction with paragraph (b) above, smaller holdings are known to be associated with villages attached or near to banana farms and other large scale farms where villagers are employed as casual labour.

Therefore, the following assumptions have been made in order to assess the number of smallholders that can be accommodated on each project or within each zone:-

(a) The average holding size in development zones adjacent to banana plantations is 1 ha per family.

(b) Smallholders in the Asayle project area will also have an average holding size of 1 ha in order to provide adequate labour for the 11 large scale farms to be incoporated into this project.

(c) An average holding size will be 2 ha per family in remaining development projects and from 1.5 to 2 ha in development zones.

28.2 Development Projects

Estimated cultivable areas and smallholder requirements for development projects, excluding the Qoryooley project and the EDF scheme, are given in Table 28.1. Full discussion of the gross project areas (as opposed to gross areas affected given in Table 26.1) is given in Annex VII. For some projects, the gross area affected cannot be developed due to either water distribution problems or predicted gu season water shortages. This therefore requires the development of a smaller gross area into which present holdings are concentrated and the present net cultivated area maintained. The maximum net cultivable area in each project also includes existing banana farms. This banana production will be allowed to continue but independent of the project itself.

For the Asayle project it is assumed that the maximum holding for the large scale farmers will be 30 ha per farmer. This will be in accordance with the maximum private holding permitted by the 1975 Land Registration Act (see Annex III, Chapter 5). Therefore, the total area worked by each smallholder family will be nearly 1.5 ha of which 1 ha will be their own holding. No labour shortage is envisaged because selected cropping patterns given in Chapter 18 can be undertaken at the rate of 2 ha per family.

TABLE 28.1

Development Projects: Cultivable Areas and Smallholder Requirements

Project(1)	Gross project area (ha)	Maximum NCA (2) (ha)	Maximum NCA annual crops(3) (ha)	Families required (4)	Families affected by project(5)
Faraxaane	5 000	4 000	4 000	2 000	2 640
Der flood	1 200	960	960	480	260
Mukoy Dumis (Phase I)	2 210	1 650	1 650	825	130
Shalambood	5 405	4 324	3 966	1 983	1 980
Golweyn	2 340	1 873	1 765	883	850
Asayle	1 830	1 464	1 320(6)	990(6)	930

Notes:
(1) Not applicable for banana drainage project.
(2) Data from Annex VII.
(3) Excludes banana production to be continued in each area.
(4) At 2 ha per family except Asayle project.
(5) See Table 27.2.
(6) 330 ha for large scale farmers and 990 ha for smallholders.

In general, Table 28.1 indicates that a net resettlement of smallholders into all projects but Faraxaane is required. However, the estimated present population farming in the Faraxaane area is not accurate (see Chapter 27).

28.3 Development Zones

Estimated maximum cultivable areas and smallholders that can be accommodated in each development zone are given in Table 28.2.

TABLE 28.2

Development Zones: Cultivable Areas and Smallholder Requirements

Zone	Gross area excluding perennial crops(1) (ha)	Maximum NCA annual crops(2) (ha)	Smallholder families	
			Required (3)	Present numbers (4)
Primo Secondario banana zone	1 445	870	870	440
Waagade	3 235	1 940	1 940	650
Majabto	1 745	1 050	1 050	650
Janaale	2 670	1 600	800 - 1 060	1 180
Degwariiri	1 835	1 100	550 - 730	880
Bandar	1 815	1 090	545 - 730	790
Haduuman	1 940	1 160	580 - 770	930
Jeerow	2 325	1 390	695 - 930	1 170
Tahliil	2 955	1 770	885 - 1 180	1 070
Non-development areas				
1	4 595	-	-	470
2	2 495	-	-	-
3	580	-	-	-

Notes:
(1) From land use survey data
(2) Assumes 60% land use efficiency
(3) At 1.0 ha per family for the first three zones and 1.5 to 2.0 ha per family for Janaale to Tahliil zones
(4) See Table 27.2.

It is assumed that the maximum net cultivable area in each zone will be only 60% of the gross area because development is based on utilising the existing network of canals and fields. The first three zones listed in Table 28.2 (Primo Secondario banana zone, Waagade and Majabto) are considered to be the main zones from which banana producers will obtain labour. In general, Table 28.2 indicates that a net resettlement into the first three zones is required. However, for the remaining zones, a net resettlement out of the zones may be required.

28.4 Discussion

Exact smallholder requirements for each project or development zone can only be determined after a far more detailed survey than that carried out by this study. However, data given in Tables 28.1 and 28.2 give a good indication of what is needed, particularly when the following important points are borne in mind:-

(a) The development of banana production and large scale farms growing annual crops will require a labour force.

(b) No allowance has been made for population expansion which is undoubtedly taking place. The likely result of this is that holding sizes will decrease.

(c) The village centralisation programme that has already been undertaken in Qoryooley district is due to be carried out in the rest of the Study Area (see Annex III, Chapter 4). Therefore, any population movement required by the Government should be based on smallholder requirements and development proposals for each project or zone.

(d) For the EDF scheme, Citaco (1974) estimated that 50% of the smallholders that will be affected by the project need to be resettled outside the project area.

(e) Any resettlement considered necessary should be at a minimum.

Therefore, with the given assumptions, resettlement will probably involve the following:-

(a) The der flood project to absorb smallholders from Jeerow and Tahliil zones.

(b) If the Mukoy Dumis project is considered feasible, it represents the largest area that can absorb any smallholders requiring resettlement.

(c) Smallholders who would be the most suitable for resettlement would be those with, for example, less than 1 ha. Therefore, their resettlement would involve an improvement, because the minimum holding size assumed for this study is 1 ha per family.

CHAPTER 29

DEVELOPMENT PROJECTS: CROPPING RECOMMENDATIONS

29.1 Cropping Patterns

Modifications to the recommended cropping pattern (pattern A) given for the Qoryooley project are required for some of the other identified development projects. Restrictions that determine the final cropping pattern are:-

(a) The present net cultivated areas of irrigated annual crops which will determine the gu season cropping intensity as a result of predicted gu season water shortages in June and July. Estimated gu season cropping is, in general, less than the maximum theoretically possible in order to avoid an increase in the risks of water shortages in June and July. The present restricted water supplies during these months are only available at a 75% probability level (see Annex II).

(b) Where holding sizes are less than 2 ha or gu season cropping is restricted to less than 40%, a greater proportion of proposed cropping involves maize and sesame to ensure adequate supplies for domestic consumption.

(c) The cropping intensity of rice cannot exceed 20% because of the restriction of labour for bird scaring.

(d) The final cropping pattern will depend on labour availability and requirements because availability of labour is considered the limiting factor affecting any selected cropping pattern (see Chapter 18).

Therefore, modified cropping patterns are not required for the following projects:-

(a) Faraxaane project

(b) Shalambood project

(c) Golweyn project.

Modified cropping patterns for the remaining projects are discussed in Sections 29.3 to 29.6. Labour requirements have been calculated from data presented in Chapter 18. Unless stated, crop yields will be the same as those taken for the Qoryooley project and, therefore, gross margins have been based on figures given in Table 18.1. Gu season forage production is included but, as for the Qoryooley project, is considered optional.

TABLE 29.1

Gu Season Cropping Intensity for each Development Project

Project	Present irrigated NCA annual crops (1) (ha)	Maximum NCA annual crops (2) (ha)	Gu season cropping intensity (%) Possible (3)	Assumed (4)
Asayle	1 320	1 320	100	40
Faraxaane	2 324	4 000	58	40
Der flood	229	960	24	20
Shalambood	1 743	3 966	44	40
Mukoy Dumis (Phase I)	113	1 650	7	-
Golweyn	706	1 765	40	40

Notes:
(1) From Table 27.1
(2) From Table 28.1
(3) Obtained by dividing Column 1 by Column 2.
(4) Assumed maximum gu season cropping to cover June and July water shortage risks
(5) Full water availability for separate development of bananas will be provided.

29.2 Project Development

Development proposals are based on those given for the Qoryooley project, i.e. co-operatives with minimum mechanisation requirements and under supervisory management. Therefore, proposals for the development of the Faraxaane, Shalambood and Golweyn projects will be the same as for the Qoryooley project. Changes will be required for the Asayle project (to accommodate large scale private farmers), and the der flood project, and are discussed in the appropriate sections of this chapter.

29.3 Asayle Project

29.3.1 Smallholders

The assumed average holding size of only 1 ha per family necessitates an increase in the annual cropping intensities of maize to 60% and sesame to 50% in order to provide domestic requirements. Consequently, less cash cropping will be possible but this is offset by income obtained as casual labour for the large scale farmers. It is considered, therefore, that rice should be excluded from the cropping pattern for the following reasons:-

(a) Its greater mechanisation requirement.

(b) The gu season cropping restriction (40% intensity) and the increased maize cropping needed.

(c) Its bird scaring requirement which will restrict labour needed for bird scaring on any rice grown by the large scale farmers.

(d) A simplified cropping pattern for smallholders will enable full development to be carried out as well as enable large scale farmers to obtain sufficient labour.

(e) Cotton is considered a more suitable cash crop because of fewer irrigation problems, less mechanisation and greater flexibility in harvesting requirements compared with rice.

The recommended cropping pattern is given in Table 29.2.

TABLE 29.2

Asayle Project: Recommended Cropping Pattern for Smallholders

	Cropping intensity (%)		
	Gu	Der	Total
Maize	40	20	60
Sesame	-	50	50
Cotton	-	30	30
Forage (optional)	20	-	20
TOTAL	60	100	160

Estimated daily labour requirements for this pattern per 100 ha (net) are as follows.

TABLE 29.3

Asayle Project: Smallholders' Labour Requirements

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Maize	40% (gu)	18	56	36	14	28	-						
	20% (der)[1]				-	8	27	21	7	15	-		
Sesame	50%						-	20	52	32	28	44	-
Cotton	30%				-	28	36	26	14	28	60	30	-
Forage	20%	9	27	20	8	-							
TOTAL		27	83	56	22	64	63	67	74	75	88	74	-

Note: (1) Der maize planted from mid August.

The maximum labour availability for 100 ha (net), assuming two people per family, is 200 people per day. Therefore, less than 50% of the available labour will be absorbed.

29.3.2 Large Scale Farmers

Labour for the large scale farmers in the project is to be drawn from an assumed total of over 900 families also within the project. However, because the exact number of smallholders affected by this project is not known, it is assumed that available labour will be less than the 50% that will not be required for smallholder production. For example, if the average holding is found to be 1.5 ha per family, there will only be about 650 families absorbed by the project. Smallholder crop production will therefore involve, during peak demand periods, about 70 to 75% of the available labour for either pattern A or the modified pattern given in Section 29.3.1. This will leave just over 100 people per 100 ha (net) as available labour for the large scale producers during peak demand periods (weeding and harvesting). It is assumed, therefore, that the available labour for the large scale farmers will be between 70 and 80 people per day per 100 ha (net). This lower figure has been taken in order to allow for problems in actually obtaining labour from a village, despite its theoretical availability.

For cropping pattern A, the greatest labour requirement is for picking cotton. At a 35% intensity, the 11 farms (330 ha net) require nearly 250 people per day during January just for picking cotton. Therefore, a reduced intensity of cotton is necessary to avoid any risk of a labour shortage.

The recommended modified cropping pattern is given in Table 29.4.

TABLE 29.4

Asayle Project: Recommended Cropping Pattern for Large-scale Farmers

	Cropping intensity (%)		
	Gu	Der	Total
Maize	20	20	40
Rice	20	20	40
Cotton	-	15	15
Sesame	-	25	25
Forage (optional)	20	-	20
TOTAL	60	80	140

Estimated daily labour requirements for this pattern per 100 ha (net) are as follows (Table 29.5):-

TABLE 29.5

Asayle Project: Large-scale Farmers' Labour Requirements

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Maize	20% (gu)	9	28	18	7	14	-						
	20% (der)(1)					-	22	26	13	11	7	-	-
Rice	20% (gu)	-	7	16	13	7	-						
	20% (der)				-	3	7	23	10	5	-	-	-
Cotton	15%				-	14	18	13	7	14	30	15	-
Sesame	25%						-	10	26	16	14	22	-
Forage	20%	9	27	20	8	-							
TOTAL	140%	18	62	54	28	38	47	72	56	46	51	37	-

Note: (1) Der maize planted from early September.

Therefore, there should be no problem in obtaining sufficient labour for this pattern. Der season cropping could be increased to 100% by increasing the intensity of maize. Maize production would then entail the use of a herbicide, which would reduce the labour requirement for weeding and, therefore, the peak labour demand in October would not increase significantly. The use of a herbicide on maize would allow labour to concentrate on other crops.

29.3.3 Project Development

The smallholder section will require farm unit organisation as for the Qoryooley project. However, the supply of inputs and machinery for the large scale farmers needs to be different. Where possible, the farmer must provide his own tractor. Certain items of equipment will be available for hire, for example, combine harvesters. The amount of equipment needed is represented by that required by one farm unit on the Qoryooley project and listed in Appendix G. No extra mechanisation is needed by the large scale farmers because it is estimated that adequate labour is available from the smallholder sector. The large scale farmers should also be able to obtain their own supplies of chemicals, fertilisers and smaller items of equipment, such as microsprayers, sacks, picking bags, as well as provide their own storage facilities. They should also arrange their own marketing. Therefore, the inputs to be provided by the project for the large scale farmers will be in the form of advice, training and supervision as well as some farm machinery for hire.

29.4 Mukoy Dumis Project (Phase I)

This project has been identified in order to assess the feasibility of bush clearance and opening virgin land for agricultural development. However, with the predicted water shortages and the minimal amount of present cultivation in the area, expansion of crop production will be limited. Water availability will restrict croppng in this project to the der season only (see Table 29.1). The following modifications to the basic pattern are proposed:-

(a) Rice production should be excluded because a single crop each year would make the requirement of specialised equipment (combine harvesters, drills) totally uneconomical.

(b) Extra maize production is necessary to ensure adequate domestic supplies.

(c) Labour availability restricts the maximum intensity of cotton to 40% due to the high requirements at picking.

The recommended modified cropping pattern is given in Table 29.6.

TABLE 29.6

Mukoy Dumis Project: Recommended Cropping Pattern

	Cropping intensity (%)		
	Gu	Der	Total
Maize	-	30	30
Cotton	-	40	40
Sesame	-	30	30
Forage (optional)	20	-	20
TOTAL	20	100	120

Estimated daily labour requirements for this pattern per 100 ha (net) are as shown in Table 29.7.

TABLE 29.7

Mukoy Dumis Project: Labour Requirements

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Maize 30%(1)				-	12	41	32	12	23	-		
Cotton 40%				-	38	49	35	19	38	79	40	-
Sesame 30%						-	12	31	19	17	26	-
Forage 20%	9	27	20	8	-							
TOTAL 120%	9	27	20	8	50	90	79	62	80	96	66	-

Note: (1) Maize planted from mid August.

The estimated maximum available labour is 100 people per day per 100 ha (net).

The reduced gu season cropping and, therefore, the reduced gross margins for the recommended cropping pattern are not the only factors to lessen the economic viability of this project. Machinery, facilities and services would only effectively be used for one season every year instead of two seasons as on other projects. However, gu season cropping can be increased by the cultivation of other suitable short-season drought-tolerant crops that can utilise rainfall and available water supplies predicted for May. Sesame cannot be grown well in the gu season because of pests and diseases as well as poor seed-set caused by overcast weather. On the other hand, safflower and sunflower are possible crops to grow under these conditions but further research is necessary to verify this and obtain proper recommendations.

29.5 Der Flood Project

This project has been identified as an alternative to the more intensive development of irrigated agriculture proposed for the Qoryooley project and other Master Plan projects. It is aimed primarily at providing a large single pre-planting flood irrigation for suitable crops and has, therefore, been designed as a series of basins that will require only minimal land levelling. Compared to other projects, this project will have greatly reduced engineering costs. An area of irrigable land with only a small amount of existing crop cultivation was selected because the water availability situation dictates that this form of irrigation development can only be for der season cropping.

With the present knowledge of improved crop production in Somalia, sesame is the only crop suitable for a flood irrigation system. However, it will be possible to provide several post-planting irrigations to other crops grown on this project, but with reduced efficiency as a result of the less accurate land levelling to be carried out. Therefore, other crops can be included, but at reduced management and yield levels. Their inclusion is necessary because:-

(a) A certain amount of maize must be produced for domestic requirements.

(b) Sesame is one of the least financially suitable cash crops that have been recommended (see Table 18.1).

Two cropping patterns are proposed:-

(a) Maize and the maximum amount of sesame that can be managed by available labour.

(b) The introduction of more profitable cash crops. Cotton is considered the only suitable crop at present, and moderately good crop production should be possible from a single pre-plant flood irrigation followed by several other irrigations during flowering.

The two cropping patterns are given in Table 29.8 and their estimated daily labour requirements are shown in Table 29.9. The gu season cropping intensity is restricted by water availability and existing crop cultivation (see Table 29.1).

TABLE 29.8

Der Flood Project: Selected Cropping Patterns

(a) Maximum Sesame Production

	Cropping intensity (%)		
	Gu	Der	Total
Maize	20	20	40
Sesame	-	80	80
Forage(1)	20	-	20
TOTAL	40	100	140

(b) With Cotton

	Cropping intensity (%)		
	Gu	Der	Total
Maize	20	20	40
Sesame	-	60	60
Cotton	-	20	20
Forage(1)	20	-	20
TOTAL	40	100	140

Note: (1) Forage optional

The final cropping intensities were determined by assessing labour requirements and availability. Even with lower expected yields, 40% maize cropping should be provided sufficient for domestic requirements. From Table 29.9 no labour shortages are envisaged and 100% der season cropping is possible.

TABLE 29.9

Der Flood Project: Daily Labour Requirements for Selected Cropping Patterns

		Daily labour requirement (people/100 ha net) (1)											
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
(a)	Maximum Sesame Production												
Maize	20% (gu)	9	28	18	7	14	-						
	20% (der)(2)				-	8	27	21	8	15	-		
Sesame	80%						-	32	83	51	45	70	-
Forage	20%	9	27	20	8	-							
TOTAL	140%	18	55	38	15	22	27	53	91	66	45	70	
(b)	With Cotton												
Maize	20% (gu)	9	28	18	7	14	-						
	20% (der)					8	27	21	8	15	-		
Sesame	60%						-	24	62	38	34	53	-
Cotton	20%				-	19	25	18	10	19	39	20	-
Forage	20%	9	27	20	8	-							
TOTAL	140%	18	55	38	15	41	52	63	80	72	73	73	-

Notes: (1) Maximum daily available labour = 100 people, assuming 2 ha per family and 2 working people per family.

(2) Der season maize planted from mid August.

Because of expected lower yields, mainly as the result of decreased irrigation efficiency, full project development (inputs, services, facilities, staff, machinery, etc.) will not be required. Farmers will be supervised by a smaller number of staff and only a minimum amount of machinery for basic land preparation will be available to the farmers.

Estimated yields for this project are given below:-

	Projected yield (q/ha)		
	Year 4	Year 8	Note
Maize	20	30	shelled
Sesame	8	10	threshed
Cotton	15	18	seed-cotton

Projected yields for Year 4 are considered as those yields attainable with the given agronomic recommendations. Year 8 yields are considered the maximum yield potential and require further agronomic research. No reduction in sesame yields is expected because of the low management levels required by this crop and its known suitability for flood irrigation.

Further development of this project will depend upon the level of crop management that can be obtained. Returns can be increased by, for example, increasing the intensity of cotton and reducing sesame cultivation to provide only domestic requirements. Crops like safflower and sunflower are also suitable for this type of irrigation management and, once sufficient research work has been carried out, could also be included.

29.6 Net Water Requirements

Net water requirements for each project are calculated in the same way as for the Qoryooley project (Chapter 19) using the net irrigation requirements per crop and the selected cropping pattern. Therefore, net water requirements for the Faraxaane, Golweyn and Shalambood projects will be similar to the Qoryooley project because the same cropping pattern is proposed for all five projects (see Table 29.10).

Modified net water requirements for the remaining projects are also presented in Table 29.10. The net irrigation requirements for each crop given in Table 19.4 were adjusted for the modified cropping patterns presented in Sections 29.3 to 29.5. Net water requirements were then calculated assuming that, on each project, 93.6% of the total net cultivable area will be used for field crop production and 6.4% will be used for houseplots. Net water requirements for houseplots will therefore be the same as given in Table 19.6. Water requirements given in Table 29.10 assume that forage crops and houseplots will receive full irrigation during the gu season. However, in most years, forage crops will only receive partial irrigation. This will also be the case in the gu season for houseplots in the Mukoy Dumis and der flood projects.

TABLE 29.10

Development Project: Net Water Requirements

Monthly net water requirements at field inlet ($m^3 \times 10^3$ per 100 ha net) (1)

	A	M	J	J	A	S	O	N	D	J	F	M	Total
Qoryooley, Faraxaane, Golweyn and Shalambood projects	-	46.9	54.5	50.1	32.1	52.8	88.9	92.5	113.8	90.1	26.5	-	648.0
Asayle (2)	-	47.0	53.1	47.7	19.2	30.8	58.2	68.9	111.7	100.7	24.9	-	562.2
Der flood (3)	-	33.2	34.4	26.2	11.1	22.1	44.8	59.1	116.9	112.1	24.7	-	484.6
Mukoy Dumis	-	19.4	16.1	5.5	8.8	33.7	72.2	86.0	122.4	105.2	29.9	-	499.3

Notes: (1) At 93.6 ha field crops and 6.4 ha houseplots

(2) Based on average cropping pattern of smallholders and large scale farms.

(3) Based on cropping pattern including 20% cotton in der season.

(4) No allowance has been made in this table for dry off in the late season stage.

CHAPTER 30

DEVELOPMENT ZONES: CROP PRODUCTION PROPOSALS

30.1 Development Proposals

Development proposed for these zones is based on the improvement of existing farming systems (predominantly smallholders) through the improvement of infrastructural services and improved water supplies from the existing network of canals. The development of smallholder crop production is therefore to be carried out through the extension services of the Ministry of Agriculture in order to train, organise and supervise farmers. Chemicals and fertilisers will be available through ONAT, which will supply an improved tractor hire service. Tractors will only be required for land preparation such that all other operations will be carried out by hand or, after future development work, animal drawn implements. These proposals also assume that labour for the majority of banana farms comes from three zones (banana labour supply zones):-

(a) Waagade zone

(b) Majabto zone

(c) Primo Secondario banana zone

Therefore, for the remaining zones, full development of smallholder agriculture is proposed in order to maximise production of annual crops.

30.2 Cropping Patterns

30.2.1 Introduction

Modifications to the basic recommended cropping pattern (pattern A) are necessary. Restrictions that affect the final pattern are as follows:-

(a) Gu season water availability limiting gu season cropping to existing areas of cultivation. Estimated gu season cropping per zone is given in Table 30.1. The normal 40% gu cropping is possible in all zones except Waagade where only 20% is possible. In Degwariiri, Haduuman and Jeerow zones, up to 60% gu cropping is possible due to the high intensity of existing agriculture. However, for these zones, a maximum of 40% is taken in order to avoid risking water shortages in June and July (see Chapter 29, Section 29.1).

(b) Assumed average holding sizes in three zones are only 1 ha. Therefore, increased maize and sesame cultivation is necessary.

(c) Bird scaring requirements limit rice cultivation to 20% each season.

(d) Due to decreased mechanisation inputs available, increased labour requirements are necessary for such operations as rice drilling, rice harvesting and uprooting cotton.

(e) More simple cropping patterns are necessary in order to facilitate training and advisory work by extension services as well as their adoption by farmers. In general, only one cash crop like rice or cotton should be introduced to the existing pattern of maize and sesame.

(f) The lower level of expected crop management and farmer organisation will result in lower yields than estimated for development projects (see Section 30.5). Maize and sesame cropping may need to be increased in order to provide adequate domestic supplies.

TABLE 30.1

Development Zones: Gu Season Cropping Intensity

	Net area annual crops (ha)		Maximum gu season cropping (%)	
	Present (1)	Maximum (2)	Possible (3)	Assumed (4)
Primo Secondario banana zone	384	870	44	40
Waagade	570	1 940	29	20
Majabto	570	1 050	54	40
Janaale	1 038	1 600	65	40
Degwariiri	776	1 100	70	40 - 60
Bandar	691	1 090	63	40
Haduuman	823	1 160	71	40 - 60
Jeerow	1 028	1 390	74	40 - 60
Tahliil	943	1 770	53	40

Notes: (1) See Table 27.1.

(2) See Table 28.2. Assumes maximum NCA is 60% of gross area excluding perennial crops.

(3) Column 1 divided by Column 2.

(4) Lower intensity taken to allow for June and July water shortages.

30.2.2 Labour Requirements

Due to the envisaged increase in labour requirements for cotton and rice, particularly at harvesting, modified daily labour requirements have been calculated and are presented in Table 30.2. The same method as described in Appendix D was used and modified labour inputs are presented in the appropriate chapters of Part II of this annex. Figures given in Table 30.2 are used to determine modified cropping patterns since labour availability is the main factor controlling any cropping intensity.

TABLE 30.2

Daily Labour Requirement of Selected Annual Crops with Reduced Mechanised Inputs

Crop		Planting date	Daily labour requirements (people/100 ha net)											
			Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Cotton (1)						-	94	123	89	51	95	197	176	-
Rice (2)	(a)	May 1st-May 15th	-	68	84	70	209	-						
	(b)	Aug 15th-Sept 15th				-	31	53	119	51	194	-		
Tobacco		Aug 1st-Aug 30th (3)		-	20	23	163	162	257	313	229	104	-	
Tomatoes		Aug 1st-Aug 30th (4)			-	31	177	167	202	289	119	-		

Notes:
(1) Increased labour for uprooting (90 manhours/ha)

(2) Increased labour for drilling and basal dressing (35 manhour/ha) and harvesting (200 manhours/ha), but excludes bird scaring.

(3) Transplanting date. Nursery planted in June.

(4) Transplanting date can also be in September.

30.2.3 Proposed Cropping Patterns

Proposed cropping patterns are discussed in the following sections of this chapter. All patterns include a proportion of maize and sesame as well as some form of cash cropping as follows:-

(a) Rice only
(b) Cotton only
(c) Rice and cotton.

All alternatives are only considered possible where 40% gu season cropping is permissible because there will be an adequate annually cropped area to provide sufficient maize and sesame.

30.3 Banana Labour Supply Zones

The three zones from which it is considered that banana farms will obtain casual labour are assumed to have an average holding size of 1 ha per family. Therefore, with the lower expected yields, a greater proportion of land will be used for maize and sesame production, leaving only a small proportion for any cash crops. However, for Waagade zone, only 20% gu season cropping is possible and, therefore, all the holding will be required for maize and sesame. For example; for maize, assuming a yield of 20 q/ha (see Section 30.5), an annual cropping intensity of 70% represents 0.7 ha per family, i.e. 14 q/ha/year of maize. An average family requires at least 10 q of maize per year. Proposed cropping patterns for 1 ha holdings are given in Table 30.3 and estimated daily labour requirements for these patterns are in Table 30.4.

TABLE 30.3

Banana Labour Supply Zones: Cropping Patterns for 1 ha Holding

	Cropping intensity (%)								
	With rice			With cotton			Waagade zone		
Crop	Gu	Der	Total	Gu	Der	Total	Gu	Der	Total
Maize	40	20	60	40	20	60	20	50	70
Sesame	-	50	50	-	50	50	-	50	50
Cotton	-	-	-	-	30	30	-	-	-
Rice	-	20	20	-	-	-	-	-	-
TOTAL	40	90	130	40	100	140	20	100	120

From Table 30.4 it can be seen that less than 50% of the maximum available labour will be involved with annual crop production during any given month. This assumes two working people per family and 1 ha per family. The total number of families required to farm in June is nearly 3 900 (see Table 28.2). Therefore, for most of the year, over 4 000 working people should be available every day to work as casual labour on banana farms. From Chapter 15 banana production will

TABLE 30.4

Banana Labour Supply Zones: Labour Requirements for Selected Cropping Patterns

Daily labour requirements (people/100 ha net) (2)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
(a) With Rice												
Maize	40%(gu)	18	56	36	14	28	-					
	20%(der)(1)					18	27	21	8	15	-	
Sesame	50%						-	20	52	32	28	44
Rice	20%				-	6	11	24	10	39		
TOTAL	130%	18	56	36	14	42	38	65	70	86	28	44
(b) With Cotton												
Maize	40%(gu)	18	56	36	14	28	-					
	20%(der) (1)				-	8	27	21	8	15	-	
Sesame	50%						-	20	52	32	28	44
Cotton	30%				-	28	36	26	14	28	60	53
TOTAL	140%	18	56	36	14	64	63	67	74	75	88	97
(c) Waagade Zone												
Maize	20%(gu)	9	28	18	7	14	-					
	50%(der)(1)					-	55	65	33	28	18	
Sesame	50%						-	20	52	32	28	44
TOTAL	120%	9	28	18	7	14	55	85	85	60	46	44

Notes: (1) Maize planting dates can vary between August and September.
(2) Maximum labour availability = 200 people per day per 100 ha (net).

Source: Table 30.2 and Chapter 18.

require an average of 5 000 people per day for field work and packing. Therefore, these three zones should theoretically be able to provide the vast majority of labour required by banana farms. Sufficient labour for the development of banana production in the Study Area should therefore exist, bearing in mind the following factors:-

(a) Estimated availability given above from the three zones.

(b) Some banana production is in other zones which decreases the demand from the above three zones.

(c) Natural population expansion.

30.4 Other Development Zones

In the remaining six zones, 40% gu season cropping is possible (see Table 30.1). Therefore, as the average holding size is assumed to be 1.5 to 2.0 ha per family (Table 28.2), the introduction of a cash crop is possible. Proposed cropping patterns for 2 ha holdings are given in Table 30.5 and daily labour requirements for these patterns in Table 30.6.

Because of the reduced level of supervision that can be afforded by an extension service operating in any particular zone, the level of crop management cannot be expected to be as high as in a project situation. Therefore, lower overall cropping intensities have been selected. The general level of 120% cropping is similar to that already practised (see Annex IV, Chapter 4).

This will ensure full labour availability, which can be seen in Table 30.6, and is obtained by limiting the intensity of cotton to 20% per season to enable this cash crop to receive good management. The maximum intensity of rice is already limited to 20% (see Section 30.2.1). Therefore, certain farmers may be able to increase der season cropping to the maximum 100%. If holding sizes are, on average, only 1.5 ha per family, full cropping (140%) can be undertaken, but the increased cropping will be of maize and sesame in order to provide adequate domestic supplies.

30.5 Yields

Less intensive supervision and, consequently, moderate crop management, will lower yields compared to those considered possible on well organised projects. A lower level of inputs, such as land levelling, and the number of farmers carrying out full recommendations for fertilisers and pest control measures, will also lower average expected yields. Average yields considered possible are:-

Yields (q/ha)

	Year 4	Year 8	Notes
Maize	20	25	shelled
Sesame	6	8	threshed
Cotton	12	15	seed-cotton
Upland rice	15	20	unmilled

TABLE 30.5

Development Zones : Cropping Patterns for 2 ha Holdings

	With rice			With cotton			With rice & cotton			With tobacco			With tomatoes		
Crop	Gu	Der	Total	Gu	Der	Total	Gu	Der	Total	Gu	Der	Total	Gu	Der	Total
Maize	20	30	50	40	20	60	20	30	50	40	-	40	40	-	40
Sesame	-	30	30	-	30	30	-	30	30	-	30	30	-	30	30
Cotton	-	-	-	-	20	20	-	20	20	-	-	-	-	-	-
Rice (1)	20	20	40	-	-	-	20	-	20	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-	-	-	-	-	20	20	-	-	-
Tomatoes	-	-	-	-	-	-	-	-	-	-	-	-	-	25	25
TOTAL	40	80	120	40	70	110	40	80	120	40	50	90	40	55	95

Note: (1) 20% cropping intensity maximum per season due to bird scaring requirements.

TABLE 30.6

Development Zones: Labour Requirements for Cropping Patterns for 2 ha Holdings

		Daily labour requirements (people/100 ha net)											
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
(a)	**With Rice**												
Maize	20% (gu)	9	28	18	7	14	-	-	-	-	-	-	-
	30% (der)(2)	-	-	-	-	12	41	32	12	23	-	-	-
Sesame	30%	-	-	-	-	-	-	12	31	19	17	26	-
Rice	20% (gu)	-	14	17	14	42	-	-	-	-	-	-	-
	20% (der)	-	-	-	-	6	11	24	10	39	-	-	-
TOTAL	120%	9	42	35	21	74	52	68	53	81	17	26	-
(b)	**With Cotton**												
Maize	40% (gu)	18	56	36	14	28	-	-	-	-	-	-	-
	20% (der)	-	-	-	-	-	22	26	13	11	7	-	-
Sesame	20% (der)	-	-	-	-	-	-	12	31	19	17	26	-
Cotton	20%	-	-	-	-	19	25	18	10	19	39	35	-
TOTAL	110%	18	56	36	14	47	47	56	54	49	63	61	-

continued

TABLE 30.6 (cont.)

Development Zones: Labour Requirements for Cropping Patterns for 2 ha Holdings

Daily labour requirements (people/100 ha net)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
(c) With Cotton and Rice													
Maize	20% (gu)	9	28	18	7	14	-	-	-	-	-	-	-
	30% (der)(2)	-	-	-	-	-	33	40	20	16	11	-	-
Sesame	30%	-	-	-	-	-	-	12	31	19	17	26	-
Rice	20%	-	14	17	14	42	-	-	-	-	-	-	-
Cotton	20%	-	-	-	-	19	25	18	10	19	39	35	-
TOTAL	120%	9	42	35	21	75	58	70	61	54	67	61	-
(d) With Tobacco													
Maize	40%	18	56	36	14	28	-	-	-	-	-	-	-
Sesame	30%	-	-	-	-	-	-	12	31	19	17	26	-
Tobacco	20%	-	-	4	5	33	32	51	63	46	21	-	-
TOTAL	90%	18	56	40	19	61	32	63	94	65	38	26	-

continued

TABLE 30.6 (cont.)

Development Zones: Labour Requirements for Cropping Patterns for 2 ha Holdings

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
		Daily labour requirements (people/100 ha net)											
(e) With Tomatoes													
Maize	40%	18	56	36	14	28	-	-	-	-	-	-	-
Sesame	30%	-	-	-	-	-	-	12	31	19	17	26	-
Tomatoes	25%	-	-	-	-	8	44	42	50	72	30	-	-
TOTAL	95%	18	56	36	14	36	44	54	81	91	47	26	-

Notes: (1) Maximum daily labour availability = 100 people ha (net), assuming 2 working people per family and 2 ha per family.

(2) Der season maize planting dates can vary between August and September.

Source: Table 30.2 and Chapter 18

Due to the lower input requirements of sesame, only slight yield reductions compared to the maximum projected yields of 8 to 10 q/ha should occur. This is in contrast to maize, rice and cotton where much higher levels of management are required for good crops.

30.6 Tobacco and Tomato Production

Both these crops are considered to have potential as cash crops (see Chapter 12). However, this potential is limited to small areas of production mainly due to limited markets and the intensity of crop management required. It is therefore recommended that any development of these two crops should be by well organised and supervised co-operatives or private farms. The development of these crops is unsuitable for either large scale projects or smallholders in general.

The inclusion of either crop within any cropping pattern is restricted by two factors:-

(a) Rotational requirements limit maximum cultivation to only 30% per year to avoid the build-up of soil pests.

(b) High labour requirements (see Table 30.2).

Two cropping patterns are presented in Table 30.5 and the estimated daily labour requirements are in Table 30.6. The higher labour demanded by these crops not only restricts their cropping to about 20 to 25%, but also reduces the overall cropping intensity to less than 100% per year. Consequently, before development of these crops is proposed in any area, a thorough investigation of labour availability is essential. The expected yields given in Chapter 12, will only be possible under good management and these two crops are considered suitable as cash crops only at these higher yield levels.

CHAPTER 31

NON-DEVELOPMENT AREAS

31.1 Introduction

There are certain parts of the Study Area where it is not possible to extend improved water supplies given the existing network of canals and barrages. This is due mainly to the lack of available command. Two types of present land use are affected and comprise about 7 700 ha (gross):-

(a) Uncultivated land, mainly acacia dry woodland.

(b) Marginal annual crop production.

31.2 Acacia Woodland Areas

Acacia woodland and scrub comprises about 6 300 ha (gross) along the northern and southern margins of the Study Area. These are presently used as a valuable source of firewood and charcoal as well as being grazing areas for livestock. No expansion of crop production into these areas is recommended because it would involve only rainfed cropping. Because of the erratic rainfall and the heavy Study Area soils limiting rainfall penetration and water conservation, rainfed cropping is impractical as a long term development proposal. These areas should be maintained for their present purposes.

31.3 Marginal Annual Crop Production

Command problems limiting the area that can be supplied by an improved canal system will affect a small area of annual crop production (415 ha net) in the north of the Study Area adjacent to Bandar and Degwariiri zones (see Table 27.1 and Figure 26.1).

About 470 families of smallholders are affected (see Table 27.2). Existing crop production levels are low with an average yield of 6 q/ha for maize and 2.5 q/ha for sesame (see Annex IV). Because the only feasible development of crop production in the Study Area is by proper irrigation, development proposals for these two areas are as follows:-

(a) Smallholders can continue farming with the knowledge that no improvement in the already poor water supplies is possible.

(b) Any resettlement of smallholders to other zones or projects that may be necessary (see Chapter 28) should first involve smallholders farming in these marginal areas.

However, the detailed survey work necessary to establish the feasibility of improving irrigation supplies within the Study Area for either specific projects or any development zone will also give a more accurate indication on the practical limits of the present irrigation system. Therefore, with this more accurate information of commandable and uncommandable areas, a better assessment of farmers requiring resettlement from non-development areas can be made. Any areas that are therefore abandoned should be used to develop grazing and suitable tree species for firewood and charcoal.

CHAPTER 32

INFRASTRUCTURE REQUIREMENTS

32.1 Introduction

Full discussion of present infrastructural services and their constraints in any development work is given in Annex III, Chapter 3. Recommendations for the general improvement of essential services such as crop research and seed multiplication are discussed in Chapter 24. Consequently, for other development projects similar to the Qoryooley project, these recommendations are also applicable. For the banana drainage project and development of banana production outside this project, recommendations for the improvement of the National Banana Board are necessary and have been discussed in Chapter 15. For annual crop production in development zones, specific requirements involve improvement of extension services, farmer training, agricultural supplies and tractor hire services. Also, for both development projects and zones, an estimation of extra storage and handling facilities required by the agricultural marketing agency (ADC) is needed.

32.2 Seed Multiplication

Present facilities at the Afgooye Seed Centre are not large enough to provide sufficient stocks of pure seed for more than one or two projects even on a basis of supplying replacement stocks every five or six years. Therefore, it would be necessary to expand greatly the number of seed multiplication farms, but this would be very costly. However, of the recommended annual crops, only maize and cotton require properly supervised multiplication because:-

(a) Cross-pollination is a risk with maize, even for composite varieties.

(b) All harvested cotton must be ginned at Balcad to obtain cotton seed for planting.

Therefore, it is recommended that seed multiplication centres concentrate on composite maize varieties and only the maintenance of pure stocks of recommended varieties of other annual crops. Separate facilities must be made for cotton and should, logically, involve the large cotton scheme at Balcad itself. For the remaining crops, such as rice, sesame and groundnuts, a properly organised seed inspection service will be required to carry out the following tasks:-

(a) Advising project technical staff and extension services on simple methods of maintaining good seed stocks by careful and selective harvesting.

(b) Inspection of retained seed stocks.

(c) Organisation of farms or projects to multiply stocks under supervision of the inspection service and for direct sale to ONAT.

Consequently, only well qualified and experienced staff will be required to enable maintenance and multiplication of seed of acceptable purity.

32.3 Extension Services

Present services involve extension work with smallholders, supervision of co-operative group farms and operation of the Plant Protection Service (PPS). The continued operation of a separate service for pest control work is not recommended. Advice and training on pest control should be part of general extension work. It is considered that each village is capable, through its village committee, of organising the supply of any equipment needed. Therefore, the extension services only require trained field assistants to work in the villages within the development zones.

There are estimated to be between 8 000 and 9 000 families within the development zones (see Table 28.2). Assuming full development of these zones will take 20 years, between 400 and 450 farmers must be taught each year. If one field assistant works with 10 farmers each year and, assuming a 100% loss rate of extension staff, nearly 100 field assistants will be required within the nine development zones. Field assistants should be graduates from the Afgooye agricultural secondary school and they must have obtained supervised practical experience at a suitable project before working in the villages.

It is also recommended that full use is made of the Janaale Farmer Training Centre (FTC). Practical courses are necessary to cover more complicated subjects which will be more difficult to teach in the villages, such as irrigation, field levelling and pest control methods. A further five assistants should be allocated to the FTC. Two experienced technical officers, with at least diploma level qualifications, will also be necessary to supervise these extension services.

32.4 ONAT

32.4.1 Agricultural Supplies

One of the major infrastructural developments needed for the Study Area development zones is the establishment of small ONAT sub-depots similar to the buying stations provided by the marketing agency, ADC. Ideal locations are the large villages in which ADC operates buying stations with at least one sub-depot per development zone. Each sub-depot should carry adequate fresh stocks of recommended fertilisers, chemicals, seed, hand-operated equipment and tools.

32.4.2 Tractor Hire Service

Poor availability of tractors for land preparation is another constraint to agricultural development. For development zones, the estimated number of tractors required by the ONAT hire service is given below.

The estimated net cultivable area of all the development zones is between 12 000 and 14 000 ha, at full development. The maximum daily requirement for land preparation is taken to be 0.7 tractor per 100 ha (see Figure 20.1). Therefore, at full development of all nine zones and assuming an operational efficiency of 60%, the ONAT hire service will require about 140 to 170 tractors i.e. approximately 15 to 20 tractors per development zone. Also based on implement requirements listed in Appendix G, about 30 ploughs and harrows, and 60 toolbars and sets of attachments will be needed. Coupled with this, a vast improvement in operator skills and tractor maintenance is necessary if any increase in this hire service is to be effective so ONAT must instigate a suitable training programme.

32.5 Marketing (ADC)

At full development of the Qoryooley project, it is estimated that present storage facilities at Qoryooley and Shalambood will effectively be fully utilised during each harvesting period (August to September and December to February). Therefore, any further development will require expansion of storage facilities and organisation of transportation.

Estimated surplus production at full development of the Study Area is given in Tables 32.1 and 32.2. The estimates are based on Year 4 yields, a single cropping pattern and assume that the Study Area population will rise 50% during the period until full development is reached. From Tables 32.1 and 32.2 and assuming rice and maize production is equal in both the gu and der seasons, total surplus production per year is estimated as follows:-

	Gu (q)	Der (q)
Maize	55 000	55 000
Rice	93 000	92 000
Cotton	-	140 000
Sesame	-	6 000
Total/year	148 000	293 000

Therefore extra storage facilities for about 290 000 q will be needed at full development of the Study Area. Because most of this annual production will be transported away from the Study Area, only temporary facilities are needed. These should take the form of raised slabs and tarpaulins.

32.6 Rice Milling

At full development, it is estimated that rice production from the Study Area, excluding the Qoryooley project, will be about 180 000 q/year. Assuming 65% milling and a daily milling output of 120 q/day, this annual production will require 1 000 days of milling. If one mill operates for 330 days per year, this represents the total capacity of three mills. Therefore, at full development, three more mills similar to those already at Shalambood will be required.

TABLE 32.1

Development Projects: Estimated Surplus Production

Crop	Annual cropping intensity (%)	Annual NCA (1) (ha)	Yield (q/ha)	Annual production (q)	Domestic consumption (2) (q)	Annual surplus production (3) (q)
Maize	40	7 120	35	249 000	130 000	100 000
Rice	40	7 120	25	178 000	-	160 000
Sesame	25	4 450	8	36 000	33 000	3 000
Cotton	35	6 230	20	124 000	-	120 000

Notes:

(1) Total NCA development projects = 17 800 ha (excluding Qoryooley project).

(2) Present population estimated at 9 000 families. Future population assumed to be 13 000 families requiring 10 q/ha/year maize and 2.5 q/ha/year sesame.

(3) Adjusted for reducing cropping in several projects.

TABLE 32.2

Development Zones: Estimated Surplus Production

Crop	Annual cropping intensity (1) (%)	Annual NCA (2) (ha)	Yield (q/ha)	Annual production (q)	Domestic consumption (3) (q)	Annual surplus production (4) (q)
Maize	60	7 200	20	144 000	130 000	10 000
Rice	15	1 800	15	27 000	-	25 000
Sesame	50	6 000	6	36 000	33 000	3 000
Cotton	15	1 800	12	22 000	-	20 000

Notes:

(1) Average intensity.

(2) Total NCA development zones = 12 000 ha

(3) See Table 32.1. Present population in development zones = 9 000 families.

(4) Adjusted for reduced cropping in several zones.

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APPENDICES

APPENDIX A

CHEMICAL CONTROL METHODS

A.1 Introduction

There is a variety of methods, outlined below, for applying crop pesticides and herbicides and which are available or are practised in Somalia.

(a) Hand application of dust or granule formulations (pesticides only).

(b) ULV (ultra low volume) spraying using battery-operated microsprayers or adapted motorised knapsack (pesticides only).

(c) Low volume (LV) spraying using a modified microsprayer (herbicides only).

(d) Low and high volume (LV and HV) spraying using knapsack sprayers (pesticides and herbicides).

(e) Tractor pto-operated boom sprayers (pesticides and herbicides).

(f) Aerial spraying (pesticides and herbicides).

When applying chemicals, the aim is to use a method which is the most economical, the last labour intensive and the most effective. A comparison of these methods is put forward in this appendix, together with simple financial analyses of application costs, in order to determine the most feasible method for the Study Area. The discussion is limited to application methods and does not include information on chemicals to be used. This is discussed in the appropriate chapters on crop recommendations. Application costs are based on late 1977 internal prices (e.g. ONAT) with labour costs at So. Shs. 1.00 per manhour. Labour costs were based on survey information collected during 1977 (see Appendix D). Estimated costs will be given including or excluding labour costs to cover both smallholders' and large scale crop production i.e. where labour is effectively free or must be hired. Application of fungicides is not discussed as no fungal problems exist in the Study Area.

A.2 Hand Application Methods

These methods are the most labour intensive and also have a limited scope in the context of known pest problems on crops in the Study Area. Usage is as follows:-

(a) Spot applications of dusts or granules for wide row crops and bananas.

(b) Broadcasting granular formulations of systemic pesticides in narrow-row crops (e.g. Carbofuran to control rice stemborer) or as pre-planting treatments against soil pests.

A.2.1 Labour Requirements

Estimated requirements are:-

(a) Broadcasting - 5 manhours per hectare
(b) Spot applications, dusting - 25 manhours per hectare

A.2.2 Application Costs

(a) With labour costed - So. Shs. 5 or 25 per hectare
(b) Without labour costed - nil

A.3 ULV Microsprayers

As part of their experimentation programme, Ciba-Geigy are operating a ULV spraying service at several projects along the Shabeelle river. A team of operators is employed using light, battery operated ULVA microsprayers. One or two litres of the oil-based ULV formulation can be applied before refilling is necessary. At a basic application rate of 2.5 l/ha per application, plus the ease of application, one advantage of this method is speed and a low labour requirement. The other advantages include:-

(a) Better sticking properties compared to conventional water-based formulations used for high volume spraying.

(b) The very small droplet size and movement in the air gives better chemical coverage on the plant.

(c) Minimal equipment maintenance.

The disadvantage of ULV spraying is that spraying is limited to periods in the day when winds are very light. In the Study Area, ULV spraying will be restricted to about three hours in the early morning before the moderate or strong winds pick up.

A.3.1 Labour Requirements

Walking speed of operator = 29.2 to 4.5 km/h
Spray width (depends on crop height) = 3 to 5 m
Average spraying time = 0.70 manhour/ha
Total labour requirement with filling time = 0.85 manhour/ha

This corresponds with the average requirement of 50 minutes per hectare recorded by Ciba-Geigy (i.e. 0.83 manhour/ha including filling).

A.3.2 Application Costs

Estimated 1977 price for ULV microsprayers is So. Shs. 200 each. Estimated life is one to two years when on an intensive spraying programme for cotton, such that one sprayer can be used to spray 200 to 300 ha in one year. Depreciation costs are based on these figures. Each microsprayer uses eight 1.5 volt standard torch batteries with an average battery life of seven hours. 1977 battery prices were So. Shs. 1.80 each. Application costs per hectare are as follows:-

	So. Shs. per hectare	
	With labour	Without labour
Depreciation costs	0.60	0.60
Labour	0.85	-
Batteries	1.75	1.75
Contingencies (10 - 15%)	0.30	0.35
Application cost/ha	3.50	2.70

No maintenance costs are involved as it is effectively cheaper to replace than repair.

A.4 LV Microhandy

Ciba-Geigy have also developed a modified version of the ULVA microsprayer for low volume application of herbicides. It involves the same principle of a rapidly spinning disc to disperse very fine droplets. It has a modified carrier enabling a 5 litre container to be attached. The Microhandy is easily used with one hand. At standard spray rates of 12 litres per hectare, several refills per hectare are necessary. The advantages and disadvantages are the same as for the ULVA microsprayer.

A.4.1 Labour Requirements

Due to the larger droplet size, spray width is limited and, as a greater volume is carried, walking speed is slower; both of these in comparison with the ULVA microsprayer. A slightly increased filling time is also required. Labour requirements are estimated as follows:-

Walking speed (operator generally not impeded by plants)	= 3.6 km/h
Spray width	= 3 m
Estimated spraying time	= 0.90 manhour/ha
Total labour requirement with filling time	= 1.15 manhours/ha

A.4.2 Application Costs

The 1977 ONAT price for each Microhandy is So. Shs. 201.50. Consequently, depreciation and maintenance costs can be taken as for the ULVA microsprayer. Battery costs will be higher due to the longer spraying time per hectare. Application costs per hectare are as follows:-

	So. Shs. per hectare	
	With labour	Without labour
Depreciation costs	0.60	0.60
Labour	1.15	-
Batteries	2.35	2.35
Contingencies (10 - 15%)	0.40	0.45
Application cost/ha	4.50	3.40

A.5 Motorised Knapsack Sprayers

These sprayers are used mainly for low-volume applications (e.g. as mistblowers) as they are better equipped to produce a more even distribution of finer droplets than conventional knapsack sprayers. Certain makes (e.g. Fontan R.II manufactured by Cooper Pegler, UK) can be adapted for ULV spraying as well as applying dusts and granules. The ULV adaptation with the standard 10 litre tank reducs spraying times since no refilling is necessary. LV applications are also faster because filling times are reduced compared to the Microhandy. Spraying times during the day remain the same. Disadvantages of motorised sprayers however, are weight (approx. 22 kg when full), maintenance and increased costs.

A.5.1 Labour Requirements

(a) For ULV spraying, the slowest operator speed is taken due to the extra weight carried:-

Walking speed	=	2.9 km/h
Spray width	=	3 to 5 m
Average spraying time	=	0.85 manhour/ha
Total labour requirement	=	0.95 manhour/ha

The overall requirement assumes no filling time needed, but an allowance is necessary to cover engine maintenance.

(b) For LV spraying, extra time is required for filling. This can involve from one refill per hectare (e.g. for herbicide solutions at 12 l/ha) up to a maximum of five refills (e.g. pesticide solutions at 50 l/ha). Consequently, labour requirements will also involve an assistant for measuring and preparing chemical solutions. Extra requirements are as follows:-

Maximum refilling time at 8 - 10 minutes per refill	= 0.80 manhour/ha
Assistance at one assistant per 4 sprayers	= 0.45 manhour/ha
Spraying time (see paragraph (a))	= 0.95 manhour/ha
Maximum LV labour requirement	= 2.20 manhours/ha

A.5.2 Application Costs

The 1977 ONAT price for a 'Carpi' motorised sprayer is So. Shs. 1 712. Ciba-Geigy estimate the price of a Fontan R.II sprayer to be So. Shs. 2 000. Costs will be based on the Fontan sprayer due to its versatility and improved performance over the Carpi sprayer. During 1977 spraying trials at CARS, Afgooye, the Carpi sprayer proved to be the least reliable. Application costs are as follows:-

	So. Shs. per hectare	
	With labour	Without labour
Depreciation costs (4 year life expectancy and 200 ha/year sprayed)	2.50	2.50
Maintenance costs, including fuel and oil, at 20% capital cost per annum	2.00	2.00
Labour (ULV and LV)	0.95 - 2.20	-
Contingencies (10 - 15%)	0.55 - 0.70	0.70
Application cost/ha	6.00 - 7.40	5.20

A.6 Hand-pumped Knapsack Sprayers

Compared to motorised sprayers, standard knapsack sprayers have the advantage of being cheaper and require less maintenance. However, they are the most labour-demanding method of crop-spraying as they can only be used for high volume (HV) spraying (i.e. 50 to 300 l/ha). Consequently, application rates are slow due to more frequent refilling, narrow spray widths and greater operator work requirement during spraying. Crop cover is also less efficient due to larger drop size, run-off and less contact with under-surfaces of leaves.

A.6.1 Labour Requirements

Operator speed	= 3.6 km/h (1 m/s)
Spray width	= 0.75 to 3.0 m
Spraying time	= 0.95 to 3.70 manhours/ha
Refilling time at 100 to 200 l/ha, 20 l spraying capacity 8 - 10 minutes per refill	= 0.80 to 1.60 manhours/ha
Assistance for refilling based on one person for 4 sprayers	= 0.6 manhour/ha
Total labour requirement	= 2.35 - 5.90 manhours/ha

The above estimates show a wide range of labour inputs needed depending on spray volume and spray width. Ciba-Geigy estimated application of herbicide solutions, at a rate of 150 l/ha and using nozzles for the full width of 3 m, to take 2.0 to 2.5 hours per hectare spraying time, exclusive of assistance.

A.6.2 Application Costs

Several knapsack sprayers are available at ONAT, ranging in price from So. Shs. 400 to 720 each. During spraying trials at CARS, Afgooye, the Cooper Pegler CP 3 sprayer proved to be the most efficient. Ciba-Geigy also currently recommended the use of this sprayer. Five easily changeable nozzles give the CP 3 sprayer versatility. This sprayer also has the largest tank volume (20 litres) compared to others available. The 1977 ONAT price for the CP 3 sprayer is So. Shs. 720. Application costs, using the CP 3, are as follows:-

	So. Shs. per hectare	
	With labour	Without labour
Depreciation costs (based on 150 ha/year and 5 year life expectancy)	1.00	1.00
Maintenance costs (based on 15% capital costs per annum)	0.75	0.75
Labour	2.35 - 5.90	-
Contingencies (10 - 15%)	0.40 - 0.75	0.25
Application cost/ha	4.50 - 8.40	2.00

A.7 Boom Sprayers

Tractor-drawn boom sprayers are also used for HV spraying, with application speed dependent upon the boom width. Typical times for standard equipment are 0.3 and 0.6 hour per hectare at an efficiency of 70%. Consequently, boom sprayers are both the quickest ground-based method of crop-spraying and the least labour-demanding. However, they have several disadvantages. Application efficiency can vary depending on operator skills, blocked nozzles etc. HV spraying results in incomplete crop cover. Also, on the heavy Study Area soils, tractor movement can easily be impeded under wet soil conditions such that either field damage is risked or spraying delayed until the soil is sufficiently dry. Both are detrimental to crop production. Under irrigated conditions on heavy soils and with the erratic rainfall in the Study Area, in-field tractor operations should be kept to the minimum.

A.7.1 Operation Costs

It has been estimated that the average 1977 operating cost of 60 to 70 hp tractors, with standard equpment included, So. Shs. 70 per hour (see Appendix C). This cost is inclusive of maintenance, fuel, oil, driver's wages etc. Consequently, at an expected operating time of 0.5 h/ha, operating costs are estimated at So. Shs. 35/ha.

A.8 Aerial Spraying

During 1977, Ciba-Geigy arranged several demonstrations of aerial spraying at the Balcad cotton scheme and the Libsoma project, Afgooye. The aim was to indicate the efficiency and rapidity of both ULV insecticide and LV herbicide applications in comparison with standard ground-operated methods. The necessity was due to increasing problems in providing effective spraying with limited labour on schemes that are scheduled for further expansion. A-D-Airspray (Kenya) Ltd supplied a fully-equipped aircraft for the demonstration and the following estimated costs were collected from them. Due to the highly skilled nature of aerial spraying, any future work will entail routine arrangements with the same or similar firms based in Kenya.

A.8.1 Application Costs

Costs were estimated for Somalia to be as follows:-

(a) LV herbicide application:- So. Shs. 40 to 50/ha

(b) ULV insecticide application:- So. Shs. 27 to 32/ha

These estimated rates will only be applicable if the minimum area to be sprayed per trip (ex Kenya) is at least 1 000 ha within a 100 km radius. Minimum operating times were estimated to vary from 120 ha/h (LV) to 200 ha/h (ULV).

A.9 Discussion

A.9.1 Crop Spraying

Labour requirements and estimated application costs for all methods are summarised in Table A.1. In general, the most efficient method of pesticide application is by ULV spraying, using ULV microsprayers. The only cheaper method is using standard knapsack sprayers where labour is not a costed item (e.g. on co-operatives) but a significantly greater labour input is involved with less efficient spraying. Other less labour-demanding methods are far more costly (i.e. boom sprayers and aerial spraying) with far greater technical problems involved. As the labour input for ULV spraying is small and no real labour shortage exists in the Study Area, the latter two methods are considered superfluous. Consequently, where herbicide recommendations are made, LV application should be with the equally efficient Microhandy. Despite the shortened spraying time per day, both these methods have sufficient flexibility to accommodate daily variability in weather conditions, soil moisture, irrigation and general crop management. 1977 ONAT chemical prices show no differences between ULV formulations and standard WP or EC formulations.

A.9.2 Dust and Granule Application

In certain circumstances, application of dusts or granules will be necessary, for example, nematode control in bananas or cutworm control in sesame. Although sprayers like the Fontan R.II can be modified to apply dusts and granules application costs and labour inputs using this method will be much higher than for spraying. This is due to the low percentage of active ingredient in these formulations and correspondingly higher application rates. Most dust or granular formulations contain less than 10% active ingredient. Tractor pto-operated spreaders can also be used. At 8 km/h with a spreading width of 6 m and an operating efficiency of 70%, this would require 0.3 h/ha. At a cost of So. Shs. 70 per tractor-hour, this represents an estimated application cost of So. Shs. 21/ha.

Therefore, since these applications will not be required at frequent intervals, hand application methods are recommended.

TABLE A.1

Labour Requirements and Application Costs of Chemical Application Methods (1977)

		Spray volume	Labour requirement (manhours/ha)	Application cost (So. Shs./ha) With labour (5)	Application cost (So. Shs./ha) Without labour (1)
Hand application (dust and granules)		-	5 - 25	5 - 25	-
ULVA microsprayer		ULV	0.85	3.50	2.70
Microhandy		LV	1.15	4.50	3.40
Motorised knapsack sprayer	(a)	ULV	0.95	6.00	5.20
	(b)	LV	2.20	7.40	5.20
Hand-pumped knapsack sprayer (2)		HV	2.35 -5.90	4.50 - 8.40	2.00
Boom sprayer		HV	0.5(3)	35.00	35.00
Aerial spraying:	(a)	ULV	0.02(4)	27 - 32	27 - 32
	(b)	LV	0.03 (4)	40 - 50	40 - 50

Notes:
(1) Smallholder or group farm co-operative situation

(2) Full range given: normally less than 3.5 manhours/ha such that costs with labour less than So. Shs. 5.80/ha.

(3) Tractor driver only

(4) Includes ground staff assistance

(5) Labour costed at So. Shs. 1.00/manhour except for boom sprayer and aerial spraying.

Source: Ciba-Geigy (East Africa) Ltd, A-D-Airspray (Kenya) Ltd and survey data (1977)

APPENDIX B

WEED CONTROL METHODS

APPENDIX B

WEED CONTROL METHODS

B.1 Introduction

Weed control is one of the major problems affecting production in the Study Area. Several methods can be used for a range of annual crops and these are discussed below. However, in order to minimise weed levels, control measures must not be limited to within growing crops. Regular canal clearance, destruction of weeds on any fallow land and timely land preparation will all markedly reduce weed levels within the field. Discussion on weed control in perennial crops is given in Chapter 15.

B.2 Hand Weeding

This is the least expensive and most effective means of weed control if practised properly. In terms of present methods, effective hand weeding will require the following improvements:-

(a) More frequent weeding. For all annual crops it is essential to weed twice within the first 20 to 25 days, with a total of three to four weedings per crop before full cover is reached.

(b) Better timing. Any weeding must be at least three to four days prior to an irrigation in order to allow effective dessication to take place.

(c) With furrow irrigation, weeding must be toward the ridge in order to maintain the furrow and place weeds onto the ridge to hasten dessication.

(d) Better implements need to be introduced to replace the very small short-handled yambo. The East African jembe (mattock) will be more effective for wide-row crops. For rice, with narrow rows, long-handled hoes of the correct blade width or specially designed rice-weeders will also reduce labour inputs and increase efficiency.

However, hand-weeding is the most labour-intensive method of weed control and therefore must be considered in conjunction with other methods if labour shortages are likely to occur. With furrow irrigation both chemical and mechanical control can be used, but with basin irrigation, chemical control is the only alternative to hand weeding. With the high Study Area population, utilisation of hand weeding must be considered first before recommendation or introduction of other methods.

B.3 Mechanised Cultivation

The advantages of this method are speed and the ability to combine several operations in one pass when a reasonable degree of mechanisation is required. Combined operations that simultaneously control weeds are ridging up (for furrow irrigation) and top dressing which requires a covering up operation. It also represents a simple flexible mechanised input requiring only cultivator bodies attached to a tool-bar. Disadvantages of mechanised cultivation are as follows:-

(a) It is not recommended for basin irrigation due to continual damage to bunds and inefficient control while crossing bunds.

(b) Tractor movements within fields can easily be restricted and delayed under wet conditions on the heavy soils due to erratic rainfall in the Study Area.

(c) With furrow irrigation, headland damage will occur due to restricted turning at field watercourses and surface drains.

(d) Although the same operation frequency and timing as hand weeding will be required, not all cultivations can be mechanised. For tall crops, such as cotton and maize, final cultivations will require hand labour.

Consequently, mechanised cultivation should be restricted and only used to supplement hand labour where considered necessary or in emergencies.

B.4 Herbicides

Ciba-Geigy are presently evaluating chemical weed control methods for a range of crops grown under irrigation. Their current recommendations for Somalia are provisional for most crops as formulations and application methods are still under test. Specific recommendations are only available for maize, rice, sugar-cane and bananas. Current recommendations for selected crops are given in Table B.1.

For maize, no further weeding is necessary but for upland rice, several extra hand weedings are required due to the short residual effect of present Preforan and Stam F34 recommendations.

The advantages of herbicides are low labour inputs and avoidance of mechanised cultivation on the heavy Study Area soils. However, considerable skill is required in order to apply the required dosage, and to time applications in relation to weed growth, crop growth and soil moisture. Some recommendations may not give full control over certain weeds e.g. sedges, of which Cyperus is of particular importance (see Annex IV Appendix B). Present prices (ex ONAT) also make chemical control expensive.

TABLE B.1

1977 Ciba-Geigy Herbicide Recommendations: Irrigated Crop Production, Somalia

Crop	Herbicide	Timing	Application rate (l/ha)	Residual effect
1 Maize	Primextra 500 FW (atrazine/duel) (1)	Pre-emergence	5	4 months
2 Rice	Preforan 30 or 34 E.C. (2) (fluorodifen)	Post-emergence	12	4-6 weeks
Bananas (a)	Gesapax 500 FW (ametryne)	Pre-emergence	4	2-3 months
Bananas (b)	Gesapax/Gepiron (ametryne/MSMA)	Post-emergence (successive treatments)	4	3-4 months

Notes: (1) Duel = metolachlor

(2) Normally used in ratio of 60% Preforan and 40% Stam F34 (Propanil)

Source: Ciba-Geigy (1977)

B.5 Discussion

Estimated costs of weed control methods are summarised in Table B.2. A range of alternatives incorporating mechanised cultivation is included in this table. Herbicides represent, on average, the most expensive means of weed control. Mechanised cultivation is slightly more costly than hand labour, particularly when both are combined. However, under smallholder farming or with co-operative group farms, where labour is effectively free, other methods become disproportionately expensive by comparison. As the majority of the high Study Area population is engaged in smallholder agriculture, and as labour is not considered to be a restriction, hand weeding must be considered as the main method of weed control for annual crops. Hand weeding will be more efficient with the use of better implements to replace the yambo. Exceptions will occur and are discussed under each crop in Annex VI in relation to chosen cropping patterns. An example is mixed cropping by large scale farmers. In order to avoid labour availability problems, a single herbicide application can be used on maize crops so that hired labour can concentrate on weeding other crops. Chemical weed control in maize is the easiest and cheapest of present herbicide recommendations.

TABLE B.2

Estimated Weed Control Costs (1977)

Method	Data	Cost/ha (So.Shs.) With labour	Cost/ha (So.Shs.) Without labour(1)
Hand weeding	50 manhours/ha at So.Shs. 1.00 per manhour and 3 to 4 weedings per crop	150 - 200	Nil
Mechanised cultivation	0.89 tractor-hour/ha at So.Shs. 70/ha		
	(a) 3 cultivations plus hand weeding	237	187
	(b) 2 cultivations plus 1 to 2 hand weedings	175 - 225	125
	(c) 1 cultivation plus 2 to 3 hand weedings	163 - 213	63
Herbicides	Spraying time (with LV Microhandy) = 1.15 manhours/ha (2) 5 to 12 l/ha at So.Shs. 37.50/l(3)	189 - 451	188 - 450

Notes: (1) For smallholder situation
(2) See Appendix A
(3) Average 1977 cost (ONAT)

APPENDIX C

MACHINERY OPERATION COSTS

APPENDIX C

MACHINERY OPERATION COSTS

All operation costs are given in So. Shs. per operating hour and are based on 1977 financial prices or, where necessary, estimated prices.

C.1 Medium Duty Tractors (60 to 75 hp)

Capital cost:- 1977 ONAT prices for Fiat/Same 4-WD tractors are So. Shs. 85 000 (60 hp) and So. Shs. 110 000 (70 to 75 hp)

	Cost factor	Operating costs (So. Shs./h) 60 hp	70 - 75 hp
(i)	Depreciation 10 000 hours working life	8.50	11.00
(ii)	Maintenance 25% capital cost per year and 1 500 hours per year	12.00	15.00
(iii)	Wages So. Shs. 15 per operator for a 6 hour day. Based on 4 operators to include shiftwork, mechanic's time, assistance etc. to cover an 8 hour tractor working day.	10.00	10.00
(iv)	Fuel 6 - 8 l/h at So. Shs. 1.60/l	9.50	12.50
(v)	Tax and registration Less than So. Shs. 1 000 per year	1.00	1.00
(vi)	Implement costs Based on capital cost range of So. Shs. 8 000 to So. Shs. 25 000 per implement. Depreciation and maintenance costs based on 10 000 hour working life and 500 hours use per year. Cost range is So. Shs. 4 to 12.50 per hour	12.50	12.50
Sub-total		53.50	62.00
20% contingencies		10.70	12.40
TOTAL		64.20	74.40

Average operation cost is So. Shs. 69.30 per hour and taken as So. Shs. 70 per hour.

C.2 Heavy Duty Tractors (100 hp)

Requirements for banana production only.

Capital cost:- 1977 ONAT price for Fiat/Same 4-WD tractors is So. Shs. 150 000 (100 hp)

	Cost factor	Operating costs (So. Shs./h)
(i)	Depreciation	15.00
(ii)	Maintenance	25.00
(iii)	Wages. As for medium duty tractors	10.00
(iv)	Fuel. 11 l/h at So. Shs. 1.60/l	17.50
(v)	Tax and registration	1.00
(vi)	Implement costs. As for medium duty tractors	12.50
Sub-total		81.00
20% contingencies		16.50
TOTAL		97.50

Note: Depreciation, maintenance and tax estimated in same way as for medium duty tractors.

Alternative requirements for banana production involve 60 to 70 hp crawler instead of 100 hp 4-WD wheeled tractors. Cost estimates based on UK prices show that at the same power output, cost prices for crawlers are 50% greater than for wheeled tractors. Using ONAT prices, estimated cost price of 60 to 70 hp crawlers is virtually the same as 100 hp 4-WD tractors. Therefore operation costs are assumed to be identical and taken as So. Shs. 100 per operating hour.

C.3 Combine Harvesting

Capital cost:- Estimated at So. Shs. 276 000 as 1977 financial price for MF 307 model (77 hp) including conversion for rice harvesting. Estimated capital cost based on 1977 UK FOB price.

	Cost factor		Operating costs (So. Shs./h)
(i)	Depreciation	10 000 hour working life	28.00
(ii)	Maintenance	15% capital cost per year and 400 hours use per year	103.50
(iii)	Wages	As for tractors (see Section C.1)	10.00
(iv)	Fuel	10 l/h	16.00
(v)	Tax and registration	As for tractors	1.00
Sub-total			158.50
20% contingencies			31.50
TOTAL			190.00

Estimated operating cost taken as So. Shs. 190/h. It must be noted that this cost will vary considerably with annual usage due to the high cost component for maintenance. Compared to tractor operations, less maintenance is envisaged due to less usage per year (i.e. as 15% and not 25% capital cost per annum). Fuel consumption assumes steady operation on firm flat land.

C.4 Land Levelling Costs

Capital cost:- Estimated 1977 financial price for land levellers based on Eversman 3212 RT model is So. Shs. 34 600. Estimated price based on 1977 USA FOB price.

Relevelling of fields costed as follows:-

	Cost factor	Operating costs (So. Shs./h)
(i)	Tractor operating costs (medium duty)	70.00
(ii)	Implement cost including 20% contingencies deducted (see Section C.1)	15.00
Sub-total (basic tractor cost)		55.00
(iii)	Leveller cost, based on 10 year working life, 280 hours use per year and 10% capital costs per year for depreciation and maintenance costs	24.00
(iv)	20% contingencies (leveller cost only)	5.00
TOTAL COST		84.00

C.5 Hand Operated Equipment

Capital costs are estimated ONAT prices based on known FOB prices from the country of origin.

Estimated yearly usage for each implement is based on a 4 to 6 hour working day, 30 day planting season (i.e. 30 day period for each operation) and one or two seasons per year depending upon the crop. Estimated labour requirements are taken from Appendix D and costed at So. Shs. 1.00/manhour.

C.5.1 Estimated Capital Costs

Implement		Origin	Cost (So. Shs.) FOB country of origin	ONAT retail price
Groundnut sheller		Tanzania	450	800
Groundnut stripper		Senegal	550	1 100
2 row rice drill		Senegal	359 - 500	700 - 1 000
Rice thresher	(a)	India	1 000	2 000
	(b)	Senegal	2 150	4 300
Rice weeder		India	62.50	125
Seed-dressing drum		Somalia	-	1 000 (1)

Note:- (1) locally made; not sold through ONAT

C.6 Animal-drawn Equipment

All data are based on information collected from Indian manufacturers. Yearly usage can be calculated as for hand-operated equipment. However, as each implement can cover at least 0.5 ha/day, full use per year will depend on communal ownership and operation by smallholders. Cost estimates assume 25 hectares per year usage, although on co-operatives up to 60 hectares per year can be expected. Estimated operation costs are given below.

C.5.2 Estimated Operating Costs

	Groundnut sheller (1)	Groundnut stripper (3)	Rice drill	Rice thresher (2)	Rice weeder	Seed-dressing drum
Depreciation - 10 year life (So.Shs./year)	80	110	70-100	200-430	12.50	100
Maintenance - 10% capital cost/year (So.Shs./year)	80	10	70-100	200-430	12.50	100
10% contingencies (So.Shs.)	16	22	14-20	40-86	2.50	20
Cost/year (So.Shs.)	176	242	154-220	440-946	27.50	220
Estimated usage/year (as ha/crop)	100	18-20	20	30	10-12	up to 500
Cost/ha without labour (So.Shs.)	2	13	8-11	15-32	2-3	0.50
Labour requirements (manhours/ha)	4	20	30	50	25-30	negligible
Cost/ha with labour	6	33	38-41	65-82	27-33	less than 1.00

Notes: (1) Used for providing planting material only

(2) Output = 2 q/h. Calculations based on 25 q/ha yield

(3) Output = 2 q/h. Calculations based on 20 q/ha yield (pods)

C.6.1 Estimated Operating Costs for Animal-drawn Equipment

Implement	FOB Bombay	ONAT retail price	Depreciation 5 year working life	Maintenance 10% capital cost/year	Contingencies (10%)	Total	Cost/ha (1) (So.Shs.)	Cost/ha (2) with labour (So.Shs.)
Cultivator	190	380	76	38	11	125	5	25
Bund-former	100	200	40	20	6	66	3	23
V-ridger	175	350	70	35	10	115	5	25
Wooden leveller	250	500	100	50	15	165	7	27
Harrow	450	900	180	90	27	297	12	32

Notes: (1) Assumes 25 hectares per year usage

(2) Assume labour requirements of 2 men per team and 0.5 ha covered per 5 hour day, i.e. 20 manhours/ha

C.7 Miscellaneous Equipment

Operational cost data for selected shellers and rice-levelling equipment are given below, based on an annual usage of 500 hours. All capital costs are estimated prices based on FOB prices from country of origin.

Make	Ransomes (UK) 'Cobmaster' Maize-sheller	Ransomes (UK) 'Lion' Maize-sheller	Ce Co Co (Japan) Rice-huller
Operation	100 cc engine	Tractor pto	2 hp engine
Capital cost (as 1977 ONAT price) (So. Shs.)	3 000	28 000	20 000
Operational costs/year (So. Shs.)			
Depreciation (10 year life)	300	2 800	2 000
Maintenance (10% capital cost/year)	300	2 800	2 000
Fuel (250 litres at So. Shs. 2.25/l)	560	-	560
10% contingencies	116	560	456
TOTAL COST/year (So. Shs.)	1 276	6 160	5 016
Tractor cost per hour (So. Shs.)	-	40.00 (1)	-
Operational cost per hour (500 h/year) (So. Shs.)	2.50	52.00 (2)	10.00
Capacity per hour (q)	7.5 shelled grain	30 shelled grain	6 paddy (input)
Assumed yield per hectare (q)	35 (shelled)	35	25 (paddy)
Cost per hectare (So. Shs.)			
(a) without labour	12.00	61.00	42.00
(b) with labour	22.00	71.00	52.00
Cost per quintal (So. Shs.)			
(a) without labour	0.35	1.75	1.70 (3)
(b) with labour	0.65	2.00	2.10

Notes:
(1) Cost per hour of 60 hp tractor without implements and with one operator.
(2) So. Shs. 6 160/500 + So. Shs. 40 = So. Shs. 52.
(3) At 65% milling percentage, cost per milled quintal is So.Shs. 2.60 (without labour) and So. Shs. 3.25 (with labour).

APPENDIX D

ESTIMATED LABOUR REQUIREMENTS : ANNUAL CROP PRODUCTION

APPENDIX D

ESTIMATED LABOUR REQUIREMENTS: ANNUAL CROP PRODUCTION

D.1 Introduction

All estimated requirements are based mainly on information obtained from the following sources:-

(a) Study Area surveys

(b) Development projects along the Lower Shabeelle river (listed in Chapter 1)

(c) Reported data from the FAO pilot project, Afgooye (FAO, 1975), 'Management of the Shabelli River' (HTS, 1969) and 'Agricultural Sector Project Identification (IBRD, 1973).

The overall lack of accurate information from within Somalia necessitated much cross-reference in order to determine average requirements. These requirements are given as manhours per hectare per operation in order to avoid any confusion over defining the standard unit of mandays. However, unless stated otherwise, one manday is taken to be four manhours as used for the labour availability study presented in Annex IV, Appendix A.

From a wide range of examples, survey data showed that at average work and payment rates, one manhour can be costed at So. Shs. 1.00. This figure is used in Part II to cost labour requirements for each crop under consideration. However, as smallholder agriculture is the predominant farming system to be developed, labour costs will be both included and excluded in order to compare costs between smallholder systems and large scale production. This has also been carried out in Appendices A and B which compare pest and weed control methods.

D.2 Estimated Labour Requirements

Crop	Operation		Information	Manhours/ha/ operation
All crops	(a) Weeding	(i)	Wide row crops, e.g. maize	50
		(i)	Narrow row crops, e.g. rice	
			(a) by yambo	60
			(b) by improved rice-weeder	25 - 30
	(b) Fertiliser application	(i)	Broadcast	5
		(ii)	Side-dressing before tractor cultivation (for covering up)	10
		(iii)	Side-dressing with covering up by hand tools	25
	(c) Chemical application	(i)	Broadcasting granules	5
		(ii)	ULVA microsprayer (pesticides)	0.85 (i.e. 1 manhour)
		(iii)	LV Microhandy (herbicides) (See Appendix A)	1.15 (i.e. 1 manhour)

Crop	Operation		Information	Manhours/ha/ operation
All crops	(d) Seed-dressing		Less than ten minutes per quintal of seed using dressing-drum. Most seed rates less than 100 kg/ha	Nil (See misc. labour)
	(e) Planting	(i)	Check-row (e.g. maize at 80 cm x 80 cm)	20
		(ii)	Row planting on ridges	
			(a) wide spacing (e.g. maize)	25
			(b) close spacing (e.g. groundnuts)	40
	(f) Thinning		If required for wide row crops (can be combined with a weeding)	20
	(g) Loading		Loading and unloading of harvested grain/produce. Assumes 8 manhours to load and unload 5 tonne trailer (except cotton with 5 manhours for 2 tonnes). For all crops except tomatoes and tobacco. Final input dependent on yield	2 - 6
	(h) Irrigation	(i)	Basin irrigation	9
		(ii)	Furrow irrigation. Based on 4 men per team using 60 siphons, 6 hours per irrigation and 300 m furrow length	
			(a) Furrow spacing = 0.8 m	17
			(b) Furrow spacing = 0.6 m	22
			(Note:- Irrigation period and furrow length discussed in Annex VII)	
	(i) Watercourse and surface drain clearance		50 m cleared in 4 hours and assumes 300 m field width. Therefore, 100 m length of watercourse equivalent to 3 ha NCA	
			(a) watercourse clearance	3
			(b) surface drain clearance	3
	(j) Miscellaneous labour		10% extra requirement to total requirement per crop to cover contingencies and small inputs	Variable
Maize	Harvesting		Cutting and stooking	40
			Cutting stover	25
			Loading stover	15
			Cob picking and dehusking	40
			Cob picking only	25

Crop	Operation		Information	Manhours/ha/ operation
	Shelling	(a)	pto-driven sheller (30 q per hour output) with 8 operators	10
		(b)	Hand-operated (7½ q per hour output) with 2 operators (Note:- assumes yield of 35 q/ha shelled grain)	10
Rice	Bird scaring		Elder children only at 3 per ha/day (12 h/day). At 1977 wage rate of So. Shs. 4/day, costed as equivalent to 1½ mandays/ha/day (At 35 days bird scaring period from flowering to harvest, costed equivalent is 420 manhours/ha).	105 child-days
	Drilling		2-row hand operated drill	30
	Cutting and threshing	(i)	Cutting with sickle; threshing with treddle-operated thresher	200 - 250
		(ii)	Threshing only (25 q/ha)	50
Cotton	Picking		3 pickings:-	
			(i) 25% crop at 17 kg per 4½ hour day	135
			(ii) 55% crop at 30 kg per 4½ hour day	165
			(iii) 20% crop at 20 kg per 4½ hour day	90
			Total	390
			(Based on yield of 20 q/ha seed cotton)	
	Uprooting		As for sesame	90
	Burning trash		After raking uprooted plants	3
Groundnuts	Harvesting		Lifting and gleaning (after mechanical blading)	130
	Stripping		Hand operated stripper (output = 2 q/h) with 2 operators and assuming yield of 20 q/ha (pods)	20
	Shelling		For planting material; using reciprocating thresher and hand sowing (seed rate = 1 q/ha)	4
Sesame	Harvesting		Pulling and stooking	90
	Threshing		By hand only on mats, etc.	50

Crop	Operation	Information	Manhours/ha/ operation
Sunflower	Harvesting	Cutting heads only	25
	Threshing	Using maize-shellers and assuming yield of 15 q/ha (shelled) and slower operating speed	7
Castor	Harvesting	Using stripping cup; assumes hybrid dwarf varieties	60
	Hulling	As for maize (note:- using separate huller)	10
Tomato	Nursery	All operations (as manhours per transplanted hectare)	30
	Transplanting		65
	Gapping	25% of crop	16
	Harvesting	At 2 manhours/q and assuming yield of 20 t/ha	400
	Loading	Loading only (unloading at Afgooye by ITOP staff). At 4 manhours per 5 tonnes	20
Tobacco	Nursery	As for tomatoes	30
	Transplanting	As for tomatoes	65
	Gapping	As for tomatoes	16
	Topping	Topping and desuckering over 30 day period	80
	Picking	6 - 7 picks every 4 - 5 days (includes placing on strings and transportation to barns)	400
	Grading	25 kg per 5 hours; assuming 1 200 kg/ha yield of cured leaf	240
	Packing	Packing and loading after grading	25
		(Note:- Most data from Chinese Technical Aid experimental tobacco farm, Afgooye)	

D.3 Calculation of Seasonal Labour Requirements

Seasonal labour requirements for selected annual crops are required in order to finalise any cropping pattern recommended for the Study Area. The selected crops are maize, sesame, upland rice, cotton, groundnuts and mixed forage (see Chapter 18).

The method of estimating these requirements is the same method used to assess labour availability in the Study Area (see Annex IV, Appendix A).

Labour requirements per field operation (planting, weeding etc.) for each crop are presented in the relevant chapters of Part II of this annex and Section D.2. These requirements are converted into a daily labour requirement by using this formula:-

$$\frac{\text{Manhours per operation per hectare}}{\text{Working hours per day(d)}} \times \frac{\text{NCA per crop (ha) (a)}}{\text{Number of days to complete operation (b)(c)}}$$

= daily labour requirement per field operation per crop (i.e manpower per day)

Notes: (a) NCA per crop (ha) is taken as 100 hectares. This will enable easy calculation of labour requirements for a selected cropping intensity (as per cent) in any cropping pattern.

(b) For gu season crops, the operation period is taken as 15 days, i.e. 15 days to plant and, therefore, 15 days for each weeding, harvesting etc.

(c) For der season crops, the operation period is 30 days.

(d) One manday is taken as four manhours.

For example; a single weeding will take 50 manhours. The daily labour requirement for a single weeding of maize is therefore:-

$$\frac{\text{50 manhours}}{\text{4 hours per day}} \times \frac{\text{100 ha (net)}}{\text{15 day operating period}}$$

= 83 people per day

However, the following exceptions have been made:-

(a) 20 day operation periods have been taken for post-harvest operations of gu maize, 35 days for gu forage harvesting and 70 days for carting cotton.

(b) For irrigation labour, the operating period is taken as the required period of irrigation per crop.

(c) For the 10% miscellaneous labour input, the operating period is taken as the crop length plus 15 or 30 days depending on the season.

Calculated daily labour requirements per field operation are given in Table D.1.

TABLE D.1

Daily Labour Requirements per Field Operation per 100 ha NCA

	Gu season			Der season				
	Maize	Upland rice	Mixed forage	Maize	Upland rice	Sesame	Cotton	Ground-nuts
Shelling pods	-	-	-	-	-	-	-	3
Apply basal fertiliser	8	-	8	4	-	4	4	4
Planting	42	-	67	21	-	17	21	33
Herbicide spraying	-	3	-	-	1	-	-	-
ULV pest control (1)	4	4	-	2	2	-	2	-
Top dressing	42	8	-	21	4	-	21	-
Hand weeding (1)	250	200	168	126	100	84	168	168
Irrigation (1)	39	25	42	37	25	30	24	35
Harvesting	42	-	86	21	-	75	-	108
Cotton picking								
(1)	-	-	-	-	-	-	113	-
(2)	-	-	-	-	-	-	138	-
(3)	-	-	-	-	-	-	75	-
Carting	10	10	see harvesting	5	5	2	3	5
Post-harvest operations	13	-	18	8	-	42	-	17
Stover collection	50	-	-	33	-	-	-	-
Trash burning	-	-	-	-	-	-	3	-
Miscellaneous	8	6	10	7	5	7	9	9

Note: (1) Total requirements for several operations

Source: Labour requirements presented in Annex VI, Part II and Section D.2.

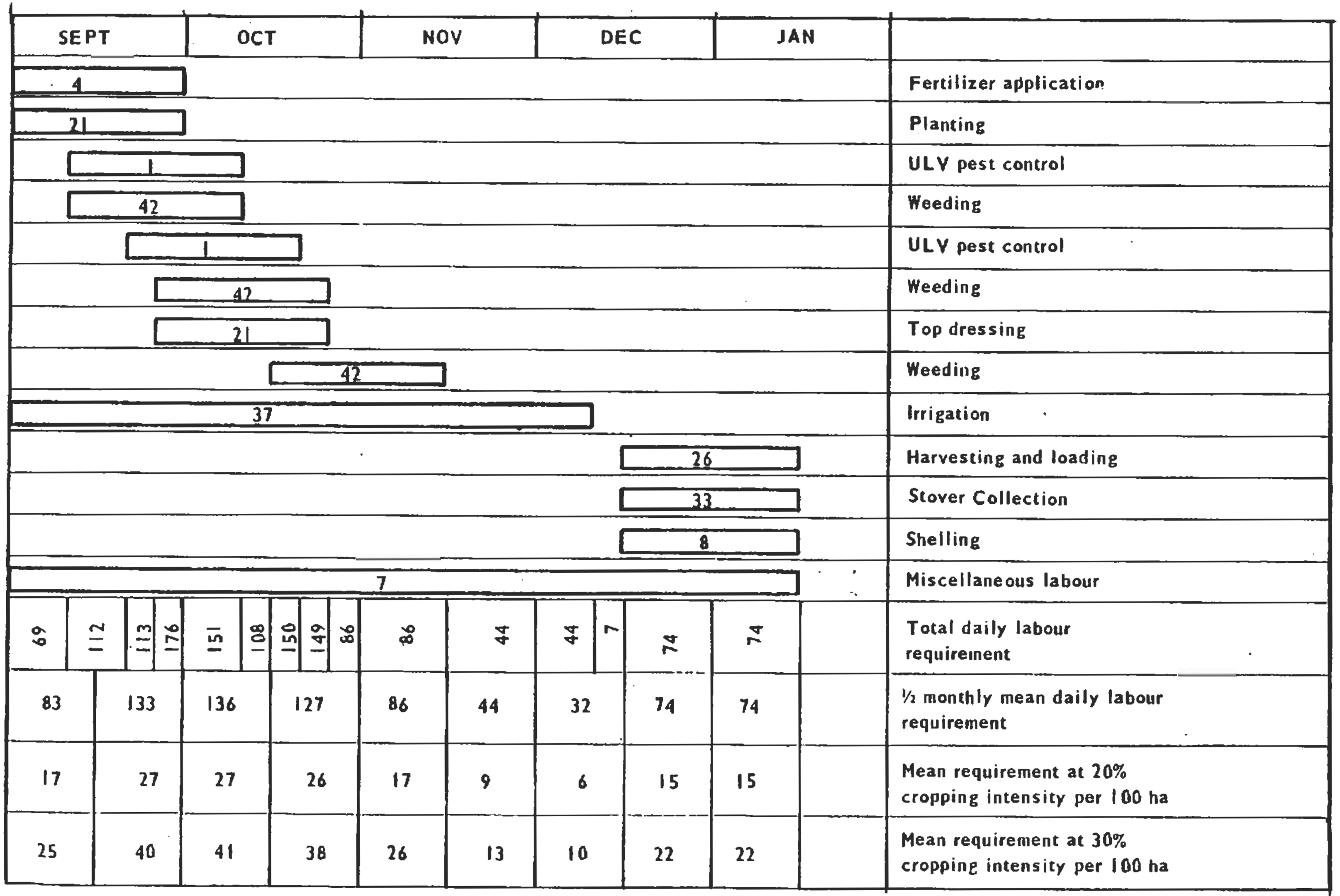
Seasonal labour requirements are then calculated by incorporating the expected timing of field operations for each crop. Two examples for maize and cotton are given in Figures D.1 and D.2. Using the monthly mean data for 100 hectares (net) presented in these tables, the labour requirement for a particular cropping intensity for that crop in any cropping pattern can then be calculated. Examples for maize and cotton are also given in Figures D.1 and D.2. Full seasonal labour requirements for the selected annual crops are given in Chapter 18 as part of the discussion on cropping patterns.

FIGURE D.I.

SEASONAL LABOUR REQUIREMENTS: DER SEASON MAIZE

Planting date . September 1st - 30th

N.C.A. 100 ha

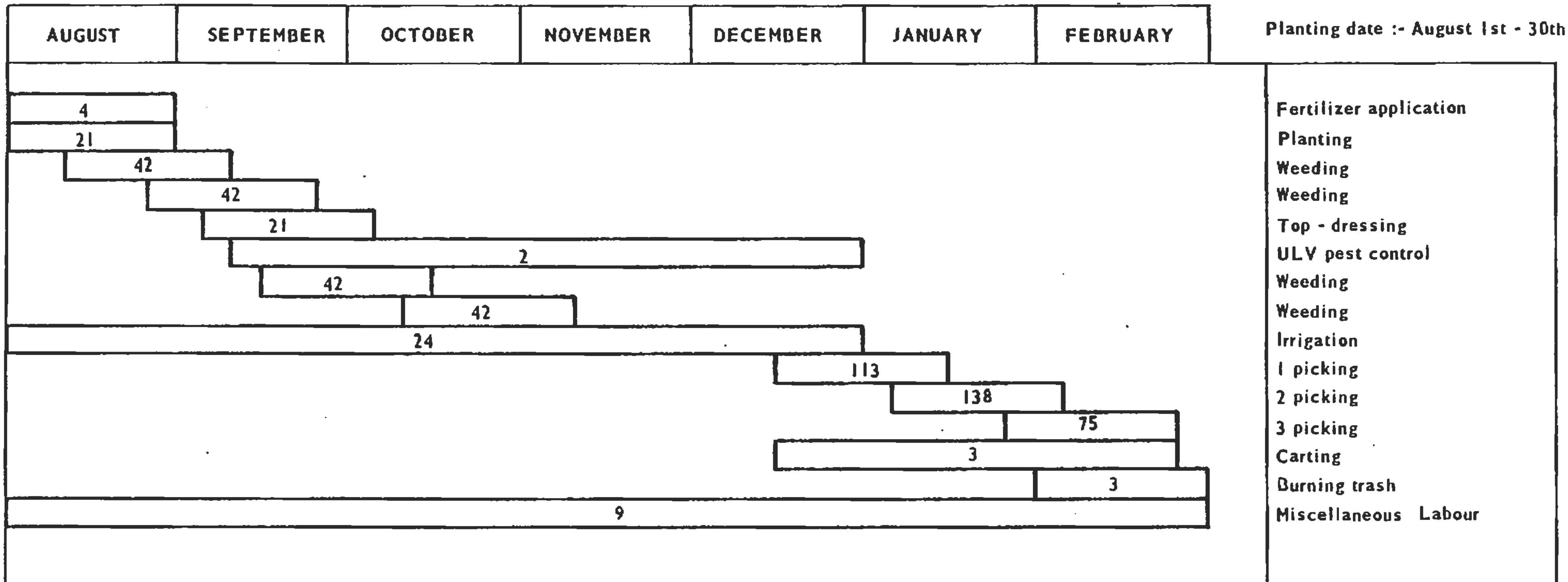


Source:- Annex 6: Part II and Table D.I.

Notes:- [42] daily labour requirement per operation

FIGURE D.2.

SEASONAL LABOUR REQUIREMENTS; DER SEASON COTTON



Total daily labour requirement	58	100	142	117	138	98	140	98	77	119	77	35	151	125	263	150	225	228	90	12	-

½ monthly mean daily requirement	73	114	117	126	98	77	64	35	35	151	217	175	136	64
Mean requirement at 35% cropping intensity	25	40	41	44	34	27	22	13	13	53	76	61	48	22
Mean requirement at 50% cropping intensity	36	57	59	63	49	39	32	18	18	76	108	88	68	32

Source:– Annex 6; Part II and Table D.I.

Notes:- [21] daily labour requirement per operation

APPENDIX E

CROP NUTRITION, FERTILISERS AND FERTILISER RESEARCH TRIAL DATA

APPENDIX E

CROP NUTRITION, FERTILISERS AND FERTILISER RESEARCH TRIAL DATA

There is an overall lack of reliable research and production data on the response of crops to fertiliser applications and applicable to the Study Area. Consequently, fertiliser recommendations given in Chapters 4 to 15 are mainly based on the limited research work carried out at Afgooye, estimated nutrient removal, and related to fertility of the Study Area soils. In all cases further research work is necessary to confirm these general recommendations.

E.1 Available Fertilisers

The chemical composition and 1977 prices of fertilisers regularly stocked by ONAT through the FAO Fertiliser Scheme are given in Table E.1. Recommendations are based on the use of urea, DAP and potassium sulphate. Use of the compound fertiliser is considered unpractical due to its high potassium content and low potassium requirements of most crops. Theoretically, because of the high pH of Study Area soils, sulphate of ammonia is considered a better source of nitrogen than urea. However, it is a much more expensive method of applying nitrogen, costing So. Shs. 9.40 per kg N compared to So. Shs. 2.85 per kg N for urea. Also, research trials with several crops have shown little or no difference in yield response to either fertiliser (see Section E.3). DAP is considered a suitable fertiliser for basal dressing as it contains a sufficient amount of nitrogen for early growth. On the other hand, urea should only be applied as a top dressing. As it can lose a considerable quantity of nitrogen to the atmosphere, it should always be covered up when applied, and an irrigation given immediately afterwards.

TABLE E.1

Available Fertilisers: ONAT, 1977

Fertiliser	Composition (%)			1977 ONAT price
	N	P_2O_5	K_2O	(So. Shs.)
Diammonium phosphate (DAP)	18	50	-	145.75
Urea	46	-	-	131.50
Potassium sulphate	-	-	50	153.00
Sulphate of ammonia (SA)	21	-	-	196.90
Compound	12	6	20	156.00

E.2 Nutrient Removal

Estimated removal of nutrients by selected crops under consideration is given in Tables E.2 and E.3. Data given in Table E.2 are based on information collected from the following sources:-

'Fertiliser use. Nutrition and manuring of tropical crops', A. Jacobs and H.von Uexkull (1960)

'Hunger signs in crops', H. Sprague et al (1964)

'Fertiliser guide for the tropics and sub-tropics', J.G. de Geus (1970)

'Rice', D.H. Grist (1965)

'Tropical crops', J.W. Purseglove (1975)

'Castor, sesame and safflower', E.A. Weiss (1971)

'Manuring of coffee, cocoa, tea and tobacco', Centre d'Etude de l'Azote (1966)

TABLE E.2

Estimated Nutrient Removal per 1 000 kg of Yield

Crop		Nutrient removal (kg/ha)			Notes
		N	P_2O_5	K_2O	
Maize		28	10	26	
Rice		19	7	21.5	Only 19% K_2O removal in grain (i.e. 4 kg/ha)
Cotton		54	22	41	Only 5% K_2O removal in seed cotton (i.e. 2kg/ha)
Groundnuts		85.5	19	55	Most nitrogen supplied through nodule Rhizobia
Sesame		52	10	56	
Castor		33	11	12	
Tobacco	(a)	58	18	102	Total removal
	(b)	22.5	6.5	48	Removal in cured leaf
Tomato		3	1	4	
Bananas		12	3	41	

Note: No information available for sunflower and safflower.

Source: See text

TABLE E.3

Estimated Nutrient Removal at Projected Yields

Crop	Yield (q/ha)			Nutrient removal (kg/ha) N	P_2O_5	K_2O	Notes
Maize	35	(shelled)		98	35	91	
	40	(shelled)		112	40	104	
Upland rice	25	(paddy)		48	18	54	10 - 12 kg/ha K_2O
	30	(paddy)		57	21	65	removed in grain
Paddy rice	35	(paddy)		67	25	75	14 - 18 kg/ha K_2O
	45	(paddy)		86	32	97	removed in grain
Cotton	20	(seed cotton)		108	44	82	4 - 5 kg/ha K_2O
	25	(seed cotton)		135	55	103	removed in seed cott
Sesame	8	(threshed seed)		41	8	45	
	10	(threshed seed)		52	10	56	
Groundnuts	20	(unshelled)		121	27	77	
	30	(unshelled)		181	41	115	
Castor	15	(hulled)		50	17	18	
Tobacco	12	(cured leaf)	(a)	70	22	122	Total removal
			(b)	27	8	57	Cured leaf only
	15	(cured leaf)		87	27	153	Total removal
Tomato	150	(fresh fruit)		45	15	60	
	200	(fresh fruit)		60	20	80	
Bananas	250	(fresh fruit)		300	75	1 025	
	300	(fresh fruit)		360	90	1 230	

Note: No information available for sunflower and safflower.

Source: Table E.2 (nutrient removal) and Chapters 4 to 15 (yields)

E.3 Fertiliser Trial Data

A limited number of fertiliser research trials have been carried out since 1964 at CARS Afgooye, concentrating mainly on maize and upland rice. A brief but intensive programme was also carried out in 1974 at the FAO pilot project, Afgooye, on eight important annual crops. Results of selected trials are tabulated below and were extracted from CARS semi-annual reports (1964 - 1975) and the FAO pilot project progress reports (FAO, 1975). Trials with very low yields due to reported management problems or with erratic data have not been included. Where possible, significant differences between treatment means are indicated.

Although all trials were carried out at Afgooye, the results are considered applicable to the Study Area. Soil type is virtually the same and land occupied by the research station in 1964 had been previously cultivated.

E.3.1 Maize Fertiliser Trials

All yields are given as q/ha of shelled grain. It is assumed that most nitrogen is applied as a top dressing.

1965 Variety: Local White

Site: CARS

Treatment (kg/ha)			Yield (q/ha)
	Nil		15.4
N	P	K	
42	0	0	16.5
84	0	0	19.0
52	52	87	25.4
104	104	174	24.6
156	156	261	20.3

1971 Varieties: Local White (LW), Kenya Hybrid H511 (H511) and Katamani Composite B (KCB)

Site: CARS

Results are mean yield from two trials.

Treatment (kg/ha)			Yield (q/ha)			
			LW	H511	KCB	Mean
	Nil		8.5	6.0	7.2	7.2
N	P	K				
0	50	50	5.0	6.6	9.2	6.9
100	0	50	13.4	21.9	19.6	18.3
100	50	0	21.5	26.4	19.0	22.3
100	50	50	22.1	23.2	17.5	20.9

Least significant difference (LSD) between treatment yields not reported.

1972 Varieties: Local White (LW)
Katamani Composite B (KCB)

Site: CARS

Results are mean yields from two trials

Levels of N (kg/ha)		0	50	100	150	Mean yield (q/ha)
Levels of P applied (kg/ha)	0	15.0	27.4	27.0	32.7	25.5
	50	16.5	27.9	34.3	33.9	28.2
	100	16.2	27.7	33.4	34.0	27.8
Mean yield (q/ha)		15.9	27.7	31.6	33.5	

Variety mean yields:- LW = 28.8 q/ha
KCB = 23.9 q/ha

LSD not reported

1972 Variety: Local White

Site: CARS

Treatment (kg/ha) N	P	Yield (q/ha)
100	0	37.0
100	50	39.5
100	100	39.5

LSD not reported

1972 Variety: Local White

Site: CARS

The trial assessed response to three nitrogenous fertilisers; ammonium sulphate (SA), ammonium nitrate (AN) and urea.

Levels of applied

N (kg/ha)	Fertiliser	Mean yield (q/ha)
0		26.9
25		31.5
50		33.8
75		32.3
100		34.9
	SA	37.8
	AN	36.4
	Urea	30.6

LSD not reported

1974 Variety: Local White

Site: CARS

Treatment (kg/ha) N	P	K	Yield (q/ha)
0	50	50	26.6
50	50	50	32.2
100	50	50	35.3
150	50	50	34.9

LSD not reported

1974 Variety: Local White

Site: FAO pilot project

Trial designed to assess response of two nitrogenous fertilisers.

Results are for two trials.

Treatment (kg/ha)				Yields (q/ha)		
N	P	K	Source of N	1974 gu	1974 der	Mean
100	50	50	Urea	33.2	38.7	36.0
100	50	50	SA	35.7	38.0	36.9

No significant differences reported

1974 Variety: Local White

Site: FAO pilot farm

Results are mean yields of two trials.

Levels of N (kg/ha)		0	50	100	150	Mean yield (q/ha)
Levels of	0	23.2	31.9	35.2	39.3	32.5
applied P	50	27.8	38.0	41.4	43.3	37.6
(kg/ha)	100	32.0	39.1	43.7	49.6	41.1
Mean yield (q/ha)		27.7	36.2	40.1	44.1	

LSD at 5% probability level = 2.5 q/ha (nitrogen) and 2.3 q/ha (phosphorus)

No significant interaction between N and P.

1974 Variety: Local White

Site: FAO pilot farm

Results are for two trials

Treatment (kg/ha)			Yields (q/ha) 1974 gu	1974 der	Mean
	Nil		12.4	31.4	21.9
N	P	K			
0	50	0	15.2	38.5	26.9
0	0	50	13.7	37.8	25.8
0	50	50	16.5	41.8	29.1
80	0	0	26.5	40.2	33.4
80	0	50	30.5	41.6	36.1
80	50	0	33.7	43.4	38.6
80	50	50	33.9	44.7	39.3
LSD at 5% level			4.0	3.0	

E.3.2 Upland Rice Fertiliser Trials

All yields are given as q/ha of threshed paddy.

(a) Trials to Assess Single Applications of Nitrogen at Planting

Site:- CARS

Year	Season	Yield (q/ha) at levels of applied N (kg/ha) 0	15	25	30	50	60	75	100	Variety
1968	Gu	18.1	18.8		22.9		39.6			Dawn
1971	Gu	12.7		17.7		16.8		15.1	13.4	Dawn
1971	Der	9.2		13.2		16.8		24.2	21.3	Saturn
1972	Gu					41.8			45.0	Saturn
1972	Der					22.6			30.6	Saturn

LSD not reported

(b) Trials to Assess Split Applications of Nitrogen

Site:- CARS

Year	Season	Yield (q/ha) at levels of applied N (kg/ha) 0	50	100	Variety	Date of top dressing
1968	Der	12.5	19.5 - 22.5(1)	-	-	Onset of rapid shoot growth
1971	Der	20.6	24.3	-	Saturn	Prior to heading
1971	Der	14.5	16.5	-	Dawn	Prior to heading
1972	Der	-	22.6	30.6	Saturn	Onset of rapid shoot growth
1973	Der	16.3	-	29.2 - 31.9(1)	Vista	
1973	Der	24.4	-	25.5 - 31.9(1)	No. 843	Onset of rapid shoot growth

LSD not reported

Note: (1) Higher yield obtained with split dressing at planting and onset of rapid shoot growth compared to single applications at either stage.

(c) Trials to Assess Different Nitrogenous Fertilisers

Year	Season	Yield (q/ha) SA	Urea	Variety	Trial site
1974	Der	30.3	29.9	Dawn	FAO pilot project
1968	Der	23.9	25.1	-	CARS
Mean yield (q/ha)		27.1	27.5		

Notes: (1) 50 - 100 kg/ha N applied with each fertiliser.

(2) No significant difference reported for 1974 trial.

(d) Trials to Assess NPK Applications

1968 Variety: Not known; Dawn or Saturn

Site: CARS

Treatment (kg/ha)			Yield (q/ha)
	Nil		14.2
N	P	K	
0	0	50	12.3
0	100	0	18.3
0	100	50	13.3
50	0	0	25.7
50	0	50	24.6
50	100	0	24.4
50	100	50	23.4

LSD not reported

1968 Variety: Dawn or Saturn

Site: CARS

Treatment (kg/ha)			Yield (q/ha)
	Nil		12.5
N	P	K	
50	0	0	23.6
100	0	0	29.8
100	0	50	19.3
100	75	0	20.0
100	75	50	23.2

LSD not reported

1972 Varieties: Vista and No. 843

Site: CARS

Treatment (kg/ha)		Yield (q/ha)		
		Vista	No. 843	Mean
Nil		16.4	17.3	16.9
N	P			
100	0	24.2	20.7	22.5
100	25	33.6	25.3	29.5
100	50	27.4	25.7	26.6
100	75	35.7	26.1	30.9
100	100	33.1	26.6	29.9

LSD not reported

1973 Varieties: Vista and No. 843

Site: CARS

Treatment (kg/ha)			Yield (q/ha)		
			Vista	No. 843	Mean
	Nil		24.1	45.7	34.9
N	P	K			
0	50	50	25.1	52.2	38.7
100	0	50	32.1	58.5	45.3
75	50	50	35.9	65.2	50.6
100	50	0	37.5	61.2	49.4
100	50	50	33.0	63.1	48.1

LSD not reported

1973 Varieties: Saturn, Vista and No. 843

Site: CARS

Treatment (kg/ha)		Yield (q/ha)			
		Saturn	Vista	No. 843	Mean
Nil		20.3	34.6	25.6	26.8
N	P				
100	0	25.9	35.0	29.2	30.0
100	25	31.8	48.0	29.3	36.4
100	50	27.3	44.8	37.9	36.7
100	75	23.6	40.6	31.5	31.9
100	100	19.2	31.4	36.7	29.1

LSD not reported

1974 Variety: Dawn

Site: FAO pilot project

Levels of N (kg/h)		0	50	100	150	Mean yield (q/ha)
Levels of applied P (kg/ha)	0	10.1	14.5	14.9	24.3	16.0
	50	11.3	17.4	23.6	32.3	21.1
	100	14.2	17.2	30.6	36.0	25.1
Mean yield (q/ha)		12.0	16.3	22.9	31.0	

LSD at 5% probability level:- N 1.8 q/ha
P 1.5 q/ha
NP interaction 3.1 q/ha

E.3.3 Cotton Fertiliser Trials

Yields are given as q/ha of seed cotton. Only one trial has been carried out since 1964.

Variety: Acala 4 - 42

Site: FAO pilot project

Levels of applied N (kg/ha)		0	50	100	150	Mean yield (q/ha)
Levels of applied P (kg/ha)	0	21.3	23.5	23.5	24.9	23.3
	50	24.9	27.4	28.3	30.9	27.9
	100	22.9	25.4	26.7	34.5	27.4
Mean yield (q/ha)		23.1	25.4	26.2	30.0	

LSD at 5% probability level:- N 2.1 q/ha

P 1.9 q/ha

No significant interaction between N and P.

E.3.4 Groundnut Fertiliser Trials

Yields are given as q/ha unshelled pods.

1974 (2 trials) Varieties: Florigiant (gu trial)
Sudan (der trial)

Site: FAO pilot project

Treatment (kg/ha)		Yield (q/ha) Florigiant	Sudan	Mean
Nil		22.4	21.4	21.9
N	P			
0	50	34.8	25.4	30.1
0	100	42.4	27.2	34.8
0	150	48.8	28.8	38.8
20	50	37.6	-	-
20	100	44.8	-	-

LSD atobability level 5% pr 1.8 2.0

1974 (2 trials) Varieties: Florigiant (gu trial)
Sudan (der trial)

Site: FAO pilot project

Treatment (kg/ha)			Yield (q/ha) Florigiant	Sudan	Mean
Nil			19.4	20.5	20.0
N	P	K			
0	0	50	24.2	21.3	22.8
20	0	0	25.8	26.2	26.0
20	0	50	28.2	27.8	28.0
0	50	0	31.2	26.0	28.6
20	50	0	24.4	32.1	28.3
0	50	50	33.0	27.3	30.2
20	50	50	35.6	32.2	33.9

LSD at 5% probability level 4.1 3.3

E.3.5 Sunflower Fertiliser Trials

Yields given as q/ha of threshed seed.

1974 Variety: 'Local' probably Predovic

Site: FAO pilot project

Results are mean yields for two trials

Levels of applied N (kg/ha)		0	50	100	150	Mean yield (q/ha)
Levels of applied P (kg/ha)	0	13.5	16.8	19.2	20.4	17.4
	50	15.9	18.7	20.8	22.8	19.5
	100	16.4	19.9	22.3	24.9	21.1
Mean yield (kg/ha)		15.2	18.5	20.7	22.9	

LSD between treatment means at 5% probability level = 0.8 q/ha

Gu trial mean = 20.9 q/ha
Der trial mean = 17.7 q/ha

1974 Variety: Probably Predovic

Site: FAO pilot project

Results are for two trials

Treatment (kg/ha)			Yield (q/ha) Gu season	Der season	Mean
Nil			15.9	10.3	13.1
N	P	K			
0	0	50	15.9	11.0	13.5
0	50	0	20.5	11.0	15.8
0	50	50	22.4	12.2	16.8
100	0	0	19.1	11.3	15.2
100	0	50	23.7	10.7	17.2
100	50	0	26.2	16.6	21.4
100	50	50	-	16.8	-
LSD at 5% probability level			2.7	0.7	

1974 Variety: Probably Predovic

Site: FAO pilot project

Source of nitrogen trial. Results are for two trials.

Treatment (kg/ha)				Yield (q/ha)		
N	P	K	Fertiliser	Gu	Der	Mean
100	50	50	Urea	22.8	12.8	17.8
100	50	50	S.A.	22.7	12.1	17.4

No significant difference between fertilisers at 5% level.

E.3.6 Sesame Fertiliser Trials

Yields given as q/ha threshed seed.

1974 Variety: Local

Site: FAO pilot project

Results are mean yields for two trials.

Levels of applied N (kg/ha)		0	50	100	150	Mean yield (q/ha)
Levels of applied P (kg/ha)	0	2.6	3.8	4.9	5.2	4.1
	50	2.9	4.3	5.3	5.8	4.5
	100	3.1	4.8	6.0	6.4	5.1
Mean yield (q/ha)		2.9	4.3	5.4	5.8	

LSD at 5% level = N 0.3 q/ha

P 0.3 q/ha

No significant interaction.

1974 Variety: Probably Predovic

Site: FAO pilot project

Source of nitrogen trial. Results are for two trials.

Treatment (kg/ha)				Yield (q/ha)		
N	P	K	Fertiliser	Gu	Der	Mean
100	50	50	Urea	22.8	12.8	17.8
100	50	50	S.A.	22.7	12.1	17.4

No significant difference between fertilisers at 5% level.

E.3.6 Sesame Fertiliser Trials

Yields given as q/ha threshed seed.

1974 Variety: Local

Site: FAO pilot project

Results are mean yields for two trials.

Levels of applied N (kg/ha)		0	50	100	150	Mean yield (q/ha)
Levels of applied P (kg/ha)	0	2.6	3.8	4.9	5.2	4.1
	50	2.9	4.3	5.3	5.8	4.5
	100	3.1	4.8	6.0	6.4	5.1
Mean yield (q/ha)		2.9	4.3	5.4	5.8	

LSD at 5% level = N 0.3 q/ha

P 0.3 q/ha

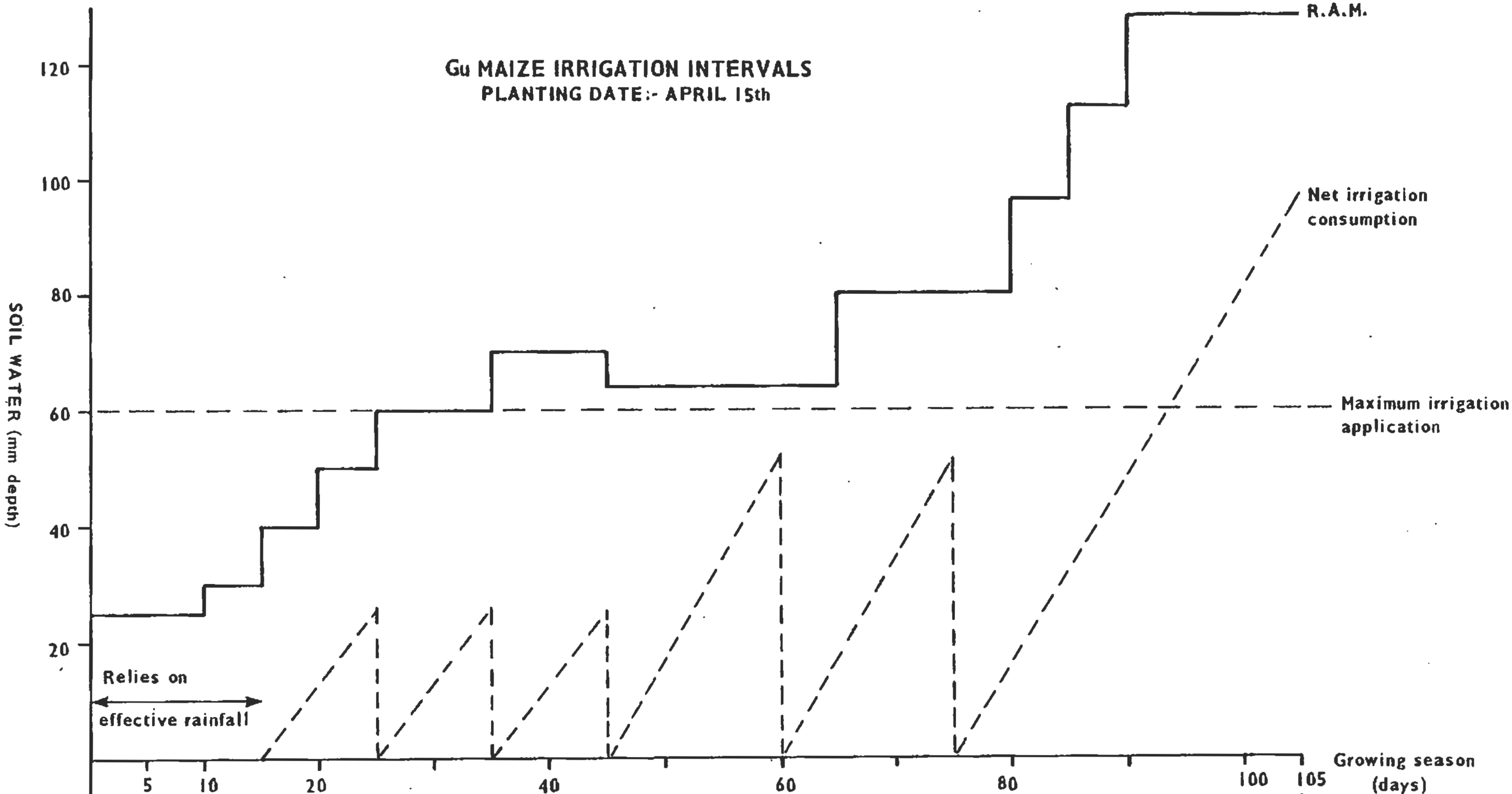
No significant interaction.

APPENDIX A

CHEMICAL CONTROL METHODS

APPENDIX F

CROPPING PATTERN A: ESTIMATED IRRIGATION INTERVALS

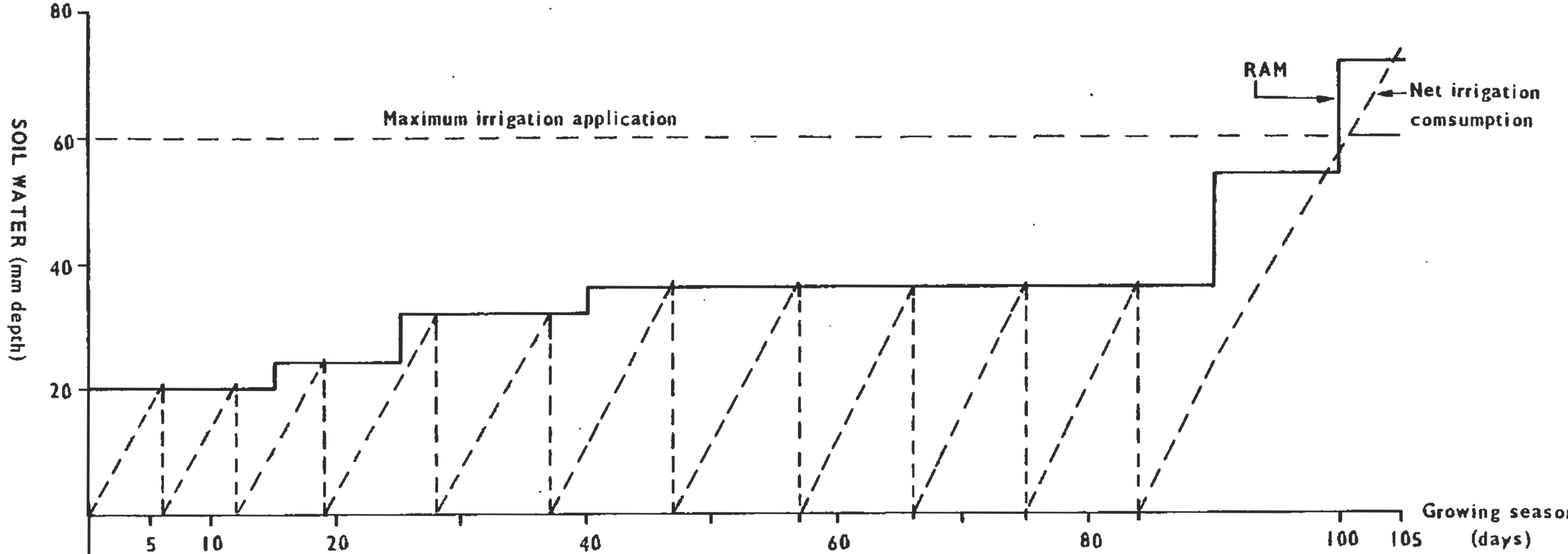


Irrigation interval	15 (I_1)	25	35	45	60	75 (I_6)															
Root depth (mm)	200	200	300	400	500	600	600	700	700	800	←→	800									
A.W.C. (%)	25	25	20	←→	20																
P.M.D. (%)	50	←→	50	40	40	40	40	50	50	50	60	70	80	80	80						
R.A.M. (mm)	25	25	30	40	50	60	60	70	70	64	64	64	64	80	80	80	96	112	128	128	128
N.I.R. (mm/day)	0	0	0	2.6	←→	2.6	3.5	←→	3.5	3.2	←→	3.2									

FIGURE F.1

Gu UPLAND RICE IRRIGATION INTERVALS

PLANTING DATE:- MAY 1st

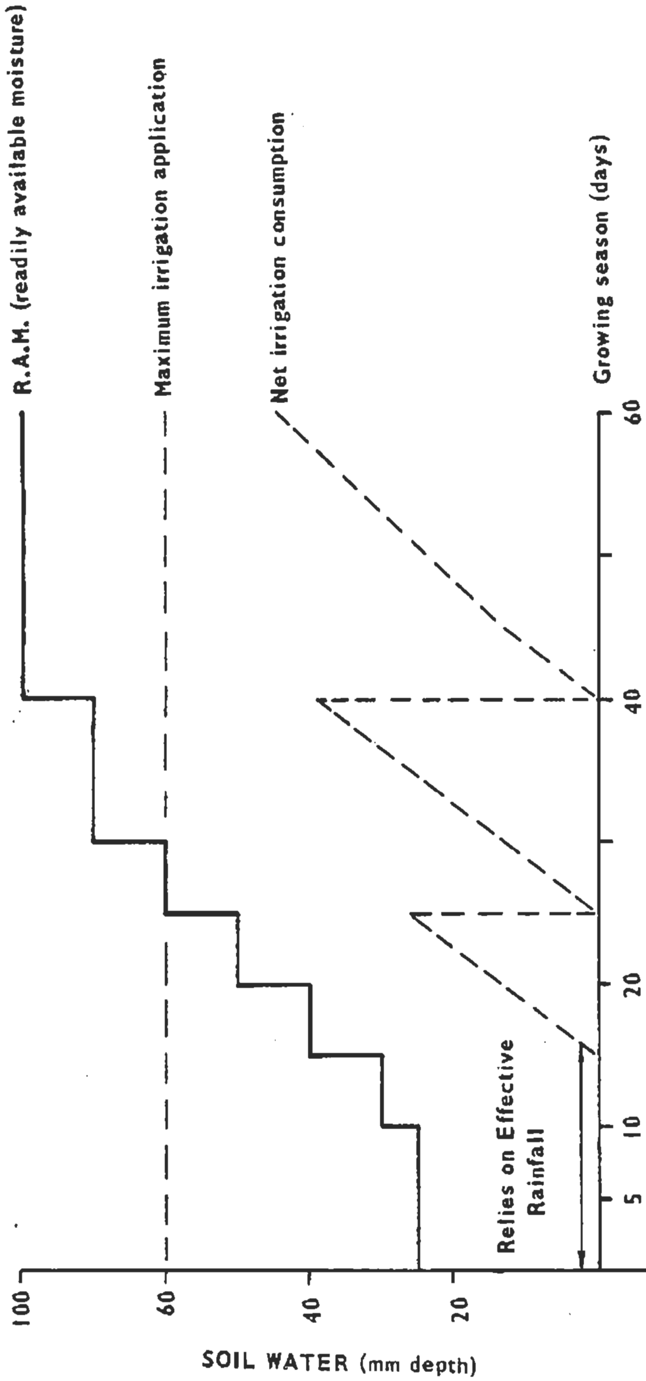


Irrigation interval	I_1	6	12	19	28	37	47	57	66	75	84 (I_{11})		
Root depth (mm)	200	200	200	300	300	400	400	400	450 ←→ 450				
A.W.C. (%)	25	25	25	20 ←→ 20									
P.M.D. (%)	40 ←→ 40	60	60	80									
R.A.M. (mm)	20	20	20	24	24	32	32	32	36 ←→ 36	54	54	72	
N.I.R. (mm/day)	3.5 ←→ 3.5	3.7 ←→ 3.7	4.1 ←→ 4.1	3.3 ←→ 3.3									

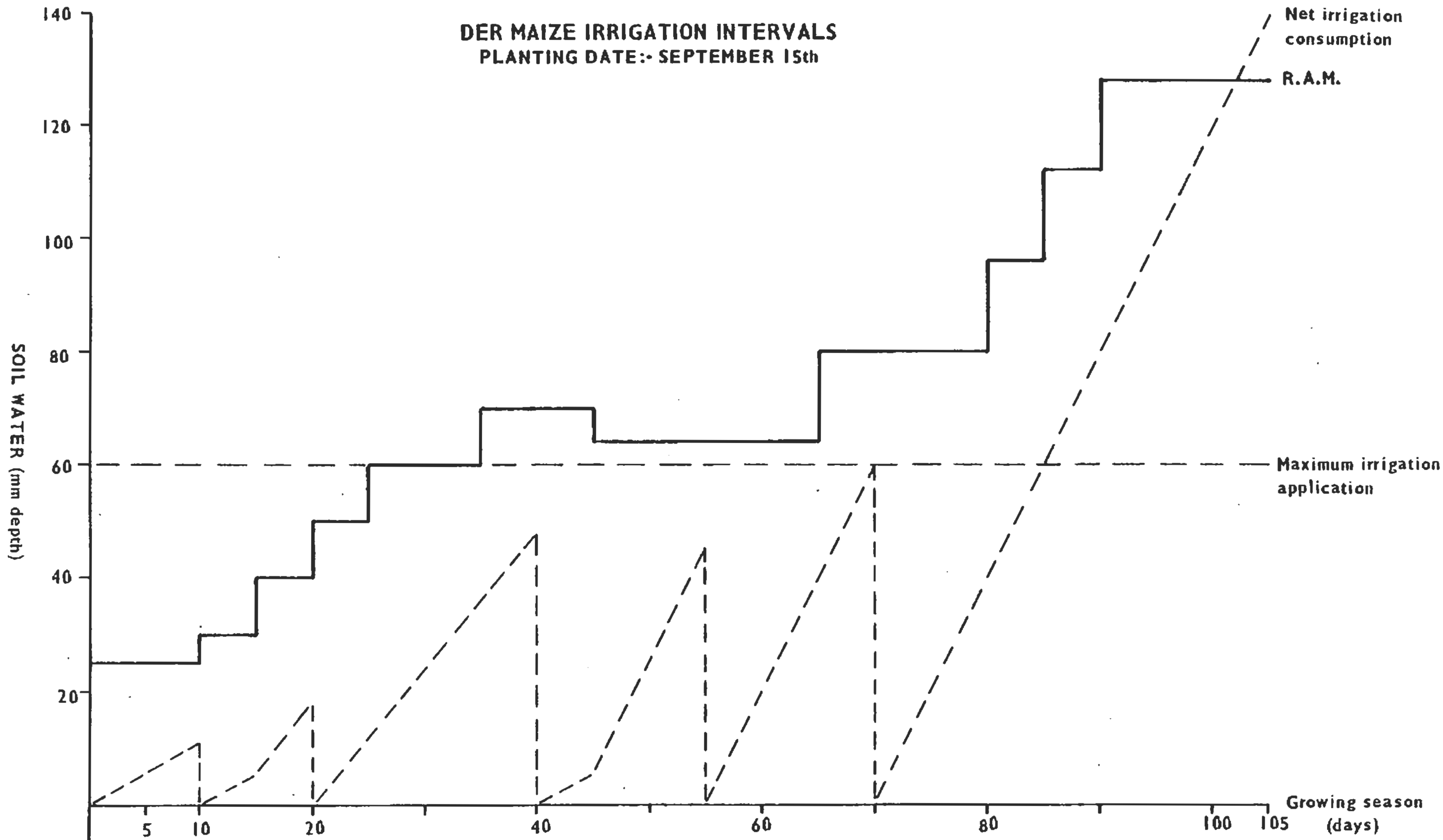
FIGURE F.2

FIGURE F.3

Gu FORAGE IRRIGATION INTERVALS
PLANTING DATE:- APRIL 15th



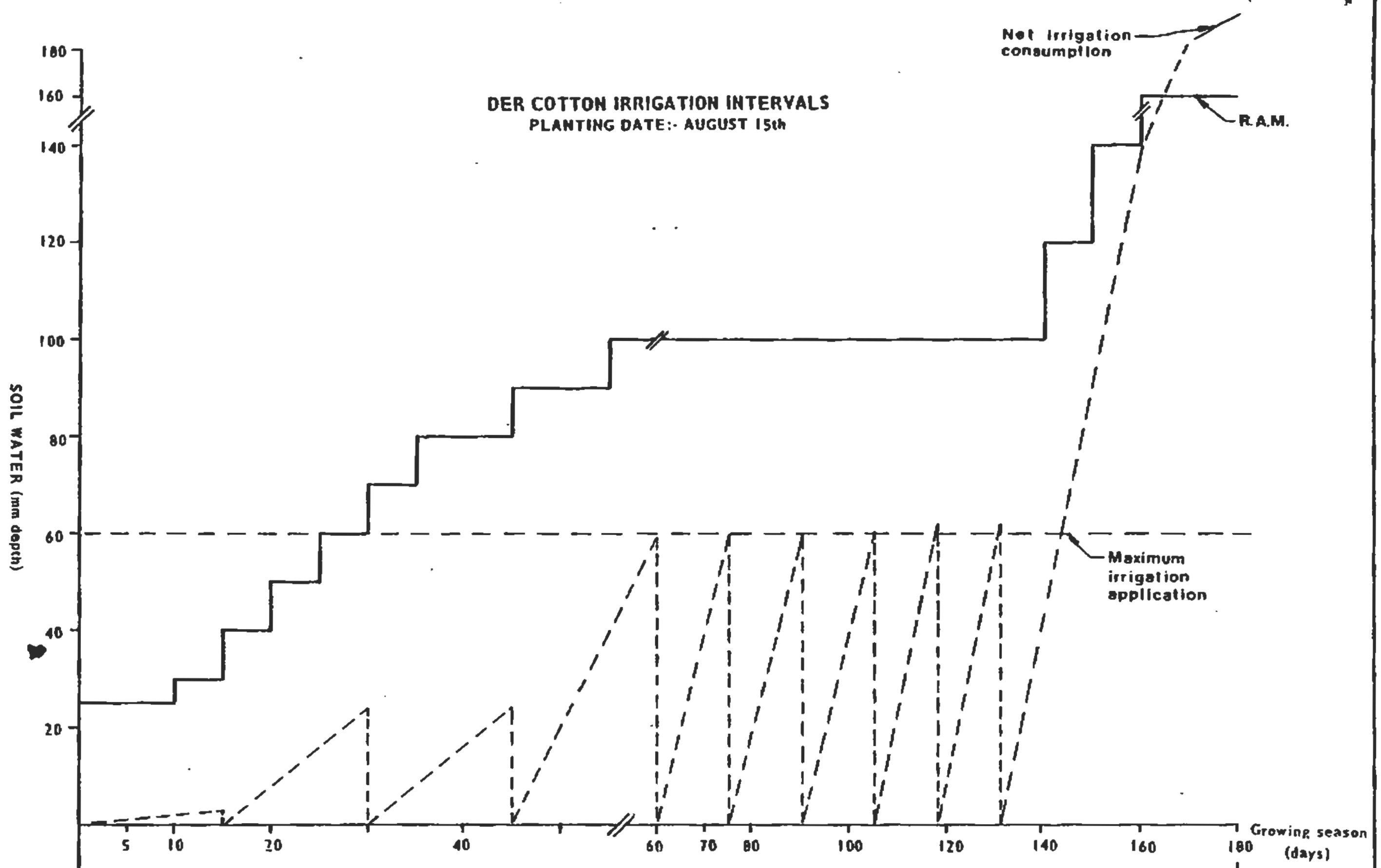
Irrigation interval (I)				15 (I_1)		25			40 (I_3)			
Root depth (mm)	200	200	300	400	500	600	700	700	800			800
A.W.C. (%)	25	25	20									20
P.M.D. (%)	50											50
R.A.M. (mm)	25	25	30	40	50	60	70	70	80	80	80	80
N.I.R. (mm/day)	0	0	0	2.6					2.6	2.1	2.1	2.1



Irrigation interval	I_1 · 10 · 20 · 40 · 55 · 70(I_6)
Root depth (mm)	200 200 300 400 500 600 600 700 700 800 ←→ 800
A.W.C. (%)	25 25 20 ←→ 20
P.M.D. (%)	50 ←→ 50 40 ←→ 40 50 50 50 60 70 80 80 80
R.A.M. (mm)	25 25 30 40 50 60 60 70 70 64 64 64 64 80 80 80 96 112 128 128 128
N.I.R. (mm/day)	1.1 1.1 1.1 2.4 ←→ 2.4 4.0 ←→ 4.0

FIGURE F.4

FIGURE F.5



Irrigation interval	I_1 15 30 45 60 75 90 105 118 131 (I_{10})
Root depth (mm)	200 200 300 400 500 600 700 800 800 900 900 1000 ←→ 1000
A.W.C. (%)	25 25 20 ←→ 20
P.M.D. (%)	50 ←→ 50 60 70 80 80
R.A.M. (mm)	25 25 30 40 50 60 70 80 80 90 90 100 ←→ 100 120 140 160 160
N.I.R. (mm/day)	0.2 0.2 0.2 1.6 ←→ 1.6 4.0 ←→ 4.0 4.8 ←→ 4.8 3.9–3.9

Note:- Moisture requirement during final 10 days not critical

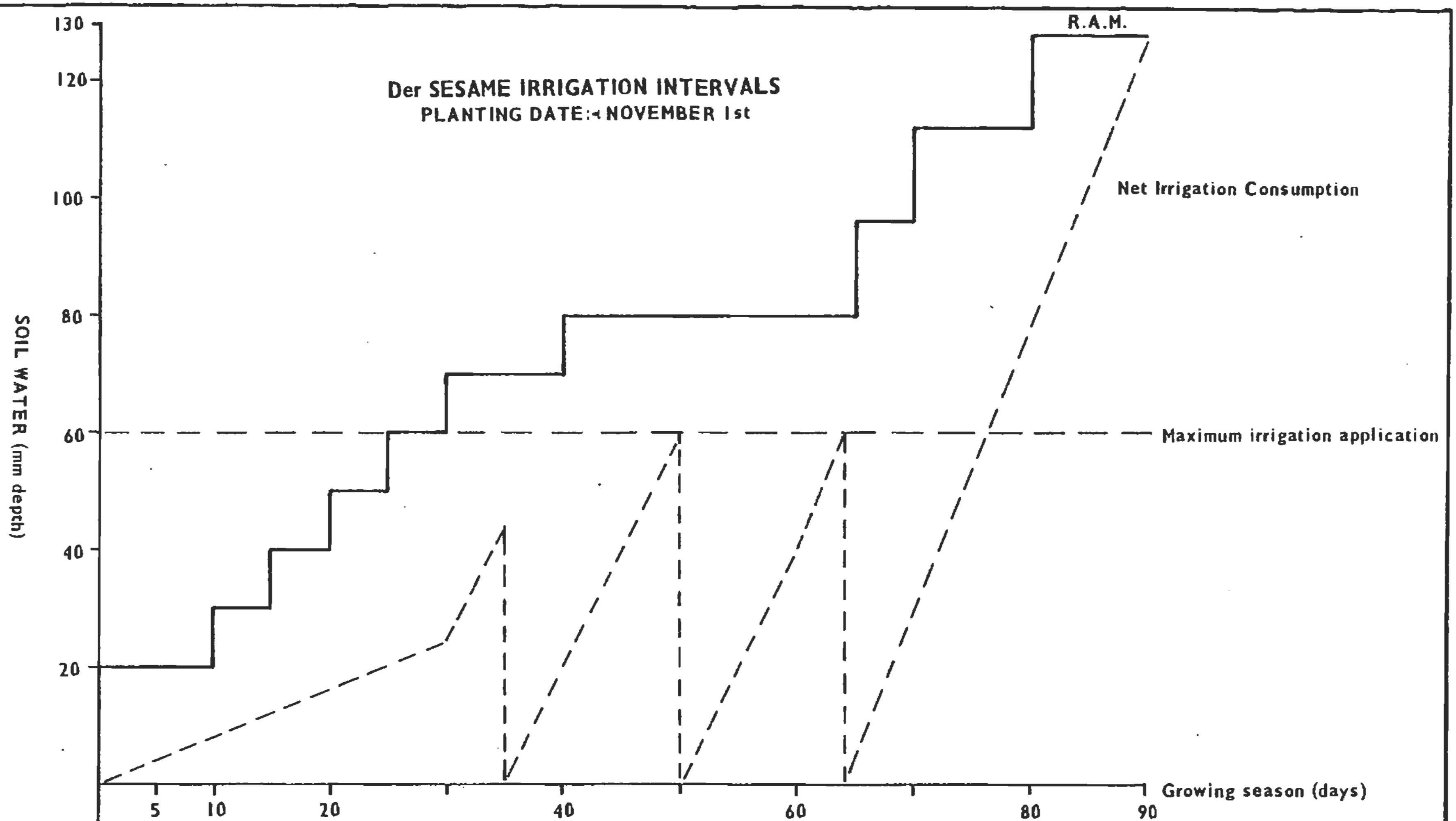
APPENDIX F

CROPPING PATTERN A, ESTIMATED IRRIGATION INTERVALS

The method of calculating irrigation intervals is given in Chapter 2, and outlined in Chapter 19. Estimated intervals for crops selected in cropping pattern A are shown figuratively in this appendix and are based on the data tabulated below each figure. The following abbreviations are used:-

RAM	Readily available moisture
AWC	Available water content (total available moisture)
PMD	Permissible moisture depletion
NIR	Net irrigation requirement

FIGURE F.6

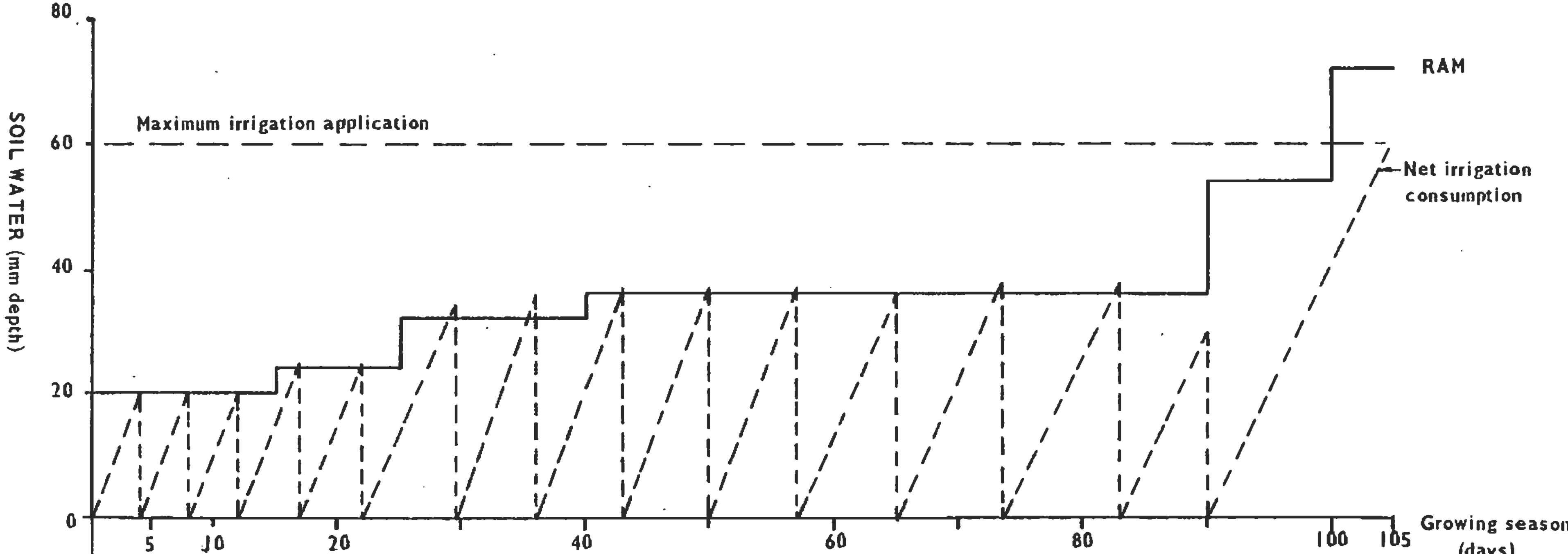


Irrigation intervals (I)	I_1 … 35 … 50 … 64 (I_4)
Root depth (mm)	200 200 300 400 500 600 700 700 800 ←→ 800
A.W.C. (%)	25 25 20 ←→ 20
P.M.D. (%)	50 ←→ 50 60 70 70 80 80
R.A.M. (mm)	25 25 30 40 50 60 70 70 80 80 80 80 80 96 112 112 128 128
N.I.R. (mm/day)	0.8 ←→ 0.8 4.0 ←→ 4.0 4.9 ←→ 4.9

Notes:- Assumes 100 mm applied as pre - planting irrigation and 60 mm applied at planting in order to delay further irrigation until after susceptible seeding stage.

FIGURE F.7

DER UPLAND RICE IRRIGATION INTERVALS
PLANTING DATE:- SEPTEMBER 1st



Irrigation interval (I)	I_1 4 8 12 17 22 29 36 43 50 57 65 74 83 90 (I_{15})
Root depth (mm)	200 200 200 300 300 400 400 400 450 ←→ 450
AWC (%)	25 25 25 20 ←→ 20
PMD (%)	40 ←→ 40 60 60 80
RAM (mm)	20 20 20 24 24 32 32 32 36 ←→ 36 54 54 72
N.I.R. (mm/day)	4.9 ←→ 4.9 5.1 ←→ 5.1 4.2 ←→ 4.2 4.1 4.1 4.1

APPENDIX G

QORYOOLEY PROJECT FARM UNIT DATA

APPENDIX G

QORYOOLEY PROJECT FARM UNIT DATA

Present Land Use and Crop Yields

Farm unit	Present land use (1) Net areas (ha) Class 1	Class 2	Class 3	Present yields (2) (q/ha/year) Maize	Sesame
Murale	-	212	8	8.6	1.7
Tawakal	-	290	12	8.6	1.7
Garas Guul	-	286	10	8.6	1.7
Shamaan	55	182	52	9.6	1.9
Tugarey	65	149	46	9.8	1.9
Nimcooley (3)	-	81	88	11.3	2.2
Gayweerow	-	28	246	13.4	2.2
Jasiira	-	16	306	13.7	2.5
Pilot Farm	-	-	82	14.0	2.6
TOTAL (3)	120	1 244	850	-	-

Notes: (1) Definition of classes given in Chapter 17. Data relate to gross affected area of 5 800 ha.

(2) Based on maize yields of 6 q/ha (Class 2) and 10 q/ha (Class 3) and sesame yields of 2.5 q/ha (Class 2) and 4 q/ha (Class 3). Assumes 140 % maize per year and 60% sesame per year per hectare (net). Also includes 0.2 q/ha/year for haggai sesame catch-crop. All data from Chapter 17, Table 17.2.

(3) Excludes area of unsuitable land.

Farm Unit Areas and Cropping at Full Project Development

(for cropping pattern A)

Data	Farm units							
	Murale	Tawakal	Garas Guul	Shamaan	Tugarey	Nimcooley	Gayweerow	Jasiira
NCA	369.5	533.5	529.5	415	482	263	611	623
Houseplot area	24	34	34	26	31	17	39	39
NCA field crops	345.5	499.5	495.5	389	451	246	572	584
Total NCA field crops per year (1):	552	800	793	623	721	393	913	935
(a) maize (40%)	138	200	198	156	180	98	228	234
(b) rice (40%)	138	200	198	156	180	98	228	234
(c) forage (20%)	69	100	99	78	90	49	114	117
(d) cotton (35%)	121	175	174	136	158	86	200	204
(e) sesame (25%)	86	125	124	97	113	62	143	146

Note: (1) At 160% cropping intensity.

Farm Unit Machinery and Equipment Requirements: Farm Unit Requirements

Unit	Maximum requirements per 100 ha NCA (field crops)	Murale	Tawakal	Garas Guul	Shamaan	Tugarey	Nim-cooley	Gay-weerow	Jasiira	Pilot farm	NCA (field crops) Estimated 1977 (1) financial price (So. Shs.)	Price (1) source
	100	345.5	499.5	495.5	389	451	246	572	584			
Tractors (a) 70 hp	-	2	3	3	2	2	1	3	3	1	110 000	ONAT
(b) 60 hp	-	3	3	3	3	4	3	4	4	2	85 000	ONAT
Combine harvester	0.16	1	1	1	1	1	1	1	1	1	280 000	FOB UK
Mouldboard plough	0.33	1	2	2	1	2	1	2	2	1	8 000	ONAT
Disc harrow	0.24	1	1	1	1	1	1	2	2	1	13 000	ONAT
Tool bar	0.47	2	3	3	2	2	1	3	3	1	2 500	Estimate
Cultivator bodies (set)	0.33	1	2	2	2	2	1	2	2	1	1 500	Estimate
Ridging bodies (set)	0.30	1	2	2	2	2	1	2	2	1	1 500	Estimate
Rice drill	0.20	1	1	1	1	1	1	1	1	1	25 000	FOB UK and Kenya
Land-levels	0.16	1	1	1	1	1	1	1	1	1	34 600	FOB USA
A-frame	0.03	1	1	1	1	1	1	1	1	1	4 000	Estimate
V-ditcher body	0.03	1	1	1	1	1	1	1	1	1	800	Estimate
Rake	0,14	1	1	1	1	1	1	1	1	1	8 000	Estimate
Blading bodies (set)	0.22	1	1	1	1	1	1	2	2	1	1 500	Estimate
5 tonne trailer												
(a) non-tipping	-	6	6	6	6	6	5	7	7	2	15 000	ONAT
(b) tipping	-	1	1	1	1	1	1	1	1	1	21 700	FOB UK
ULVA microsprayers	1.4	8	9	9	8	9	6	12	12	5	200	ONAT
Microhandy sprayers	0.5	3	4	4	3	4	3	4	4	3	200	ONAT
Sack elevator	-	1	1	1	1	1	1	1	1	1	20 000	Estimate
Maize shellers	0.5	2	3	3	2	3	2	3	3	1	3 050	FOB UK
Cutter bar mower	-	1	1	1	1	1	1	1	1	1	11 000	FOB UK
Sack trolleys	-	4	5	5	4	5	3	6	6	2	500	Estimate
Seed dressing drum	-	1	1	1	1	1	1	1	1	1	1 000	Estimate
Scale	-	1	1	1	1	1	1	1	1	1	10 000	Estimate
Hand tools	-	400	550	550	450	500	300	650	650	150	25	FOB Tanzania
Sacks	-	2 000	2 500	2 500	2 000	2 250	1 200	2 900	2 900	700	6	ADC
Cotton picking bags	-	430	530	530	430	480	260	620	620	150	6	Estimate
Water cart	-	3	4	4	3	4	2	5	5	1	700	Estimate

Note: (1) FOB prices converted to financial prices by adding 25% CIF costs and known 60% ONAT handling costs.

Farm Unit Machinery and Equipment Requirements (cont.): Farm Building Requirements

Surface areas per farm unit (m^2)

Building	Murale	Tawakal	Garas Guul	Shamaan	Tugarey	Nimcooley	Gayweerow	Jasiira
Grain storage shed	180	220	220	180	210	180	230	230
Concrete drying slab				100				
Workshop				80				
Machinery shed	50	60	60	50	60	50	70	70
Fertiliser store	70	90	90	70	80	70	100	100
Chemical store				20				
Farm office				30				
Tool store			40				50	50
Fuel tanks (1)	13	15	15	13	15	13	17	17

Note: (1) capacity in cubic metres

Pilot Farm Equipment Requirements - Research Section

(a) Research Equipment

Item	Number required	Estimated financial price/unit (So.Shs.)
Balances	2	1 000
Hand-operated maize shellers	2	150
Hand-operated groundnut sheller	1	850
Hand-operated groundnut stripper	1	1 100
Rice weeders	4	125
Rice thresher (treddle type)	1	1 000
Rice cutter	1	350
2 row rice-seeder	1	1 000
Rice huller	1	20 000

Source: Appendix C

(b) Animal-drawn Equipment

Item	Number	Estimated cost (So.Shs./unit)
Polycultivator (+ attachments)	1	4 000
Bund former	1	200
Light cultivators	2	150
V-ridger	1	350
Basin leveller	1	500
Track chains	4	100

Source: Appendix C

APPENDIX H

QUELEA QUELEA (SUDAN DIOCH)

APPENDIX H

QUELEA QUELEA (SUDAN DIOCH)

For the last two years an FAO/UNDP project has been investigating the problems of Quelea quelea and other seed-eating bird species that attack rice, sorghum and sunflower crops in southern Somalia. Unfortunately, during this study, only a limited amount of information could be obtained from the FAO programme. Coupled with this, reports from other sources have resulted in conflicting information. Therefore, as a result of this information, observations made during this study, and following discussions with technical staff involved with rice projects along the Shabeelle river, the problems of birds in relation to the Study Area can be clarified.

The main problem is caused by the seasonal migration of Quelea quelea into large areas of southern Somalia. In general, the first flocks arrive in the Study Area in mid-July and remain until February or March. Population levels in the Study Area and along the Lower Shabeelle river vary depending on two factors:-

(a) The general migratory population which will fluctuate annually.

(b) Rainfall during both gu and der seasons.

In normal rainfall years, populations in the riverine areas are moderate during the period of mid-July to December. This is because the migratory population is spread out over both the rainfed areas and the riverine areas in southern Somalia. Consequently, severity of attack on any susceptible crop will depend on variations in these moderate population levels and the cultivated area of susceptible crops. For example during the 1977 gu season, rice crops in the Study Area and at Afgooye required bird scarers to prevent serious losses. In some unprotected fields, losses of up to 100% occurred. However, in the 1977 der season, attacks on rice crops in the Afgooye area were much less, mainly due to the larger area of rainfed sorghum grown adjacent to the rice production areas. Similar observations were made by the FAO pilot project (FAO, 1975).

After December, when food supplies decline in the rainfed areas away from river, a secondary migration into the riverine areas takes place. The resulting higher population levels along the river in January and February can cause serious damage to any rice, sorghum or sunflower unharvested during this period. This secondary migration was confirmed by observations during the 1978 jilal season. Also, at the Haawaay crash programme rice farm about 100 km downstream of the Study Area, no birds were seen during the rainy season and are only reported seen during each jilal season. However, in bad rainfall years, the concentration of Quelea into riverine areas also occurs during the mid-July to December period, also as the result of decreased food supplies in rainfed areas. Consequently, attacks on susceptible crops can be heavy, particularly in drought years and if these crops are isolated.

A second problem, although less serious, is the resident population of seed-eating species, the most common of which are weaver-birds (Ploceus spp). In normal years, their importance is insignificant, but in the jilal season and in years of poor rainfall, attacks by these species can increase the damage done by Quelea. However, the resident species are the only likely problem for sunflower.

Observations at CARS, Afgooye during 1977 showed that, despite bird scarers, Quelea were attacking sorghum trials, but ignored adjacent unguarded sunflower plots. Only a few birds were seen on the sunflower and these were larger seed-eating species such as widow birds (Coliuspasser sp). Therefore, in normal years birds should only be a minor problem for sunflower except during the jilal season. Only in bad rainfall years will these species and Quelea be a problem during the July-December period on sunflower crops.

No specific Quelea control recommendations are available. The FAO/UNDP programme concluded that bird scaring was only necessary in certain years and that during years of low to moderate Quelea incidence, more damage was caused by the bird scarers than grain loss caused by Quelea. On the other hand, in bad years it was stated that bird scaring was ineffective. However, the bad year to which the FAO project was referring was 1975 which was a serious drought year in Somalia. In 1975, there were only two small areas of rice production along the Lower Shabeelle river and these were effectively the only food supply available to Quelea. Drought years are estimated to occur every seven to ten years.

However, during 1977 there was ample evidence to prove that, in general, bird scaring is required. During 1977, Quelea populations were reported to be moderate and observations at several rice farms showed that the number of bird scarers employed varied from one to six persons per hectare. Where only one person per hectare was used during the season, grain losses of over 50% occurred. Where six persons per hectare were used, little bird damage was seen, but damage by the bird scarers was evident. In 1977, the optimum number of bird scarers was three persons per hectare.

Although in some years it is likely that bird scaring will not be required, it is considered that in any development plans for susceptible crops, provision for bird scaring each year should be made. This is because annual rainfall in the Study Area is unpredictable and, therefore, annual incidences of bird attack will also be unpredictable.

Therefore, control recommendations for the Study Area are as follows:-

(a) All susceptible crops must be planted in order to be harvested before the end of December. This is to avoid the more predictable larger populations of Quelea and other species that will be more difficult to control.

(b) For rice and sorghum in normal years, provision for at least three people per hectare must be made.

(c) For sunflower, an allowance should also be made for the same number of bird scarers until sufficient evidence is collected to prove otherwise.

Avicide baits and bird scaring equipment are not recommended. Experiments carried out at CARS, Afgooye between 1965 and 1970 showed that minimal control resulted with these methods. However, international co-ordination should still be continued between the FAO/UNDP programme in Somalia and other African countries to combat population increases of Quelea quelea.