Somali Democratic Republic
Ministry of Agriculture

Bay Region Agricultural Development Project

Mid-term Review

Volume 2
Annex 1 Crops
Annex 2 Livestock

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Bay Region Agricultural Development Project

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Annex 1 Crops

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Agriculture

This chapter is intended to provide a broad outline of the environment and the agriculture of the Bay Region. This background information is needed to permit a better understanding of the discussion which follows on applied agricultural research in the Region.

1.1 LOCATION AND PHYSICAL FEATURES

The Bay Region is located between the coordinates latitude 1°30′ and 3°30′ N and longitude 42°30′ and 44°35′ E which encompass an area of approximately 4.0 million hectares. The boundaries of the Region are not formed by any distinct physical features. The Region lies between the Jubba and Shebeelle rivers - the only two rivers with perennial flows in Somalia.

The Bay Region may be sub-divided into three major physiographic units:

(a) the limestone plateau which occupies the northern portion of the Region,
(b) the limestone depression, a narrow strip of land between the limestone plateau, and
(c) the basement complex which occupies a large part of the southern half of the Region.

The altitude of the limestone plateau ranges between 400-650 m, that of the limestone depression is 350-400 m, whilst the basement altitude ranges between 80-350 masl.

The topography of the limestone plateau may be described as gently rolling with few catchments of any size. The basement complex topography is generally flat with a gentle slope NE-SW. Drainage lines may be incised as they pass out of the Region to the south. Outcrops of basement rock, known locally as Buur, are scattered throughout the basement complex.

1.2 CLIMATE

1.2.1 Data Availability

Climatic records for Bay Region are generally inadequate. Only four stations have provided data. Records for Baydhabo stretch back to 1922 but not continuously whilst for Buurhakaba spasmodic records cover more than 40 years. For the other two stations - Diinsoor has intermittent data for six years and Bonka full records for four years. Thus the climatic picture for the Region as a whole is far from complete. However, with the possible exception of rainfall, climatic factors are unlikely to show critical variation over the Region since there are no outstanding topographic or other features either within or adjacent to the Region which could conceivably affect climatic factors significantly.

1.2.2 Rainfall

Rainfall in the Bay Region has a distinctly bimodal distribution. The majority of the precipitation occurs in the post equinoctial months of April and May (the Gu season) and October and November (the Dayr season). For example taking the long term Baydhabo records, 45.1 per cent of annual average rainfall (589.5 mm) occurred in April - May whilst 39.2 per cent occurred in October - November with 8.9 per cent falling in the intervening months of June through September. The mean monthly rainfall for Baydhabo for 45 years of records are shown below in mm:

J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
2	6	24	144	122	12	14	6	20	142	89	13	589

Rainfall is obviously of primary importance in the determination of differential development potential within the Region both in terms of arable agriculture and of rangeland productivity. Consequently efforts were made in past reports, HTS (1977) and HTS (1982), to interpolate, by subjective means, existing data from stations both within and adjacent to the Region for the production of isohyetal maps for annual and seasonal rainfall. Whilst it was recognized that the limestone escarpment in the north-central part of the Region gave rise to increased precipitation, the isohyetal maps did not closely follow differences in elevation but show declining rainfall with increasing altitude on the limestone plateau. Another anomaly occurs in the south east of the Region where isohyets have been drawn where no topographic changes occur.

The rainfall data for the three stations within Bay Region presented in Table 1.1 show some relationship between elevation and precipitation. Based on this relationship it may be concluded that the rainfall on the limestone plateau, which is mostly at an elevation in excess of 400 masl, will be typified by Baydhabo rainfall. Over the major part of the remainder of the Region the rainfall data for Buurhakaba and Baardheere will be typical. The Diinsoor data represent the rainfall in the transition zone in the proximity of the escarpment.

The annual and seasonal rainfall data from the three Bay Region stations have been subjected to detailed probability analysis HTS (1982). The results are presented in Table 1.1 and emphasize the considerable within-region variation.

1.2.3 Other Climatic Factors

The climatic data shown in Table 1.2 have been extracted from the long term records that are available for Baydhabo and may be regarded as being broadly typical of Bay Region as a whole. The climatic data have been selected to form the basis for the calculation of theoretical crop water requirements useful for the assessment of potential production levels under variable rainfed conditions.

Temperatures in Bay Region fluctuate very little through the year; the mean monthly temperatures are within + or - 2.0°C of the mean annual temperature and do not limit crop production.

Average relative humidities are lowest in the dry season (Jillal) in the months of December through to March and are highest during the two rainy seasons. Humidities also remain relatively high during the dry season (Haggai) in the months of June, July and August, when the mean daily number of sunshine hours are also at their lowest. The highest number of sunshine hours occur during the December-March season.

Wind is the only climatic parameter which may not be typical in Baydhabo - because of the exposed position of the town on the top of the escarpment windspeeds may be somewhat higher than for the other parts of the Region. Any differences are not expected to have any significant implications. For Baydhabo the average annual daily windrun is 320 km which is equivalent to an average windspeed of 3.74 m per second with a range from a July peak of 4.74 m per second to a low of 2.54 m per second in November.

TABLE 1.1 RAINFALL DATA ANALYSIS - BAY REGION 1982

		Baydhabo	Buurhakaba	Diinsoor	Bardeera*
Number of years of records		45	26	6	39
Altitude masl (approx)		400	200	320	110
Annual mean rainfall in mm		589.5	442.0	543.5	442.2
Probability of Exceedence	%				
	80	413	349	449	339
	50	547	420	507	406
	20	740	595	675	581
Gu season rainfall April/May Probability of Exceedence	%				
	80	168	82	146	77
	50	240	134	205	158
	20	344	310	279	262
Dayr season rainfall Oct/Nov Probability of Exceedence	%				
	80	112	83	95	56
	50	215	182	169	133
	20	344	272	281	261

*Station outside Bay Region
Source: HTS 1982.

In the Inter-Riverine Agricultural Study (HTS 1977) the Baydhabo climatic data were used with the Penman formula to calculate the open water evaporation (Eo) which is also given in Table 1.2. The annual total calculated Eo for Baydhabo in this report was 2 306 mm which compares with the 1 468 mm quoted for annual Penman Eo based on Baydhabo climatic data in the FAO World Bank Report (1977) produced in the same year. The source of this discrepancy cannot be detected from the limited data given in the reports. For the purposes of this report the reference crop evapotranspiration data have been devised by multiplying the figures contained in Table 1.2 by 0.80.

1.2.4 Climate and Crop Production

With the bi-modal distribution of rainfall in the Bay Region double cropping is possible and most farmers in the arable areas endeavour to obtain a crop in both the Gu and Dayr seasons. An analysis of the daily rainfall data for Baydhabo has provided some guide on the seasonal duration and start dates of the two wet seasons. The start and end dates of each season were defined arbitrarily as the first and last daily falls greater than 10.0 mm; records of rainfall exceeding 10.0 mm, but separated from the season by 10 days or more, were discarded. Table 1.3 summarises the statistics relating to the start dates and durations of the two seasons; it is assumed that the respective series of values fit a normal probability distribution.

TABLE 1.2 OTHER CLIMATIC DATA FOR BAYDHABO (BAIDOA).

Climatic Parameter	Temperature[1]	Humidity	Wind Run	Sunshine	Calculated Penman Eo
Unit	°C	%	km/day	hours/day	mm/day
Period of Records	1922-73	1923-73	1953/74	1934-58	-
No. of Years of Records	30	28	16	10	-
January	27.4	63	340	9.28	7.8
February	28.1	61	320	9.60	8.3
March	28.3	63	310	8.89	8.2
April	27.4	72	330	7.59	7.3
May	26.0	77	280	7.68	6.4
June	25.1	73	360	6.86	6.3
July	24.1	74	410	5.20	5.8
August	24.6	71	400	6.73	6.6
September	25.5	68	350	7.26	7.1
October	25.6	74	250	6.24	6.1
November	25.8	75	220	7.94	6.3
December	26.6	69	300	8.93	7.0
Annual Means	26.2	70	320	7.67	6.9

Source. Inter-Riverine Agricultural Study HTS 1977.

Note: [1] *Mean monthly.*

TABLE 1.3 STATISTICAL DESCRIPTION OF BAYDHABO RAINY SEASONS

	Probability of Occurrence	Gu Season	Dayr Season
Start			
	1 year in 4	by 1st April	by 2nd October
	average	9th April	10th October
	3 years in 4	by 17th April	by 18th October
Duration	1 year in 4	49 days	46 days
	average	38 days	33 days
	3 years in 4	27 days	20 days

Source: HTS 1982

The information in Table 1.3 illustrates the erratic timing of the beginning of the rains and the short duration of the rains in both seasons. These characteristics of rainfall have important implications for arable agriculture. Early land preparation and timely planting are of critical importance for maximum utilisation of rainfall. For example the local sorghum, which is by far the most important arable crop, takes between 115-125 days from planting to harvest, so that with such short duration rainy seasons, soil moisture holding capacity is of crucial importance in determining yields.

Theoretical crop water requirements compared with actual availability of water in terms of rainfall serves as a useful indicator of crop production potential. The theoretical calculated consumptive use of sorghum is shown in Table 1.4 for both the Gu and the Dayr seasons and relates to optimal plant populations growing under conditions of no water stress and producing near maximum grain yields.

TABLE 1.4 CALCULATED CONSUMPTIVE USE OF LOCAL VARIETY OF SORGHUM

	Gu Season				Dayr Season			
Months	April	May	June	July	Oct.	Nov.	Dec.	Jan.
Reference crop evapotranspiration	175	159	151	144	151	151	174	193
Crop coefficients*	0.42	0.65	0.85	0.70	0.42	0.65	0.85	0.70
Calculated monthly consumptive use in mm	73	103	128	101	63	98	148	135
Calculated total consumptive use in mm		405				444		

* Derived from Doorenbos and Pruitt (1975)

The seasons in which total rainfall is sufficient to meet in full the potential consumptive use of sorghum are extremely rare, even in the wettest parts of the Bay Region. In Baydhabo rainfall can be expected to exceed 344.0 mm (see Table 1.1) only one year in five. The higher rainfall cannot always be expected to give maximum results because most of it occurs in the first two months of both seasons and moisture stress is likely to occur in the second half of the growing period of crops taking more than 100 days from planting to harvest.

There is no simple relationship between seasonal rainfall and potential crop production levels. The effectiveness with which a given quantity of precipitation is translated into grain production is determined by such factors as rainfall distribution, storm intensities and soil conditions relating to the retention of rain water in the profile. Given the conditions of soil and climate within the Bay Region arable farming areas, it is suggested that a seasonal rainfall of less than 200 mm will produce no significant grain crop. This statement may need modification where significant amounts of stored soil moisture are present in the profile within the root range of the crop prior to the commencement of the season. At Buurhakaba in both seasons and at Diinsoor in the Dayr season rainfall is less than 200 mm in more than 50 per cent of the years indicating a very high failure rate for the sorghum crop.

An examination of the climatic data indicates that the Gu season is comparatively a much more reliable cropping season than the Dayr season. The Gu season rainfall is generally higher than that of the Dayr season and the duration of the Gu rainy season has been shown to be longer than the Dayr. In addition, the potential crop evapotranspiration rate is significantly lower in the second half of the Gu as compared with the second half of the Dayr season. Thus the critical crop-soil water balance is significantly more favourable in the Gu season for crop production.

The higher humidities and cloudy conditions of the late Gu and Haggai seasons favour the build-up of crop insect pests and lead to a higher incidence of crop fungal diseases as compared with the Dayr season. The condition of the harvested grain crops is generally inferior in the Gu season since the climatic conditions at the Dayr harvest are low humidities and bright sunshine.

1.3 SOILS

In 1982 further soils investigations were carried out in Bay Region by Hunting Technical Services adding to previous investigations undertaken by Lockwood/FAO (1968). The additional studies carried out in 1982 were required to provide a more detailed and comprehensive data base for development planning.

A semi-detailed soil survey, involving a sampling density of one site per 500 hectares, was carried out in four areas, each of 62 500 hectares, which had been selected for use as Pilot Agricultural Development Units (PADU's). A similar sampling density was used for a survey of an area of limestone depression soils (+ or - 60 000 ha) which was believed to have suitable groundwater for the development of irrigated crop production. Maps were produced at a scale of 1:50 000 for the PADU's and 1:100 000 for the potential irrigation area.

In addition to these more detailed studies, sufficient sampling was carried out over the remainder of the Region at a density approximating to one site per 10 km^2 which, with the aid of field observations, aerial photography and satellite imagery, combined to facilitate the production of a regional soil map at a scale of 1:250 000.

Four major groups of soils had been identified by Lockwood/FAO in 1968 and these groups were retained as the basis for the 1982 soil classification and mapping. The soil groups were identified largely on the basis of the parent materials from which they have been derived including the limestone plateau, the basement complex, coastal plain materials and alluvial deposits. The soils from each group presently being used for rainfed arable agriculture are as follows:

Parent Material	
Limestone Plateau Soils	Amin Baydhabo (Baidoa) Bardeera Berdaale Uiamo
Basement Complex	Buurhakaba (Bur Acaba) Modu Mode
Alluvial Deposits	Valley Bottom Soils

The outstanding characteristics of all presently cultivated soils in Bay Region are fine textures, good moisture holding capacity and a depth of profile that can be exploited by crop roots in excess of 1.0 metres. Other important features of the major arable soils in the Region are discussed in the succeeding sections.

1.3.1 Amin Soils (Am)

These soils occur in scattered, mostly large, discrete areas in the west and north-west of the Bay Region with the major areas around Ufurow, Qansaxdheere, Borame and Wangarasle. The total area of these soils is 99 900 hectares mostly in the altitude range 350-450 masl and consequently with a somewhat higher rainfall than much of the region.

The Amin soils are red-brown to brown vertisols associated with the softer marl beds of the Jurassic limestone plateau. Topography is generally flat. Depth of soil is rarely limiting. Despite the heavier textures of these soils they are remarkably well drained.

As these soils dry, they crack extensively; the strongly self-mulching surface soil fill the cracks and ensures a natural and continuing circulation of the soil in the upper profile layers.

Detailed analysis of the Amin soil has been carried out for only one site, (HTS,1982) and the results may be regarded as indicative rather than definitive. The pH of the three horizons identified in this pit ranged between 7.82 - 7.91 which may be described as moderately alkaline.

The cation exchange capacity of all horizons was very high as were the levels of exchangeable calcium, magnesium and potassium. The exchangeable calcium to magnesium ratio was more than 4.0 in all horizons; this may be described as moderately high and signifies favourable physical properties of the soil.

The exchangeable sodium in the upper horizon was medium but increased to high levels in the lower horizons. Below 64 cm the ESP rose to 21 and the EC of the saturation extract was 6.22 mmhos/cm which is unlikely adversely to affect root development of any present and potential crops.

Samples from a total of 14 sites were analysed for exchangeable Na, CEC, ESP and ECe as part of a routine procedure. The majority of these samples exhibited similar trends to the pit sample, exchangeable sodium levels increased with depth whilst the CEC declined with depth. At the same time samples from increasing depth showed an increase in ESP level and an increasing electrical conductivity of the saturation extract. However, salinity in the lower horizons could only be regarded as a limiting factor for agricultural purposes at one of the 14 sites. The Amin soils are reputedly the most fertile in the Bay Region and are already more than 70 per cent cultivated. However little data is available to support this reputation. Indeed the only data on the macronutrients in Amin soils suggests that available phosphate levels are very low and could be a limiting factor (CARS Afgoi, 1967). On the other hand this same publication showed that levels of potassium in Amin soils were exceptionally high. Phosphate availability is almost certainly restricted by the relatively high pH of the Amin soil.

1.3.2 Baidoa Soils (Ba)

These soils occur in a large discrete block, located to the west of Baydhabo town, and cover an area of 132 590 hectares. The altitude of this area is between 450-525 masl and since it is situated on the limestone plateau adjacent to the limestone escarpment at its most prominent point, it probably receives the highest rainfall in the whole Region.

The Baidoa soils are brown to dark brown vertisols which were formed in situ within the deep mantle of the limestone plateau. The soils are deep, in excess of 120 cm, and topography is flat. There are few drainage lines.

The high clay content of the Baidoa soils results in much swelling and shrinking as moisture conditions change. As these soils dry out, large cracks appear and solution holes and associated 'gilgai' microrelief develop.

Based on the detailed analysis of samples from one pit in Baidoa soil some impression of the more important characteristics may be obtained. The pH of the several horizons was around 7.6 which is referred to as being mildly alkaline. The cation exchange capacity of all horizons was very high and very high levels of exchangeable calcium, magnesium and potassium were registered. The ratio of exchangeable calcium : magnesium was between 3.25-3.5 which suggests favourable physical properties of the soil.

The exchangeable Na was medium in the top-soil,but increased to very high below 52 cm where it was associated with EC level reaching 8.5 mmhos/cm and an ESP of 17.

The results of these analyses from a single pit were compared with 24 sites sampled for routine analysis for exchangeable Na, CEC, ESP and ECe. The pit was shown to be quite typical in terms of these four parameters which remained at levels well within crop tolerance limits in all the samples that were analysed.

The fertility levels of the Baidoa soils have not been investigated in any depth. The only data which is available on macronutrient levels is from CARS Afgoi (1967) which showed that levels of available phosphate in the surface horizons of Baidoa soils are very low - the average of 5 samples was 6 kg of available P per ha - and that levels of potassium are high, averaging over 700 kg of K per hectare.

1.3.3 Uiamo Soils (Ua)

The Uiamo soils are the principal cultivable soils of the mantled limestone plateau in the south west of the Region. A total of 273 000 hectares of Uiamo soils have been mapped. A large proportion of these soils are within the altitude range 80-300 masl where rainfall is likely to be significantly less than on the limestone plateau. However, a broad belt of land with Uiamo soils is located adjacent to the fading limestone escarpment to the south west of Baydhabo most of which is in the altitude range 350-450 masl and which could benefit from the increase in rainfall which occurs with the increasing altitude of the limestone plateau. The rain-bearing winds are south-east or south in direction.

The Uiamo soils are grey to grey brown vertisols of rather variable depth, but usually at least 1.0 m. These soils bear the typical surface characteristics of vertisols - a slight but regular micro-relief, large surface cracks delineating the master peds and solution holes. Surface and sub-surface textures are clay loam to clay over a massive or weakly prismatic subsoil. Coarse sand grains occur throughout the profile to a depth of about 1.5 m having entered the profile through cracks. Shell fragments and small black concretions are common features of the upper horizon whilst calcium carbonate and gypsum may be found in heavy concentrations below about 80 centimetres.

Detailed analyses of samples taken from 6 pits in Uiamo soils are reported by HTS (1982) and show wide variation between sites in both physical and chemical characteristics. The pH varies between 7.8 and 8.1 whilst the cation exchange capacity ranges from very high to medium. The exchangeable calcium: magnesium ratio varies from 0.54-5.6:1 and suggests that soil physical properties may be less than favourable in some parts.

Profiles with the highest cation exchange capacity also showed levels of exchangeable sodium increasing with increasing depth of horizon. In these profiles ESP levels rose to more than 20 and the EC of the saturation extract exceeded 7.0 mmhos/cm in the lower horizons of three of the six sites. A similar trend was manifest in the 22 profiles of Uiamo soils examined as part of the routine analysis programme. Most profiles exhibited very high levels of exchangeable sodium at around 75 cm depth and several ESPs in excess of 30 were recorded. Nevertheless the level of electrical conductivity in these lower horizons exceeded 7.5 mmhos/cm in only 4 horizons. Whilst conditions in the lower part of the profile are unlikely to restrict root development completely, they will undoubtedly have some influence on the rate of water uptake.

The information that is available on the macronutrient levels of Uiamo soils is limited to the CARS (1967) report on phosphorous and potassium levels in Somali soils. Available phosphate levels range from low to high medium in the Uiamo soils which were generally higher than in either the Amin or Baidoa soils. The available potassium in the Uiamo soils was satisfactory for all the top-soil samples analysed. These results to some extent confirm local opinion on these soils which are regarded as being fertile and are cropped extensively with rainfed sorghum.

1.3.4 Bur Acaba Soils (Br)

These soils are derived from the products of the erosion of the basement complex granites and metasediments and drift materials from the limestone plateau. A total area of 192 440 hectares of these soils has been mapped, the majority in a large single block of land sometimes described as the Buurhakaba plain. The altitude of this plain ranges from 150-300 masl and consequently is situated in one of the areas of lowest and least reliable rainfall in the Bay Region. The plain is level to gently undulating.

The Bur Acaba soils are dark brown vertisols. The surface exhibits slight microrelief; occasional gravel smears occur. During the dry season large cracks and solution holes appear. Textures are loam to clay becoming heavier with depth, and surface layers have excellent self-mulching characteristics. Generally the soils are deep, in excess of 1.0 m.

Detailed analysis of the Bur Acaba soils has been carried out for two sites (HTS, 1982) and 25 sites were covered by the routine analysis for exchangeable Na, cation exchange capacity, ESP and EC of saturation extract.

The pH of the several horizons of the two pits covered by detailed analysis ranged between 7.95-8.02 which may be described as moderately alkaline. The cation exchange capacity of the soils from the two sites was surprisingly different ranging from medium in one to low in the other. A similar variation also occurred in the samples included in the routine analysis. However, in both cases declining cation exchange capacity occurred with increasing depth of the horizon. The exchangeable calcium : magnesium ratio was 3.7 and 3.0 in the top soil of the two pits but this worsened considerably in the deeper horizons. This suggests that the favourable physical characteristics of the top soil are not repeated in the subsoil.

The exchangeable sodium in the upper horizons of the two pits was very low but increased to very high levels in the lowest horizons. The low levels of exchangeable sodium in the upper horizons were not repeated in many of the samples included in the routine analysis programme, but the majority showed increasing levels of exchangeable sodium with depth of horizon.

A few of the sites sampled for routine analysis showed high ECe values throughout the profile which could interfere with crop growth and suggests that the Bur Acaba soils could be less attractive for agriculture than the three soils described earlier. The higher EC levels in the upper parts of the profile will result in increased crop susceptibility to drought conditions. Salt-sensitive crops such as beans may be retarded if the surface horizon has an ECe greater than 3.0 mmhos/cm - this level was exceeded at 5 of the 25 sites included in the routine sample analysis (HTS, 1982). Further investigations are required to confirm these findings.

Based on the information that is available in the CARS (1967) report, the Bur Acaba soils have low-medium levels of available phosphate and generally contain ample supplies of available potassium. No other data with a direct bearing on the fertility levels of these soils has been located. However they continue to be cultivated extensively, mostly for sorghum, despite marginal rainfall conditions, so fertility levels appear to be sufficient to support acceptable grain yields when rainfall conditions permit.

1.3.5 Valley Bottom Soils (VB)

The valley bottom soils occupy an area of approximately 279 000 hectares in the southern half of the Region. These soils are found in the drainage lines which begin at the foot of the limestone escarpment and pass in a south or south easterly direction over the basement complex. Most of the valley bottom soils are below the 300 m contour and are consequently situated in that part of the Region with the lowest and most erratic rainfall.

The soils are relatively recent alluvial deposits derived from the clay plains of the limestone plateau mixed with erosion products of crystalline origin from the basement complex. Physical characteristics of these soils are very variable. Textures vary from sandy loam to clay, often overlain with sands in the river courses. High sand content of the soil is an adverse factor because of poor moisture holding capacity and may account in part for the low utilization of these soils for arable agriculture. Susceptibility to periodic flooding in the wet season is also a factor to be reckoned with and may also contribute to low utilization.

In view of the wide diversity of soils within the soil group and the present limited knowledge of the range of variation, further discussions of the chemical characteristics and fertility aspects of these soils would not be very meaningful. However, it should be stressed that useful land for arable agriculture is almost certainly included in the areas of valley bottom soils, but further investigations are required to establish the extent and the precise nature of these soils.

1.3.6 Other Soils with Agricultural Development Potential.

Three other distinct soil types were identified within Bay Region as being presently cultivated and with some potential for further development of arable agriculture, namely Bardeera (B), Modu-Mode (Mo) and Berdaale (Bd). However, these occupy only small areas.

1.3.7 Agricultural Implications of Bay Region Soils

All the soils of the Bay Region currently being cultivated and with potential for agricultural development are fine textured and in the clay loam to clay range. These soils crack to considerable depths when dry and are strongly self mulching.

The fine textured soils of Bay Region can only be effectively tilled with traditional hand tools when dry. Also tractor use on wet soils results in wheelslip and tractors may be efficiently used only during a limited period.

Heavy soils have low permeability. High intensity rainfall forms puddles which may result in poor establishment and/or loss of plants at a later date due to waterlogging.

Poor permeability of heavy soils may result in high run-off causing the development of erosion channels, gullying and general deterioration. Deep gullies have developed, closing roads.

Moisture conservation measures through bunding may be counter-productive in wet years by increasing the amount of water held on the soil and prolonging the period of water-logging.

Fertility levels of the Bay Region soils are generally not high. Applications of inorganic and organic fertilisers may be required to maintain fertility levels and thus make shifting cultivation unnecessary.

Crop rotation may also help with the maintenance of soil fertility and may be important for the control of soil borne diseases.

1.3.8 Existing and Potential Areas for Rain-fed Arable Agriculture

The cultivation intensity in Bay Region was recorded by HTS (1982) using aerial census techniques. The major concentrations of existing areas of arable farming occurs on the Baidoa soils to the north and south west of the town of Baydhabo. More than 60 per cent of these soils are under cultivation. A similar cultivation intensity is found on Amin soils around the town of Qansaxdheere. The next most intensely cultivated lands are the Uiamo soils located to the north of Diinsoor and the Bur Acaba soils where the cultivated land occupies between 30-60 per cent of the total area. Less intensively cultivated areas, in the range 10-30 per cent cultivated, are found in the south west corner of the Region on Uiamo soils.

Comparative studies were made by HTS (1982) of the land areas cultivated in 1973 and 1982. It was concluded that only a small net increase in the area of cropped land (includes recently abandoned land) had occurred over this period. Further studies were made of the changes in the extent of cultivation between 1960-1982 by reference to earlier 1960 mosaics. However, for the areas selected no significant changes were recorded. The lack of change in the cultivated area is puzzling since there has been a considerable increase in the human population over the same period which must have resulted in increased demands for food crops.

The present distribution of the cultivated land areas within Bay Region follows the heavy textured soils and areas with the higher rainfall probabilities. There is potential for increasing the cultivated land area within all areas of existing cultivation. Even within the areas of most intensive land use (e.g. on Baidoa soils) there is some scope for expansion of the cropped areas since long term fallow periods are not regularly practiced and land pressure is apparent in only a few areas.

The potential new development areas for the expansion of rainfed agriculture are mostly located in a less reliable rainfall belt than the present cultivated areas, but this lack of rainfall does not wholly account for the absence of cultivators. The availability of water supplied for domestic purposes and livestock is a major determinant of the distribution of people in relation to the cultivable land.

The usual way of providing such water supplies has been through the construction of surface reservoirs, or wars. Such construction has not taken place in some areas and an explanation could be the lack of land pressure in the presently developed areas. The insignificant changes in the cultivated areas in the Bay Region, referred to earlier in this section, would support this explanation. It may be concluded that within Bay Region the availability of suitable land is not a constraint to the expansion of rainfed agriculture at the present time.

1.4 CURRENT AGRICULTURE

1.4.1 The Structure of Farming

In Somalia all land is owned by the State and individuals acquire usufruct rights to a piece of land, through the clearance and development of the land for crop production.

A farm family engaged in rainfed agriculture, with only family labour resources at its disposal, may cultivate between 1 and 3 hectares of land for rainfed crop production. In a survey carried out in Baydhabo 82 per cent of farmers were entirely dependent upon family labour and it is likely that in the other three districts of the Region this percentage could be much higher.

Virtually all farmers own livestock which may include cattle, camels, goats and sheep. The use of animal power for land cultivation is limited to no more than a few dozen farmers in Baydhabo District. Tractor ploughing services are provided by ONAT, but the areas of land prepared by tractor are only a tiny fraction of the total cultivated area.

Sedentary farmers cultivate for long periods without marked loss of soil fertility and there is little evidence of any regular pattern of shifting cultivation. However, many of these cultivators will move large distances with their animals in search of better grazing or water. Such movements are usually outside the cropping seasons.

1.4.2 Crops and Cropping Patterns

Sorghum is by far the dominant crop in the Bay Region. In most farms, sorghum is planted in both the Gu and Dayr seasons. The only addition to sorghum monocropping may be the interplanting of cowpeas in both seasons. A handful of farmers are planting groundnuts, but in no fixed rotation. Other crops of minor importance include maize (Gu season only), sesame, cowpea, mung bean, sweet potato, cherry tomatoes and some cotton.

1.4.3 Sorghum Husbandry and Factors Limiting Yield Levels

(a) Land Preparation

A short-handled hoe is normally used, known locally as a 'yambo'. Cultivation is done in dry conditions only. The soils are self mulching clays which, if weed-free, require only smoothing and crack filling with the yambo. Patches of perennial weeds receive special treatment (e.g. deep cultivation to 15-20 cm using a long-handled yambo, stolons extracted and either fed to livestock or dessicated and removed from the field). The most important species is *Digitaria rivae.*

Two members of the family *Compositae* are important weeds; both are stoloniferous and have similar rooting characteristics:

Lactuca taraxicifolia - small plant 10 cm, edible and used as dry season vegetable.

Lonchus exauriculatus - larger plant than *L. taraxicifolia*, bitter and non-edible, but eaten by livestock.

Control is by uprooting and desiccating the stolons.

The yambo is used to cultivate land only where weeds are a problem. If land has been used for a number of years and has been well weeded, no land preparation is necessary.

(b) Varieties

The local variety remains dominant throughout the Region. Recent introductions of two new varieties, Dabar and GBR 148, have not yet been adopted by the farmers. The local variety, the origins of which are obscure, includes a range of plant types and grain colour. Plant height is usually in the range 170-200 cm under reasonable growing conditions. Panicles are compact and erect or goose-necked. The time taken from planting to harvest ranges between 115-125 days.

(c) Seed

Farmers generally use their own seed. Seed quality is not thought to be a problem because of the short carry-over between seasons. Farmers select the best panicles for seed. It may be stored on the panicle or as threshed grain when it is commonly mixed with fire ash as a protection against insects. Grain from the storage pits is not used for seed because, under the high temperature conditions generated in these pits, the sorghum grain rapidly loses viability.

In drought years, which are not infrequent, farmers may be faced with complete crop loss. Seed reserves are not normally held to guard against such a crop loss and the farmer is commonly dependent upon ADC for his seed supplies. Any benefits which may accrue from the farmers' continuing mass selection are lost. The ADC seed is unselected and the quality of supplies is said to be variable. However all ADC seed is treated with a fungicidal seed dressing primarily for the control of seed borne smut disease.

The use of seed dressing by individual farmers has increased considerably in recent years through the efforts of the extension service and the plant protection department of the Ministry of Agriculture. In the survey of farms in Baydhabo District, 77 per cent of farmers said they were treating their seed with a chemical seed dressing. This was in general agreement with the amount of Dithane distributed for the 1983 Gu season which was sufficient for the seed to plant in excess of 50 000 hectares.

(d) Planting, Spacing and Seed Rate

The time of planting of sorghum is commonly determined by local calender which is lunar and kept by a village elder; the calender is not written. The village elder advises on when to plant within broad limits prior to the beginning of the Gu and Dayr season rains. The crop is usually planted after the first rain but may also be dry planted when the farmer considers there is a good chance of rainfall.

Planting holes are made in the top-soil using a special long-handled yambo. Spacing is irregular and row planting is rare. A pinch of seed is placed in each hole, usually about 5 seeds, but the number may be varied depending on anticipated problems with insects, birds and other pests as rats and ground squirrels, and on the farmer's expectation of seasonal rainfall. The seed is covered in the holes by the foot of the sower.

The irregular spacing associated with the rapid traditional method of planting gives a density of planting holes of 10 000 - 15 000 per hectare. A change to row planting with regular within-row spacing using traditional tools would undoubtedly increase the labour requirement greatly.

The seed rate of sorghum used by Bay Region farmers is thought to vary between 6-8 kg per hectare.

(e) Cultural Practices during the Growing Period.

Thinning is carried out by the majority of farmers 2-4 weeks after seedling emergence; the number of plants left per hole is between 2 and 4 depending to some extent on seedling vigour. The first weeding using the yambo is carried out simultaneously with the thinning operation. The second weeding is carried out 5-6 weeks after seedling emergence in most situations. A third weeding is carried out by some farmers.

Intercropping of sorghum is practised by some farmers; usually the other crop is cowpea which is commonly planted where only low plant populations of sorghum have been established.

(f) Pests and Pest Control

In seasons of adequate rain, insect pest damage is undoubtedly the major constraint on sorghum production levels in Bay Region. The sorghum is commonly under attack by one pest or another from seedling emergence until the grain has matured. The frequency and severity of insect pest attack are unpredictable and the farmer must be always alert to the dangers if he is to safeguard his crop.

In the past three seasons over much of Bay Region, sorghum in the seedling emergence stage and for several weeks after has been subject to serious damage caused by leaf eating insects. Two major types of insects have been involved in this early season attack - the common cricket and a number of different species of grass hoppers. These insects have a wide range of diet and normally show no special preference for sorghum. However, they were present in such numbers and feeding so voraciously that the young sorghum plants were not spared. Limited efforts were made to control these pests using the insecticides Cygon and BHC 3 per cent (as a bait) but, with only limited coverage, damage due to these pests was extensive.

A more regular and specific pest of young sorghum in the Bay Region is the sorghum shoot fly *Atherigona indica.* The eggs of this fly are laid on the young sorghum leaves and the larvae burrow into the central shoot destroying the growing point and causing 'dead heart'. This pest does not have devastating effects but does contribute to a loss of plants which ultimately lowers yield levels.

The stalkborer *Chilo partellus* is, perhaps, the major pest of sorghum in the Bay Region and is reported as being responsible for major reductions in yield levels in most seasons. The severity of the stalkborer problem is probably due to a combination of factors. The practice of cropping sorghum in both Gu and Dayr season favours the maintenance of high populations for much of the year, particularly when combined with sorghum monocropping and the failure to dispose of crop residues which carry large numbers of pupae. Attempts to control the stalkborer with the use of insecticides are being supported by the Plant Protection Department through the Extension Service but only on a limited scale. The regional total area was not much more than 1 000 ha in Gu 1983. The main insecticide being used is diazinon supplied under the trade name Basudin 10G. Three applications are recommended in the worst years beginning when the sorghum is 15-20 cm in height with two more applications following at 2-week intervals after the first. Stalkborer infestation occurs over a long period.

There are two important insect pests which attack the sorghum inflorescence: aphids and the American bollworm. The importance of these pests is extremely variable. Chemical control is used in the cases of serious outbreaks. Malathion is used to control aphid outbreaks and Sevin 85 per cent is used for American bollworm.

The insecticides which are distributed through the Plant Protection Department and the Extension Services are provided to the farmer free of charge. Thus there is no routine use of insecticides; they are mostly used in crisis situations. The economics of insecticide use can only be a matter for speculation, given the data currently available.

A major pest hazard for the sorghum crop in the Bay Region are the seed-eating birds which can completely remove the ripening grain in the worst years. Indeed serious damage was caused to the 1983 Gu season sorghum crop in many areas of Bay Region. The major species of bird which is responsible for a high proportion of the damage caused to the sorghum crop in Bay Region is the red billed quelea or Sudan Dioch. Control of this pest is usually obtained by spraying poisons on their roosting sites from aircraft. However in the Gu season of 1983, the aircraft which should have covered the roosting sites of the quelea in Bay Region was unserviceable at the critical time and no spraying was undertaken. The aircraft is operated by the Bird Control Project which is a national project and so outside the control of BRADP.

At the field level, farmers and their families spend many days bird scaring as the sorghum grain ripens. There are numerous species of seed eating birds in addition to Quelea spp. which attack the sorghum. The effectiveness of the bird scaring operation is dependent upon bird population levels and in bad years is to no avail. Local farmers often fly kites over the fields of ripening grain to scare away the birds. The origin of this practice is unknown.

(g) Harvesting and Storage

The sorghum harvest is carried out by hand; the stalk is broken just below the panicle and the sorghum head is placed in a sack. The time of harvest depends on whether or not the crop is threatened by birds. If there is a danger of heavy bird losses harvesting may take place not much later than the soft milk-stage. Following harvest the panicles are thoroughly sun-dried.

The traditional form of sorghum storage in southern Somalia is in ground pits and Bay Region is no exception in this respect. The pits are dug to a depth of 1.5-2.5 m with a diameter of 3.0-4.0 m usually located in an area with a dry profile for most of the year. The pits are generally lined with sorghum stover. Sorghum panicles are then placed in the pit and the pit is completely filled and piled to maximum height above ground. A wooden frame is then placed on the pile and sorghum stover is then placed on the wooden frame. Finally soil is placed on this 'thatched' cover completely sealing the hole. Within these sorghum pits high temperatures are generated by the respiration of the seed in a sealed environment and the oxygen is quickly eliminated. Seed viability is lost due to high temperatures and the storage pests of the grain do not survive because of the lack of oxygen. This pit storage is reputed to be very effective but no detailed investigations have been undertaken to determine the levels of storage losses occurring under the variable conditions of Bay Region.

(h) Marketing

The sorghum grain is removed from the panicles before marketing. The panicles are placed in a mortar and are pounded in the traditional way. Before threshing, the panicles are separated according to grain colour so that the threshed seed is uniform in colour. The white colour is preferred for most food preparations and commands a premium price.

Until recently ADC has been the monopoly buyer of grain through its agents who are located in strategic villages. These agents are responsible for payments to the farmer and for the organization of collection. The scale of ADC operations in Bay Region are illustrated by the purchases for the 1982 Dayr season as shown below:

	Quintals
Baydhabo	17 000
Qansaxdheere	25 000
Buurhakaba	5 200
Diinsoor	5 600
Total	52 800

This total purchase level compares with the 155 000 quintals of sorghum purchased in Gu 1982.

(i) Post Harvest Events

Following the harvest of the sorghum panicles, the stover is then fed to the livestock. The utilization of the stover may be

(i) through direct grazing in the field;
(ii) through cutting and carrying for immediate use either by the farmer's own livestock or through sale in the market;
(iii) as conserved material at a later date; the stover is dried thoroughly and stacked.

The direct grazing of sorghum stover in the fields is the usual practice in most areas which are too far away from urban markets. The grazing animals include those belonging to the farmer and animals from other areas which are brought in specially to make use of the crop residues. Apparently the owners of these extraneous animals, in some cases, may have assisted with the sorghum harvest and may take the grazing in part payment for their labour. All classes of livestock utilize the grazing following the removal of the sorghum grain crop and assist in cleaning the land in preparation for the succeeding crop in the following season.

In the vicinity of the major town Baydhabo, large areas of sorghum stover are cut and carted into town for feeding the town herd. In August 1983 the value of the stover per unit area was in excess of the value of the sorghum grain which had been harvested previously.

A minority of farmers cut their sorghum stover after the grain harvest and place it in a stack for feeding to their animals during the following months. The more prudent of these farmers may simply stack the stover and keep it in reserve for the really severe drought period - up to 2 years after harvest but this is rare.

The practice of ratooning sorghum after the removal of the stover is quite widespread after the Gu season crop (Ratoon sorghum will rarely survive the extreme drought conditions and high temperatures of the jillal season). Farmers generally recognise that ratooning is bad practice resulting in carry-over of insect pests and diseases and the extension service is attempting to discourage the practice. Nevertheless the farmers continue to ratoon the Gu season crop and this may result in part to a lack of resources to uproot the crop. Later, if the expectation of rainfall is poor the ratooned sorghum is allowed to continue growing and the farmers argue that a fodder yield and a little grain from a ratoon crop is better than little or nothing from a newly seeded crop.

2

Review of Past Research at Bonka

2.1 THE HISTORY OF RESEARCH AT BONKA

The first applied research at Bonka was carried out by the Italian Administration during the period of the UN Trusteeship 1950-60. At the end of this period the Italians removed most of their official records from Somalia including their records of research at Bonka which are probably still stored in the archives of the University of Florence. Crops included in trials at this time included sorghum, groundnuts and cotton. The work programme during this period also included the introduction and testing of animal drawn implements; some proto-types introduced at this time may still be seen at the Bonka Extension Centre.

The experimental station at Bonka was established by the Italians in 1952 and in 1956 a Farmers Training Centre was established on land adjacent to the experimental station. The Centre was built using ICA funds under the Marshall Plan under an agreement between the governments of the USA, Italy and Somalia.

After Somali Independence in 1960 the Bonka FTC received continued assistance from the USA both for the provision of physical facilities and equipment and also with personnel. The experimental station was not included as part of the package and no research was carried out on land of the FTC until 1964 when some trials were reported for the Gu season.

During the period 1965-70 there was a USAID financed project, implemented by a team from the University of Wyoming, which was largely concerned with research at the Afgoi Experimental Station but was also involved with the Bonka Farmers Training Centre and extension in Bay Region. As a result a few trials were undertaken on FTC land.

With the changes which occurred in late 1969, research work at Bonka was halted and nothing happened until 1975. In this year a national research project was commenced in which the Ministry of Agriculture personnel were assisted by FAO technical advisers. However, over the period 1976-78 only limited staff were available when a new research station was established on new land across the road from the FTC. Much of the time of the limited number of staff was spent on procurement of materials and supervising construction of buildings and few trials were carried out in this period.

The period 1979-80 was an improvement on previous years. A programme of screening of introduced sorghum varieties was begun under the auspices of FAO.

In 1981 the research at Bonka became an integral part of BRADP. An expanded programme of trials has been undertaken during the last four seasons and have included agronomic investigations in addition to varietal testing and screening work.

2.2 RESEARCH FINDINGS AT BONKA 1963-83

The research findings summarised in this section are not comprehensive. For the University of Wyoming period 1965-70 the only documents consulted were those held at the Extension Centre library at Bonka and these records are known to be incomplete. However a small amount of investigational work carried out during this period was reported on and is reviewed.

2.2.1 Dayr Season 1963

Rainfall during this season was 371 mm which is somewhat above average and the distribution was generally satisfactory. Planting of the trials did not commence until 20th October because of labour problems. Results are summarised as follows:

(a) Observation plots to compare effect of light cultivation with mouldboard ploughing to 5" depth, sorghum grain yield not measured but no differences discernable.

(b) Continuous cropping with sorghum demonstration first year. Emergence good, but severe insect infestation - cricket, grasshoppers, budworms, stalkborer. Plant growth very poor,only 10 per cent headed. Late planting probably accounts for poor result.

(c) Plots of mung beans, millet, black eye peas, sorghum, peanuts, popcorn, white beans, sweet corn with and without FYM. Planted very late, no grain harvested. All gave visual response to FYM.

(d) 14 Varieties of sorghum, selected from original 34 imported varieties, planted 10-15 October, with one cultivation of 6th November. It was noted throughout the season that early planting and early maturity were distinct advantages in relation to incidence of pests and diseases. This trial produced easily the best results of the season with top yield of 640 kg per hectare from a 90-day variety. Major problem was stalkborer. Poison bait controlled cricket and grasshoppers. Bird damage serious on later maturing varieties.

(e) Miscellaneous crops planted included: maize, alfalfa, cotton, sunflower, peanuts and lima bean. Maize matured and gave a satisfactory yield. A small plot of alfalfa established and performance indicated that it might survive the dry season. Cotton ratooned through Dayr season, suffered heavy insect damage and produced little. Sunflower and peanuts both produced well and suffered surprisingly little insect damage. Lima bean also performed favourably but local farmers apparently were not willing to experiment with them for food.

2.2.2 The Period 1965-70

Two reports have been obtained covering investigations at the Bonka FTC during the period 1965-70 and these are the semi-annual reports, covering the period 1st July - 31st December in 1967 and 1968, prepared by the University of Wyoming Team. The most important results of the trials carried out in the two years are summarised below:

(a) Observations on the use of farmyard manure, fertilizer and green manure on sorghum yields.

An acre of land was used for this observation trial in the 1967 Gu season; one half was treated as a check plot and the other half had received an application of farmyard manure prior to the beginning of the 1966 Dayr season. Thus the residual value of the FYM was being tested. A recently introduced sorghum variety known as Wadaker was planted. A remarkable yield response to the residual FYM was demonstrated; the treated plot produced 2 840 kg per ha of grain as compared with the control plot yield of 1 270 kg per ha of sorghum grain. Unfortunately the first seasons results of this trial and the third seasons results in the 1967 Dayr season have not been located.

In 1968 Gu season an additional application of FYM at the rate of 5 tons per acre was applied to the same half of the observation plot as received the FYM prior to the 1966 Dayr season. The results from the 1968 Gu crop were a grain yield of 3 770 kg per ha from the FYM plot compared with a yield of only 1 440 kg per ha from the non-treated plot.

During the 1967 and 1968 season observation plots were planted with sorghum to compare the response in terms of grain yield to a seedbed application of the compound fertilizer 17-17-17 at the rate of 224 kg per ha and the results were as follows in kg per ha.:

	No fertilizer	With fertilizer
1967	500	1 040
1968	990	2 220

Rainfall in the 1967 Gu season was 348 mm and in the 1968 Gu season was 295 mm. The high yields of 1968 reflect to some extent the improved distribution of rainfall. The variety Wadaker was planted on these observation plots in both years.

The results obtained from these observation plots demonstrate that soil fertility levels are low and almost certainly limit crop yields. The use of farmyard manure is obviously beneficial and can be encouraged immediately. The economics of using inorganic fertilizers require more detailed examination and further field trials.

A demonstration showing the value of a green manure crop and the yield of sorghum planted in the following season was conducted for several seasons on the same land, but no published results have been obtained. However, in the 1968 report it said 'Results from this demonstration gathered during past seasons have shown an increase in sorghum yield of more than 34 per cent over a continuously cropped plot'.

(b) Investigation on the effect of a single season fallow on subsequent sorghum yield.

This demonstration/observation trial was begun in the 1966 Dayr season. The trial consisted of 8 plots, two of which were cropped with sorghum continuously; three plots were fallowed in the Dayr season and three during the Gu season. The average yields of these treatments for the first four seasons, in kg per ha, are shown as follows:

	1966 DAYR	1967 GU	1967 DAYR	1968 GU	AVERAGE
Continuous Sorghum	1 556	1 393	664	1 329	1 236
Dayr Fallow	-	1 131	-	1 592	1 362
Gu Fallow	1 729	-	773	-	1 251
Rainfall in mm	216.6	348.0			

The history of the land use of the site of these plots prior to the commencement of the observations has not been recorded. The effect of the fallow on the yield of the following sorghum crop does not appear to have been very significant although in the last two of the four years the fallow appeared to give a higher yield than the continuous cropping treatment.

(c) Miscellaneous Observations

(i) Sorghum Seed Multiplication

Two newly introduced varieties, namely Martin and Wadaker, were planted on some scale in both the 1967 and 1968 Gu seasons and the yields obtained are given as follows:

Season	Variety	Area Cropped in ha	Av. Yield in kg per ha
1967 Gu	Wadaker	5.00	1 410
	Martin	3.50	940
1968 Gu	Wadaker	4.10	1 295
	Martin	3.85	1 477
	Local	1.00	682

A plot of maize was grown alongside the sorghum in 1968 Gu season and the yield was 1 704 kg per hectare. However, the 1968 Gu season rainfall was exceptionally good and the performance of the maize was outstanding and unlikely to be repeated in more normal seasons.

(ii) Groundnut Seed Multiplication

Large areas of groundnuts were planted at the Bonka FTC in both the 1967 and 1968 Gu seasons. The variety grown was a spanish bunch type and commonly referred to as 'Spanish Bunch'. The areas and yield of this variety are given below:

		1967	1968
Area of crop planted	ha	3.0	4.1
Average yield of unshelled nuts	kg/ha	850.0	503.4
Total Production of unshelled nuts	Tonne	2.55	2.06

The groundnuts were reported as having few problems of pest and disease attack and as a potential cash crop for the area.

(iii) Pulses
The pulse crops, cowpea and mung bean, were planted in the 1967 and 1968 Gu seasons with favourable results. A new purple seeded variety of cowpea supplied from Afgoi appeared to be a considerable improvement on the local variety and produced around 400 kg per hectare in both years. Mung beans were reported as growing well at Bonka producing yields equivalent to those of the cowpea.

(iv) Safflower
A small area of safflower was grown at Bonka FTC in the 1968 Gu season. Two varieties, Frio and Gila, were included. The Frio variety produced a yield of 470 kg of seed per hectare and the Gila variety produced in yield of 621 kg per ha of seed. These yields compare with the yield of other oilseeds so far tried.

(d) Sorghum Variety Improvement
A sorghum variety improvement programme was commenced in the mid-sixties and two trials are reported in the 1968 Gu season. Two approaches were being followed - the selection of improved material within local populations and the importation of varieties including hybrid varieties from USA. This work was terminated prematurely and seems to have contributed little of lasting value. The varieties Wadaker and Martin were distributed to farmers but they are no longer identifiable as the very mixed populations of the local variety hide any vestiges of these varieties.

2.2.3 The Period 1975-80

In 1975 the re-establishment of an agricultural research programme in Somalia was commenced with FAO assistance. The Bonka Experimental Station as distinct from the Bonka Farmers Training Centre (now Extension Centre) was developed as part of the national programme of rehabilitation of research under the direction of the Agricultural Research Institute (ARI). Between 1975-77 the Bonka Experimental Station was developed. Buildings were constructed, equipment procured and 10 hectares of land were cleared and cultivated. The first trials reported from Bonka in the Annual Progress Reports of ARI appeared in 1978. The scope of the experimental programme undertaken between 1978-80 and the results achieved have been most disappointing. However, during these years the staff on the station were most inexperienced and lacked basic training in experimental techniques. In addition, over the period 1978-80 there was little support in programme formulation or in supervision of the work that was undertaken.

Two agronomic investigations were carried out at Bonka in 1978; one of these investigations was concerned with a comparison of two local methods of bunding and the other with frequency of weeding.

The purpose of bunding land is to conserve maximum rainfall by preventing run-off. The practice of bunding is widespread in those areas where run-off is a problem. The trial at Bonka in 1978 included only two treatments:

(i) bunded plots of 4 sq m or 1/2 500 ha, known as 'moos'
(ii) bunded plots of 25.0 x 25.0 m or 1/16 ha known as 'jibaal'. It was surprising that a non-bunded treatment was not included. In the event there was no discernible difference in crop performance between bunded macro-plots (or jibaal) and bunded micro plots (or moos) which produced mean yields of 372 and 392 kg of dry grain per hectare, respectively.

The weeding trial included a no-weeding control and three treatments of commencement of weeding, at 1, 2 and 3 weeks after germination. The results shown below amply demonstrate the importance of an early start to weeding operations.

		Mean Yield in kg per ha of dry grain
1.	No weeding	196
2.	1st weeding 1 week after germination, then as required	726
3.	1st weeding 2 weeks after germination, then as required	637
4.	1st weeding 3 weeks after germination, then as required	458

In 1979 some trials were undertaken at Bonka but no results have been reported. Indeed no raw data from these trials remain and any work done in 1979 was fruitless.

A repeat of the 1979 blank sheet was avoided in 1980. Although there is no report on the years work, the raw data from some of the work done during the Gu season are preserved. These data refer to sorghum variety testing and screening and cover two variety trials. The results of one of these trials which included 9 varieties ex-Texas USA together with the local Fududuq variety are shown below.

	Sorghum Variety	Average Plant Height in cm	Mean Yield of Grain in kg per Ha
1.	SAN BERNADO	150	NIL
2.	BTx 430	63	972
3.	GBR 148	80	2 167
4.	BTx 624	60	1 278
5.	M35 - 1	196	889
6.	77CS 1	70	1 653
7.	CS3541	90	1 722
8.	BTx 623	60	792
9.	RTAM428	70	819
10.	LOCAL FUDUDUQ	200	652

L.S.D. at 5 per cent level between mean grain yields = ± 479
Coefficient of Variation = 36.5 per cent.

The above results have been included because it was in this trial that the variety GBR 148 was planted for the first time. Seed of this variety has already been released to farmers on a small scale through the extension service and GBR 148 formed a major part of the seed multiplication programme at the Bonka Seed Farm in the 1983 Gu season.

A second variety trial, carried out in 1980 with material from Egypt and Sudan produced generally lower yields than the Texas material although both trials were planted on the same day and similar management practices were followed. The average yield for the trial including the Texas material was 1 083 kg per ha compared with 408 kg per ha from the trial containing the Egyptian and Sudanese varieties.

The 1980 Dayr season apparently produced little worthwhile information and no raw data or reports of the work done have been located.

2.2.4 The Period 1981-83

(a) Staffing

The Bay Region Agricultural Development Project assumed responsibility for the Bonka Research Station in 1981. The staffing of the station was greatly strengthened - four Somali graduates were allocated to the sorghum, grain legume, groundnut, safflower, and sunflower investigations, respectively. Three of these graduates have since left for overseas training courses of 2½ - 3 years and so cannot be expected to make any significant contribution to Phase I of BRADP.

USAID were to provide the technical assistance for the applied and adaptive research programmes at the Bonka Research Station. However, the expatriate personnel due to arrive at the beginning of 1981 were not in post until May/June 1983. This delayed arrival of technical assistance has obviously had far-reaching effects on the programme.

A consultant funded by USAID spent two short periods at the Bonka Research Station to assist with programme formulation and to provide some guidance on field experimental techniques - he was on the station for some weeks leading up to, and during, planting and again during the harvesting period of the 1981 Gu season.

In October 1981, a sorghum breeder funded by the Government of Canada through its International Development Research Council (IDRC) was appointed to the Bonka Research Station. The sorghum breeder, officially called an adviser, is responsible to the Ministry of Agriculture and the Project Leader is the Director of Research. The sorghum project is nationwide - three stations originally included in the programme were Bonka, Afgoi and Abu Rein (N.W. Region 30 km west of Hargeisa). At Bonka the sorghum research programme is supported by BRADP which provides all the local funds and facilities including personnel costs, land, labour, office accommodation and furnishings and any necessary equipment. The expatriate costs and his transport are provided by IDRC. At Bonka the sorghum breeder is assisted by a graduate from the Somali University who is seconded from BRADP. In addition, a further four technicians from the Afgoi Agricultural High School are assigned to the sorghum programme, but none is reporting for duty at the time of writing.

(b) Sorghum Breeding

Three main lines of work are being followed in the sorghum breeding programme which are briefly outlined below:

- **The introduction and screening of exotic varieties.** Major sources of material are countries with similar environments such as Kenya, Uganda, Ethiopia, Egypt and Sudan and ICRISAT supplies most of the seed. The material introduced and examined in the last four seasons includes:

  (i) International Sorghum Drought Resistant Observation Nursery known as ISIDRON - 80 because it included 80 lines and varieties and was received in 1980.

  (ii) International Sorghum Preliminary Yield Trial, ISPYT, also supplied from ICRISAT and first planted in the Dayr season of 1981.

(iii) International Disease and Insect Nursery, IDIN, which included 30 varieties and was first planted in the 1981 Gu season.

(iv) Ugandan collection ex-Serere, Kenyan Nursery material and drought tolerant lines ex-Egypt were imported in 1982 and planted in the same year.

(v) Sorghum Programme of Observations on Drought and Mould Resistant Lines, ex-ICRISAT, were also obtained in 1982 after mould caused by *Fusarium phoma* and *F. curvularia* was identified in the Shebeelle Valley.

(vi) Miscellaneous material introduced includes some F5 material, a bird resistant Australian hybrid and medium altitude lines ex-ICRISAT, Mexico.

The major selection criteria being used by the sorghum breeder are yield, drought tolerance or yield/rainfall relationship, maturity period (earliness is essential, say 90 - 100 days) and resistance to bird damage, stalkborer and smut.

- **Selection from within collections of local germplasm.** A germplasm collection mission from ICRISAT Genetic Resources Unit visited Somalia during August - September 1979. A total of 69 samples were collected. Seed from this collection was planted at Bonka in the 1981 Gu season and again in the 1982 Gu season. A third planting was planned for the 1983 Gu season when it was intended that all the collection would be examined in detail in a replicated trial. However, for a variety of reasons this trial was not planted so little has emerged from this line of investigation so far.

- **A programme has been commenced for the production of hybrid varieties.** The first hybrids have been developed from local material crossed with selected exotic varieties and at the time of writing two seasons results were available. Crossing is restricted to the Dayr season because Gu season conditions of high humidities and low sunshine hours are not favourable for pollination. Crosses are also being made using selected local lines for comparison with the Local x Exotic crosses.

Based on the early trials involved with screening exotic varieties, two selections were made and the decision was taken to produce seed of these varieties at Bonka for distribution to farmers. Both these varieties have been included in trials which included the local variety. Fududuq and the results of these varieties are shown in Table 2.1.

The data contained in Table 2.1 show little justification for bulking and seed distribution of the two new varieties in preference to the local Fududuq variety. There is some suggestion in the data that given stalkborer control Dabar is higher yielding than Fududuq but that without such control Dabar may be inferior in yield.

Farmers appear to have rejected Dabar in most areas where they have had the opportunity to make assessment. Considerable quantities of seed were

TABLE 2.1 TRIAL MEAN GRAIN YIELDS OF NEW SORGHUM VARIETIES AND LOCAL FUDUDUQ 1981-82 IN KG PER HA

	Trial Name	Season	Local Fududuq	Dabar	GBR 148
1.	Sudanese variety trial - BONKA	1981 Gu	523	770	-
2.	ISDRON 80 - BONKA	1981 Dayr	953	861	493
3.	Insecticide x Variety Trial BONKA	1981 Dayr			
	(a) 2 applications of Basudin		310	647	305
	(b) No Basudin applied		117	136	117
4.	Insecticide x Variety Trial DAYNUUNAY	1982 Gu			
	(a) 2 application of Basudin		499	582	398
	(b) No Basudin applied		317	181	185
5.	Insecticide x Variety Trial QANSAXDHEERE	1982 Gu			
	(a) 2 application of Basudin		1471	1314	1188
	(b) No Basudin applied		1595	1464	1131

Source: Bonka Research Station Progress Reports

distributed in 1980-81 between Bonka and Audinle but in 1982 only one small field of pure Dabar was observed. Dabar grain quality is apparently good, but it is soft and has poor storage characteristics. These latter characteristics may be responsible for the reluctance of farmers to replace the local variety with Dabar.

The variety GBR 148 based on the results shown in Table 2.1 may be little better than the Fududuq variety. However the few demonstration plots of this variety have created a favourable impression with the extension staff and local farmers. A number of people appear to be convinced that it is more productive than the local sorghum and state that GBR 148 has larger heads and shows greater drought resistance. However, experience in the field with this variety is still very limited and another season could change these initial impressions.

The important conclusion to be drawn from this brief review of the background to the selection of these two new varieties which have been recently released is that they may be no more productive than the local variety and, in the case of Dabar, with a much less acceptable grain quality. The multiplication and distribution of seed of these varieties could be a 'blind alley' in terms of increased grain production and could be counterproductive in the future in that farmers will be less willing to listen to the Field Extension Agents.

(c) Sorghum Agronomic Investigations

(i) Spacing Trials

A spacing trial was carried out in the 1981 Gu season in which 5 different treatments were compared. The treatments were all based on one plant per hill and did not attempt to include any treatment equating with local practices. The farmers in Bay Region generally appear to obtain a density of planting hills of between 10 000-20 000 per hectare whilst the number of plants per hill is 2-3 giving plant populations in the range 20 000-60 000 plants per hectare.

The treatments used in the trial and the yields obtained are shown in Table 2.2. The variety planted in this trial was the local Fududuq. Unfortunately the actual plant populations at harvest were not specified in the report on this trial. However, assuming that the plant populations were somewhere near the intended levels, the results of this trial suggest that maximum grain yields are probably obtained from, 33 000 - 48 000 plants per hectare. However it should be emphasised that the 1981 Gu season was one of exceptionally high rainfall and therefore atypical.

TABLE 2.2 SPACING TRIAL YIELDS IN THE 1981 GU SEASON

Treatments		Theoretical	Mean grain[1]
Between row spacing (cm)	Within row spacing (cm)	plant population plants per ha	yields in kg per ha
100	100	10 000	288
100	50	20 000	449
75	40	33 000	548
70	30	48 000	585
60	30	56 000	546

Notes: [1] *LSD at 5 per cent level between treatment mean yields = ± 113. Coefficient of Variation = 30.6 per cent.*

Source: *Bonka Research Station Progress Report 1981 Gu Season.*

A second sorghum spacing plant population trial was attempted at Bonka in the 1982 Gu season, but no results were obtained due to misunderstandings during harvesting.

(ii) Weeding Trial
A simple weeding trial was carried out at Bonka in the 1981 Gu season which included four treatments. The variety used in this trial was the local Fududuq variety. The treatments and mean yields obtained are shown below in Table 2.3.

TABLE 2.3 RESULTS OF THE WEEDING TRIAL IN THE 1981 GU SEASON

	Treatments	Mean grain yield[1] in kg per ha
1.	first weeding one week after seedling emergence	421.0
2.	first weeding two weeks after seedling emergence	385.3
3.	first weeding three weeks after seedling emergence	370.7
4.	no weeding	265.3

Notes: [1] *LSD at 5 per cent level of difference between treatment mean yields = ± 71.6. Coefficient of Variation = 20.9 per cent.*

Source: *Bonka Research Station Progress Report 1981 Gu Season.*

All the weeding treatments were weeded a second time at a suitable interval after the first weeding, except the control. The no-weeding treatment resulted in a much lower yield level than the weeding treatments - the differences being significant at least at the five per cent level. On the other hand there were no significant yield differences between the three weeding treatments although there was a consistent trend of declining yield with increasing delay in the timing of the first weeding. Unfortunately no information is reported on the situation in which the trial was conducted; for example cultural practices prior to planting were not explained, no mention was made of weed flora or weed populations, the occurrence of rainfall during the critical periods was not recorded, and no observations were made on the effects of the different weeding treatments either in terms of subsequent weed flora and populations or in terms of labour requirements for the second weeding.

(iii) Insecticide Trials

Insect pests are of major importance in limiting sorghum yield levels yet little attention has been given to investigating control measures. In recent years some efforts have been made to investigate the effects of chemical methods of stalkborer control on yield levels.

In the Dayr season of 1981 a trial was conducted to examine the effects of applications of Basudin 10 (10 per cent Diazinon) granules for stalkborer control on subsequent yield levels. The trial had two replications and 10 varieties. The varieties included were six selected lines from the ISIDRON 80 trial, two varieties recently released to farmers, namely Dabar and GBR 148, a local selection LGP 23 and a local variety. The trial consisted of just two replications and a split plot design was used.

The yields obtained in this trial are shown in Table 2.4. Poor rainfall conditions were mainly responsible for the low yield levels. Nevertheless all varieties with just one exception produced substantial yield increases with applications of Basudin 10. The general response to this stalkborer control measure was somewhat surprising because the Dayr season is reputedly much less favourable to insect pests and damage is thought to be significantly less than in the Gu.

TABLE 2.4 MEAN YIELD OF SORGHUM VARIETIES IN INSECTICIDE TRIAL IN KG PER HA, 1981 DAYR SEASON.

	Variety	Mean grain yield with Basudin application	Mean grain yield no insecticide used
1.	71403	465	54
2.	71341	168	73
3.	71464	465	79
4.	71258	227	104
5.	71261	143	175
6.	71506	422	243
7.	GBR 148	305	117
8.	Dabar	647	136
9.	LGP 23	135	55
10.	Local (Fududuq)	310	117
Means		298	115

The same trial was repeated at two off-station sites in Daynuunah and Qansaxdheere in the 1982 Gu season. For reasons not stated the results of this trial were given in grams per plot as shown in Table 2.5.

TABLE 2.5 AVERAGE GRAIN YIELDS FROM TWO INSECTICIDE x VARIETY TRIALS 1982 GU SEASON IN GRAMS PER PLOT

		Daynuunah		Qansaxdheere	
		Mean grain yield with Basudin application	Mean grain yield no insecticide use	Mean grain yield with Basudin application	Mean grain yield no insecticide use
1.	71403	310	206	854	1095
2.	71341	262	193	599	1021
3.	71464	490	326	1635	1420
4.	71258	673	203	740	608
5.	71261	418	167	499	534
6.	71506	461	137	740	1198
7.	GBR 148	398	185	1188	1131
8.	Dabar	582	181	1314	1464
9.	LPG 23	301	182	1311	1345
10.	Local (Fududuq)	499	317	1471	1595
	Mean	439	209	1035	1141

Source: *Bonka Research Station Progress Report 1982 Gu Season.*

The results of these off-station trials are contrasting. At Daynuunah the use of Basudin for stalkborer control doubled yield levels and was in good agreement with the results obtained in the 1981 Dayr season trial at Bonka. In the Daynuunah trial, all varieties showed considerable yield improvement with applications of Basudin. On the other hand the Qansaxdheere results show no benefits from the use of Basudin overall and the individual varietal responses are most inconsistent. The Qansaxdheere situation apparently provides much more favourable growing conditions for sorghum because of higher soil fertility levels and the incidence of stalkborer was said to be low. However, no observations were made to determine levels of stalkborer infestation.

Further repeats of this variety x insecticide trial have been attempted at Bonka and the sub-stations in both the 1982 Dayr season and the 1983 Gu season but because of inadequate rainfall the trials failed to germinate or establishment was so poor that the trial had to be abandoned, or other uncontrollable events occurred which resulted in the loss of the trial.

An insecticide trial examining the effectiveness of three insecticides for sorghum stalkborer control was conducted at Bonka in the 1983 Gu season. The insecticides tested were Basudin 10G, Sevin 85% W.P. and Malathion. The variety used was GBR 148. Two applications of each insecticide were made at 38 and 57 days after sowing (this timing was said to be the best guess for optimum timing but would seem to be too late). No observations were made to determine the incidence of stalkborer either in the control plots or in the treated plots. No yield data were available at the time of writing.

(d) Oilseeds

Oilseeds which have been included in the Bonka programme since 1981 are sunflower, safflower and groundnuts. These crops are presently the responsibility of one Somali graduate. Since 1981 the oilseed programme has consisted only of varietal screening trials.

(i) Sunflower

A series of variety trials have been carried out at Bonka since 1981. In the 1981 Gu season, nine varieties supplied by FAO were planted and yields ranged from 42.0-368.2 kg per ha. The same varieties were planted again in the 1981 Dayr season, but yields were little better and varietal performance in the two seasons was inconsistent.

In the 1982 Gu season, eight varieties from the USA were planted in a variety trial for the first time. These varieties were 15-20 days earlier than the FAO varieties grown in 1981, averaging 120-125 days as compared with 135-140 days from planting to maturity. The yields of the USA varieties were considerably more encouraging, ranging from 3.69-15.86 quintals per hectare. However, new seed of these USA varieties was not available for further testing in the 1982 Dayr season.

For the 1982 Dayr season, 14 sunflower varieties supplied by FAO were planted in a trial at Bonka. The performance of these varieties was disappointing in comparison with the USA varieties but did better than the varieties supplied in 1981. The yield range of the varieties planted in the 1982 Dayr season was between 288-581 kg per ha. However, in the absence of any other seed, this trial was repeated in the 1983 Gu season at Bonka, but the results were not available at the time of writing.

The work done on sunflower at Bonka has demonstrated that the crop can be successfully grown and so may be a potential cash crop. However the sunflower programme of varietal introductions and screening appears to have depended upon suppliers who have taken little account of Bay Region conditions with the result that most of the varieties tested were ill-adapted. A most important requirement is for short-term variety; none of the varieties so far introduced appears to be less than 120 days.

(ii) Safflower

Seed of six varieties of safflower were planted in 1981 Gu season in a variety trial. Seed of three of these varieties were not viable and only low plant populations of the other three varieties were established. Some seed of these three varieties, Oleic, N-1 and Local, was obtained and planted at Bonka in the 1981 Dayr season in observation plots. Seed yields from these plots ranged from 133-179 kg per hectare.

A supply of seed was obtained from the 1981 Dayr season crop and in the 1982 Gu season, observation plots were planted at Qansaxdheere. The yields obtained were excellent, as follows:

Variety	Yield of seed in kg per ha
N-1	1091
Oleic	1066
Local (Gila)	807

In the same 1982 Gu season, seed of four varieties newly imported from the USA was planted at Bonka. Two failed to germinate due to waterlogging and only poor stands of the other two varieties were established. These varieties, Gila and Mexico Dwarf F3 produced the equivalent of 228 kg and 109 kg per ha of seed, respectively.

In the 1982 Dayr season, observation plots of the three varieties of safflower, Oleic, N-1 and Gila, were planted at Bonka and at Qansaxdheere and Daynuunay sub-stations. The plots at Qansaxdheere again produced some good yields whilst the crop almost failed at Bonka and no crops were harvested at Daynuunay (the plots were destroyed by livestock due to lack of fencing and a watchman). The yields obtained in the 1982 Dayr season are shown as follows:

Variety	Yield of seed in kg per ha	
	Bonka	Qansaxdheere
N-1	15	831
Oleic	52	932
Gila	21	881

The poor performance of the safflower at Bonka was said to be due to the high rainfall. However, the rainfall at Qansaxdheere was equally as high as at Bonka. Soil differences may have an important role in determining safflower production potential. If the Qansaxdheere results can be verified, safflower would appear to have potential as a cash crop in some parts of the Bay Region.

(iii) Groundnuts

Groundnuts are already grown in the Bay Region by a minority of farmers. The local variety is a Spanish Bunch type. Three other varieties were compared with this local variety in trials carried out at Bonka in the 1981 Gu season and the following Dayr season and these results are shown below.

Variety	Mean yields of unshelled nuts in kg per ha	
	1981 Gu	1981 Dayr
Local	1487	374
Florunner	1745	319
Starr	1362	459
Spanhoma	1754	501

The excellent yields obtained in the 1981 Gu season were from a replicated trial in which the coefficient of variation was 37.8 per cent so it was not surprising that there were no significant differences between varieties. No information is contained in the report on the type of trial carried out in the Dayr season.

These same four varieties were planted at Daynuunay and Qansaxdheere in the 1982 Gu season and produced the following yields:

Variety	Mean yields of unshelled nuts in kg per ha	
	Daynuunay	Qansaxdheere
Local	589	2247
Florunner	926	2331
Starr	946	2270
Spanhoma	876	2367

The outstanding yields obtained at Qansaxdheere are rather puzzling in that they are so much higher than have been obtained elsewhere. Local opinion suggests that the reason for these high yields is the much higher fertility status of the Qansaxdheere soils, which may, or may not, be true.

In the 1982 Gu season, seed of 45 selected varieties of groundnuts suited to Bay Region conditions was supplied by ICRISAT. The seed was planted at Bonka for bulking so that sufficient seed would be available for a replicated trial in the following season. These varieties are adapted for dry land conditions, mainly bunch type, erect or semi-erect in growth habit, and include some high oil varieties. The yields of unshelled nuts of the 10 best ICRISAT varieties in the 1982 Dayr season are shown below.

Variety No.	Yield in kg per ha
35	1219
7	1214
18	1152
43	1089
39	1079
30	1064
33	1056
36	1054
20	995
44	991

The ICRISAT material appears to have been carefully selected so that there is a good chance that a suitable variety will emerge from the testing programme.

(e) Grain Legumes

The grain legume programme has been concerned mainly with cowpea and mung beans, which are the most important of the minor crops in the Region. Also included in the grain legume programme are pigeon pea, chick pea, Tepary bean and Faba bean.

(i) Cowpea

In the 1981 Gu season, a cowpea variety trial was conducted which included 10 varieties from IITA in Nigeria and six local selections. The trial was repeated in the following Dayr season. Wet conditions prevailed in the Gu season and the Bonka Local was significantly outyielded by two of the exotic varieties. In the very much drier conditions of the Dayr season the Bonka Local was the highest yielding variety significantly outyielding (at the five per cent level) all the exotic varieties except one.

In the 1982 Dayr season a cowpea trial, including six varieties ex USA and Bonka Local, was carried out at Bonka. The yield range of these varieties was 342-886 kg per ha. The local variety was best and exhibited considerable drought resistance. However, the coefficient of variation of this trial was 75 per cent so the results are inconclusive.

In the 1983 Gu season a new variety trial was undertaken which included nine varieties ex IITA in Nigeria. This trial lost two replications due to poor seedling emergence and the remainder had such uneven plant populations that it has not been treated as a trial but rather as a source of seed for next season.

The cowpea programme has been based on extraneous sources of seed. None of the introduced varieties has so far proved better than the local variety either in terms of yield or in terms of other field characteristics.

(ii) Mung Beans

A collection of eight varieties of mung bean, including five varieties from the Asian Vegetable Research and Development Centre (AVRDC), a local Afgoi variety, seed ex-Mogadishu market, and a Baidoa Local, were planted in the 1981 Gu and Dayr seasons in variety trials. In the wet Gu season of 1981 the three local lines produced very much higher yields than the three varieties of Somali origin whilst in the drier Dayr season there was little difference between the local Afgoi varieties and the locals despite the improved earliness of the former.

A collection of 20 varieties of mung bean from AVRDC was planted in a trial at Bonka for the first time in the 1981 Dayr season and compared with the local variety most of the exotic varieties were 8-10 days earlier to first pick than the local variety. None of the exotic varieties produced a higher yield than the local. A similar result was obtained when the trial was repeated in the 1982 Dayr season. Early experience with these exotic varieties indicates that the local variety has superior storage characteristics, particularly a greater resistance to the grain borers.

In the 1983 Gu season, the 20 varieties ex AVRDC were for the third time included in a trial with the local variety. A second trial including 10 varieties ex ICRISAT was also planted. However, although both trials were excellent through to harvest, the maturing crop was largely devoured by birds. No yield results were obtained but sufficient seed was harvested to repeat the trial in the 1983 Dayr season.

A trial designed to investigate the effect of timing of the first weeding of the mung bean on subsequent performance was carried out in the 1981 Dayr season . The results of this trial are shown in Table 2.6.

TABLE 2.6 RESULTS OF MUNG BEAN WEEDING TRIAL IN THE 1981 DAYR SEASON

	Treatments	Mean grain yield[1] in kg per ha
1.	First weeding one week after seedling emergence	696
2.	First weeding two weeks after seedling emergence	492
3.	First weeding three weeks after seedling emergence	797
4.	No weeding	601

Note: [1] *Coefficient of Variation = 47.5 per cent.*

Source: *Bonka Research Station.*

This trial produced no significant differences between treatments. The high coefficient of variation is illustrative of the extreme variability that occurred in this trial partly as a result of soil heterogeneity. Nevertheless the yields obtained are remarkably high.

Attempts to repeat this trial were unsuccessful in 1982. A second trial was eventually planted in the 1983 Gu season, but suffered the same fate as the variety trials: almost total loss of grain to birds.

(f) Crop Rotation Investigations
Two trials were designed prior to the 1981 Gu season in which the effect of the previous season's land use on crop yield was examined. The trials were designed by a Consultant Agronomist who also supervised the planting and harvesting of the 1981 Gu season crops.

2.3 PRESENT EXTENSION RECOMMENDATIONS

2.3.1 Introduction

The technical content of the present extension programme in Bay Region has been examined in some detail with the following objectives in mind:

(a) to determine the extent to which the Bonka Research Station knowledge and experimental results have contributed to the present extension message and to suggest how this present message can be improved in the light of existing information and experience.

(b) to identify weaknesses in the extension message which can be used in the determination of applied research priorities.

A work programme was prepared for the 1983 Gu season by the National Extension Service (NES) in Mogadishu. This programme was distributed to the Regional Extension Officers, including the Bay Region REO. The contents of the programme included detailed recommendations on crop husbandry practices as well as instructions on extension work. The crop recommendations were not area-specific but were prepared for all regions with arable agriculture. Unfortunately the desire for broad geographical application undoubtedly reduced their relevance to the Bay Region.

A second source of extension recommendations are the recently produced crop-specific publications prepared jointly by the Central Agricultural Research Station at Afgoi and the Agricultural Extension and Farm Management Training Project (AFMET). Bay Region crops which are covered by these publications are sorghum, cowpeas, groundnuts and mung beans. Fortunately these publications have not yet been distributed in the Bay Region.

2.3.2 The NES 1983 Gu Season Recommendations

In the 1983 Gu season programme for extension workers, under the heading *Adoption of Technology*, a number of recommendations on agronomic practices are outlined. Most of these recommendations are very general and of little practical value to the farmer, providing a most unsatisfactory basis for the field extension agents (FEA) at the village level. The following sections comment on the agronomic recommendations contained in the Gu season programme.

(a) Land Preparation

The section of *land preparation* states that the three alternative methods of soil preparation are : *by hand using a 'yambo' or reverse shovel; by animal-drawn implements; tractorisation* and that *the depth of tilling should be 5-8 cm, 10-15 cm and 16-25 cm*, respectively. In addition, it says that secondary tillage is very necessary following tractor ploughing.

Depth of cultivation should, of course, be related to specific conditions of soil, weed populations, etc, and not to the source of tillage power.

The section on land preparation should include more than advice on methods and depth of tillage. Land preparation must be seen as a series of operations related to previous land use and to the cropping calendar. The first operation is to clear the land of debris to be followed by removal of roots and/or stubble. In the case of sorghum, removal and disposal by burning of the stubble roots should be encouraged in the interests of stalkborer control and of crop hygiene in general. The type and depth of tillage in land preparation must be related to soil conditions, the presence or absence of stoloniferous weeds and to previous management. The self-mulching clay soils which constitute the vast majority of the cultivated lands of Bay Region can be successfully farmed with minimal tillage where there is no problem with stoloniferous perennial weeds. Where these weeds occur, the stolons must be rooted out with deeper cultivation.

No specific studies have been undertaken at the Bonka Research Station comparing the effect of different land preparation techniques on subsequent crop performance and weed control. There is, however, on the station sufficient knowledge of the weed flora and related control requirements to permit the formulation of helpful advice and recommendations on land preparation.

Finally, the importance of timely land preparation should be stressed. The data on Baydhabo rainy seasons in Table 1.3 can be used to determine target dates for the completion of land preparation operations. In order to take full advantage of the rains in the vast majority of years, land preparation for the Gu season should be completed by the last week in March and for the Dayr season by the last week in September. Planting can then take place immediately after the first rains. The importance of early planting is well recognised through experience at Bonka Research Station.

(b) Seed Selection

In the section on seed selection in NES Gu season work programme there is little practical advice for the farmer. The section includes a general description of seed quality, but there are no suggestions as to how this desirable quality might be achieved. The farmers of Bay Region need advice on: the selection of the best heads (or panicles) of sorghum at harvest for seed for the following seasons crop; the methods or techniques for the storage of seed sorghum, particularly in relation to protection against grain storage pests; and on the quantities of sorghum seed to store (a stock of seed adequate for one season's cropped area is an insufficient reserve, especially in the more drought-prone areas).

The NES programme recommends the use of seed of improved varieties including the Dabar variety of sorghum. This variety has been examined in the light of experimental results at the Bonka Research Station (see Section 2.2.3) and has been shown to be little better than the local variety. Furthermore, experience at farm level has demonstrated that Dabar has inferior storage characteristics in comparison with the local varieties.

In order to assess the quality of seed presently being planted by farmers, a seed sample survey was included in the NES 1983 Gu season programme. Samples of seed of sorghum and maize were to be collected by the FEAs and were to be submitted to the AFMET Agronomist for quality assessment. The following information was to be collected for each sample:

- crop
- name of farmer
- whether a contact farmer or non-contact
- name of village, District, Region
- date of drawing sample

Whilst such a seed sample survey may provide an assessment of the general quality of seed in a particular season, the information collected will provide no indication of the factors affecting seed quality. Obviously it is of considerable importance to know what factors are affecting seed quality at farm level so that improvements can be identified and incorporated in the extension message. In this latter context it would have been useful to have included the following additional questions.

- Source of seed (Farmers own seed, ADC, Extension Service or other farmer)

For farmers own seed:

- variety and seed colour
- age of seed i.e. from which harvest
- does the farmer make panicle selections for his seed supply
- methods of threshing
- storage conditions (as grain on the panicle, where stored)
- methods of insect control (use of fire ash, use of Malathion dust)

(c) Planting Recommendations

The data presented in Table 2.7 are taken from the 1983 Gu season programme of the NES and include the major rainfed crops which are grown in Bay Region. The recommendations contained in Table 2.7 obviously relate to row planting, and the so-called optimum plant populations are based on one plant per hole. In existing farms neither of these practices is followed; spacing tends to be irregular and there is usually more than one plant per hole. In considering the recommendation on row planting it must be borne in mind that the vast majority of farmers are cultivating only with manual labour. To follow the recommendation the farmer, therefore, has first to set out a straight line and then to maintain the line at the correct spacing during planting whilst at the same time ensuring a regular within-row spacing. Even if available, the additional labour is unlikely to be supplied unless the household is convinced that substantial benefits will be forthcoming. Such benefits have still to be demonstrated. Investigations are required to establish whether traditional planting practices produce low densities of planting holes. This should be investigated after germination rather than at harvest.

The optimum time of planting for sorghum which is given in Table 2.7 as '*1 week before the rains begin*' is inadequate guidance for the farmer. It presumably meant to say that sorghum can be dry planted, anticipating the rains, if there is a high probability of rainfall occurring in the following week.

TABLE 2.7 NES PLANTING RECOMMENDATIONS FOR THE MAJOR RAINFED CROPS IN THE 1983 GU SEASON

Crop	Optimum time of planting	Sowing depth (cm)	Seed rate in kg per ha	Spacing (cm)	Optimum plant population per ha
Sorghum	1 week before rains or	2.5	5-7	100 x 40	25 000
	immediately after first rain			75 x 50	26 600
Cowpea	April 15-25	5.0	20	75 x 20	66 600
				75 x 50	26 600
Groundnut	April 15-25	5.0	40	60 x 20	83 300
				70 x 20	71 000
Mung Bean	April 15-25	5.0	7-8	60 x 30	55 500

Source: *NES Work programme for Gu season 1983.*

The importance of early land preparation has been referred to in a previous paragraph. This will ensure that the sorghum can be planted immediately after the first rains whether they occur in late March or mid April.

(d) Cultural Recommendations

There are some important errors contained in this section of the NES 1983 Gu season programme. The first is the recommendation on weeding which says that the *first weeding should be carried out when the crop plants are 6-8 weeks old followed by a second weeding before the flowering stage.*

Two weeding trials have been carried out at the Bonka Research Station comparing first weedings at one, two and three weeks after seedling emergence. In one trial there was a significant difference between sorghum yields following the one week weeding, (which produced a much higher yield) and the three week weeding. The 6-8 week recommendation for the first weeding is obviously far too late and should be changed to 1-3 weeks.

The second error in the NES 1983 Gu season programme is in relation to thinning. The programme states that *'there should be only two plants per hill instead of the present 5 to 7 plants on farmers' fields. This operation should be carried out when the plants are 8-10 weeks old'.* The two plants per hill contradicts the spacing recommendations given earlier, but more importantly the time of thinning that is recommended is around the time of flowering which is obviously far too late. Although no specific trials have been undertaken on thinning at the Bonka Research Station, it is obviously a standard practice on the research trials with sorghum and a recommendation on this matter can best be given by staff on the station.

(e) Control of Borers

The section on control of borers in the NES 1983 programme is very vague and imprecise. There is the implication that all maize and sorghum crops should be treated for borer in the early stages of plant growth as a routine measure without actually stating that it should be a routine measure. The section continues *It is suggested that either Basudin/Diazinon/Dursban - as per availability should be dusted in the whorl of the plants at knee height (about 25 cm) followed by a second dusting when the plants are 50 days old.* Instructions to extension workers should be as precise as possible. Thus number of days after planting or seedling emergence should be used rather than height of plants - the latter can vary considerably across a field.

2.3.3 Crop Specific Extension Publications

(a) Sorghum

The publication on 'sorghum' produced by the CARS and the AFMET project runs to 13 pages and contains some useful information amongst much that is irrelevant. There is a need to relate the recommendations to the Somali situation and to make these recommendations concise and easily understood. The particular needs of the extension agent in Bay Region are not met by this pamphlet. Many of the shortcomings of the NES 1983 Gu season programme are repeated in this pamphlet and there are additional ones, for example, in one and a half pages on grain storage, there is no mention of pit storage, the most widely used form of storage in Bay Region. There is just one mention of the Bonka Research Station - a reference is made to the first occasion that the Dabar variety was included in a trial when it produced a 50 per cent higher yield than the local variety. No records of this trial were found.

(b) Groundnuts

The contents of the pamphlet on groundnuts would be misleading rather than helpful for Bay Region. For example in the second paragraph of the pamphlet in the section on *Adaption* it is stated that *Groundnuts are best grown in a well-drained, light coloured loose friable sandy loam soil having medium to coarse texture. The use of fine textured soil is avoided whenever possible.*

If such a statement is taken literally by the extension worker then he would be reluctant to recommend groundnut production on any of the major arable soils of Bay Region. In fact the structural characteristics of most of these soils are excellent for groundnuts and there are few problems with the extraction of the nuts at harvest.

A major criticism of the extension publication is that there are virtually no references to the Somali situation. For example, *thorough seedbed preparation for groundnuts* is advised with no attempt to say what it means to the farmer with only a 'yambo' at his disposal. Other such statements include: *The seed should be sound and viable* with no indication of how this might be achieved by the farmer in practice. *Proper weed control is necessary to grow groundnuts* with no suggestion as to how this weed control should be achieved.

These is a paragraph in the section on *Harvesting* which says *After harvesting, the groundnut is cured in the field. It is not advisable to expose the nuts to the direct sunlight because this reduces seed viablility and increases seed breakage. Groundnut must be cured to 10% moisture or less for marketing and safer storage.* The programme should state how the FEA can interpret such information so as to make it understandable to the farmer in the field.

(c) Cowpea

The two-page leaflet on cowpea prepared by CARS and AFMET is not comprehensive. The points that are dealt with have many shortcomings and do not form a very solid basis for FEA advice. There is no sensible advice on land preparation. The characteristics of varieties are not described. Regular applications of Thiodan are recommended at two weeks after planting followed by two applications after flowering. This may, or may not, be necessary in Bay Region. The final paragraph in this leaflet is headed *Seed Storage* and deals only with the results of trials at IITA in Nigeria and at CARS on the use of peanut oil on cowpea seed to prevent insect attack which really has little relevance to the present situation in Bay Region.

(d) Mung Beans

The one and a half page leaflet on *mung beans* is even more superficial than the cowpea leaflet and contains some dubious recommendations. For example precise inter-row and within-row spacings are recommended (twice) with no recognition of the difficulties facing the farmer using only a 'yambo' in implementing this recommendation.

There is a concluding section on *Weeding* which recommends that *the first weeding should be done when the plants have attained a height of 10-15 cm.* This timing would almost certainly be too late in Bay Region in the Gu season if the recommended time of planting (3-4 weeks after the sorghum) is followed and weed growth would in most situations have a severe effect on crop growth.

There are no sections on insect pest problems, harvesting or storage, all of which should have received some attention.

2.4 CONCLUSIONS

A review of the research work which has been carried out at Bonka over the past 20 years, first at the Farmers Training Centre and latterly at the Research Station, has revealed that the field experiments conducted over this period have produced few economically useful innovations. Research has made very little direct contribution towards the improvement of agriculture in the Region. Nonetheless useful information has been obtained about the problems which farmers face.

A review of some of the existing extension programmes and literature has revealed a surprisingly low standard of technical content. The future of agricultural development in the Bay Region is dependent upon the quality of extension advice and if BRADP is to succeed in its primary objective of increasing agricultural production, immediate attention should be given to improving the technical content of the extension message in cooperation with the research staff.

The Bonka Research Station has an immediate and major role to play in drafting new extension literature, particularly for the four major crops - sorghum, groundnuts, cowpea and mung bean. The basic experience and knowledge gained on the station in recent years combined with the data from the experimental records could be used to produce better advice than is currently given.

3

Present Research Facilities and Current Proposals for Future Research Programme

3.1 BONKA RESEARCH STATION (BRS)

3.1.1 Land

The Bonka Research Station has approximately 12 ha of land of which 10 ha are currently under cultivation and available for crop trials. This land has been under fairly continuous cultivation at least since the 1950s when it was the site of an experimental farm under the Italian administration.

The soils of the BRS are typical of the Baidoa soils group which have been described earlier in Section 1.2.3. The general topography of the station appears to be flat, but significant run-off is said to occur during high intensity rainfall from various parts of the station, in particular from the land adjacent to the main road. No topographic survey of the station is available.

There is considerable variation in microtopography on the farm. Poor tractor ploughing techniques (with a disc plough) have undoubtedly contributed to this variation. During the cropping season rainfall accumulates in the small depressions producing waterlogged conditions which because of the low permeability of the soil may be persistent. The waterlogged conditions are commonly the cause of seedling losses and irregular stands. A further contributory cause of irregular crop performance on the station is the variation in soil fertility levels. As a result, there has been a very high variation in statistical error in many trials. Coefficients of variation have frequently exceeded 40 per cent and so few conclusive trial results have been obtained.

The land of the BRS has never been fenced and in the off-season local livestock are left to graze over cropped lands.

3.1.2 Buildings and Equipment

Most of the buildings at the BRS were constructed in the late 1970s with FAO assistance using local materials and methods. A main building, originally built as an office-with-store, but used only as a store, is already unusable. Because of the poor foundations, the natural swelling and shrinking of the clay soil has produced large cracks in the walls and floors of this building to the extent that it is now in a state of collapse.

The present office on the station was originally intended to be the Director's house and was of rather better construction. Although there have been problems with cracking walls and floors, it has been possible to maintain this building in reasonable condition. This building now consists of four offices, a large central conference room and a storage room.

The latter was formerly intended as the kitchen and it is planned to convert this room for use as a laboratory during the next two years. The office space available in this building is wholly inadequate in terms of the demands of the senior station staff as well as being unhygienic because of a bat-infested roof.

A third building was constructed using local building materials and methods which remains serviceable and is currently used for seed storage and seed cleaning. The seed storage capacity of this building is insufficient and it does not provide suitable environmental conditions for storage or adequate protection against storage pests. Appended to this building is a small store which is used for fuel storage.

Other buildings on the research station include two Butler rondavels, one of which is used for storing tools and tyres and the other for storing agrochemicals. These provide adequate storage capacity for these items. A recently constructed store for spare parts and servicing materials and equipment is located alongside a covered servicing bay also recently completed.

The equipment that is available for use on the Bonka Research Station was either provided under the FAO-supported project to strengthen agricultural research in Somalia in 1976 and 1977 or has arrived recently as part of BRADP support programme.

The major items imported under the FAO-supported project in the 1970s and which are still on the research station and available for use include the following:

1	International 45 hp 4-wheel tractor 1976
1	Fiat 640 4-wheel tractor 1977
2	mounted offset disc harrows, 3.0 m working width
1	3-furrow disc plough
1	small cultivator
1	trailer

The International tractor is presently out of order, but there is a possibility that this tractor can be made to work if some spares can be obtained. In addition, various minor items were supplied which are still in use including hand tools, scales and a soil test outfit.

A wide range of items have been supplied under BRADP which have mostly arrived in the last 12 months and have so far been little used. These items include farm machinery and associated tools, hand tools for cultivation, soil analysis and soil testing equipment and office furniture. The farm machinery provided by BRADP consists of the following items:

2	Dayton 18 hp horticulture tractors	
2	Dayton 8 hp Rotatillers	
2	spring shank cultivators)	
2	Lift-type discs)	
1	rotavator)	for garden tractors
1	mowing unit)	
2	18 inch threshers	
1	plot thresher	

The horticultural tractors appear to have been ordered with little appreciation of their usefulness on BRS. In addition to the equipment listed, the BRS has access to some machinery from the nearby Extension Centre and from the Seed Farm.

3.1.3 Current and Prospective Staffing

During the first two years of BRADP no technical assistance was provided by USAID for the applied agricultural research programme. The agreement to provide an agronomist was not honoured until April 1983, with the arrival of the University of Wyoming team. The agronomist has been made Director of BRS. He is also team leader of the Wyoming team.

Also included in the USAID technical assistance programme for the BRADP agricultural component were an extension specialist/agronomist, a seed farm specialist, and a range management adviser. Only the seed farm specialist post had been filled at the end of September 1983. Because of an overlap of the functions of the extension post with the national AFMET project, also funded by USAID, a proposal was being considered to substitute an additional research worker for this post - possibly an entomologist. Similarly the post of rangeland management adviser was also to some extent overlapping with the Central Rangelands Project and it has been proposed that his assignment be changed to that of an entomologist. These proposals have been put forward by the University of Wyoming team leader and are presently being considered by USAID.

There is a national programme for sorghum research; the Project Leader is the Director of Research in Mogadishu. This programme is supported by Canada (IRDC) which finances an internationally recruited geneticist/sorghum breeder who had been working at Bonka since October 1981 and is scheduled to continue until 1986. Transport is provided for the sorghum programme by IDRC but all other facilities are financed by BRADP except for two members of personnel who are paid out of Department of Research MOA funds.

There are nine Somali staff at BRS with an educational background and some technical knowledge of field experimentation. Amongst the Somali staff are four graduates from Afgoi. One of these graduates is the Deputy Director of the Bonka Research Station who is largely occupied with administrative duties and is likely to be required to continue in this role in the future. The other three graduates have been at Bonka for only a short period since leaving university and have had little research experience. They are candidates for further training overseas and are likely to leave Bonka for this purpose within the next year or two.

In addition to the four graduates, there are four field assistants with secondary agricultural high school training, mostly with a few years'experience in field experimentation. These field assistants are assigned to specific research investigations.

The remainder of the BRS permanent employees are made up of one graduate taking an English course in preparation for overseas study; 2 tractor drivers; 1 mechanic; 1 Administrative Officer, 2 Field Assistants (Intermediate School level); 1 store keeper, 1 meteorological recorder, 1 messenger, 4 watchmen, 1 bulldozer driver (with highways component of BRADP); and one permanently sick person. The total establishment for the station is 23 persons. The allocation of the senior staff by field of activity is as follows:

Activity	Post	Name	Qualifications
1. Administration	Deputy Station Director	Addow Adan Magan	B.S.
2. Sorghum	I/C	Adan Ali Osoble	B.S.
	Field Assistants	Ali Nur*	B.S.
		Fowsisja Haji Mohamud	S.A.H.S.
		Haji Shiekh*	S.A.H.S.
3. Grain Legumes	I/C	Ali Mohamed Abdi	B.S.
	Field Assistant	A/Karim Nuur Mohamud	S.A.H.S.
	Field Assistant	Fadumo Mohamed Osman	I.S.
4. Oil seeds	I/C	Mohamed Mohamed Shekh	S.A.H.S.
	Field Assistant	Muuse A/Rahman Malin	I.S.
5. Sub-stations	I/C	Ahmed Abdulahi Mohamed	S.A.H.S.

*Note: * salaries paid by ARI.*

3.2 SUB-STATION ACTIVITIES

The concept of sub-station activities was introduced to BRADP during the visit of a Consultant Agronomist in the 1981 Gu season. Since that time some simple trials have been undertaken on farmers' fields in Daynuunay, Qansaxdheere and Buurhakaba. The sites where such trials have been undertaken have been referred to as sub-station, but of course such sites remain only as long as the farmers are prepared to cooperate.

The sub-station trials were carried out by Bonka staff assisted by the District Extension Coordinator and were a useful point of contact between research and extension. Farmers were expected to assist with the implementation of the trials and were to be compensated for the use of their land and their labour by receiving the product of the trials. The trials on these so-called sub-stations were only a limited success and in addition to the unavoidable trial failures due to poor rainfall, there were considerable losses due to other factors such as animal intrusions into the trials, insect pest attack and human interference. The establishment of formal sub-stations where such losses can be prevented is seen as the only solution to the problem of field experimentation in the outlying districts. However in view of the difficulties of organising the establishment of formal sub-stations and the shortage of staff for the Bonka programme, the current proposal is to terminate all sub-station activities.

3.3 PLANNED PROGRAMME FOR FUTURE RESEARCH AT BONKA

3.3.1 Sorghum Research

The sorghum breeding programme will continue in Stage II of BRADP (1984-86). No major changes are envisaged in the content of the programme; the selection criteria are likely to remain unchanged. The responsibility for the sorghum breeding work remains that of the IDRC geneticist who is also directing this work at two other stations in the country - at Aby Rein and Labar Garas.

The agronomic trials that are being carried out with sorghum are in theory the responsibility of Adan Ali Osoble; assistance has been provided by the IDRC expert. Some of the topics which have been covered in agronomic trials with sorghum include insect and disease control using agro-chemicals, plant population, time of planting, use of fertilisers green manure crops and intercropping. No detailed plans had been prepared for agronomic investigations in the 1983 Dayr season.

3.3.2 Agronomist's Work Plan

The Team Leader/Agronomist of the University of Wyoming team submitted a brief Plan of Work to USAID in accordance with the terms of the contract covering the period July 1 1983 to July 1 1984.

(a) Equipment Procurement

The work plan begins with a list of equipment which, it is implied, is important for the reduction of error variation in crop trials.

2 30-35 hp row crop tractors with adjustable wheels for various row widths
2 row crop planters, 4 rows each (one ordered)
1 planting disc for row crop unit planters (ordered)
2 4-row front mounted cultivators
1 50 hp tractor for seed bed preparation
1 brillon field cultivator (3.0 m working width)
1 offset disc harrow (3.0 m working width)

Plans are being made to move the BRS alongside the Seed Farm. Temporary requirements have been identified for seed storage (metal garbage cans, renovated Butler hut), fuel storage (1 000 litre tank), spare parts storage (shelving - existing building) and pesticide storage (renovated Butler hut).

(b) Improvements in Experimental Efficiency

A review of results of experiments conducted at Bonka revealed a high proportion of trials with very high coefficients of variation. The high error variation was caused by a variety of factors including:

- poor experimental designs and inadequate replication
- poor seed quality
- high soil variation and uneven microtopography of the soils
- poor hand planting techniques

Methods to improve these factors are proposed.

(c) Production of Extension Bulletins

The need for crop bulletins for farmers and extension workers is identified and an example of the outline of a bulletin on sorghum is presented. However, no proposals are made on the production of such bulletins.

(d) Specific Areas of Research Required

Five lines of investigation are suggested which are summarised as follows:

(i) Sorghum plant characteristics which may have a bearing on susceptibility to bird damage;

(ii) Dual-purpose sorghums or sorghum specially bred for grain production and others for forage production;

(iii) Sorghum plant population studies to determine the effects of population on forage and grain yields and forage grain ratios;

(iv) Cowpea, mung bean and peanut intercropping trials with sorghum;

(v) Oil seed production.

4

A Review of Research Needs and Future Proposals

4.1 APPROACH AND LINES OF INVESTIGATION

The paucity of useful results from previous annual crop research programmes at Bonka serves to emphasise the need for a carefully directed programme which is closely related to the needs of the farmer. Priority should be given to work which is likely to be widely and readily applicable in the field. Established crops should take precedence over introduced crops.

Sorghum is currently the dominant crop occupying more than 95 per cent of the total cropped area in Bay Region. This crop should command the highest priority in the research programme, which should be largely built around it. All aspects of sorghum crop husbandry require study and improved varieties are urgently needed.

The scope for major crop diversification (i.e. introduction of new crops such as groundnut and/or sunflower, and reduction of sorghum in the farming system) is uncertain. The majority of farmers try to guarantee their staple cereal and they have developed a capability to store it following good harvests, thus guarding against subsequent crop failures. It seems likely that the area of sorghum currently planted by the average farmer is that deemed to assure a continuing supply of grain for the family. Any significant surpluses of sorghum depend on a succession of good harvests.

The capacity of household labour is an important limitation on the area of land which can be cultivated. The farmers' attitude to the high risks involved in arable agriculture is also to be considered. In the Baydhabo area one crop in four will be a failure whilst around Buurhakaba this risk increases to one crop loss in two. Experience has taught the farmer to limit investment in crop production because of the high risks involved. A further constraint on the cultivated land area may be the shortage of land. On the Baidoa soils the currently cultivated areas are in excess of 60 per cent of the total area; the remainder being used for livestock, fallow or other purposes.

In situations where an expansion of the cultivated area is not possible, any crop diversification will require a reduction in the sorghum area. The replacement of sorghum on part of the cultivated area with a cash crop may be acceptable only if the sorghum production foregone is compensated by a higher yield on the remaining sorghum area. If new crops cause a reduction in the grain harvest, then there is the danger that the present self-sufficiency will be upset in Bay Region. Investigations are required to determine the limitations on the expansion of the cultivated area before any precise estimate can be attempted of the scope for crop diversification in the small farm sector.

There are two other possible ways in which crop diversification could take place whilst minimising the effects on sorghum production, i.e:, by interplanting the sorghum with alternative crops and by including crops in rotation with sorghum which would give a boost to sorghum yields. Interplanting and rotation trials should be included in the experimental programme. The grain legumes, cowpea and green gram, which are the most important of the minor food crops grown in Bay Region, are already grown in combination with sorghum and are recommended for inclusion in interplanting trials. The Terms of Reference for the Study contain a specific request to examine the future role of groundnuts and sunflower in the production system of Bay Region with a view to developing an oil extraction facility in the Region. The scope for immediate expansion of these crops in the small farm sector is believed to be negligible in the project term.

In those parts of the Region where land is not limiting, there is the possibility of diversifying cropping through the adoption of alternative technology which would enable the farmer to handle a larger area and/or to increase yields. This would involve oxenisation and/or the use of tractors. Investigations are required to test the economic feasibility of such innovations in the uncertain climate of Bay Region. Investment in one operation (e.g. land preparation) usually implies changes in technology for subsequent operations (e.g. for weed control) which involves further investment. It is unclear whether adequate returns can be obtained on such investment, given the high rates of crop failure. The risks might be minimised through the adoption of moisture conservation practices, but the effectiveness of these practices requires investigation.

The introduction of alternative food or cash crops is not considered a priority at this time. The testing of new varieties and plant breeders' lines of all minor crops should be minimised, unless these crops have a well defined role in future cropping patterns. There is, however, a case for the introduction and testing or perennial forage crops on fallow land.

4.2 SCREENING AND SELECTION OF ANNUAL FOOD CROPS

A major part of the work undertaken at the BRS has been the screening and testing of breeders' lines and varieties of sorghum, cowpea, sunflower, groundnuts and a range of minor crops. The general approach to this work has not been very fruitful. There has been a lack both of specificity in requests for improved planting material and of selectivity by international agencies supplying seed. As a result, a good deal of material has been included in trials which should have been discarded prior to planting.

The aspect of outstanding importance which must be taken into account in varietal selection is the very short growing seasons. In the wetter parts of the Region, the duration of the rainy seasons, as defined by the first and last daily fall of 10,0 mm or more, averages only 38 days in the Gu season and only 33 days in the Dayr, whilst one year in four this is stretched to 49 days and 46 days, respectively. In the clay soils of the Bay Region the total available water in the top 75 cm at field capacity, is probably about 15 cm, sufficient to meet the demand for consumptive use of an average crop for a period of six weeks. Thus maturity should be achieved within 100 days if field reduction due to moisture stress is to be avoided.

4.2.1 Sorghum

The sorghum varietal improvement programme constitutes a large proportion of the current work load on BRS. A wide range of imported material is being examined, much of which has been received without any detailed information on varietal characteristics. Thus all the material received has to be screened and characteristics determined by detailed recording. If such information was supplied from the seed source, a more discriminating approach could be adopted, reducing the amount of material under test. The selection criteria for Bay Region are early maturity, high yield and good grain quality (i.e. suitable for storage by traditional methods and acceptable to the local people in terms of processing characteristics and taste). The high yield criterion refers to the overall production potential of a variety over a number of different seasons with a range of different conditions.

The sorghum variety improvement programme should continue to receive the highest priority since sorghum is by far the most important crop in the Bay Region. However there is an immediate need for a more precise definition of the objectives and methodology of the programme to help outsiders understand the work and to keep the programme as simple as possible. It is of the utmost importance that the sorghum improvement programme effort is focussed on those areas likely to yield the quickest results.

4.2.2 Cowpea

The work on cowpea at Bonka since 1981 has consisted almost totally of a series of variety trials comparing the local variety with exotic varieties from IITA and the USA. From this work no variety has emerged which is any better than the local variety. Future prospects for a new cowpea variety offering major yield improvements over the local variety are not bright.

The cowpea has only a minor role in the present farming system where it is generally interplanted in the sorghum. Most of the cowpea produced is consumed on the farm, very little is marketed.

Even if a new cowpea variety emerged producing significantly higher yields than the local variety, the impact on the present situation would be very small. Thus the continuance of the cowpea variety testing programme should receive only low priority in the experimental programme.

4.2.3 Mung Bean

The situation with mung bean is the same as with cowpea. A series of variety trials including material from ICRISAT has failed to produce any variety that is superior in yield to the local and in all cases the grain quality of the exotic varieties is softer and more susceptible to insect attack than the local. Prospects for the emergence of a new variety of mung bean offering significant improvements in production potential over the local variety are not good. Even if such prospects were encouraging, the level of production increase achievable with mung bean is unlikely to cause any significant improvement in the farming system.

4.2.4 Groundnuts

Interest has been expressed by Government in the production and processing of oilseeds in the Bay Region. Groundnut is the most suitable oilseed for the area; it is a good crop to include in a crop rotation and its by-products are of nutritive value for livestock. Present varieties grown are mostly confectionary types. Varieties with a high oil content need to be introduced and tested. A beginning was made on a programme of introduction and testing in the 1982 Gu season when seed of 45 varieties, supplied from ICRISAT, was planted. This programme should be continued with yield of oil and early maturity (not more than 100 days) as major selection criteria.

4.2.5 Sunflower

This crop has been selected for vegetable oil production but is generally considered to be inferior to groundnuts. Sunflower is not a legume and is, therefore, less favoured as a rotation crop. Nutrient value of sunflower by-products is also lower. Nevertheless, sunflower could be important in future cropping patterns because short-term varieties are available and the crop is easily handled by the small farmer with only hand labour at his disposal. Sunflower has the disadvantage of being susceptible to bird damage. Nevertheless varietal screening of introduced varieties should continue with major emphasis on early maturity and oil yield.

4.2.6 Safflower

The short-term role for oilseeds in the farming systems of Bay Region is not large and there seems little justification for continuing with safflower as a third oilseed crop at Bonka. The proposal to drop safflower is based on the erratic performance of the crop in past trials, in particular its susceptibility to waterlogged conditions in the seedling stage. Also, because of the spiny nature of the seed head, threshing using present techniques will be unpleasant for the farmer if not unacceptable. The varieties so far introduced have growing periods in excess of 130 days and short-season varieties may not be available.

4.2.7 Maize

No introductions or screening of maize varieties have been undertaken at Bonka in recent years and yet there is a significant area of maize planted on the Baidoa soils, in particular by the larger farmers. It is suggested that an effort should be made to obtain some short-term maize varieties with growing periods in the range 70 - 90 days for screening at Bonka. The objective of this programme would be to investigate the potential for maize production particularly in the Gu season when sorghum is commonly subject to severe bird damage.

4.2.8 Other Crops

Minor grain legume crops being grown on BRS include pigeon pea, chick pea, Tepary bean and Faba bean. These crops are deserving of only minor attention in the present situation. The usual justification for grain legume programmes is the improvement of levels of human dietary protein but in the Bay Region, where high levels of animal protein are traditionally consumed, such justification does not exist.

The introduction of additional exotic crops and crop varieties should be discouraged so as to avoid the unnecessary diversion of research resources away from the more pressing requirements of crops with a well defined role in the future cropping pattern.

4.3 CULTIVATION METHODS FOR FOOD CROPS

The majority of land preparation in Bay Region is done manually using the traditional yambo. Tillage by the yambo is irregular and selective. The deeper cultivation by yambo, up to 15 cm depth, is reserved for areas infested with perennial stoloniferous weeds; elsewhere in the field minimal tillage is practiced. The use of alternative sources of power for land cultivation (tractors and draught animals) account for only about one per cent of current land preparation. No large changes in the method of land preparation are likely to occur in the foreseeable future.

The scope is restricted for improvement of traditional practices, where only manual labour is available as a source of power. It should nonetheless be carefully examined since the majority of farmers will continue to be dependent on traditional practices. A general review of the hand tool situation should be undertaken. The suitability of the several types of yambo for cultivation of the clay soils of Bay Region should be assessed and alternative types of hand tools should be tested and the potential for local manufacture determined.

Moisture conservation techniques, which are widely used in other areas of Somalia and already practiced in isolated areas in Bay Region, could be usefully tested to determine their applicability to local soils. These techniques involve the formation of basins which may be 2.0 x 2.0 m or 1/1200 ha in area, known locally as *'moos'*, or 25.0 x 25.0 m or 1/16 ha known locally as *'jibaal'*. A special tool known as a *'kebaba'* is used to form the bunds. These basins are designed to prevent run-off and are most obviously beneficial on sloping ground. However, the effectiveness of such basins may be worth investigation on flatter areas, particularly if there is minor microtopographic variation. Where such variation occurs, there is water accumulation in the depressions which invariably leads to uneven stands. The two sizes of bunded basins should be compared with flat cultivation.

The use of ox-drawn equipment for land cultivation is being actively promulgated by the NES. An ox-training service is being provided. It is assumed that the use of ox-cultivation is economic for the average farmer. According to extension staff, the major factor restricting the expansion of ox-drawn cultivation is the scaricity of ox-drawn equipment in general and ox-ploughs in particular. In the past a wide variety of ploughs have been imported but little has been recorded on their suitability for use on the clay soils of Bay Region. A review should be carried out of past and present experience with plough design in the Region. Using this local experience and that gained in a similar environment on similar soil types, ox-drawn and camel-drawn implements should be procured for testing.

The ONAT tractors which are hired to small farmers are equipped only with 3-furrow disc ploughs. The disc plough has been used since the introduction of tractors. At first sight there does not appear to be any need for disturbing and turning the upper part of the soil profile when these cracking, self-mulching clay soils are naturally circulating the top soil. The major merit of the disc plough is that a sufficient depth of tillage 15-20 cm can be achieved to ensure that perennial stoloniferous weeds are uprooted and turned to the surface. Where such weed populations do not exist, a chisel plough can provide effective tillage, making full use of the surface mulch for seedbed preparation and shattering any plough pan to permit good penetration of the early rains. The use of a chisel plough achieves considerable fuel savings and a much faster coverage of the ground. Thus a useful investigation would be a comparison of the effect on sorghum yield of the two methods of land preparation - chisel plough and disc plough. Other forms of land preparation might be incorporated in the same trial, such as the traditional minimal cultivation using the yambo and land preparation using animal drawn implements.

A line of investigation, included under the heading 'cultivation methods', is the study of the effectiveness of bare fallowing as a moisture-conservation measure. Land which is bare fallowed for a whole season stores rainfall which may raise the moisture level in the upper part of the profile to field capacity and at this point the total available water in the top metre of the profile may be as high as 20 cm in the majority of Bay Region arable soils.

With a bare fallow at field capacity the only losses of moisture that can take place are from the soil surface. The clay soils of the Bay Region, on drying, form a deep surface mulch which once formed effectively breaks the capillary connection with the sub-soil and precludes further moisture losses. Although some additional losses may occur from the deep cracks in the soil there is a good chance that a useful quantity of stored soil moisture can be carried over and utilised by the crop planted in the following season. In some years, this stored soil moisture could make the difference between success and failure of the succeeding crop and in the majority of years could be expected to produce some yield response.

Some encouraging crop yield responses have been reported elsewhere in the lower

Shabeelle when bare fallowing is included in the crop rotation. However, a high level of technology is being employed on the SDA settlement project using a mechanised system of cultivation and herbicides on virgin land. The appropriateness of such techniques in densely settled areas of Bay Region is questionable from all viewpoints - practical, technical and economic. Nevertheless, the Australian bare fallow system may make some contribution to an improvement in productivity in the long term, especially in sparsely settled areas. Consequently it is suggested that some investigations are undertaken to establish potential production benefits from bare fallowing. These investigations could be done on the micro-level at BRS where soil moisture levels could be monitored. A macro-level examination of the effects of bare fallowing could be undertaken on the Seed Farm.

4.4 SOIL FERTILITY INVESTIGATIONS

The information on the major arable soils of Bay Region has been reviewed in Section 1.2.3 and suggests that all these soils are of high potential for agricultural development. However the limited chemical analyses of the macronutrient content of these soils have shown that phosphate is generally deficient whilst potash is available in ample quantities. No evidence has been reported to indicate that either micronutrient levels or trace elements are limiting anywhere in the Region.

An indicator of the inherent fertility levels of a soil is its ability to sustain long-term continuous cropping. Under the tropical semi-arid conditions of Bay Region there will be inevitably a steady deterioration in fertility levels with continuous cropping. Ultimately fertility will decline to a level at which the farmer abandons the land, which reverts to a bush fallow, and he then has to clear and develop new land.

All the areas of arable soils in Bay Region appear to exhibit the typical characteristics of land rotation; the cultivated lands are interspersed with areas of thicket vegetation dominated by *Dichrostachys* and *Acacia* spp, typical colonisers of abandoned land. However, the period of cultivation is a long one, perhaps covering many years. It is important that investigations are conducted to determine the approximate length of the cultivation cycles on the various arable soils under different rainfall conditions. The much greater frequency of cropping in the higher rainfall area can be expected to exhaust the soil at a faster rate than in the more marginal rainfall areas.

Sorghum is the dominant crop in Bay Region and yield levels are much influenced by fluctuations in rainfall received and by the ravages of insect pests and birds. The variability of sorghum yields is likely to be so wide that seasonal and annual comparisons are precluded. The detection and quantification of declining fertility in terms of sorghum yields is complicated by other factors in a monocropping system. Soil borne diseases and nematodes may be important factors retarding crop growth and ultimately affecting sorghum grain yields. Also there have been recent suggestions that the mycorrhiza associated with sorghum roots produce a toxin which builds up in the monocropping system with eventual deleterious effects on grain production.

In view of the combined problems of declining soil fertility and soil related hazards associated with sorghum monocropping, there is a case for the inclusion of a rotation trial in the experimental programme. Crop rotation is possibly the most effective and cheapest method of combating declining sorghum yields and extending the cultivation period in present circumstances.

A trial was begun in the 1981 Gu season in which the principal objective was to obtain a measure of the influence of the preceding crops, especially legumes, upon the yield of sorghum. However, this trial was designed only as a short-term investigation comparing continuous sorghum with sorghum alternating with other crops. The latter treatment, at least at this point in time, is unrealistic since it is unlikely that a farmer will accept a 50 per cent reduction in his sorghum area. Thus a wider range of alternative rotations must be included in a future rotation trial which should be designed as a permanent trial. Sorghum intensities should be varied and a fallow treatment could also be introduced. Because of the need for continuity of operation of the rotation trial, Bonka may be the only site where it could be carried out although ideally the trial should be repeated on the four major soil types.

Crop yields in Bay Region are obviously limited by low soil fertility levels although there is little hard data to support this statement. In demonstration plots at Bonka in the 1960s, the application of 10-15 tons of farmyard manure doubled sorghum yields and the application of 17-17-17 compound fertiliser at the rate of 200 lb per acre had a similar effect. Present yields on Baidoa soils are so low that poor soil fertility must be a contributory factor. It is generally agreed that the fertility status of Amin soils is much higher than the Baidoa soils and this general impression was confirmed by the results from recent trials carried out at Qansaxdheere and Bonka with sorghum and groundnuts; yields of both crops at Qansaxdheere were more than double the yields obtained on the Baidoa soils with little difference in rainfall. Sorghum yields are erratic on the other two major arable soil groups of Bay Region - the Uiamo and Bur Acaba soils - both of which are largely situated in areas of relatively low and uncertain rainfall.

There is a strong case for carrying out fertiliser investigations on the Baidoa soils, which does not apply to the other arable soils of Bay Region and this case is supported by the following points:

(a) The Baidoa soils are located in the most reliable rainfall zone of the Bay Region and there is some chance that economic sorghum yield responses to applications of fertiliser can be attained.

(b) The highest rural population density of the Region occurs on the Baidoa soils and there is much greater land pressure than elsewhere. More than 60 per cent of the Baidoa soils are cropped so that the scope for shifting cultivation is greatly diminished. Thus fertiliser use may be essential to maintain crop production levels and to retain the present sedentary population in the existing settlements even in the short term.

(c) The major areas of Baidoa soils are within easy reach of Baydhabo and because of the proximity to the urban market, farming activities are more commercialised. Thus farmers in these areas are likely to adopt the use of purchased inputs much more readily than in the more remote parts of the Region.

The fertiliser investigations should initially be restricted to sorghum and should include applications of nitrogenous and phosphatic fertilisers only. Nitrogen levels are invariably low in tropical soils and the indications are that the Baidoa soils contain only small amounts of available phosphorus. On the other hand potassium levels in these soils are high. Perhaps the best approach to these investigations would be to establish a single replication of several treatments on a number of farmers' fields preferably on exhausted land. The treatments could include the following:

(i) Control - no fertiliser applied;

(ii) Nitrogen alone - top-dressing at rate of 45 kg of N per ha (urea);

(iii) Phosphate alone - seed-bed application at rate of 45 kg of P_2O_5 per ha (TSP);

and (iv) Nitrogen and phosphate applied together as in (ii) and (iii).

4.5 CROP MANAGEMENT

4.5.1 Spacing and Plant Population Investigations

There is a complete absence of any data on which to base spacing recommendations for the crops of Bay Region. Nevertheless advice is being given by the extension service based on experience elsewhere in Somalia. For example, row planting is recommended for sorghum at spacings of either 100 x 40 cm or 75 x 50 cm at one plant per hill, giving plant populations of 25 000 and 26 600 plants per hectare respectively.

In the early reports on Bay Region it is frequently stated that sorghum yields in the Region are limited by low plant populations. However, no information has been presented on plant populations in farmers' fields or current experiments which demonstrate that farmers could substantially increase their yields by increasing the number of plants or planting hills in their fields. Before advising farmers to change their spacing, there should be some knowledge of current plant populations. There is a need to determine the density of planting hills in the average field at planting as well as at harvest and the related plant populations. Spacing trials can then include treatments which are truly representative of the present situation in the field.

The major factor limiting yields of sorghum in Bay Region is rainfall and the spacing/yield relationship will undoubtedly be affected by rainfall conditions. Thus the spacing trials should be conducted at a number of sites and over several seasons. Because of the outstanding importance of the sorghum crop, a series of spacing trials should commence at the earliest opportunity.

Spacing trials with crops other than sorghum are not of high priority and the present extension recommendations can be followed.

4.5.2 Intercropping

In the present farming system intercropping is practised over small areas. Cowpeas and green gram are interplanted in the sorghum. Intercropping has a number of potential advantages which should be tested in the varied climatic conditions prevailing in Bay Region before being recommended to the farmers.

The potential benefits of intercropping include:

(a) Variable growth habits and differing spatial arrangement of leaves of crop plants may increase the leaf area index of mixed stands and therefore the production potential per unit area;

(b) A non-leguminous crop may benefit from the nitrogen fixed by a leguminous crop growing alongside;

(c) Risk of total crop loss is much reduced by planting a mix of crops of varying drought tolerance or of varying susceptibility to insect pests or birds;

(d) Intercropping may be used to introduce a new crop to the farmer; instead of replacing a staple food crop the new crop is grown in a mixed stand.

Sorghum is likely to feature in all intercropping systems. During the more reliable Gu rains it could be mixed with maize. Bird damage on the Gu season sorghum crop can be very high and the maize would not be affected by such birds.

Crop combinations which might be tested include sorghum - groundnuts, sorghum - sunflower, sorghum - grain legumes. Crop mixes of three and even four crops could be tried. Returns from these combination should be compared with pure stand cropping.

4.5.3 Weed Control

The research workers at BRS should be required to undertake the occasional weed survey and the weed collections should be identified at the National University. Through these surveys major weed problems can be identified and the requirements for weed control investigations can be defined.

4.6 PESTS AND PEST CONTROL INVESTIGATIONS

The damage caused by insect pests is generally recognised as a major factor limiting crop production levels in Bay Region, a factor second only in importance to rainfall in determining yield levels. The important insect pests have been identified, but no investigations of the biology of these pests in the locality have been made. Much of the knowledge of these insect pests is derived from studies conducted elsewhere in the world and measures to control insect pest damage in Bay Region are restricted to the use of chemical pesticides. However, the quantities of pesticides currently used are extremely small and applications are restricted to attempts to control limited but severe outbreaks of insect pests rather than systematic or routine control. Thus there is a need to develop a pest control strategy for the future.

Sorghum monocropping is widely practiced in Bay Region and there is little doubt that the sorghum insect pest complex should be the focus of any entomological investigational programme. Two crops of sorghum per year are generally planted, one in the Gu season and one in the Dayr season. Under such conditions insect pest problems are likely to be somewhat worse than in a monomodal rainfall area since the carry-over period with two crops per year is so much shorter.

The stalkborer *(Chilo partellus)* is the most prominent of the sorghum pests in Bay Region. Unlike most other sorghum pests, stalkborers are an ever present problem causing serious damage in virtually all crops, the damage being marginally greater in the Gu season than in the Dayr. Some results of Bonka insecticide trials have demonstrated very significant yield improvements where stalkborer populations have been reduced. The potential production increases resulting from stalkborer control provide ample justification for a major programme of investigations.

A comprehensive approach to the stalkborer investigations in Bay Region is proposed which should include the following activities:

(i) Establish contact with other international agencies and national research bodies engaged in investigations into stalkborer control and review published literature extracting information relevant to the Bay Region situation.

(ii) Confirm that the species *Chilo partellus* is the major species in Bay Region and if so study the biology of this species in the local environment which might include egg-laying habits, larval behaviour, hibernation habits of pupae, breeding cycle, and existence of alternative hosts.

(iii) Examine the role of ratoon sorghum and the sorghum stubble in the carry-over of larvae and pupae of the stalkborer from one season to the next and make recommendations on the need for halting the practice of ratooning and for improving crop hygiene.

(iv) Carry out surveys to determine the within-season variation in stalkborer attack in Bay Region, sampling sorghum stalks to determine stalkborer populations over as wide an area as possible.

(v) Investigate the effectiveness for stalkborer control of a range of insecticides - both systemic and contact.

(vi) Study the factors determining the effectiveness of currently recommended contact insecticides (including rates, timing and numbers of applications) on stalkborer populations and on sorghum yield levels taking account of soil fertility levels.

(vii) Establish the economics of routine applications of insecticides for stalkborer control in sorghum.

(viii) Establish whether opportunities exist for biological control of stalkborer through the identification of natural enemies - insect parasites, viruses etc.

Investigations on the other insect pests of sorghum should include the following:

(a) The use of systemic insecticides for the control of sorghum shoot fly (this could be combined with stalkborer control using a systemic insecticide).

(b) Screening of insecticides for controlling outbreaks of crickets, grasshoppers and armyworm.

(c) Screening of insecticides and method and timing of application to sorghum head for control of American bollworm and the Beve bug *Calidea* spp.

4.7 CROP STORAGE

In previous reports on the Bay Region it has been categorically stated that grain storage losses from the traditional pit stores are considerable and that special efforts are required to improve storage. This statement is repudiated by many local people who insist that losses are not great and commonly cite instances where grain has been stored in these pits for 5 or 6 years with no serious deterioration in grain quality. However, it is admitted that soil type has an important influence on the efficiency of pit storage although the relationship between soil texture and efficiency of storage is not clear. Also in years of high rat populations, it is often not possible to exclude rats from the pits to prevent losses.

Investigations are required:

(i) to determine the extent of grain losses from storage pits

(ii) to correlate grain losses with type of pit

(iii) to identify favourable features of most effective storage pits to facilitate production of a set of recommendations on pit construction and management.

4.8 FORAGE CROP ADAPTATION INVESTIGATIONS

A major objective of these investigations would be to introduce and explore the possibilities of forage crop production. In view of the importance of livestock in Bay Region it is surprising that forage crops have not featured in any previous reports from Bonka. A few species have been introduced over the years and can be seen growing today but there has been no serious effort to assess the potential of these crops in formal observation trials.

Some work on forage crops has been started at CARS and seed of a number of species is available including the following:

Cassia occidentalis	)	
Crotalaria comanestia	)	
Crotalaria tropeae	)	
Clitoria ternatea	)	Local land races
Vigna radiata	)	
Vigna unguiculata	)	
Cyamopsis tetragonoloba Mixed var.		
Lablab purpureus Unknown origin		
Leucaena leucocephala (ex-Australia)		

These species would form the starting point for a programme designed to identify and evaluate suitable forage crop species to be included in the future farming system. Large observation plots of these species should be planted at a few locations to determine yields of green material and palatability.

4.9 FORAGE CROP MANAGEMENT AND CONSERVATION

Initially this line of investigation may be concerned with the utilisation of sorghum stover. At present most of the sorghum stover is grazed in the field after the removal of heads. It is necessary to determine if this is the most suitable manner of utilisation. Also the forage value of different sorghum varieties are worth investigation and a joint programme covering this aspect of the work could be established with the sorghum breeder.

The selection of suitable forage crop species would be followed by studies of management in the field and methods of conservation. Initially conservation will be as hay but, in the long-term, silage may be a possible alternative. The use of pits for grain storage could be extended to silage.

A laboratory is to be established in Mogadishu in the near future for the analysis of range plants and other livestock feeds. Such a service will be of considerable assistance in forage management and conservation studies.

5

The Seed Farm

5.1 HISTORICAL

The Bonka Seed Farm was started in 1976 when 100 ha of land were cleared. The initial development of the land was financed through the Ministry of Agriculture which received some support from FAO. In addition, FAO funds were used for the purchase of the farm machinery required for the operation of the farm.

At the beginning local varieties of crops were planted with the specific objective of producing seed as an insurance against shortages in surrounding areas of less reliable rainfall. The farm was run by the Extension Department of the MOA.

5.2 RESOURCES

5.2.1 Land Availability and Land Development

The Bonka Seed Farm consists of a total area of approximately 200 ha all of which has typical brown cracking clay soils of the Baidoa soil group. The topography of the area is generally quite flat, but there is a tendency to gully formation in some areas. Run-off occurs when there is high intensity rainfall.

The area of cleared land on the farm is currently 100 ha and the cultivated area is about 81 ha. The difference is taken up by a farm machinery park and buildings, roads and wars, uncultivated irregularly shaped areas and strips within fences forming turning areas for the tractors.

The remaining 100 hectares has variable bush cover but is mainly *Dichrostachys Acacia* spp. thicket which should present no difficulties for future land development.

5.2.2 Buildings and Equipment

The farm is presently extremely poorly equipped with buildings. The existing structures consist of a large open-sided dutch barn (approximately 40 x 5 m covered area) and a couple of small huts of local construction (one serves as an office and lubricant/fuel store and the other as a multipurpose store for grain, tools etc). The dutch barn provides the only cover for machinery. It is also used for repair and maintenance of machinery and grain storage. Only a small part of the machinery on the farm can be accommodated under cover.

The current stock of farm machinery on the seed farm is considerable and at first sight apparently greatly exceeds the needs of a 100 ha farm. However a closer examination reveals that much of it is unsuitable for the soil conditions on the farm or for the crops being grown. Further, vital parts and attachments have gone missing or have not been supplied.

The tractor power on the farm includes an MF 275 and an MF 2057 with dual rear wheels. The latter has been provided by BRADP within the last 12 months. It is generally unsuited to the requirements of the seed farm. Several smaller tractors could have been purchased for the cost of this 120 hp unit and performed the operations required equally effectively and with greater security. Heavy reliance on one large machine cannot be justified in a situation where the mechanics have limited ability and the supply of spare parts is erratic in the extreme.

A similar error of judgement in the selection of equipment was made with the selection of the combine harvester, which is an International 1420, an axial flow combine. This machine is equipped with a cutter bar and table for small grain cereals and has no sorghum header attachments. It is far too large for the foreseeable needs of the seed farm and is of considerable mechanical complexity.

In the past, land preparation on the seed farm was done by the ubiquitous disc plough. Two disc ploughs remain in the machinery pool on the farm, one 3-furrow and one 2-furrow. There is also an offset disc harrow which is probably of the same origin as the disc ploughs.

The cultivation equipment recently arrived for use with the large MF tractor includes a 3-piece folding chisel plough and a spring tine cultivator. Only the central section of the chisel plough can be used on the heavy clay soils of the seed farm; with all three sections of this chisel plough there is far too much wheel slip for efficient operations.

Also amongst the recently acquired new machinery on the seed farm is a trailed Brillon implement with a single row of vertical discs at the front attached to a spring tine chisel plough. The chisel tines are half mouldboard and the implement is designed for chopping up and uprooting sorghum stubble but has not yet been tried on the seed farm.

Two inter-row cultivators have been supplied under the BRADP funding,but neither is functional. An inter-row sweep cultivator is useless because depth control wheels were not supplied and a rotary inter-row cultivator is lacking parts for the control of the movement of the rotary drums.

A John Deere trailed cutter bar, of ancient design, has been provided for cutting the sorghum stalks. The cutter bar has a 2.5 m working width and is virtually unsupported - only a thin wire holds the blade for cutting height control. This implement is most unsuited for the task for which it was ordered. Similarly the lightweight windrower, designed for hay making under very different conditions, is not the best implement for windrowing heavy sorghum stover.

An International 2400 series baler has been provided by BRADP. This machine produces very large bales and its intended purpose on the seed farm is not clear. Is is a belt-type machine which restricts the range of use. This baler has been supplied without power take-off and without twine. The 3-point linkage for picking up the bales that has been provided does not permit the bales to be lifted high enough for loading on to the available transport.

Also recently received under BRADP are four 4-wheeled high-sided trailers. The sides of these trailers are fixed and they are non-tipping. It is difficult to imagine anything less convenient as a form of transport.

There are on the station three planting machines; a typical 4-row planter, a seed drill and a drill for small seeds. The latter two have been supplied under BRADP and are both larger machines than is desirable for the purpose of the seed farm.

5.2.3 Present Staffing

The Seed Farm Manager supplied by the University of Wyoming under contract to USAID arrived in May 1983 and is scheduled to stay for the next 4½ years. Prior to his arrival, the farm was without expert guidance.

The current Deputy Farm Manager has been in post since October 1982 when his predecessor left to take up a scholarship in the USA. He has been educated to Secondary Agricultural High School level. His duties are mostly administrative. The second most senior Somali has an Intermediate High School education and is responsible for the farm machinery on the farm. He also has a role in training the people who operate the machinery and those who service and repair it.

The support staff on the seed farm include the following:

6 guards
4 tractor drivers
3 field foremen
2 field inspectors
1 warehouseman
1 mechanic
1 clerk
1 secretary

5.3 PAST SEED PRODUCTION

The records of production on the seed farm over the years are incomplete. The available data are unreliable because there is some confusion and inconsistencies between the areas planted and the areas harvested. Consequently only selected data are presented which are fairly verifiable.

5.3.1 Sorghum

In the last two seasons, sorghum has been the dominant crop on the seed farm; 16.9 ha were planted to this crop in 1982 Dayr season and 41.4 ha in the 1983 Gu season. Rainfall in the 1982 Dayr season was above average whilst it was about average in the 1983 Gu. The two varieties Dabar and GBR 148 were grown in both years. The Dabar variety was originally imported from the Sudan as emergency food aid. The GBR 148 was obtained from the Bonka Research Station where it was introduced from the USA in 1980. Some five kg of seed was released to the seed farm in the 1981 Dayr season and the first distribution of seed of this variety to villages was a 10 quintal assignment from the 1982 Dayr season crop.

The average yields of the Dabar and GBR 148 varieties on the seed farm in the 1982 Dayr season were 6.0 and 5.0 quintals of grain per hectare, respectively. The quantities of seed distributed to farmers for the 1983 Gu season crop were 25 quintals of Dabar and 35 quintals of GBR 148. The 1983 Gu season production is shown as follows:

Variety	Area harvested in hectares	Total production of seed (quintals)	Average yield of seed in kg per hectare
Dabar	17.5	20	114
GBR 148	19.9	110	552
BT x 4	4.0	negligible	negligible

The production from the 1983 Gu season will be distributed to the villages; enough seed will be retained for planting the Dayr season crop.

The 1983 Gu season crop suffered considerable damage due to pest attacks. Heavy infestations of stalkborers were mainly responsible for the poor performance of Dabar and there were considerable losses due to birds. Large concentrations of birds were noted after the 20th August and many farmers, anticipating the problem, harvested before the grain was fully mature. The bird damage was expected because the areas of a good grain crop were very restricted (crop failure occurred all around at Diinsoor, Qansaxdheere and Buurhakaba). There was an almost complete loss of grain from the BT x 4 variety which had been expected to perform well. This variety is slightly later maturing than both Dabar and GBR 148 and this delay was enough to cause almost complete loss of grain.

5.3.2 Cowpea

This crop has been grown on the seed farm on a large scale with only limited success. There has been complete crop failure in the last two seasons. In the 1983 Gu season more than 10 ha of cowpea was planted but none was harvested. The crop was lost in the seedling stage (3-4 leaf stage) due to the ravages of crickets and grasshoppers. Attempts to control these pests using Gamesan (lindane) bait were only partically successful and rainfall after the insecticide had been used greatly reduced the effectiveness of the treatment. A similar occurrence was responsible for the loss of the 1982 Dayr season crop.

It was reported that the last successful season for cowpea was the 1981 Gu season crop which produced bumper yields. During the latter half of 1981 cricket populations escalated dramatically and caused major losses in the 1981 Dayr crop. High populations of crickets appear to have persisted and have been an ever-present problem through 1982 and 1983.

5.3.3 Groundnuts

This crop has been grown on the seed farm for a number of years but, as far as can be ascertained, with only limited success. The high labour demand may have contributed to the poor performance.

In the 1983 Gu season some 20 ha of groundnuts were planted on the seed farm. However they were sown one month later than the other crops and in a major proportion of the area the groundnuts failed to germinate. Some 6 ha of groundnuts did have acceptable plant populations and were harvested with an estimated yield of around 3 quintals per hectare. The variety was a local Spanish bunch type.

5.4 DISTRIBUTION OF SEED

The first step in the seed distribution process is the letter which is sent at the end of each season by the seed farm authorities to the PMU of BRADP. The allocation is decided following consultations with four MOA District Coordinators.

Sorghum and cowpea seed from the farm is cleaned and dressed with combined fungicide and insecticide dust and is usually bagged in 1.0 quintal sacks. Groundnuts are supplied in the shell. The District Coordinators are responsible for distribution to the farmers. The seed is provided to selected farmers free of charge.

The seed farm presently has no storage facilities so the seed is despatched from the farm at the earliest opportunity. It is the responsibility of the District Coordinators to ensure that the seed reaches the farmer in good condition.

5.5 THE FUTURE ROLE OF THE SEED FARM

The seed farm is considered essential for the improvement of the genetic potential of crop varieties in Bay Region and a vital link between plant breeders and the farmer. Its major functions should be to:

(a) multiply breeders' seed of proven improved crop varieties, ex-BRS or suitable outside sources, and to produce foundation seed for distribution to selected farmers and/or certified seed growers;

(b) maintain purity of seed of established varieties and to ensure a regular supply of viable seed to farmers;

(c) provide a reserve of quality seed, if possible of improved varieties, to supply to farmers in emergency.

The success of the seed farm, above all else, depends on the availability of new varieties with improved characteristics. Such varieties may emerge from indigenous breeding programmes or from the introduction and screening of exotic material. In the meantime the logistic function of the farm would be paramount; the production of local varieties of sorghum seed, properly processed and stored for provision to farmers in emergencies.

5.5.1 Sorghum

No introduced varieties have been shown conclusively to be superior in yield to the local variety. The exotic varieties which, on some occasions, have appeared to be more promising than the local variety in terms of yield have been inferior in other important characteristics, particularly in terms of grain storage quality, susceptibility to stalkborer attack and stover production.

Sorghum is so much the dominant crop in Bay Region that if it is accepted that there is no advantage to be gained from the multiplication of recently introduced exotic sorghum varieties, then, in the short term, much of the justification for the seed farm is lost. No improved varieties can be expected from the national sorghum breeding programme before 1986 and the likelihood of the selection of an outstanding exotic sorghum variety before this is not high.

The production of high quality seed of local sorghum for distribution to farmers per se would not seem to be a very fruitful exercise since no major yield improvements could be anticipated. It would almost certainly be a better proposition to encourage farmers through the extension service to do the job themselves; that is select the best heads of sorghum on their own fields, carefully thresh them to avoid seed damage, apply a seed dressing to the threshed seed and store under the best possible conditions for next season.

Prior to identification of improved seed, there is need for a preparation period for training in all aspects of seed production, from the field production to the final bagging and distribution of the seed to farmers. Also in the short term the seed farm could be used for the production of seed of local sorghum varieties properly produced, processed and stored for provision to farmers in emergency situations. At the present time there are no suitable on-farm storage facilities and, until such time as facilities become available, some of the storage capacity in Baydhabo could be used and could relieve ADC of some of their responsibility for procuring seed for supply in emergencies.

5.5.2 Grain Legumes

The two major grain legume crops currently grown are cowpeas and mung beans. A number of variety trials have been undertaken with both these crops. The mung bean trials have identified some exotic varieties with a somewhat higher yield potential than the local, but invariably grain quality has been inferior, being softer and much more susceptible to damage from storage pests. Cowpea trials have not produced any exotic varieties giving significantly higher yields than the local variety; one selection was made as being superior because of a semi-erect growth habit. Seed multiplication of these crops should be confined to bulking supplies for provision to farmers following natural disasters.

5.5.3 Oilseeds

There are two oilseed crops with some potential - groundnuts and sunflower. Groundnuts are grown by the farmers of Bay Region, but only over a relatively small area. Thus the demand for seed in the immediate future will be restricted to groundnuts and quantities of groundnut seed required will be small.

The scope for the expansion of crops other than sorghum in the farming system has been discussed in Section 4.1. No rapid expansion in the cultivated area can be anticipated which implies that no escalation in demand for seed of these oilseed crops will occur. In the long term an improvement in sorghum production levels could encourage crop diversification, but this is unlikely to result in any abrupt change or to take place in the Project term.

5.6 THE MEDIUM TERM PERSPECTIVE AND SCALE OF OPERATIONS

In the previous section the broad functions of the seed farm were defined and the possible role of the farm in the foreseeable future in relation to the various crops was discussed. The sorghum crop is likely to dominate seed demands and seed production in the medium term. The oilseeds could become of increasing importance to the end of the 1980s as sorghum yield levels increase. The grain legumes and forage crops are likely to remain as minor crops in the future and demands for seed will be small.

The current plan is to double the area under cultivation to 200 ha, but no clear reasons have been put forward to support this proposal. The factors which must be considered in the determination of the scale of operations are briefly outlined below together with the implications.

(a) **The number of crops for which seed is required.** Sorghum will undoubtedly be the main crop and an arbitrary figure can be taken for areas of crops other than sorghum.

(b) **The nature of the crop varieties, degree of outcrossing, hybrids, synthetics or line selection.** Sorghum varieties can be expected to be developed largely from line selection and the degree of outcrossing will be minimised as a factor in the selection process. Improved sorghum varieties can be grown for at least 2 or 3 years without major deterioration.

(c) **The frequency with which farmers change to new seed.** This will obviously depend on the efforts of the extension service and on future policies of the Government on seed pricing. Currently all seeds are supplied to the farmers free of charge.

(d) **The frequency of crop failure**: This will not only influence the demand for seed but will also affect production levels on the seed farm. The scale of operations on the seed farm should obviously take account of the need to bulk-up reserves as an insurance against the bad seasons and make provision for the necessary storage capacity.

A few simple calculations, based on reasonable assumptions, demonstrate the production capacity of a 200 ha seed farm for sorghum seed and the rate at which seed can be multiplied.

Assumptions:

- 25 per cent of seed farm is in fallow i.e. 150 ha cropped
- Seed rate of 8 kg per ha
- Average yield on seed farm 500 kg per ha of sorghum per crop (inclusive of crop failures)
- Average yield on selected farms 300 kg per ha of sorghum per crop
- Two crops per year are obtained.

Season 1 Production on 2.5 ha is 1 200 kg which provides enough seed for 150 ha

Season 2 Production on 150 ha is 75 000 kg which provides enough seed for 9 375 ha

Season 3 Production on 9 375 ha is 2 812.5 tonnes which provides enough seed for 351 560 ha.

The above calculations demonstrate that 20 kg of breeders' seed could be multiplied over three seasons to give sufficient seed for the total sorghum crop in Bay Region in the fourth season i.e. in two years. Such a rate of increase could never be justified because farmers' acceptance of a new variety is unlikely to be spontaneous and universal, and, even if feasible, a complete change to a single variety would not be desirable. Thus it may be concluded that a 200 ha seed farm is too large for the purposes intended and a much smaller area is desirable if production is to be confined to foundation seed only.

A maximum area of 50 ha would seem to be appropriate for a foundation seed farm; 40 ha could be used for sorghum production of which 10 ha would be in fallow in any season. A cropped area of 30 ha, assuming an average yield of 500 kg per ha, would produce an average of 15 tonnes of foundation seed per season enough to plant 1 975 ha on selected farmers' land. Production on the 1 975 ha, assuming a yield of 300 kg per ha, would plant 70 000 ha in the following season or 140 000 ha per year, yielding enough to renew the regional seed reservoir every three years. A rotation would be followed on the seed farm consisting of 60 per cent in sorghum and 40 per cent in either fallow or other crops.

If the seed farm is restricted to the production of foundation seed, a major effort would be required for the organisation of selected farmers for the subsequent multiplication of this seed. Also provision would have to be made for the distribution of seed to the selected farms, the collection of the seed produced; for the cleaning, grading, and dressing of this seed; for the storage of the seed; and finally for bagging or packaging for delivery to farmers. The development of such a system of seed production and handling is a considerable task. Nevertheless the use of selected farmers for the multiplication of foundation seed is an inevitable long-term development.

6

Crop Development Proposals for Stage II

6.1 ADAPTIVE RESEARCH

During Stage II the Project would provide the capital and operating costs for the development of BRS and three substations.

6.1.1 Staffing

A vital requirement for agricultural research is skilled manpower. In Stage I the absence of resident research workers has been a major constraint at Bonka. This can be overcome in Stage II by foreign technical assistance, but in turn this will result in a scarcity of research assistants who will have to be trained on-the-job. There is also a shortage of unskilled labour for work on BRS at critical times such as weeding and harvesting when farmers are busy with their own crops. Any increase in the workload at BRS would have to be accompanied by adequate incentives for unskilled workers in order to attract a reliable and adequate supply of casual labour.

6.1.2 Technical Assistance

Five senior research posts and one farm manager are proposed for the Bonka Research Station. Three of these posts are already filled namely the Director of the Station, who is an agronomist, the sorghum breeder, and the Seed Farm manager. The three additional posts include an agronomist, a farming systems agronomist and an entomologist. A broad outline of the job descriptions of all six posts is set out below:

(a) **Agronomist I:** University of Wyoming Team Leader; 3 years; Director of Research Programme, liaison with ARI Administration, responsibility for the station. Suggested technical responsibilities:

(i) Introduction and screening of crop varieties: groundnuts and sunflower - emphasis on high oil content and early maturity; maize - emphasis on early maturity.

(ii) Forage crop investigations - annuals and perennials: introduction and screening of forage crop species; investigations of conservation techniques.

(b) **Agronomist II:** Two years (1985-86), must have good experience of soil management and some engineering background; technical responsibilities:

(i) soil fertility investigations: establishment of long-term rotational trials; use of inorganic fertilisers.

(ii) moisture conservation investigations: comparison of flat cultivation v. the use of traditional bunding (moos and jibaals); investigations on bare fallowing to include soil moisture measurement for regular monitoring.

(iii) review of existing hand tools and identification of any possible improvements.

(iv) investigations on ox-drawn cultivation: review of available ox-drawn equipment at the Bonka Extension Centre and local manufacturing facilities; assist with the identification of suitable ox-drawn ploughs and other cultivation equipment for testing or for immediate importation; study economics of ox-drawn cultivation in current situation.

(v) Method of land preparation investigations: compare effect of different methods of land preparation (hand, ox-drawn plough, tractor) on weed populations and subsequent crop production levels; compare effectiveness and costs of primary cultivation using different tractor drawn ploughs (disc, chisel, mouldboards and spring tine implements).

(c) **Farming Systems Agronomist**: One year only (1984), must have knowledge of African farming systems; technical responsibilities:

(i) Investigations to determine the relative importance of the various constraints on the cultivated area: availability of land; availability of labour; farmers' attitude to risk of crop failure; farmers' attitude to cash crop vis a vis their basic subsistence food crops.

(ii) Determination of the present extent of shifting cultivation and the nature of the cycle: land rights and grazing rights.

(iii) Establish the scope for the enclosure of land - both for arable and for range use.

(iv) Investigate the decision making process with regard to allocation of the family labour resources - livestock needs v. arable farming needs.

(v) Identify the most attractive avenues for on-farm development and re-define research priorities as appropriate.

(d) **Entomologist:** Two and a half years from mid-1984, preferably with specialist knowledge of stalkborers and with a broad interest in insect entomology; technical responsibilities:

(i) Stalkborer control investigations: review present state of knowledge on stalkborer control; study the biology of the major species of stalkborers in the Bay Region; examine the role of ratoon sorghum and the sorghum stubble in the carry-over of larvae and pupae from one season to another; carry out surveys to determine variation in stalkborer larvae numbers; determine variation in adult moth populations using light traps or pheromone baited traps; investigate the effectiveness for stalkborer control of the full range of insecticides that are available; establish the economics of routine applications of insecticide for stalkborer control;

establish whether opportunities exist for the biological control of stalkborers.

(ii) Other investigations of field pests: study the use of systemic insecticides for the combined control of shoot fly and stalkborer; carry out screening of insecticides and testing of application equipment for the control of outbreaks of crickets, grasshoppers and armyworm; investigate control measures for American bollworm and the Beve bug both of which attack the sorghum head.

(iii) Storage pest investigation: determine the major insect pests in stored grain; development of suitable method of storage and proper pesticide use for farmers' own seed supplies.

(e) **Sorghum Breeder**
IRDC Post to continue to 1986. Maximum attention should be given to the breeding programme and present involvement with agronomic studies should cease as soon as alternative arrangements are made i.e. when Agronomist II arrives. Evaluation trials should be extended to cover the widest possible range of environments within the region.

(f) **Station Superintendent**
A sixth TA post, that of a Station Superintendent, could be filled by the current Seed Farm Manager recruited by USAID under the Wyoming Contract. The proposed amalgamation of the BRS and the Seed Farm with a complement of five research workers and their counterparts would require considerable on-farm organisation. The coordination of research and seed production and the rational use of available land, machinery and equipment provide ample justification for the assignment of a TA to fill the proposed post.

6.1.3 Local Staff

Three of the four graduate staff on the station are expected to leave for prolonged periods of postgraduate training within the next 12 to 18 months. Thus there will be a scarcity of qualified local researchers. It is proposed that during Stage II the establishment would be expanded to include one more university graduate so that there would be one counterpart for each of the five TAs. In addition, four more field assistants (high school graduates) would be recruited to bring the establishment to eight.

A suitably qualified typist would be recruited to assist in the compilation of experimental records and station reports. A librarian would also be appointed because, in the absence of adequate documentation and reporting facilities, much of the work of BRS in the last few years has gone unrecorded. Support of this nature is also needed to maintain a flow of information to the REO and his field assistants. Apart from the additional posts listed above, the staff establishment would remain unchanged in Stage II.

6.1.4 Buildings at the New Site

To achieve economies in the proposed building programme to be financed by IDA/IFAD, the BRS will be moved from its present location to the Seed Farm in 1984. This would allow joint use of the proposed new laboratory and office facilities and greatly increase the total land available for trials, allowing access to land which has lain fallow for many years. The current proposals for the new site comprise the office, store and laboratory complex, a seed processing complex and a shared equipment shed with a floor area of only 60 m^2, which is judged to be inadequate for the purpose. Accordingly, USAID have been asked to erect a structure which will serve as a multipurpose store and office, until the completion of the new buildings, and subsequently as an equipment shed and seed drying floor.

6.1.5 Transport and Equipment

The transfer of the Research Farm from its present site to the Seed Farm will permit some sharing of equipment. It is not possible to specify at this stage the exact requirements for the Research Farm following its merger with the Seed Farm since this will depend to a large extent on the programmes which are developed. At this stage it would appear that there is adequate land-preparation capacity but that there is need for additional equipment for inter-row cultivation for weed control; this need is felt most keenly by the sorghum breeder. Thus a 30-35 hp row-crop tractor should be supplied together with suitable attachments for inter-row cultivation for work on trials. Additional work and specialist staff with responsibilities for region-wide programmes will increase the transport needs; four more pick-ups and one 7 tonne truck would be needed.

6.1.6 Sub-Stations

There are strong arguments for expanding research activities in Bay Region through the establishment of off-station trials.

(a) The areal distribution of seasonal rainfall frequently shows wide variation within the Region and the spread of trials to a number of sites provides some insurance against complete loss of results in any one season which should reduce the time required to produce conclusive results. The use of several sites is considered to be of special importance to the sorghum breeding programme allowing varietal evaluation to be carried out under the widest possible range of conditions.

(b) There are four major types of arable soils in Bay Region and, although similar in physical characteristics, they should all be included in trial programmes to identify any major differences that could affect management requirements.

(c) The incidence of pests and diseases is known to show wide differences in areal distribution both within and between seasons and years. Thus investigations on pest and disease control are best carried out at a number of sites.

In the past, the term sub-station has been used to refer to off-station trials and observation plots set down on land otherwise cultivated by local farmers. These sites have been inadequately supervised and maintained during the growing season and subject to depredation by local livestock. It is proposed that, during Stage II, three sub-stations be established on a more permanent basis. For convenience, they sould be located near to the district HQs and cover the three arable soil groups - Amin soils at Qansaxdheere, Uiamo at Diinsoor and Bur Acaba soils at Buurhakaba. The central station at Bonka covers the fourth major soil group, namely the Baidoa soils.

An area of 3-4 hectares of suitable land should be acquired for the site of each sub-station. The area should be fenced to prevent entry by all livestock. If necessary the area should be surveyed and any necessary drainage and soil conservation works installed.

Each sub-station should be provided with an office/store/shed combination of buildings - the same as was proposed for the PADU's in the original World Bank Report. The establishment of the physical facilities on the sub-station would be a useful manifestation of BRADP activity at district level.

The sub-station would be equipped with a basic supply of hand tools, scales, measuring tape, containers for seed, traditional threshing and winnowing equipment. For land preparation the tractor hire services of ONAT would be used.

The programme of work to be undertaken at the sub-station would be directed by the senior research workers from the main Bonka station. The day-to-day operation of the sub-station should be the responsibility of the District Coordinators, possibly assisted by graduate students and associate experts from overseas. The sub-stations would aim to provide an effective link between research and extension at district level.

6.2 INPUT SUPPLY

The Project would support crop production in Bay Region by consolidating work begun in Stage I on the Seed Farm, by strengthening the Plant Protection Department and by organising a pilot scheme by which farmers could purchase farm inputs from retail shops at district level.

6.2.1 The Seed Farm

(a) Organisation

In accordance with the rationale set out in Section 5, 50 ha of land would be set aside for seed production. The remaining 150 ha would be available for research activities. Allocation of land need not be too rigid. In view of the much reduced seed production proposals, the amalgamation of the two activities in one farm could be to considerable mutual advantage, making much better use of available manpower, machinery and workshop facilities. Some care should be exercised in planning the joint development of research and seed production to ensure that the dual functions of the farm did not lead to a confusion of aims in either programme.

Until such time as seed of new varieties becomes available from the plant breeder, the Seed Farm should be operated as a production farm, growing the local varieties under conditions of good husbandry. Production could be made available to the ADC who would use this seed to replace their existing stocks which are held to meet emergency situations. The viability of much of the existing stocks is thought to be poor and in need of replacement. This may be particularly true of seed stored in the concrete-lined pits constructed in 1981 at Daynuunay, Baydhabo and Qansaxdheere in which threshed grain is stored.

(b) Buildings

Three sets of buildings were proposed for the Seed Farm in the IDA Appraisal Report:

- offices and seed laboratories
- seed processing complex (reception, cleaning, packaging, storage, drying floor)
- workshop and material store, equipment shed.

In the revised construction programme, only the seed processing complex has been retained and the Seed Farm will be expected to share office space and equipment sheds provided for adaptive research. Some modifications might be needed to the proposed designs for the seed processing complex to permit natural aeration of the seed drying floors. These modifications could be the subject of a variation order during construction rather than a redesign.

(c) Equipment

Despite the large amount of equipment already on the Bonka Seed Farm there are some additional items which are required to facilitate the production of seed on the scale proposed with the maximum degree of security.

The existing equipment for land preparation, though not ideal, should suffice. The large MF 2057 and the MF 275 tractors are relatively new and should last the next three years provided spare parts are made available. An additional cultivator (Triple K S-tine cultivator) and a rota-harrow could be usefully added to the existing pool of land preparation equipment. A 3-row ridger should be supplied to permit an examination of the usefulness of ridge and furrow cultivation to be carried out. This implement should be accompanied by a 3-row inter-row cultivator for later weed control operations. The supply of an International 8000 series multi-crop precision planter should be given some priority since it would reduce the labour requirement for thinning and would allow some flexibility of crop spacing.

At the present time there is no equipment on the farm for the application of insecticides or herbicides. For this purpose a 50 hp row crop tractor should be supplied together with a Hi-boy sprayer and spray package. A granular distributor for pesticide application would also be a worthwhile addition to the machinery pool though not of vital importance. The International axial flow combine does not have any sorghum header attachments which does not permit very satisfactory operation for this crop. Investigations are being undertaken to see whether other makes of header attachments can be fitted to this combine.

A multi-purpose vibrating gravity table should be provided to facilitate a speeding up of the present seed grading operation. This should be provided together with a suitable machine for seed treatment with insecticidal and fungicidal dusts and for subsequent bagging. A 20-ton grain storage silo is recommended in addition to the air-conditioned storage capacity in the proposed buildings. A 7-tonne truck will be needed once the Seed Farm becomes operational and begins to produce seed for distribution to farmers.

(d) Staffing

The ex-patriate Seed Farm Manager is not expected to be fully occupied with seed production activities over the next three years and some changes in his terms of reference may have to be discussed and agreed. These changes might include the adoption of responsibility for the overall direction of field operations for both research and seed production purposes, the participation in the implementation of the research programme, the development of the additional 100 ha of land and related activities.

In the short term the present high level of local staffing on the Seed Farm would be reduced to suit the level of mechanisation. The following are regarded as the important posts:

- Deputy General Manager - responsible for personnel and with specialist knowledge of crop agronomy and use of agro-chemicals

- Seed Manager - responsible for fixed equipment, buildings, etc, and with specialist knowledge of seed processing and testing

- Farm Mechanic - responsible for servicing and maintenance of machinery and with specialist knowledge of farm machinery

- 3 Tractor drivers also performing seed processing duties and 'roguing'

- 1 Clerk/Secretary

- 4 Watchman/Guards.

6.2.2 Plant Protection

(a) Objectives
During Stage II the Plant Protection Department would be formally absorbed by the Project with the purpose of:

(i) Cleaning up the existing chemical store and disposing of the large quantities of highly toxic chemicals which litter the floor;

(ii) Providing the resources for the staff of the department and FEAs to control with maximum effectiveness major outbreaks of insect pests (armyworm, grasshoppers and crickets);

(iii) Providing the equipment and chemicals to enable the FEAs to demonstrate to farmers the benefits of pesticides for the control of the major pests of sorghum (sorghum shoot-fly, stalkborer, aphids, American Bollworm).

(b) Programme
For the control of major outbreaks of insect pests (armyworm, grasshoppers and crickets) which occur only spasmodically, equipment and chemicals should be provided at strategic locations at regional and district levels. The quantity of chemicals would be determined by the staff and equipment available. It would not be possible to make provision to meet every contingency.

The current extension advice provided by FEAs is said to include recommendations on pest control, but staff rarely have the means to demonstrate, nor are supplies of suitably packaged pesticides obtainable by farmers. In Stage II FEAs would be provided with the necessary training and means to give farmers practical demonstrations of pest control and at the same time advise them where to purchase their requisites. FEAs would be supplied through the District Plant Protection Officer at each district centre, supported in turn by the HQ unit in Baydhabo.

(c) Staffing and Organisation
The most urgent task is the safe disposal of toxic chemicals in the MOA's Plant Protection store in Baydhabo. A USAID expert in the handling and disposal of toxic waste is reported to be assisting the Project to clean-up the existing chemical store. His duties include the selection of a site for the disposal and supervision of the handling and transport of the material to the disposal site.

The Plant protection Department in Baydhabo is currently staffed by two professional officers, one of whom is the Regional Plant Protection Officer, six semi-skilled and four auxilliary personnel (watchmen, labourers etc). No expansion of this establishment is envisaged, but in-service training should be provided by senior MOA and TA staff in the safe application of pesticides, and the handling and repair of spraying equipment. Similar training would be provided for District Plant Protection Officers (DPPO) who should be agricultural high school graduates. The Stage II budget should include provision for three additional Field Assistants (DPPOs); Baydhabo District would be served by existing staff in the regional office.

(d) Buildings and Equipment
Provision should be made for the rehabilitation of the existing offices and store in Baydhabo and for the construction of stores (25 m^2) at the three district headquarters. Four tractor-mounted boom sprayers (10 m booms), one per district, would be provided for attachment to ONAT tractors, which are expected to be generally available following the peak land preparation period. The Project would provide four motorised knapsack sprayer, one per district and 75 hand operated knapsack sprayers, to be allocated one per year to 25 FEAs for demonstration work.

(e) Materials
Pesticides currently used by the MOA are shown in Tables 6.1 and 6.2. The efficacy of some of the brands has been questioned and these should be screened by the Entomologist as soon as possible. Meanwhile budgets have been based on regular brands.

Until now, farmers have been supplied with chemicals free of charge. The amounts have been small and the supply from aid agencies unpredictable. It is understood that any sustained plant protection service for smallholders will depend upon farmers paying the costs involved, preferably by purchasing their requisites in the market place. But in the short-term the benefits of plant protection to the individual farmer have to be demonstrated. Yet there will always be a need for government to counter major attacks which are beyond the resources of individual farmers to control. Thus in Stage II no official charge would be levied by the Project. In the longer-term farmers would be expected to purchase materials and equipment themselves. The pilot scheme for farm input shops at district level should assist the development of the input market for small farmers.

6.2.3 Farm Input Shops

(a) Objectives and Programme
The Project currently supplies quantities of seed and pesticide to farmers through the MOA's District Coordinators. The quantity is small and no charge is made to consumers. Material is delivered in bulk and is often unsuitably packaged when distributed to small farmers.

In Stage II, the quantity and range of inputs would be increased, properly packaged and labelled, consumers would be charged for material costs involved and proper stock control and accounting procedures established. One shop would be opened in each district centre.

The objectives of the programme would be to make farm inputs, which could have a significant impact on production, available to farmers and thus develop a market which would eventually be served by the private sector. The objective is not to

TABLE 6.1 MoA RECOMMENDED CHEMICALS FOR BAY REGION

Insect	Biological compound	Alternative common and/or trade name
Crickets and grasshoppers	Gamma HCH	BHC, gamma-BHC, *Lindane, Gamesan* (bait)
Stalkborer	Diazinon	*Basudin, DBD, Diazitol, Neocide*
Grasshoppers, crickets and armyworm	Carbaryl Endosulfan Dimethoate	*Sevin* 85% WP *Thiodan* *Cygon*
American bollworm	Carbaryl Endosulfan	*Sevin* 85% WP *Thiodan* *Cardona*
Aphid	Dimethoate Malathion	*Rogor* *Malathion*
Smut	Zineb	*Dithane* (seed dressing)
Rats and mice		*Tomorin* *Racumin*

Source: HTS 1983.

pre-empt the private sector with a parastatal, but to test and demonstrate the benefits to entrepreneurs and smallholders alike, through a pilot scheme of three or four years' duration. The suggestion that private entrepreneurs be invited to provide retail outlets for farm inputs provided by the Project was rejected as impractical. Because of the uncertainty as to future turnover and profit margins, entrepreneurs would require substantial support, in which case charges of favouritism were bound to arise and the incentive element would be undermined.

There is unlikely to be a sufficient volume of business to justify the immediate establishment of these shops and an interval of one to two years should be allowed to build up a comprehensive inventory and stimulate demand. The Project would arrange the procurement and would staff and supervise the retail outlets at district level through the MOA District Coordinators.

Given the uncertainty and fragmentation of the present farm-input, import and distribution situation, the most difficult test will be the rapid procurement of the necessary materials. Probably the best short-term solution would be for the Project to contract this aspect of the work to an experienced organisation in the business of supplying small farmers, e.g. KFA in Nakuru, Kenya or TFA in Arusha, Tanzania. Initially, local importers are unlikely to have the necessary range of experience or established contacts with suppliers. Task

TABLE 6.2 ANNUAL PESTICIDE REQUIREMENTS OF PLANT PROTECTION DEPARTMENT

	Chemical	Assumptions	Quantity in kg
1.	*Gamesan*	Control measures required in both seasons per district per year @ 200 kg per district	800
2.	*Basudin*	Two applications per crop per season. 50 farmers per FEA (total FEAs, 25) with average of 3 ha @ 5 kg per ha per application	37 500
3.	*Thiodan*	One application per season per crop, 50 farmers per FEA, 3 ha @ 2.0 kg per ha	15 000
		Emergency reserve 2 t per district	8 000
4.	*Sevin*	One application per season per crop, 50 farmers per FEA, 3 ha @ 1.5 kg per ha	11 250
5.	*Malathion*	One application per season per crop 50 farmers per FEA @ a kg per ha	7 500
6.	*Dithane*	Seed dressing at rate of 400 g per quintal, 20% of planted area	1 950
7.	*Tomorin*	100 g per farmer, 50 farmers per FEA	125

(b) Materials

The retail stock would include pesticides, sprayers and spares, veterinary drugs (acaricides and anthelmintics), seeds, hand-tools, animal-drawn equipment, harnesses and possibly miscellaneous items of hardware (tools, nails, corrugated iron sheeting, building materials) if otherwise not available in the market place. Chemicals and drugs would be suitably packaged in small quantities with clear directions for application. Table 6.3 contains a preliminary list which has been used for budgetary purposes. Equipment would be provided for the shops (protective clothing for handling toxic chemicals, packaging equipment, scales, shop fittings, etc).

(c) Staffing

A graduate with training in commerce or business management would be responsible to the Project Director who would coordinate the operation. The Project Director would be assisted in this regard by the Financial Controller of the Project and a short-term consultant with appropriate experience (e.g. producer cooperatives in East Africa) who would join the Project for two inputs of three months. Four junior staff (agricultural high school graduates) would be recruited to operate the retail outlets in the district centres. Ancillary staff would be provided from within the existing establishment of the PMU/MOA district offices.

(d) Revolving Fund

The Project would finance farm inputs for retail sale with an initial injection of foreign exchange which would be replenished seasonally from sales. The foreign

TABLE 6.3 SEASONAL INVENTORY OF FARM INPUT SHOPS

Item	Quantity	Notes
Pesticides		typical brands
Basudin 5 g	4 000	highly toxic organochlorine
Gamesan 5%	200	highly toxic organophosphorus compound
Thiodan 35 cc	1 000	highly toxic organochlorine
Sevin, Carbaryl 85	750	
Malathion 35 cc	1 000	low mammalian toxicity
Sprayers and spares	200 units	hand operated
Seed dressing		
Dithane 5%	250	non-phytotoxic and very low mammalian toxicity
Hand tools	Lump sum	type to be specified, farmers prefer light, strong tools
Animal draught equipment	lump sum	type to be specified; camel draught equipment is likely to be preferable to ox-drawn tools; camels in better condition when ploughing has to be done
Hardware tools, nails, wire, corrugated iron, and other building materials	lump sum	if not available from local, private retailers/suppliers
Timber preservation fluid	lump sum	
Veterinary drugs		acaricides and anthelmintics (see Annex 2)

exchange required to match local currency for re-ordering of imported items would be obtained through IDA/IFAD in the same manner as is currently used for veterinary drugs.

6.3 EXTENSION

6.3.1 Rationale

Improvement of the links between research and extension must be a major objective for both the Bay Region and the AFMET project. This improvement should not only consist of a few meetings and the designation of coordinators, but also the implementation of a joint programme which builds a bridge between research and extension and puts staff from both projects in the role of partners with the farmer. Only by working together can researchers and extension staff overcome the current dearth of useful information.

Within all four districts in the Region, there are clearly three overlapping functions which must be provided by the office of the District Coordinator if *extension* in its wider sense (helping farmers to identify, analyse and deal with their production problems) is to succeed. These three functions are as follows:

(a) planning training and visit schedules, preparing extension materials, attending to the flow of technical recommendations;

(b) the commercial function: organising input supply, promotion of cash crops, marketing, transport, etc.

(c) liaison with the local community, the DC, farmers' groups, schools, community development, cooperatives and so on.

While accepting that MOA should have a discrete extension service as one of its main divisions and that staff should not be asked to carry out tasks such as input supply, it would be wrong to assume that the MOA could dispense with these functions. Thus it should be possible to subdivide the work between the two projects without duplication and without one fearing a takeover by the other. This sharing of work is currently happening in the MOA district offices in Bay Region. AFMET organises extension along T & V lines and BRADP, who pay and back-stop the District Coordinator, look after other functions.

Given current low levels of knowledge and management support for adequately fulfilling the technology transfer function (function (a) above), it is necessary to question AFMET's capacity to support the current 23 FEAs in the field. The wide dispersion of the FEAs carries the risk that new graduates will become rapidly demoralised, propounding *improvements* which neither they nor the farmers believe will give greater income. In the longer term, these problems may be resolved, but before they are an intermediate solution is needed. If AFMET and the Bay Region projects were to concentrate their efforts within a few receptive communities in the implementation of a joint programme, the induction training of FEAs should be more rewarding and the integration of adaptive research, input supply and extension more beneficial. In the Main Report such a joint programme (Pilot Village Development) is proposed for selected communities in each district.

6.3.2 Proposals for Stage II

Thus in Stage II, the technology transfer function would remain with AFMET. The Bay Region would concentrate on adaptive research and input supply. It has already been decided by the MOA authorities that, to ensure close cooperation between the two projects, an Extension - Research Coordinator would be appointed by BRADP. The activities of the two projects would be brought together at the offices of the District Coordinators. BRADP would provide office space and storage facilities for all MOA personnel as well as for the District Veterinary Coordinators, if not otherwise accommodated.

6.3.3 Buildings

Construction of district level offices is already completed at Diinsoor and is proceeding at Buurhakaba and Qansaxdheere with PL480 funds. The office for the MOA Coordinator of Baydhabo District, currently subsumed by the PMU, would be established as a distinct entity, possibly located in the current temporary project offices which will be vacated when the new project offices are constructed. Two 'C' type houses should be constructed in each outlying district, one each for the DVO and MOA coordinators. These houses would be constructed in up-country areas rather than in Baydhabo as part of the project building programme.

6.3.4 MOA District Coordinators

During Stage I the MOA district-level staff in each of the three outlying districts were budgeted under the heading "non project activities" together with Plant Protection. Meanwhile the post of the MOA Coordinator, Baydhabo District, lay vacant. Because of their importance in the implementation of proposed project activities in Stage II (e.g. in the Pilot Village Development, supervising BRS substations, plant protection and retail shops for farm inputs as well as liaison with the local community), the MOA Coordinators and their staff would be formally seconded to the Project. It would pay the operating costs at current (Stage I) levels and support the establishment and running costs of the Baydhabo District Office. Staff for this office would be drawn from the PMU.

7

Costs

This Section details the costs of the crop development proposals. Estimates for the Adaptive Research and Seed Farm components can be made with reasonable confidence as in both cases the programme is already underway and has been discussed in some detail with the Project Director and Wyoming team. On the other hand, the costs of the Plant Protection and Input Shops are based upon tentative estimates of demand. Much will depend upon the capacity of the Project to support what are essentially new proposals. Rigorous annual programming and budgeting will be necessary to ensure that materials are not wasted.

Costs are presented in the following Tables:

TABLE 7.1 AGRICULTURE - SUMMARY OF COSTS (Ssh '000)

A. OVERALL FOR AGRICULTURAL SECTOR

		1984	1985	1986
Capital Costs -	Buildings	13 890	4 340	-
	Agricultural Machinery	2 376	-	-
	Other Equipment	1 143	425	-
	Vehicles	2 396	258	-
TOTAL		19 805	5 023	-
Operating Costs -	Technical Assistance	8 863	9 953	9 953
	Local Staff	2 001	2 121	2 121
	P.O.L.	772	1 057	1 057
	Spare Parts and Tyres	861	1 295	1 295
	Farm Inputs and Consumables	7 013	5 676	5 676
	Building Costs	300	635	665
	Machinery Hire	64	87	109
	Stock Purchases	-	3 182	-
TOTAL		19 874	24 006	20 876
Plus 10% Contingencies		3 968	2 903	2 088
TOTAL COSTS		43 647	31 932	22 964
Inflation Factor from 1983		1.08	1.17	1.26
Total Inflated Costs inc. Contingencies		47 139	37 360	28 935
	(US$ '000)	3069	2 432	1 884

TABLE 7.1 AGRICULTURE - SUMMARY OF COSTS (Ssh '000) (Continued)

B. BY COMPONENT		1984	1985	1986
1. Adaptive Research				
Capital costs -	Buildings	3 430	2 940	-
	Agricultural machinery	498	-	-
	Other equipment	-	225	-
	Vehicles	1 585	-	-
TOTAL		5 513	3 165	-
Operating costs -	Technical Assistance	8 709	9 953	9 953
	Local staff	752	752	752
	POL	289	453	453
	Spare parts & tyres	244	447	447
	Farm inputs and consumables	75	75	75
	Building costs	50	150	180
	Machinery hire	-	23	45
TOTAL		10 119	11 853	11 905
TOTAL COSTS		15 632	15 018	11 905
2. Seed Farm				
Capital costs -	Buildings	9 635	-	-
	Agricultural machinery	1 290	-	-
	Other equipment	1 143	-	-
	Vehicles	553	-	-
TOTAL		12 621	-	-
Operating costs -	Local staff	262	262	262
	POL	220	303	303
	Spare parts & tyres	351	551	551
	Farm inputs and consumables	100	100	100
	Building costs	50	250	250
TOTAL		983	1 466	1 466
TOTAL COSTS		13 604	1 466	1 466
3. Plant Protection				
Capital costs -	Buildings	825	-	-
	Agricultural machinery	588	-	-
	Vehicles	258	-	-
TOTAL		1 671	-	-
Operating costs -	Technical assistance	154	-	-
	Local staff	330	350	350
	POL	113	113	113
	Spare parts & tyres	142	142	142
	Farm inputs and consumables	6 358	5 021	5 021
	Machinery hire	64	64	64
TOTAL		7 161	5 690	5 690
TOTAL COSTS		8 832	5 690	5 690

TABLE 7.1 AGRICULTURE - SUMMARY OF COSTS (Ssh '000) (Continued)

			1984	1985	1986
4. Farm Input Shops					
Capital costs	-	Buildings	-	1 400	-
		Equipment	-	200	-
		Vehicles	-	258	-
TOTAL			-	**1 858**	-
Operating costs	-	Local staff	-	100	100
		POL	-	38	38
		Spare parts and Tyres	-	31	31
		Building costs	-	35	35
		Stock purchase	-	3 182	-
TOTAL				3 386	204
TOTAL COSTS			-	5 244	204

			1984	1985	1986
5. District Offices					
Capital Costs	-				
Operating Costs	-	Local Staff	657	657	657
		P.O.L.	150	150	150
		Spare Parts and Tyres	124	124	124
		Inputs and Miscellaneous	480	480	480
		Building Costs	200	200	200
		TOTAL COSTS	1 611	1 611	1 611

TABLE 7.2 ADAPTIVE RESEARCH - COST DETAILS

1. Capital Costs

			Ssh
(a)	**Buildings**		
	(i) Office, Store, Laboratory complex 490 m², constructed in 1984 on Seed Farm Site	@ Ssh 7000/m²	3 430 000
	(ii) 3 Sub stations 140 m², constructed in 1985	@ Ssh 7000/m²	2 940 000
	(iii) Housing - costs included in overall housing programme		-
	TOTAL		**6 370 000**
(b)	**Agricultural Machinery all in 1984**		
	1 x 30 - 35 HP rowcrop tractor	@ US$13 000	199 680
	1 inter-row cultivator	@ US$ 3 000	46 080
	1 precision planter	@ US$ 8 000	122 880
	1 ridger	@ US$ 3 000	46 080
		+ 20% Spares	82 940
	TOTAL		**497 660**
(c)	**Other Equipment**		
	Hand tools, scales, measuring tapes, seed containers, threshing and winnowing equipment, etc for each Sub station 3 at, say, Ssh 75 000 in 1985 =		225 000
(d)	**Vehicles**		
	4 Pick-up trucks @ US$14000 in 1984		860 160
	1 7 ton truck @ US$30 000 in 1984		460 800
		+ 20% spares	264 190
	TOTAL		**1 585 150**

2. Operating Costs (Ssh)

		1984	1985	1986
(a)	**Technical Assistance @ US$162 000 1 year** [1]			
	Station Director	2 488 320	2 488 320	2 488 320
	Station Superintendent	2 488 320	2 488 320	2 488 320
	Agronomist	-	2 488 320	2 488 320
	Farming Systems Agronomist	2 488 320	-	-
	Entomologist	1 244 160	2 488 320	2 488 320
	Sorghum Breeder (no cost to Project)			
	TOTAL	**8 709 120**	**9 953 280**	**9 953 280**

Note: [1] *Equivalent to total all-in cost of current Wyoming assistance contract per man year.*

TABLE 7.2 ADAPTIVE RESEARCH - COST DETAILS (Continued)

				1984	1985	1986
(b)	**Local Staff**					
	1 Senior Agriculturalist	@	46 800	46 800	46 800	46 800
	5 Agriculturalists	@	42 000	210 000	210 000	210 000
	8 Agricultural Technicians	@	25 600	204 800	204 800	204 800
	4 Agricultural Assistants	@	14 250	57 000	57 000	57 000
	1 Secretary	@	18 000	18 000	18 000	18 000
	1 Librarian	@	16 000	16 000	16 000	16 000
	1 Meteorologist	@	14 400	14 400	14 400	14 400
	1 Clerk	@	14 400	14 400	14 400	14 400
	5 Drivers	@	14 400	72 000	72 000	72 000
	4 Messenger/Watchmen	@	7 200	28 800	28 800	28 800
	Casual labour			40 000	40 000	40 000
	Night allowances			30 000	30 000	30 000
	TOTAL			**752 200**	**752 200**	**752 200**
(c)	**P.O.L.**					
	7 Pick-up trucks	@	37 500	131 300	262 500	262 500
	1 Truck	@	65 000	37 500	65 000	65 000
	Tractors estimated at			125 000	150 000	150 000
	TOTAL			**288 800**	**452 500**	**452 500**
(d)	**Spare Parts and Tyres**					
	7 Pick-ups	@	31 000	108 500	217 000	217 000
	1 Truck	@	110 000	55 000	110 000	110 000
	Tractors estimated at			50 000	80 000	80 000
	Machinery estimated at			30 000	40 000	40 000
	TOTAL			**243 500**	**447 000**	**447 000**
(e)	**Farm Inputs and Consumable Items**					
	Estimated at			75 000	75 000	75 000
(f)	**Building Costs**					
	Maintenance			50 000	150 000	180 000
(g)	**Machinery Hire**					
	From ONAT - 3 Sub stations at 150 hours each per year at Ssh 100 per hour			-	22 500	45 000

TABLE 7.3 SEED FARM - COST DETAILS

1. Capital Costs

			Ssh
(a)	**Buildings**		
	(i) Seed processing complex 1370 m² @ Ssh 5500/m²		7 535 000
	(ii) Equipment shed (shared with BRS) 300 m² @ Ssh 7000/m²		2 100 000
	TOTAL		**9 635 000**
(b)	**Agricultural Machinery**		
	S-tine cultivator + rota harrow	@ US$ 6 000	92 160
	3-row ridger	@ US$ 3 000	46 080
	3-row inter-row cultivator	@ US$ 3 000	46 080
	Multi-crop precision planter	@ US$ 8 000	122 880
	50 HP rowcrop tractor	@ US$22 000	337 920
	Hi-boy sprayer and spray package	@ US$28 000	430 080
	& 20% Spares		215 040
	TOTAL		**1 290 240**
(c)	**Other Equipment**		
	Multi-purpose vibrating gravity table	@ US$ 7 000	107 520
	Bagging machinery	@ US$ 5 000	76 800
	20 T grain storage silo	@ US$50 000	768 000
	& 20% Spares		190 460
	TOTAL		**1 142 780**
(d)	**Vehicles**		
	7 ton truck	@ US$30 000	460 800
	& 20% Spares		92 160
	TOTAL		**552 960**

2. Operating Costs (Ssh)

			1984	1985	1986
(a)	**Technical Assistance** (Manager included in BRS costs)				
(b)	**Local Staff**				
	1 Deputy General Manager	@ 46 800	47 000	47 000	47 000
	1 Seed Manager	@ 42 000	42 000	42 000	42 000
	1 Farm Mechanic	@ 28 800	29 000	29 000	29 000
	3 Tractor Drivers	@ 11 130	33 000	33 000	33 000
	1 Clerk/Secretary	@ 12 000	12 000	12 000	12 000
	4 Watchmen/Guards	@ 7 200	29 000	29 000	29 000
	Casual labour		40 000	40 000	40 000
	Night allowance		30 000	30 000	30 000
	TOTAL		**262 000**	**262 000**	**262 000**
(c)	**P.O.L.**				
	5 Tractors	@ 40 000	150 000	200 000	200 000
	1 Pick-up truck	@ 37 500	37 500	37 500	37 500
	1 7 T truck	@ 65 000	32 500	65 000	65 000
	TOTAL		**220 000**	**302 500**	**302 500**

TABLE 7.3 SEED FARM - COST DETAILS (Continued)

			1984	1985	1986
(d)	**Spare Parts & Tyres**				
	5 Tractors (estimated)		80 000	150 000	150 000
	1 Pick-up truck	@ 31 000	31 000	31 000	31 000
	1 7 ton truck	@ 110 000	110 000	110 000	110 000
	Agricultural machinery (estimated)		80 000	160 000	160 000
	Other machinery (estimated)		50 000	100 000	100 000
	TOTAL		**351 000**	**551 000**	**551 000**
(e)	**Farm Inputs and Consumable Items**				
	Estimated at		100 000	100 000	100 000
(f)	**Building Costs**				
	Maintenance		50 000	250 000	250 000

TABLE 7.4 PLANT PROTECTION - COST DETAILS

1. Capital Costs

(a) Buildings

		Ssh
(i) Rehabilitation of Baydhabo store and offices		300 000
(ii) Construction of 3 x district stores Each 25 m^2 @ Ssh 7 000/m^2		525 000
	Total	825 000

(b) Agricultural Machinery

4 x 10 m tractor mounted boom sprayers	@ US $ 5 500	337 920
4 x motorised knapsack sprayers	@ US $ 600	36 860
75 x hand pump knapsack sprayers	@ US $ 100	115 200
+ 20% Spares		98 000
	Total	587 980

All in 1984

(c) Vehicles

1 Pick-up truck @ US$ 14 000		215 040
+ 20% Spares		43 010
	Total	258 050

2. Operating Costs (Ssh)

	1984	1985	1986
(a) Technical Assistance			
1 man-month to make safe existing store	153 600	-	-
(b) Local Staff			
1 Regional Plant Protection Officer @ 42 000	42 000	42 000	42 000
1 Other Officer @ 36 000	36 000	36 000	36 000
3 District Plant Protection Officer @ 25 600	76 800	76 800	76 800
6 Semi-skilled @ 16 000	96 000	96 000	96 000
4 Auxiliary Personnel @ 7 200	28 800	28 800	28 800
Casual Labour	30 000	40 000	40 000
Night Allowances	20 000	30 000	30 000
Total	329 600	349 600	349 600
(c) P.O.L.			
3 Pick-ups @ 37 500	112 500	112 500	112 500

TABLE 7.4 PLANT PROTECTION - COST DETAILS (continued)

		1984	1985	1986
(d)	Spare Parts and Tyres			
	3 Pick-ups @ 31 000	93 000	93 000	93 000
	Sprayers @ 10% of value per year	49 000	49 000	49 000
	Total	**142 000**	**142 000**	**142 000**
(e)	Farm Inputs & Consumable Items			
	Gammasan 5% 800 Kg			
	Basudin 5 G 37 500 Kg			
	Thiodan 35 e.c. 15 000 Kg + 8 000 Kg in 1984 only			
	Sevin 85% W.P. 11 250 Kg			
	Malathion 35 e.c. 7 500 Kg			
	Dithane 1 950 Kg			
	Tomarin 125 Kg			
	Miscellaneous Consumables @ S sh 40 000			
	Total	**6 357 770**	**6 021 450**	**6 021 450**
(f)	Machinery Hire			
	Assume 2 outbreaks of 2 weeks each year per District; 40 hours machinery hire per week at Ssh 100 per hour	64 000	64 000	64 000

TABLE 7.5 FARM INPUT SHOPS - COST DETAILS

1. Capital Costs				**Ssh.**
(a) Buildings				
4 shops of 50 m² @ Ssh 7 000/m² in 1985				1 400 000
(b) Equipment				
Shop fittings, scales, containers, purchasing equipment, protective clothing.		4 @ 50 000 =		200 000
(c) Vehicles				
1 Pick-up for Manager				215 040
& 20% Spares				43 010
Total				258 050

2. Operating Costs	**1984**	**1985**	**1986**
(a) Local Staff			
1 Manager @ Ssh 28 000	-	28 000	28 000
4 Shop staff @ Ssh 18 000	-	72 000	72 000
Total	-	**100 000**	**100 000**
(b) Vehicle Operations			
P.O.L. for Pick-up @ 37 500	-	37 500	37 500
Spare Parts & Tyres @ 31 000	-	31 000	31 000
Total	-	**68 500**	**68 500**
(c) Building Maintenance			
@ 2½% per annum		35 000	35 000
(d) Purchase of Initial Stock			
(Replenishment of stock will be financed from sales)			

		Quantity per Shop			
Pesticides	Basudin 5 G	4 000 Kg			
	Gammasan 5%	200 Kg			
	Thiodan 35 e.c.	1 000 Kg			
	Sevin 85% W.P.	750 Kg			
	Malathion 35 e.c.	500 Kg			
Seed Dressing	Dithane 5%	250 Kg			
Rat Poison	Tomarin	250 Kg			
	Total Chemical Cost		-	**1 559 000**	-

TABLE 7.5 FARM INPUT SHOPS - COST DETAILS (continued)

(d) Purchase of Initial Stock (cont.)	1984	1985	1986
Seeds - Selection of Vegetable Seeds 25 Kg	-	15 000	-
Animal cultivation equipment	-	65 000	-
Hand Tools	-	40 000	-
Hardware e.g. nails, corrugated iron, building materials	-	90 000	-
Hand pump knapsack sprayers 50 No	-	184 000	-
Veterinary medicines	-	1 229 000	
Total	-	3 182 000	-

TABLE 7.6 DISTRICT OFFICES - COST DETAILS

			Ssh
1.	Capital Costs - Nil		
2.	Operating Costs		
(a)	Local Salaries and Wages		
	Baydhabo		
	1 District Coordinator	@ 46 800	46 800
	1 Assistant District Coordinator	@ 28 000	28 000
	3 Clerks	@ 14 400	43 200
	1 Storekeeper	@ 21 600	21 600
	2 Watchmen	@ 8 000	16 000
	2 Messengers	@ 10 000	20 000
	Qansaxdheere		
	1 District Coordinator	@ 36 000	36 000
	1 Assistant District Coordinator	@ 28 000	28 000
	1 Semi - Skilled	@ 12 000	12 000
	4 Unskilled	@ 8 000	32 000
	Diinsoor		
	1 District Coordinator	@ 36 000	36 000
	1 Assistant District Coordinator	@ 28 000	28 000
	6 Semi - Skilled	@ 12 000	72 000
	4 Unskilled	@ 8 000	32 000
	Buurhakaba		
	1 District Coordinator	@ 36 000	36 000
	1 Assistant District Coordinator	@ 28 000	28 000
	2 Semi - Skilled	@ 12 000	24 000
	4 Unskilled	@ 8 000	32 000
	Night Allowances		85 700
		Sub-Total	**657 300**
(b)	**P.O.L.**		
	4 Pick-ups	@ 37 500	150 000
(c)	**Spare Parts and Tyres**		
	4 Pick-ups	@ 31 000	124 000
(d)	**Inputs and Miscellaneous**		
	Estimated at Ssh 120 000 per office per year		
(e)	**Building Costs**		
	Estimated at Ssh 50 000 per office per year		

APPENDIX A

REFERENCES

APPENDIX A

REFERENCES

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Bay Region Agricultural Development Project

Mid-term Review

Volume 2

Annex 2 Livestock

310261 57 83

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TABLES

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1

Introduction

1.1 TERMS OF REFERENCE

As livestock production is one of the most important economic activities of Bay Region the ToR required a thorough review of development proposals for this sector. Due consideration was to be given to the integration of livestock and crop production sections of the economy and the nomadic movement of livestock within and into the region. The economic and epidemiological rationale of the current animal health programme was to be examined as well as its organisation and management. Range improvement concepts were to be evaluated and proposals for range renovation were to be based upon available economic and physical data. The Terms of Reference thus required a broad review of the livestock improvement component of the Project together with recommendations for Stage II.

The time allocated to fieldwork and report preparation was 14 weeks. Fieldwork was conducted during the August/September period at the end of the main Gu rains of 1983. The major sorghum grain harvest occurs during this period (i.e. August). Fieldwork included detailed examination of large ruminants (cattle) and small ruminants (goats) in areas with integrated crop/livestock systems. Information on specific disease incidence and production are scarce and this required the development of evaluation methods to derive base line data estimates. The repeat aerial livestock census referred to in the ToR, for Bay Region to be completed in the Gu season 1983 prior to the Consultant's work, was not carried out. The Consultants were therefore dependent on the original 1982 census, carried out in February in the middle of the dry season when final residues of Dayr season (October to January) crops are utilised for grazing.

1.2 FIELD STUDY AND METHODS

Fieldwork within Bay Region provided data for the preparation of livestock herd structure and the evaluation of livestock production parameters. Livestock surveys were made with the assistance of locally-recruited people from the area under study, as well as the local veterinary staff. Enumerators were speakers of the Af-maymay language and well known within the local communities. For detailed information on herd structure this proved essential. Contact was made with local people prior to the field data collection to gain a general understanding of their livestock production systems and to gain the confidence of the farmers. Examples of survey recording sheets used for cattle and goats are shown in Appendix A. Initial counts of livestock were made at water points (usually wars) which were associated with specific communities. Follow-up counts were made on the same day to check small calves or kids retained at the homestead. These stock do not accompany the main herd or flock to the water point. Age and sex structure of herds and flocks were determined visually to assess groups of cattle of 0 to 1 year, 1 to 3 years and 3 years plus, and goats of 0 to 1 year, 1 to 2 years and 2 years plus. Checks were made of teeth eruption in cattle and goats in Baydhabo market, but, for surveys of large numbers of animals at wars, the visual appraisal method was adopted as the most practical. Limitations to the method include the need to generalise age categories and the tendency to overlook young stock.The survey included 2 298 cattle and 2 661 goats. Similar data for camels and sheep could not be collected due to time limitation. Surveys of these classes of stock would be desirable for a complete evaluation of productivity.

Data used for calculation of nutrient energy requirements and for the evaluation of feed systems are based upon published ruminant nutrition information particularly that contained in Booklet 2087, Nutrient Allowances and Composition of Feeding Stuffs for Ruminants published by the Ministry of Agriculture, Fisheries and Food, UK. The internationally accepted system to express nutrient energy data in terms of Mega Joules (MJ) of Metabolisible Energy (ME) was followed.

2

The Livestock Sector: Current Situation

2.1 LIVESTOCK CENSUS METHOD

The aerial survey of livestock population was carried out by RMR and results are detailed in The Bay Region Report of HTS (1982). The details of the survey method have been published by International Livestock Centre for Africa, Addis Ababa (1981). The method has been widely utilised and tested in Africa. It is recognised as a method of high reliability for total number counts of livestock. The original livestock census was made in February 1982 in the middle of the dry season and towards the end of the period when Dayr season crop residues are utilised for grazing. The second livestock survey was to be repeated during the Gu rainy season of 1983, prior to the arrival of the Consultants but this survey has been postponed to the Dayr of 1983.

2.2 LIVESTOCK NUMBERS AND MOVEMENT

The livestock population of the Bay Region determined by the RMR aerial survey in 1982 and the 1975 census of the Statistical Department of the Ministry of Planning is shown in Table 2.1.

TABLE 2.1 THE LIVESTOCK POPULATION OF BAY REGION (HEAD)

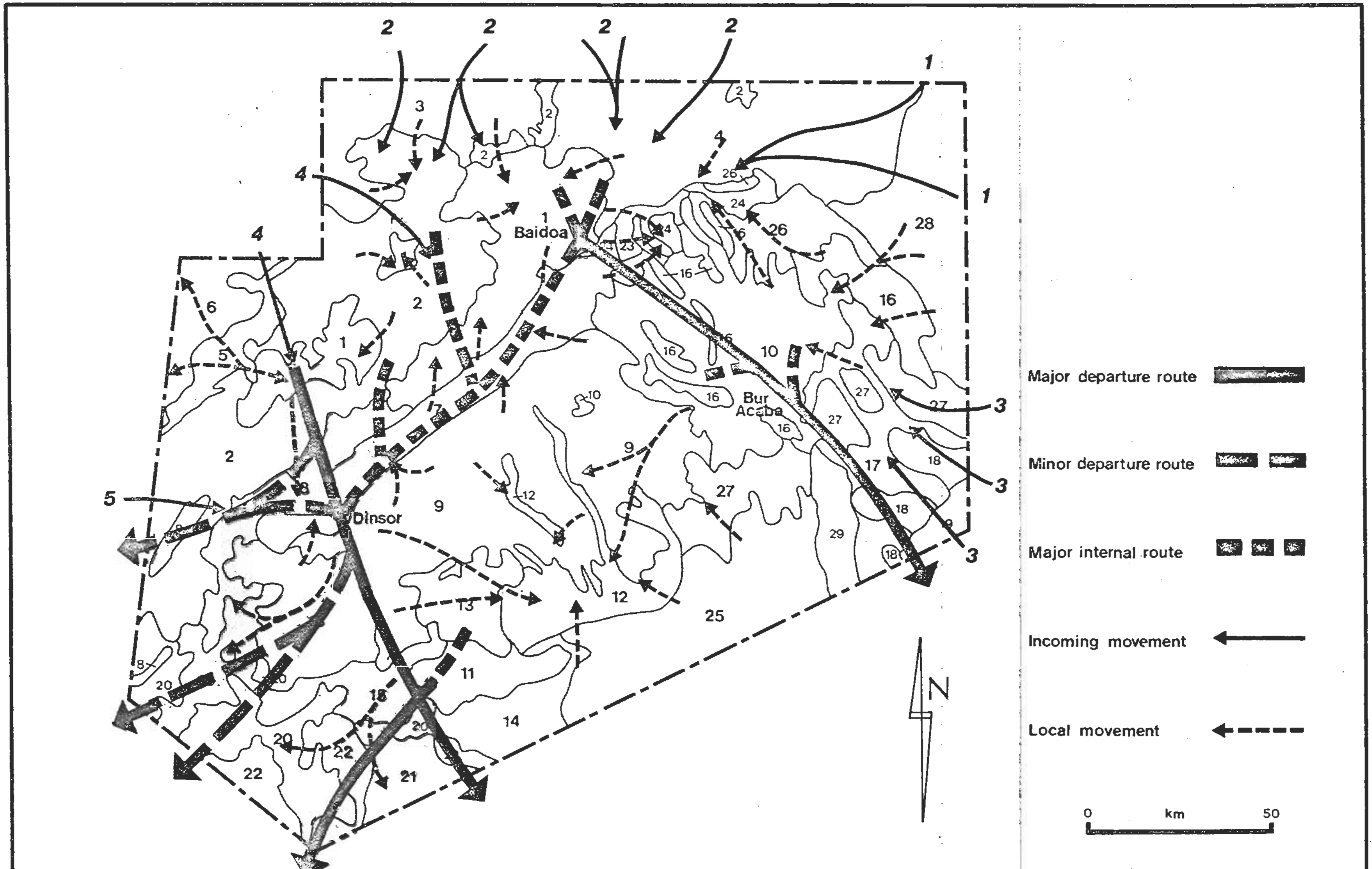
Camels	Cattle	Sheep	Goats	Source
321 722	368 065	36 193	353 173	HTS 1982
361 500	255 000	55 000	192 000	Min. of Planning 1975

Livestock population and distribution is not static; major movements are of two kinds. Stock within the region move from rangeland to farmland to make full use of crop residues particularly within the sorghum growing areas of the region. During and immediately after the rains, when surface water is available, other animals move into the region to make use of range resources and crop residues. These general movements are documented in the HTS (1982) report. Additional to the transhumant movements, three major routes for trade stock pass through and coalesce in Bay Region, south of Buurhakaba. These routes derive from Gedo, Bakool and Middle Jubba and are of considerable importance for the export of livestock which leave from the port of Mugdisho. Other export routes pass south from Diinsoor to Kismayo (HTS 1982) but are of less economic significance. Figure 2.1 shows the main routes.

2.2.1 Livestock Densities and Biomass

The important relationship between livestock and the cropping systems of Bay Region has been illustrated in the analysis of livestock biomass densities by land form classification

2.1 Principal livestock movement routes for Jillal season



Source HTS 1982

(Table 2.2 and Figure 2.2). This shows a high total livestock biomass of more than 8 000 kg/km^2 on the intensive agricultural zones (primarily strata 1, 10 and 12) within the Bay Region. This relationship between cropping systems and livestock production within the region was not fully appreciated in the original Bay Region project document.

This integration derives from the production of a dual purpose (forage and grain) local sorghum variety, and the utilisation of residual foods produced by the crop production cycle.

2.3 HERD AND FLOCK STRUCTURES AND FORM OF PRODUCTION

Somali pastoralists in Bay Region retain large ruminant livestock of indigenous breeds (cattle or camels) principally for milk production. Female animals constitute a high proportion of the total herds and flocks. Surplus livestock, males and female culls are slaughtered or sold for slaughter. Because of increased human and animal populations dependent upon the crop byproduct and rangeland resources there is reduced retention of male animals so that meat production from these systems is not increasing. Surveys of existing herds (cattle) and flocks (goats) by HTS (1982) and during this Mid-term Review illustrate that the herd and flock structures differ markedly from the assumed structures in the original project appraisal report. Producers endeavour to maximise the use of available nutrients for milk production. Surplus male stock which compete directly for nutrients and labour are frequently eliminated at an early age.

2.3.1 Offtake and Production

Offtake, which is the ratio of internal slaughter plus net exports to the total population, has been estimated for Somalia in numerous reports. The estimated offtake percentages for the major species of ruminants during the 1970s are summarised in Table 2.3.

TABLE 2.3 ESTIMATED RATES OF TOTAL OFFTAKE DURING THE 1970's (in percentages)

Source and Year	Cattle	Camels	Sheep & Goats
Official Government 1970	7.6	1.0	36.7
World Bank 1974	10.0	2.5	30.0
HTS Livestock Sector Review using 1975 Census	5.8	2.4	10.0
World Bank NRDP appraisal 1975	6.3 - 11.0	0.8 - 5.7	4.6 - 16.0
World Bank CRDP appraisal 1978	5 - 8	2 - 4	15 - 20
World Bank Agriculture Review 1979	4 - 5	1.0	11 - 20
Ministry of National Planning 1979	7.0	1.2	27.7
Food Security Project 1980	8.7	3.2	16.0

Source: *Ministry of National Planning, Livestock and Range Sector Study, Mugdisho, March 1981 cited Holtzman, J. (1982).*

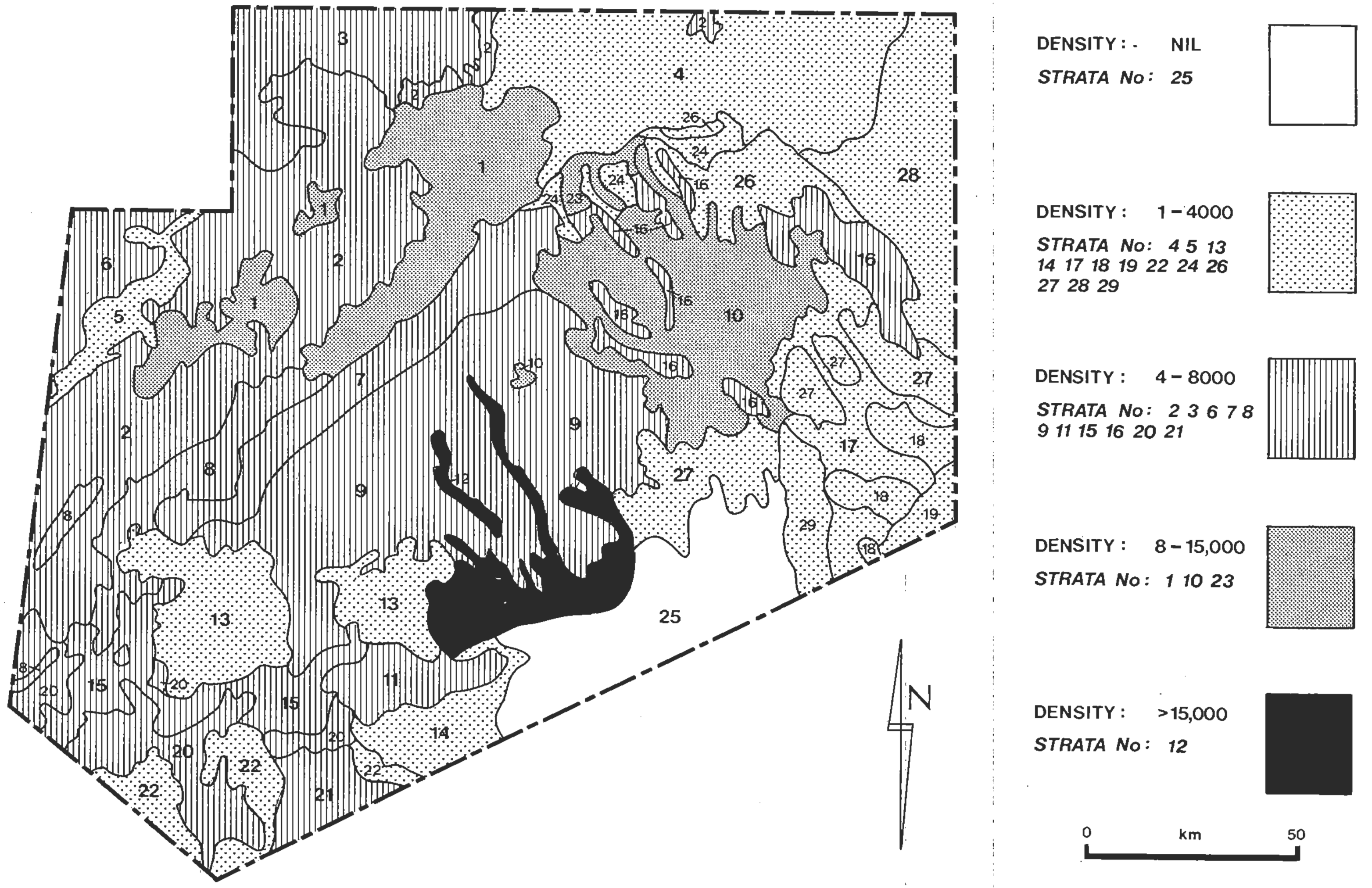
The national estimates are highly variable and are based upon a variety of methodologies. These include calculations based upon hides and skins, export statistics and estimates of local slaughter (Holtzman 1982). None of the current statistics or estimates of offtake

TABLE 2.2 LIVESTOCK AND BIOMASS DENSITIES BY LAND FORM CLASSIFICATION

Soil unit	Stratum No.	% of Region	Camels No/km²	Camels %	Cattle No/km²	Cattle %	Goats No/km²	Goats %	Sheep No/km²	Sheep %	Biomass Kg/km²	Biomass %
Clays	1, 5, 8, 10, 12, 17, 19, 20, 21, 24, 29	27.2	10.1	35	19.4	58	15.8	50	1.3	40	8 418	45
Limestone Plateau	2, 3, 4, 6, 15, 28	31.3	8.5	34	4.2	15	8.0	29	1.1	37	4 330	26
Basement Peneplain	9, 13, 16. 27	22.6	8.0	23	6.9	17	5.2	14	0.7	19	4 674	21
Basement Limestone Interface	7, 23, 26	5.1	9.9	6	7.3	4	12.2	7	0.4	2	5 241	5
Coastal	11, 14, 18 22, 25	13.8	1.2	2	3.9	6	0.7	1	0.1	2	1 302	4
Total Region	**1-20 inclusive**	**100**	7.9	**100**	9	**100**	8.7	**100**	0.9	**100**	5 150	**100**

Source: Hunting Technical Services 1982.

2.2 Distribution of biomass (kg/km)



Source HTS 1982

have been checked by examination of herd structure and local management practices and compared with hypothetical herd models.

Suggested offtake percentages are frequently low (Table 2.3). Total offtake includes animals of various age and sex groups. A simple percentage offtake figure or total number of animals, which includes many immatures, is a most unreliable indicator of production with traditional herds particularly for carcass meat production.

Recorded field data for pastoral regions including Bay Region and other Somali speaking areas of the Horn of Africa (HTS 1982, White and Meadows 1979, 1980 and 1981, Dyson-Hudson and Dyson-Hudson 1982), show distinct herd structures (Tables 2.4 and 2.5). Herd structures are characteristically those of dairy producers. The salient points to be noted from measured herd structures, as compared with hypothetical herd models are as follows:

(a) Pastoralists maximise breeding cow or goat numbers for milk production.

(b) Maximisation of breeding cow or goat numbers is achieved by early elimination of male stock and reduced retention of males for meat production; the majority of male calves which survive the first year of life are removed from the herd in years one to three; most male goats are removed from the flock in years one to two.

Herd structures assumed by the appraisal reports of the World Bank for both the Bay Region and the Central Rangelands Project in Somalia are shown in Tables 2.4 and 2.5. It is clear that assumed herd structures do not resemble those of actual Somali herds. There are major differences in the following respects:

(i) The sex ratio in the calf groups aged 0 to 1 year is not equal (i.e. 50:50 male to female).

(ii) The sex ratio in growing animal groups aged 1 to 3 years is not equal.

(iii) The percentage of male animals 3 years of age and over in Somali herds almost never exceeds 5 to 6 per cent.

(iv) The percentage of female animals 3 years of age and over is substantially higher in Somali herds than in the assumed herd structures.

The usefulness of computer and other modelling techniques used for preparation of herd projections depends on adequate information on local livestock management. These management techniques modify the herd structures markedly from the hypothetical models which assume equal retention of males and females in non expanding/non contracting herds. Projection of these models in the Appraisal Report (IDA, 1979) yields unrealistic information concerning potential and future productivity.

2.3.2 Estimated Carcass Meat Production from Cattle

Meat production in the Bay Region is subject to substantial variation between seasons, through changes in nutrient supply and modifications to herd composition which may ensue. Table 2.6 based upon aerial survey data (HTS 1982) and herd structure data (Mid Term Review 1983) suggests that about 60 per cent of cattle meat derives from cull cows. Immature male animals supply about 20 per cent of meat and mature males only 10 per cent.

TABLE 2.4 CATTLE HERD STRUCTURES FROM RECORDED FIELD DATA AND WORLD BANK APPRAISAL REPORTS

	Age and Sex Groups of Herd (Per Cent)								
	Females 3yr+	Males 3yr+	Females 1-3yr	Males 1-3yr	Females 0-1yr	Males 0-1yr	No. of Animals in Sample	Year of Sample	Source
Bay Region Mid Term Review	51.1	4.4	15.9	9.8	11.1	7.6	2 298	1983	MTR (1983)
Bay Region Project Report (1982)	67.9	3.8	12.3	4.6	6.2	5.5	N/A	1982	HTS (1982)
Garissa	45.9	1.2	19.3	11.1	13.5	9.0	20 599	1980	Meadows & White (1981)
Wajir	51.9	2.3	25.6	8.8	6.6	4.8	55 399	1980	Meadows & White (1981)
Mandera	60.9	5.2	15.3	6.3	7.2	5.1	32 051	1980	Meadows & White (1981)
Somali I	(65.9)	5.6			(16.0)	(12.6)	N/A	1972	Watson (1972) Quoted
Somali II	(66.9)	4.6			(17.7)	(10.8)	N/A	1972	Dyson-Hudson and
Somali III	(57.9)	3.8			(20.0)	(18.3)	N/A	1972	Dyson Hudson (1982
World Bank Appraisal Yr.1 Bay Project	41.3	10.0	16.8	16.8	7.5	7.5			World Bank (1979)
World Bank Appraisal Yr.20 Bay Project	37.9	15.3	14.4	14.4	9.0	9.0			World Bank (1979)
World Bank Appraisal Central Rangelands Project	36.9	12.9	14.0	14.0	11.0	11.0			World Bank (1979)
Hypothetical Mortality Discounted Herd Model (all 30% Weaning)	51.3	2.6	15.4	15.4	7.7	7.7			All calves retained Growing males up to 3 years
Hypothetical Mortality Discounted Herd Model (all 30% Weaning)	55.5	2.7	16.6	8.3	8.3	8.3			All calves retained Growing males removed at 2-3y
Hypothetical Mortality Discounted Herd Model (all 30% Weaning)	57.5	2.9	17.2	6.9	8.6	6.9			25% male calves slaughtered 0-1y. Growing males removed at 2-3 years

Note: *Bracketed figures for these models are confounded with other age groups of the same sex.*

Source: *Hunting Technical Services 1983.*

TABLE 2.5 GOAT HERD STRUCTURES FROM RECORDED FIELD DATA AND WORLD BANK APPRAISAL REPORTS

	Age and Sex Groups of Flock								
	Females 2yr+	Males 2yr+	Females 1-2yr	Males 1-2yr	Females 0-1yr	Males 0-1yr	No. of Animals in Sample	Year of Sample	Source
Bay Region Mid Term Review	54.0	5.3	13.5	9.5	10.8	6.7	2 661	1983	
Bay Region Project Appraisal	39.3	14.0	11.5	11.5	11.8	11.8			World Bank (1979) Basic Herd Without Project
Central Rangelands Project Appraisal	40.2	11.6	11.0	11.0	13.1	13.1			World Bank (1979) Basic Herd Yr.1 (57% Weaning)

Source: Hunting Technical Services 1983

TABLE 2.6 ESTIMATED ANNUAL CARCASS MEAT PRODUCTION FROM CATTLE IN BAY REGION

	Age and Sex Groups of Herd						
	Females 3yr+	Males 3yr+	Females 1-3yr	Males 1-3yr	Females 0-1yr	Males 0-1yr	Total
Herd Structure % [1]	51.13	4.39	15.92	9.79	11.14	7.61	
Animal Numbers (Head) [2]	188 160	16 155	58 585	36 030	40 995	28 005	368 000
Animal Off-take (Head)	27 850 [7]	4 038 [4]		14 000 [5]		12 990 [3]	58 880 [6]
Off-take %	7.56	1.10		3.80		3.53	16
Average Liveweight (kg)	250	300	170	170	30	30	
Total Liveweight of Off-take (kg)	6 962	1 211		2 380		389	10 942
Carcass Weight (tonnes)	3 133	545		1 070		175	4 923

Source: *Hunting Technical Services 1983*

Notes to table:

1 *Herd structure as measured from field data. See Table 2.4*
2 *Total as recorded from aerial survey (HTS 1982) by RMR. Group numbers calculated on percentage of herd structure basis. Numbers are rounded so that total differs slightly from survey total, i.e. 367 930 to 368 000.*
3 *Number of small male animals removed is derived by difference between female calf and male calf totals. A 50:50 sex ratio is assumed at birth.*
4 *Number of mature males removed is derived assuming 25 per cent annual culling. The total number of animals (4.39 per cent, 16,155 head) probably includes some trade animals moving through the region as the ratio of bulls to cows in this table is 1 to 11.6. At the rate of bulls to cows of 1 to 18 (HTS 1982) breeding bull numbers would be expected to be nearer 10 450. The estimate for carcass meat production from mature males which actually derives from Bay Region herds is thus subject to considerable error.*
5 *Number of immature males slaughtered assumes an average slaughter age of about 2 years and provision for replacement of culled breeding stock.*
6 *Off-take number derived from 16 per cent of total population. Off-take percentage derives from a herd which is not expanding or contracting with a weaning percentage of 30 to 40 per cent.*
7 *Cull cow offtake derived by difference of totals 3/4/and 5/ with 6/. Assumes no herd expansion or contraction.*
8 *Assumes 45 per cent average killing out percentage.*

TABLE 2.7 ESTIMATED ANNUAL CARCASS MEAT PRODUCTION FROM EXPORT TRADE CATTLE PASSING THROUGH BAY REGION

Export Trade Cattle Passing Through Bay Region (Males) head	20 000
Average Liveweight (kg)	300
Carcass Weight at 45 per cent Killing Out (tonnes)	2 700

Source: Hunting Technical Services Limited 1983.

1. This estimate assumes that two thirds of the cattle exported from Mugdisho derive from the routes which pass through Bay Region. This estimate is generally accepted by Livestock Traders and MLFR.

Estimated cattle carcass meat production is approximately 4 920 tonnes per annum. Comparison of this total with estimated meat production from male export trade stock (Table 2.7), which is approximately 2 700 tonnes per annum, illustrates the importance of the trade stock routes which pass through Bay Region. Trade stock carcass meat production is equivalent to some 55 per cent of beef carcass meat production from within the region.

2.3.3 Estimated Carcass Meat Production from Goats

Estimated carcass meat production from goats in Bay Region is subject to variation between seasons due to changes in nutrient supply and flock composition. Table 2.8 based upon aerial survey totals (HTS 1982)and a flock structure survey (Mid Term Review 1983) suggests that approximately 68 per cent of carcass meat production derives from cull females, 13 per cent from immature males, and 13 per cent from mature males. A small percentage, about 6 per cent derives from male kids. Total carcass meat production within Bay Region is estimated at 777 tonnes per annum.

2.3.4 Estimated Milk Production from Cattle

Milk production from cattle in Bay Region is estimated at 14 000 tonnes per annum of whole milk at approximately 5 per cent fat content (Table 2.9). Ghee production, which in Somalia achieves an extraction rate from whole milk of about 80 per cent of fat by traditional methods would have a maximum production potential of approximately 560 tonnes per annum.

2.3.5 Estimated Milk Production from Goats

Milk production from goats is estimated at 5 720 tonnes per annum (Table 2.10). Goat milk is particularly important to the nutrition of post weaning children and for general subsistence of Bay Region families.

2.3.6 Camel Production

The camel population of Bay Region determined from aerial survey (1982) was 321 000 head. Specific age and sex structures of the camel population have not been determined from field survey in this study. Previous survey work (HTS 1982) showed a

TABLE 2.8 ESTIMATED ANNUAL CARCASS MEAT PRODUCTION FROM GOATS IN BAY REGION

	Age and Sex Groups of Flock						
	Females 2yr+	Males 2yr+	Females 1-2yr	Males 1-2yr	Females 0-1yr	Males 0-1yr	
Herd Structure %[1]	54.03	5.33	13.52	9.54	10.82	6.72	
Animal Numbers (Head)[2]	190 725	18 815	47 725	33 675	38 200	23,720	Total 353,000
Animal Off-take (Head)	39 280[7]	6 270[4]		10 570[5]		14 480[3]	Total 70,600[6]
Off-take %	11.12	1.77		3.00		4.10	Total 20
Average Liveweight (kg)	30	35		22		7	
Total Liveweight Off-take (kg)	1178	219		232		101	
Carcass Weight (tonnes)[8]	530	98		104		45	Total 777

Source: Hunting Technical Services 1983

Notes

1 *Flock structure as measured from field data.*
2 *Total as recorded from aerial survey (HTS 1982) by RMR. Group numbers calculated on percentage herd structure basis. Numbers are rounded so that the total differs slightly from survey total.*
3 *Number of male kids removed is derived by difference between female and male kid totals. A 50:50 sex ratio is assumed at birth.*
4 *Number of mature males removed is derived assuming that 33 per cent annual culling. Herd structure suggests a ratio of 1-10 breeding males to breeding females.*
5 *Immature males removed assumes approximate slaughter age of 1-5 years with provision for replacement of culled breeding stock.*
6 *Off-take number and total off-take percentage (20 per cent) derives from flock models with 40-50 per cent weaning (Approx. 17-23 per cent potential off-take). Assumes no flock expansion or contraction.*
7 *Cull female total derives from the difference of totals 3/4/and5/with6/.*
8 *Assumes approximately 45 per cent killing out percentage.*

TABLE 2.9 ESTIMATED ANNUAL MILK PRODUCTION FROM CATTLE IN BAY REGION

Cows in Bay Region[1]	188 000
Lactations per annum[2]	94 000
Milk Production[3] (tonnes)	14 100
Ghee Production Potential[4] (tonnes)	560

1 *Derived from herd structure and aerial survey (HTS 1982) by RMR.*
2 *Estimates 50 per cent calving. There is clearly wide variation between years as rainfall variation influences nutrition of stock from range and crop residues.*
3 *Assumes 150 kg of milk for human use per lactation. Whole milk has approximately 5 per cent fat content.*
4 *Local ghee production methods achieve extraction of approximately 4 per cent fat from whole milk.*

Source: Hunting Technical Services Limited 1983.

TABLE 2.10 ESTIMATED ANNUAL MILK PRODUCTION FROM GOATS IN BAY REGION

Breeding Female Goats[1]	190 725
Lactations per annum[2]	114 400
Milk Production (tonnes)[3]	5 720

1 *Derived from herd structure (Table 2.5) and aerial survey (HTS 1982) by RMR.*
2 *Assumes 60 per cent kidding rate.*
3 *Assumes 50 litres of milk for human use per lactation (HTS 1982).*

Source: Hunting Technical Services Limited 1983.

camel population in Bay Region with approximate age and sex structure as given in Table 2.11. There is characteristically a relatively high percentage of mature male animals (12.5 per cent of total herd) as most of these animals are retained as pack animals. The breeding females (60.7 per cent of total herd) are more than would be expected from hypothetical herd structures based upon models with equal retention/survival of males and females (e.g. World Bank Bay Region Project Appraisal). This results from an unequal sex ratio of animals in the one to four year age group and would appear to be due to the removal or loss of some young male stock prior to four years of age and the removal or loss of some young females in this age group. Table 2.11 shows both the measured herd structure (HTS 1982) and for comparison a hypothetical structure in which the effective weaning percentage is 22 and with equal survival of male and female growing stock. The loss of immature stock probably results from a combination of mortality due to disease and intentional culling. The proportion due to each cause is not known. A camel research project supported by a Somali/Swedish mission is currently being established and further information for the interpretation of camel statistics will become available.

Apart from draught and pack use of male animals, milk production from camels is of major importance in Bay Region. The herd structure suggests that the breeding female population contains about 195 000 camels. At a mean calving percentage of 35 with lactation yields of 900 litres estimated milk production is 61 200 tonnes per annum. Camel meat production is estimated at 2 260 tonnes per annum derived from an adult animal offtake of approximately 3.5 per cent of the total population.

2.3.7 Goat Production

Goats are the most numerous of the small ruminants in Bay Region and their number (353 000) far exceeds that of sheep (36 000) (Table 2.1). The measured goat flock structure (Table 2.5) suggests that modifications to the population occur as with cattle herds due to the prime interest of producers in milk production. Male kids are sometimes slaughtered at early ages in order to obtain more milk for human consumption. The growing male goats which are retained for the first year of life are removed and sold at between about 18 months to 2 years of age. Goats are typically browsing animals and many range areas of the region are substantially browse areas. The recorded flock structure would suggest that the reproductive rates for breeding goats minus mortality (approximately the weaning rates) are about 50 per cent and variable between years to about 40 per cent.

As with cattle herd structures the measured flocks show a substantially different structure from those derived in projections in the World Bank Appraisal documents of either the Bay Region Project (1979) or the Central Rangelands Development Project (1979).

Estimates of approximate weaning percentages are derived from the flock structure data as follows. For a herd which is not substantially expanding or contracting the female animals 0 - 1 year of age or 1 - 2 years of age are assumed to represent 50 per cent of animals which could have been weaned. These offspring derive from the total breeding female flock.

Estimated weaning percentage is calculated:

$$\frac{(\text{total female age } 1-2 \text{ years} \times 2)}{\text{total breeding females Age 2 years and over}} \times 100 = \text{approx. weaning \% previous year}$$

e.g. From Table 2.8

$$\frac{(47\ 725 \times 2)}{190\ 726} \times 100 = 50.04\ \%$$

and

$$\frac{(\text{total females age } 0-1 \text{ years} \times 2)}{\text{total breeding females age 2 years and over}} \times 100 = \text{approx. weaning \% this year}$$

TABLE 2.11 CAMEL HERD STRUCTURES FROM RECORDED FIELD DATA, PROJECT APPRAISAL REPORT AND HYPOTHETICAL MODEL

	Percentage Age and Sex Groups in Herd						
	Female 4yr+	Male 4yr+	Female 1 - 4yr	Male 1 - 4yr	Female 0 - 1yr	Male 0 - 1yr	Source
Bay Region Survey[1]	60.7	12.5	9.3	4.8	6.7	6.0	HTS (1982)
Bay Region Project Appraisal[2]	50.01	11.36	13.96	13.96	5.35	5.35	World Bank (1979)
Hypothetical Model[3]	45.19	12.61	15.89	15.89	5.30	5.30	HTS (1983)

Source: Hunting Technical Services Limited 1983.

1 *Original data recalculated to age groups shown. Assumes normal distribution of age for age groups up to 18 months in the original data.*
2 *Calculated from numerical data in basic herd of Appraisal Report.*
3 *Assumes a calving rate of 35 per cent with 33 per cent mortality of young stock. Otherwise the model is mortality discounted.*

$$\frac{(38\ 194 \times 2)}{190\ 726} \times 100 = 40.05\%$$

2.4 RANGE RESOURCES

The vegetation of the Bay Region is described in detail in the HTS (1982) report. Only the main points are summarised here. The area is mainly covered by semi-arid wooded savanna. Almost 90 per cent of the area (3.7 million ha) is used as rangeland which supports an average biomass of 5 100 kg/km². The area has been classified into five major ecological units which are largely associated with the geology and soils of the region. The five units are illustrated in Figure 2.3.

2.4.1 Clay Plains

Two sources of fodder derive from the cultivated land on the clay plains. These comprise stover (mainly from sorghum crops) and vegetation on fallow land. The livestock density is normally high on these areas. Fewer animals are present after the grazing of crop residues during the dry season and in the early wet season when stock move into the range areas. Stock densities were seen to be high particularly during the harvest period when labour requirements are high. Nomads provide harvest labour and are rewarded with access to water (at traditional wars), stover grazing and sorghum grain. Range vegetation near and within cultivated zones apart from annual grasses consists of thorn shrub or tree vegetation of relatively low palatability *(Acacia zanzibarica, A. horrida, A. nubica, Caesalpinia trothae, Dichrostachys cinerea).* The ubiquitous garas tree *(Dobera loranthifolia)* which is left standing in the cultivated areas, provides shade and browsing for stock, particularly camels.

2.4.2 Limestone Plateau

These areas are frequently covered by shallow stony soils with limestone outcrops. Vegetation typically includes the dominant grass of Bay Region *Tetrapogon tenellus* and another annual species *Tetrapogon cencriformis.* Shrubs and bush cover provide an important nutrient source for browsing livestock. Typical areas visited on the limestone plateau (near Berdaale and along the Lugh road, Hawlaha Guud) had water supplies from traditional hand dug wells.

2.4.3 Basement Complex

The basement complex covers some 920 000 ha in the central part of the Bay Region. The vegetation is generally an open shrubbed bushland formation with a poor grass cover. HTS (1982) noted considerable evidence of gullying, rilling and surface compaction of these areas. The livestock aerial survey also suggested heavy grazing pressure with a livestock biomass density of 4 000 to 8 000 kg/km² (Figure 2.2). In the dry season water is obtained from wells dug in the wadi beds. The development potential of these sources is believed to be very limited.

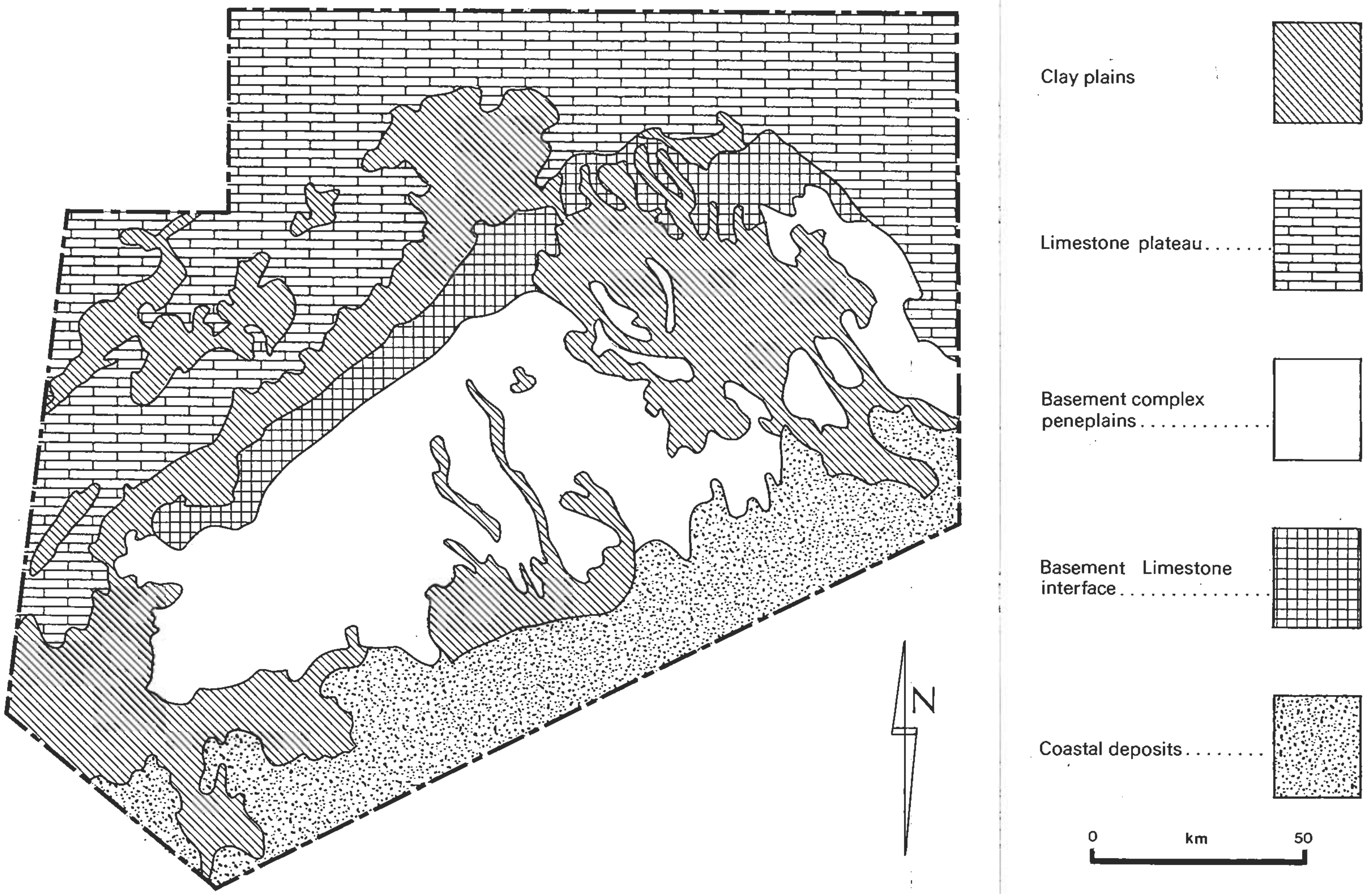
2.4.4 Basement/Limestone Interface

This marks the transition between the basement complex peneplain and the limestone plateau. It lies in a belt South West from Baydhabo along the edge of the clay plains. It consists of limestone outcrops and laterised sandy soils. The vegetation consists of open mixed shrubland but with patches of mixed *Acacia* shrubbed bushland with typical clay plains vegetation nearby. Range water supplies for livestock are obtained from traditional wars on the edge of the clay plains supplemented by springs and wells. These are used in the dry season when wars have dried up.

2.4.5 Coastal Deposits

The coastal deposits represent the transition zone between the flat alluvial marine plain and the basement complex.. The area is characterised by the absence of permanent water sources with few tracks through the bush. The vegetation is open bushland with a

2.3 Ecological units



Source HTS 1982

good grass cover. Bush species include *Acacia bussei* and *A. reficiens* as well as localised shrubs of *Dobera loranthifolia* and *Combretum hereroense.* The area is crossed by nomadic migration routes and by stock routes to Mugdisho and Kismayo. Due to the absence of permanent water sources these coastal deposits remain the most under-utilised range areas of Bay Region.

2.5 RUMINANT NUTRITION FROM RANGELAND AND CROPLAND

Feed and forage for ruminant livestock in Bay Region derives from both rangeland vegetation and from feed produced by the crop production cycle. Integration of crop and livestock production ensures animal production levels which are superior to those which could be achieved from rangeland alone. The crop production cycle supplies nutrients of moderate energy density which include:

- rogued plants affected by pests during the growing season;
- green forage (bal) after the grain harvest; sorghum heads are harvested from the standing plant while the stover is still green;
- sorghum bran (bunshoo) from household processed sorghum, (20% of the grain weight processed);
- threshed sorghum heads with residual grains (waago);
- small amounts of oil seed cakes, e.g. sesame cake produced from small local presses within the region.

Figure 2.4 illustrates the dual source of energy for the animal production system of Bay Region and the means by which the efficiency of utilisation of nutrient energy is or may be modified. Utilisation is influenced by economic factors which are largely determined by subsistence requirements, product prices received by producers, production levels and the availability of technical inputs. The relationship between input and output prices is not expected to change fundamentally in the project term.

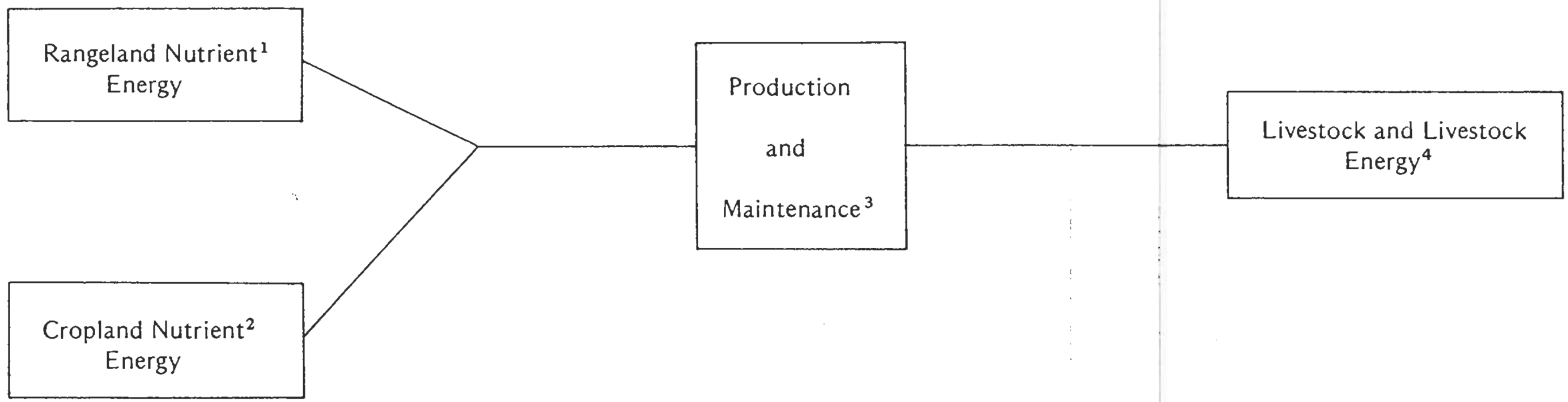
Increased energy throughput of the system could derive from

(a) increased nutrient energy production and availability from cropland and

(b) increased nutrient energy production and availability from range land. For example, an increase of 30 per cent on an annual grain yield of 600 kg per hectare would yield an 8 per cent increase in nutrient energy available from threshed heads and bran (Tables 2.12 and 2.13). One hectare of cultivated sorghum would yield 27 518 MJ of ME of which 17 066 would be available for animal production.

On the open range, especially in areas of low and uncertain rainfall enhanced rangeland production and utilisation is difficult to manipulate. Rangeland production in areas of approximately 400 to 500 mm of rainfall has been determined as approximately 1.5 tonnes dry matter per hectare in sahelian zones (Penning de Vries, 1983). Dry matter available as animal nutrient has been estimated at 1.0 tonne per hectare per year. The mean nutrient energy density of this material which is an important determinant of the productive potential of the feed is not reported. It is likely that range material will have a mean value of the order of 7 to 8 MJ energy density per kilogram of dry matter, i.e. similar to the

FIGURE 2.4 NUTRIENT ENERGY AND DEPENDENT VARIABLES IN RUMINANT ANIMAL PRODUCTION SYSTEMS IN BAY REGION



Source: Hunting Technical Services Limited 1983.

Notes:

1 *Modified by climatic factors, range composition and productivity, intensity and duration of stocking.*
2 *Modified by climatic factors; soil (edaphic) factors; crop areas and yield; export from the region.*
3 *Efficiency of utilisation dependent on herd structure, livestock type and husbandry system. Disease control : vaccinations. Parasite control : Anthelmintics, Ixodicides. Clinical treatment. Water access.*
4 *A function of input/output prices.*

2.12 ESTIMATES OF INCREASED CROP RESIDUES FROM CROP YIELD INCREASE DUE TO IMPROVED CROP PRODUCTION (30% GRAIN YIELD INCREASE)

	Gu Rains Production		Dayr Rains Production	
	Standard Crop	Improved Crop	Standard Crop	Improved Crop
Grain Yields	350 kg/ha	455 kg/ha	250 kg/ha	325 kg/ha
Yield of Waago[1]	233 kg/ha	303 kg/ha	166 kg/ha	216 kg/ha
Bran derived from Grain Yield	70 kg/ha	91 kg/ha	50 kg/ha	65 kg/ha
Yield of Forage Dry Matter	1 890 kg/ha	1 890 kg/ha	1 350 kg/ha	1 350 kg/ha
Crop Failure	1 season in 4	1 season in 4	1 season in 3	1 season in 3
Mean Annual Forage Dry Matter	1 418 kg/ha	1 418 kg/ha	900 kg/ha	900 kg/ha
Estimated Wastage	30%	30%	30%	30%
Utilisable Forage Dry Matter	992 kg/ha	992 kg/ha	630 kg/ha	630 kg/ha

[1] *Estimated yeild of Waago (threshed sorghum heads) based upon grain head to grain weight ratios for traditional sorghum varieties in the Sudan (HTS 1983) i.e. grain represents approximately 60 per cent of total sorghum head weight.*

Source: Hunting Technical Services Limited 1983.

TABLE 2.13 INCREASED NUTRIENT ENERGY PRODUCTION FOR LIVESTOCK DUE TO CROP PRODUCTION IMPROVEMENT (30% GRAIN YIELD INCREASE)

Crop Component	Annual Yield (Gu + Dayr Crop) kg/dry matter	Estimated Nutritive Value of Dry Matter ME MJ/kg	Total MJ ME[1]
Sorghum Grain	600	13.4	8 040
Sorghum Grain	780	13.4	10 452
Yield Increase	180		2 412
Threshed Heads (Waago)	399	8.0	3 192
Threshed Heads (Waago)	519	8.0	4 152
Yield Increase	120		960
Sorghum Bran	120	10.0	1 200
Sorghum Bran	156	10	1 560
Yield Increase	36		360
Forage	1 622		11 354

Total energy for livestock use from standard crop = 15 746 MJ ME
Total energy for livestock use from improved crop = 17 066 MJ ME

Source: Hunting Technical Services Limited 1983.

1 *By International Agreement 4.1852 International Joules is equal to one calorie (abbreviation 'cal').*

value of moderate quality forage. Some components of range dry matter clearly contain higher nutrient energy values as well as high crude protein levels, e.g. many *Acacia* species have leaf dry matter crude protein levels of 15 per cent. Rangeland is estimated to provide 7 000 - 8 000 MJ of ME per hectare per year.

Standard range improvement techniques which might be practiced on the open range in Somalia, (e.g. increased water infiltration from bunding, chisel ploughing and reseeding) are unlikely to produce increases in range productivity comparable to those which could be achieved from the farm and which would be justified by the costs involved. Water provision remains the only major opportunity to extend the utilisation of grazing and browsing resources, but a more detailed knowledge of range water resources and availability (wars, hand dug wells and open water sources) is required prior to further investment in water supplies for livestock in range areas. Where major epizootic diseases are controlled, nutrition remains the key to increased production levels.

2.6 LIVESTOCK MANAGEMENT AND PRODUCTION SYSTEMS

Present production systems of Bay Region show substantial integration of crop and livestock husbandry. Milk production remains the most important objective of livestock husbandry within Somalia.

2.6.1 Urban Dairy Production (Baydhabo)

Dairy cows of local breeds are maintained for milk production within Baydhabo. Animals are typically fed bran, sesame cake and sorghum forage (Bal) together with threshed sorghum head residues (waago) which are available locally. During the day animals are grazed on open land near the town. Individual producers retain 2-6 cows at their home compounds under this system. Cows with a liveweight of 280 to 300 kg under current management systems produce approximately 4 litres of milk daily at peak lactation and receive 5 kg of bran (wheat and/or sorghum), 1 kg sesame cake, in addition to forage supplements.

Standard tables of nutrient requirements (Table 2.14) suggest that a cow of 300 kg liveweight would need 36 MJ of ME for maintenance per day and 24 MJ of ME for production of four litres of milk (i.e. a total of about 60 MJ of ME per day). The 5 kg bran/1 kg sesame cake diet supplies about 60-62 MJ of ME daily which is within the daily appetite limits of 9 kg of dry matter per day. High fibre residues Bal (sorghum stalk) and waago (threshed sorghum heads) are given in small amounts to maintain rumen function and prevent acidosis on the concentrate feeding system from which most energy and protein for production derives.

TABLE 2.15 BASIC COSTS AND RETURNS FOR URBAN MILK PRODUCTION (BAYDHABO)

	Cost per kg (Ssh)		Daily Cost & Return (Ssh)
Wheat bran	1.0		5.0
Sesame Cake	5.0		5.0
High Fibre Residue			2.7
Herding (i.e. 10.0 per month)			0.3
		Total Cost	13.0
Milk Value @ 15.0/litre		4 litres	60.0

Source: Hunting Technical Services Limited 1983.

TABLE 2.14 NUTRIENT ALLOWANCES FOR DAIRY COWS

Breed	Live-weight kg	Live-weight (cwt)	Appetite DM kg	Appetite IOM kg	ME MJ	DCP g	Calcium g	Phos-phorus g	Magne-sium g	Sodium g
					Daily Allowances for Maintenance					
Dexter	300	6	9	1.8	36	200	11	11	5	9
Jersey	350	7	11	2.1	40	225	12	15	5	9
Kerry	400	8	12	2.4	45	250	15	20	6	9
Guernsey	450	9	14	2.7	49	275	16	23	7	9
Ayrshire	500	10	15	3.0	54	300	18	25	8	9
Shorthorn	550	11	17	3.3	59	325	20	27	8	9
Friesian	600	12	18	3.6	63	345	21	28	9	9
South Devon	650	13	20	3.9	67	365	24	29	10	9
					Daily Allowances for Maintenance and Pregnancy					
Dexter					59	310	20	16	8	
Jersey					63	340	23	21	8	
Kerry					68	370	28	27	9	
Guernsey					72	400	31	31	10	
Ayrshire					77	430	35	34	11	
Shorthorn					82	465	39	37	11	
Friesian					86	495	42	39	12	
South Devon					90	530	47	41	13	
			Milk Composition BF %	SNF %	**Allowances for Milk Production per kg**					
Dexter			4.2	8.8	5.4	58	3.2	1.7	0.6	0.6
Jersey			4.9	9.1	6.0	63	3.2	1.7	0.6	0.6
Kerry			4.0	8.8	5.3	53	2.8	1.7	0.6	0.6
Guernsey			4.6	8.9	5.7	63	3.2	1.7	0.6	0.6
Ayrshire			3.8	8.7	5.1	53	2.8	1.7	0.6	0.6
Shorthorn			3.6	8.7	5.0	48	2.8	1.7	0.6	0.6
Friesian			3.6	8.6	4.9	48	2.8	1.7	0.6	0.6
South Devon			4.3	8.8	5.5	58	3.2	1.7	0.6	0.6

NOTES 1. Dietary energy and digestible crude protein requirements for live weight gain during lactation are 34 MJ and 320 g DCP per kg respectively.

2. Metabolizable Energy equivalent provided by live weight loss is 28 MJ per kg.

3. If the milk composition is significantly different from the figures given then the appropriate values should be calculated using the following equation:

$$ME = [(0.386 \times \%BF) + (0.205 \times \%Snf) - 0.236]\ 1.694$$

Where ME = MJ per kg Milk

Source: *Nutrient Allowances and Composition of Feedingstuffs for Ruminants. Booklet 2087, (1980) Ministry of Agriculture, Fisheries and Food, (ADAS), UK.*

Female calves are retained and reared in the urban dairy system at least until weaning at 6-7 months of age. Male calves are frequently slaughtered within the first week of life unless they derive from highly productive cows. Such calves may be retained as potential breeding bulls. The cost of rearing a young calf is substantial. Hand fed calves (about 1 month of age) have been observed to consume 1.4 litres of milk per day (valued at Ssh 21.0) in addition to small amounts of bran.

Weaned calves and dry cows are frequently returned to relatives outside the urban areas. Dry cows are typically exchanged for animals due to calve or freshly calved which are then kept under the high cost urban feeding system. This results in a relatively high apparent calving percentage for the urban dairy system. Well-fed cows are rebred at 6 to 7 months of age after calving which results in a 15 - 16 month calving interval i.e. (Equivalent to a 70-80 per cent calving percentage on an annual basis).

Productivity levels are thus not as low or as technically inefficient as may be assumed in some analyses. Feed systems are modified during wet seasons when higher quality forage is naturally available and bran and oilseed cake requirements are reduced.

2.6.2 Semi Settled Dairy Production

Semi-settled dairy production from cattle represents an important activity within the Bay Region. The milk production objectives differ from those of the urban dairy producer who is largely concerned with the production of whole milk. Apart from basic subsistence requirements producers are interested in the production of other milk and livestock products. This is in part influenced by their access to market outlets. Less milk is traded in the whole form and more is sold in the form of locally processed milk. The two major milk products are ghee (subag) and various forms of fermented sour milk from which the fat has been extracted (for example garoor). Both these products have a longer storage life than fresh milk.

Lactation yield within the semi-settled systems is less than is observed in the best urban dairy systems. Production level is very sensitive to animal nutrition and the herdsman's skill in providing feed of the best available nutritive value for his stock. Some producers provide supplementary brans (bunshoo) for freshly calved cows of high yield potential together with threshed sorghum heads (waago). Livestock are moved between cropped and range areas to take advantage of the best quality forage and/or crop residues available dependent upon the season. For example, at harvest time at the end of the Gu rains, green sorghum stalk residues are heavily grazed by stock in cultivated areas when the grain-bearing heads have been cut and removed. Somali stockmen demonstrate a clear understanding that forage dry matter (or plant biomass dry matter) associated with forage quality (or biomass nutrient energy density) are of prime importance in determination of animal production levels.

2.6.3 Poultry Production

Poultry production in Bay Region is mainly from local-type small birds. Production of eggs per bird is low, approximately 25-30 eggs per annum (HTS 1982). There has been some influence on local breeds of past importations of Rhode Island Red and Leghorn poultry. Imported Rhode Island Red hybrids are available to farmers from the Extension Service. Birds are normally sold as two-month reared chicks at a price of ten shillings each.

Nutrition remains the major constraint to successful rearing and production of imported hybrids (egg layers). Local nutrition involves no special care with birds run on free range supplemented with scraps and cereals (sorghum). Diets recommended by the Extension Service include milk powder as a protein source (at about 15 per cent of the dry mix). Local market prices for milk powder are Ssh 40 per kilogram (i.e. 5 kg tin costs Ssh 200).The recommended ration made from materials at local market prices would cost approximately Ssh 12 per kg which is clearly not economic.

Poultry meat production is almost entirely from local birds reared under the traditional free range system. There are however large price differentials for poultry between areas of Bay Region (e.g. Awdinle, Baydhabo, Buurhakaba) and Mugdisho. A chicken which costs approximately Ssh 35 in Bay Region may cost Ssh 65-70 in Mugdisho. This price differential has resulted in a substantial daily trade between Bay Region and the Capital. Birds are transported in groups of about 200 on the roofs of buses.

2.7 LIVESTOCK MARKETING

Livestock marketing is organised through a comprehensive system of private agents and livestock traders who operate within and outside of Bay Region. Their activities support both the local trade and the gathering and movement of livestock through Bay Region. Movements are toward the main urban market centre of Mugdisho and for export through the port. Baydhabo is the principal market of the region though smaller markets are distributed in the districts. There are 21 markets in total: Baydhabo district, 7; Buurhakaba, 9; Qansaxdheere, 2; Diinsoor, 3.

Livestock exports by port (1975-1981) show that approximately 30 000 head of cattle, 3 600 camels and 56 000 sheep and goats were shipped through Mugdisho in 1981 (Table 2.16). The majority of these animals are assembled in the Bay Region area from where they are trekked to Mugdisho (cattle and camels) or transported by truck (sheep and goats). The estimates of meat production for cattle (Tables 2.6 and 2.7) illustrate the importance of the trade routes which link-up in Bay Region. These flow lines are the major sources of exportable stock from southern and inter-riverine areas of Somalia.

Export camels and sheep and goats are currently being assembled and trekked or trucked from Bay Region. Cattle exports are reportedly suspended (September 1983) due to the requirement of the major importing country, Saudi Arabia, for vaccination and quarantine arrangements in accordance with the international Zoo-Sanitary Code.

2.8 ANIMAL DISEASE

In Bay Region, these include bacterial and virus infections, ecto and endoparasitism, tick-borne diseases and trypanosomiasis. Conditions associated with nutritional imbalances are suspected. Nutritional deficiencies also occur.

Veterinary support in Bay Region has consisted mainly of vaccination against major epizootic diseases, chiefly Rinderpest and Black Quarter.

Rinderpest remains the most important potential disease threat to unvaccinated livestock in Bay Region. Since the JP 15 Pan African Rinderpest vaccination campaign of the 1960s and early 1970s relative freedom from the disease had been enjoyed in East Africa. With the general relaxation of vaccination control within the region which ensued, the disease has re-established and outbreaks have occurred in several East African countries. These include Ethiopia, Sudan, Kenya, Tanzania and Uganda.

Diseases enzootic in the Region include Anthrax, Contagious Bovine Pleuropneumonia, Contagious Caprine Pleuropneumonia and Foot and Mouth Disease. The incidence, morbidity and mortality associated with these diseases has yet to be assessed. Records are confined to drugs dispersed and sold which indicate only a general pattern of clinical treatment (see Table 2.17). The principal treatments include acaricides, trypanocides, broad spectrum antibiotics and anthelmintics.

TABLE 2.16 LIVESTOCK EXPORTS BY PORT. 1975 - 1981

	1975		1976		1977		1978[1]		1979		1980		1981	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	
Cattle														
Berbera	32 998	82.7	30 180	51.7	45 730	82.3	24 706	68.0	53 408	78.7	56 001	56.5	51 912	44.8
Mugdisho	2 485	0.2	2 050	2.5	700	1.3	500	1.4	Nil	Nil	13 776	14.6	31 009	26.7
Kismayo	4 400	11.0	26 155	44.8	8 476	15.4	11 060	30.4	14 200	30.9	24 374	25.9	31 889	27.5
Small Ports[2]	Nil	Nil	Nil	Nil	Nil	Nil	71	0.2	278	0.4	Nil	Nil	1 193	1.0
Total	**39 883**		**58 385**		**54 956**		**36 337**		**67 886**		**94 151**		**116 003**	
Camels														
Berbera	25 903	75.7	26 302	78.5	28 853	86.7	12 335	79.0	8 733	69.8	8 050	46.7	4 663	31.7
Mugdisho	5 320	15.5	1 735	5.2	250	0.8	110	0.7	Nil	Nil	3 251	18.9	3 678	25.0
Kismayo	3 000	8.8	5 465	16.3	4 193	12.6	3 177	20.3	3 755	30.2	5 944	34.5	6 384	43.4
Total	**34 223**		**33 502**		**33 296**		**15 642**		**12 508**		**17 245**		**14 725**	
Sheep														
Berbera	781 697	87.6	323 441	79.5	419 008	85.3	317 780	79.2	674 921	94.1	709 122	94.9	640 188	93.5
Mudgisho	38 045	4.3	14 500	3.6	1 400	0.3	7 500	1.9	700	0.1	6 500	0.9	28 057	4.1
Kismayo	4 630	0.5	7 765	1.9	7 423	1.5	8 100	2.0	5 284	0.7	5 151	0.7	1 665	0.2
Other Ports[2]	68 300	7.7	61 255	15.0	63 672	13.0	67 984	16.9	36 002	5.0	26 305	3.5	15 136	2.2
Total	**892 702**		**406 961**		**491 503**		**401 364**		**716 907**		**747 078**		**679 995**	
Goats														
Berbera	826 654	90.6	324 137	85.3	406 126	88.0	304 643	84.2	663 229	94.0	699 194	95.2	640 940	94.3
Mugdisho	43 172	6.2	11 202	3.0	2 600	0.6	7 500	1.9	1 300	0.2	6 710	0.9	28 057	4.1
Kismayo	5 670	0.8	7 765	2.0	17 321	3.8	8 100	2.1	5 282	0.7	4 371	0.6	2 538	0.4
Other Ports[2]	16 263	2.3	37 002	9.7	35 221	7.6	45 456	11.8	35 457	5.0	23 835	3.3	8 460	1.2
Total	**691 759**		**380 106**		**461 268**		**385 699**		**705 268**		**734 110**		**685 046**	

Source: Livestock Development Agency cited by Holtzman (1982)

1 *The data for 1978 are incomplete for cattle and camels, representing probably only six months of information.*
2 *The small ports are Maydh and Laas Qaray.*

TABLE 2.17 ESTIMATED QUANTITIES, ANIMAL DOSES AND REVENUES OF DRUGS DISPENSED BY BAY REGION VETERINARY SERVICES 1982

Drug	Function	Quantity	No. of Animal Doses	Revenues (Ssh)
Coopertox	Acaricide	500 U.S gallons	-	102 680
Bacdip	Acaricide	12.625 litres	-	2 020
Berenil	Trypanocide	39 423 Grams	39 423 Cattle	
Novidium	Trypanocide	6 097 Tablets	6 097 Cattle	109 610
Ethidium	Trypanocide	1 703 Tablets	1 703 Cattle	
Samorin	Trypanocide	600 Grams	3 000 Cattle	
Naganol	Trypanocide	5 390 Grams	1 078 Camels	43 120
Oxytetracycline (100 mg/ml)	Antibiotic	799 x 100 c.c.	-	31 960
Oxytetracycline (50 mg/ml)	Antibiotic	652 x 100 c.c.	-	16 300
Penicillin	Antibiotic	211 x 100 c.c.	-	5 775
Sulphonamides	Antibiotic	Various Forms	-	29 568
Loxon Tablets	Anthelminitic	5 012 Tablets	5 012 Sheep/Goats	
Rintal Tablets	Anthelminitic	7 720 Tablets	7 720 Sheep/Goats	28 882
Omnizole Tablets	Anthelminitic	2 182 Tablets	1 091 Sheep/Goats	
Loxon Powder	Anthelminitic	49 x 172 Grams	3 430 Sheep/Goats	
Miscellaneous	-	-	-	26 310
			Total	396 225

Source: Bay Region Veterinary Services 1983.

The only comprehensive survey of ticks was conducted by a British Veterinary Team in Northern Somalia between 1969 and 1972. Species of ticks identified on cattle included *Amblyoma sp., Hyaloma sp.* and *Rhipicephalus sp.* No *Boophilus sp.* or *Rhipicephalus appendiculatus* were identified. Nairobi sheep disease was the greatest problem among sheep and goats followed by babesiosis and heartwater. Many cases of Nairobi sheep disease were complicated by secondary *Pasteurella* pneumonia. Provisional observations in Bay Region suggest that the situation may be similar. Veterinary investigation is required to define the economic significance of anaplasmosis and babesiosis and other tickborne conditions in the region. Three trypanocidal drugs are presently used sometimes concurrently depending on availability in Bay Region. These are Berenil, Samorin and homidium (Ethidium or Norvidium). To reduce the risk of drug resistance, it would be preferable to utilise the drugs as follows: Samorin - prophylaxis of cattle moving into riverine (high risk tsetse areas); Berenil and homidium - treatment of infected cattle returning from riverine areas. Berenil and homidium should be alternated annually.

Losses from disease can derive both from increased mortality and through reduced efficiency of utilisation of available nutrients. Financial losses may result from failure to comply with the International Zoo-Society Code and the imposition of import bans.

2.8.1 Mortality

Annual herd mortality rates have been estimated for Bay Region (Table 2.18) by HTS (1982) and for Somalia as a whole (Table 2.19).

TABLE 2.18 THE ANNUAL MORTALITY RATE (%)

	No. of herds	<12 months	>12 months	Overall	Abortions[1]
Cattle	26	7.8	0.9	2.2	1.4
Camels	18	7.9	1.1	2.3	2.5
Sheep/Goats	15	17.1	3.8	4.3	2.4

Notes: [1] *Abortions as a percentage of breeding females.*

Source: *Hunting Technical Services 1982.*

TABLE 2.19 ESTIMATED LIVESTOCK MORTALITY

	Adult Mortality			Calf/Kid/Lamb Mortality		
Species	Estimated[1] Population	Mortality Rate	Estimated Annual Losses	Estimated[1] Population	Mortality Rate	Estimated[2] Annual Losses
Cattle	2 792 500- 2 867 900	5-8%	139 600- 229 400	854 200- 929 600	15-30%	150 700- 301 500
Camels	4 486 099	<5%	224 300	811 140	25%	231 800
Sheep	5 463 671	10%	546 400	3 968 649	30%	1 400 700
Goats	9 432 657	>10%	934 300	5 842 901	30%	2 062 200

Notes:

These estimates of livestock mortality are for years of normal rainfall. During years of drought, adult mortality would be significantly higher and calf, kid and lamb losses would be less, since little reproduction occurs under drought conditions.

1 *The calf/kid/lamb population are estimated in the following ways: (1975 census estimate) x (% female breeding animals in national herd) x (calving/kidding/lambing rate) x (1 - (50% of calf/kid/lamb mortality rate)). The last term is included, because we assume that half of the calf/kid/lamb crop for the year has already died at the time the estimates are made. The percentage of female breeding animals in the respective herds is based upon research findings for African herds and is assumed to be as follows: 45% for cattle, 50% for camels and goats and 55% for sheep. Birth rates, taken from the Agricultural Sector Review, are as follows: 60% for cattle, 35% for camels, and 90% for sheep and goats. The "adult" livestock population, which includes immature as well as mature stock, is calculated as a residual (Total Population - Estimated Calf/Kid/Lamb Population).*

2 *Annual calf/kid/lamb losses are calculated not as a proportion of the estimated calf/kid/lamb population but as a proportion of calculated births during normal (non-drought) years.*

Source: *Mortality rates are from the World Bank's Agricultural Sector Review, Annex 1, "The Livestock and Wildlife Subsector," December 1980. Livestock population figures are from the 1975 national census. Cited by Holtzman (1982).*

TABLE 2.20 ESTIMATE OF THE COST OF ONE PER CENT MORTALITY FOR DIFFERENT AGE AND SEX GROUPS OF CATTLE IN BAY REGION

	Age and Sex Groups of Cattle						
	Females 3yr+	Males 3yr+	Females 1 - 3yr	Males 1 - 3yr	Females 0 - 1yr	Males 0 - 1yr	Total
Herd Structure %	51.1	4.4	15.9	9.8	11.1	7.6	
No. of Animals (Head)	188 160	16 155	58 585	36 030	40 995	28 005	
1% of Total Animals (Head)	1 881	161	585	360	409	208	
Estimated Mean Value per Animal S.sh	2 500	5 000	1 500	1 500	500	400	
Capital Value of Stock m S.sh	470.4	80.7	87.8	54.0	20.5	11.2	724.6
Cost of 1% Mortality million Ssh	4.7	0.80	0.87	0.54	0.20	0.11	7.25

Source: HTS 1983

Data on mortalities arising from specific diseases and among different age and sex groups are not available. The estimates of high mortality in Table 2.18 among immature groups probably include young males intentionally slaughtered. The economic cost of disease is difficult to calculate because the information here is very limited. Diseases such as Rinderpest, which can cause high mortality in all ages of unvaccinated stock together with loss of the carcass can result in substantial financial loss. Black Quarter, which most commonly affects cattle from six months to three years of age also causes mortality of affected animals and total loss of the carcass. On the other hand, some animals with tick borne infections may be slaughtered for consumption.

Any estimate of the cost of disease requires a more detailed analysis of specific mortalities than is possible to date. It also requires regularly monitored information of herd and flock structure so that specific mortalities can be applied to different age and sex groups for the species concerned. The different groups are of markedly different economic significance. Table 2.20 illustrates estimates of the value of one per cent mortality applied to different age and sex groups for cattle. The estimates are based upon the herd structure recorded by field survey.

Rinderpest which can result in high mortality of all age and sex groups of unvaccinated stock could result in severe losses. For example 80 per cent mortality applied to the Bay Region herd would result in a loss of approximately Ssh 580 million of stock. The prime importance of effective vaccination cover for the prevention of Rinderpest is obvious.

Mortality among breeding female cows is likely to be of considerable significance to farmers because of the potential magnitude of the financial loss. The cost of one per cent mortality (Table 2.20) amongst breeding females would be at least S sh 4.7 million. This estimate is calculated using an average value of Ssh 2 500 a cow and may be an under-estimate. Good breeding cows offered in the market have a value up to S sh 6 000 (such cows are, however, rarely sold). The control of ticks which can transmit diseases such as Anaplasmosis is therefore of great practical importance to farmers.

Mortality amongst growing cattle aged one to three years from Black Quarter would cost S sh 2.6 million per annum if mortality were as high as three per cent in females of this age group.

The value of trade stock which pass through Bay Region per annum is estimated at S sh 100 million (Table 2.21). The cost of one per cent mortality among these stock would be S sh 1 million. The actual loss to the Somali economy would in fact be considerably greater than this as a hard currency loss is involved. The calculation of such a loss is confounded by several factors.

TABLE 2.21 ESTIMATED CAPITAL VALUE OF TRADE STOCK PASSING THROUGH BAY REGION AND THE COST OF ONE PER CENT MORTALITY

Trade Cattle Passing through Bay Region (Heads)	20 000
Estimated Mean Value / Animal	5 000
Estimated Capital Value of Stock (million Ssh)	100.0
Cost of One Per Cent Mortality (million Ssh)	1.0

Source: Hunting Technical Services Limited 1983.

2.8.2 Loss of Animal Production Efficiency

Substantial losses are incurred due to the loss of production efficiency through mortality and through conditions which may not always cause mortality. Losses due to endoparasites and ectoparasites represent the most important of these. The determination of such losses is complex because the magnitude of decreased growth due to parasitism alone is difficult to evaluate. There is an interaction between disease and nutrition which together affect growth rate of parasite infested animals. The loss of production efficiency is ultimately manifest through a decrease in lifetime energy conversion efficiency of the animals. Where feed and grazing is adequate a reduction in growth rate of calves and small stock of up to 25 per cent due to parasitism may be expected in individuals.

2.8.3 Endoparasite and Ectoparasite Control

Treatment for the control of husbandry conditions including ectoparasites (ticks) and endoparasites (various intestinal worms) are only available from the veterinary department. Materials available are unsuitably packaged for small farmers and are obtainable in limited amounts. Ectoparasite (tick) control concentrate fluid (Coopertox) currently available in the Veterinary Department is in large drums (5 US gallons). This form of package is intended for large farm and ranch use with mechanical spraying apparatus. Small quantities required by farmers are decanted into unlabelled bottles and containers. Coopertox concentrate contains an organochlorine compound (Toxaphene) of high mammalian toxicity and requires dilution with water at the rate of 1 in 150 before use. The current form of presentation is unsafe for users. Anthelmintics (for control of intestinal worms) are available in the veterinary department in large powder packs. These require specialist knowledge to ensure correct mixing and safe dosage rates. Anthelmintics in easy-to-apply tablets and bolus form at the correct dose rate are largely unobtainable by small farmers. The current supply system for endoparasite and ectoparasite treatment results in almost no effective application of control measures at producer level.

3

Existing Livestock Services

Official livestock support services in Bay Region include veterinary and rangeland development. Both services come under the Bay Region Agricultural Development Project.

3.1 VETERINARY SERVICE

The objective of the veterinary component of the Project is to strenghten the existing regional veterinary service previously under the control of the Director of Veterinary Services of MLFR. This was to be achieved by providing the manpower, buildings, laboratory and field equipment, and vehicles necessary to service all four districts in the region.

Three grades of technical staff are employed:

(a) **Veterinarians**
Since 1978 these have been graduates of the veterinary faculty of the University of Mugdisho.

(b) **Veterinary Assistants (VAs)**
Secondary school graduates of the veterinary school in Mugdisho, with two years' training.

(c) **Dispensers**
Staff with adult education certificates in Somali who have received 3 - 6 months training followed by examinations in the veterinary school.

In April 1981, an expatriate Veterinary Advisor was appointed under a USAID contract and in August 1981 the regional veterinary staff were transferred from the MLFR to the Project. The present location of offices and dispensaries and deployment of staff are shown in Table 3.1. Seasonal dispensaries operate in the rains in areas used by transhumant stock but deserted during the dry seasons.

The veterinary service has 6 Chevrolet pick-ups, 1 Chevrolet utility pick-up and 1 GMC lorry deployed as follows:

Baydhabo HQ	3 pick-ups
Buurhakaba District Office	1 pick-up
Diinsoor	1 pick-up
Qansaxdheere	1 pick-up
Vaccination Team 1	1 GMC lorry
Vaccination Team 2	1 pick-up

The pick-ups in Buurhakaba, Diinsoor and Qansaxdheere are shared with the agricultural department staff.

TABLE 3.1 ORGANISATION OF BAY REGION VETERINARY SERVICE - AUGUST 1983

Regional Level (Officies, dispensary laboratory, stores)	HQ Staff	1 Veterinary Advisor 1 Administrative Coordinator 1 Deputy Technical Coordinator 1 Veterinarian (laboratory) 1 Technician (VA) 1 Storekeeper (VA) 1 Vaccine Attendant 8 auxiliary staff (clerks, drivers, etc.)	2 Mobile Vaccination Teams	1 Zonal Officer (VA) 3 Vaccinators (VAs) 2 auxiliary staff
District Level (Offices)	**Baydhabo** 1 DVO (VA) 1 Meat Inspector (VA) 2 auxiliary staff	**Buurkhabaka** 1 DVO (VA) 3 VAs 1 Dispenser 3 auxiliary staff	**Diinsoor** 1 DVO (VA) 1 VA 2 Dispensers 1 Meat Inspector 3 auxiliary staff	**Qansaxdheere** 1 DVO (VA) 4 auxiliary staff
Sub-district	5 Dispensaries 3 Seasonal Dispensaries	1 Dispensary 3 Seasonal Dispensaries	3 Dispensaries 3 Seasonal Dispensaries	2 Dispenaries

Total staff = 63; 4 Veterinarians, 17 Veterinary Assistants, 15 Dispensers, 27 auxiliary.

3.1.1 Mass Vaccination

The main function of the veterinary service is to conduct vaccination campaigns against the most important infectious diseases of the region, principally Rinderpest and Black Quarter. The vaccines are produced and supplied to the regional veterinary service by the MLFR Serum and Vaccine Institute in Mugdisho. Animals in the region are vaccinated free-of-charge and the recorded vaccinations are shown in Table 3.2.

TABLE 3.2 NUMBER OF ANIMALS VACCINATED BY BAY REGION VETERINARY SERVICE - 1978 TO JUNE 1983

Diseases	Species	1978	1979	1980	1981	1982	1983 (To June)
Rinderpest	Cattle	76 690	49 680	26 520	43 000	82 890	137 916
Black Quarter	Cattle	73 093	89 656	69 890	106 950	85 164	121 713
Anthrax	Cattle	12 600	33 360	10 500	21 174	4 000	1 000
CBPP	Cattle	2 360	28 930	3 560	Nil	10 580	Nil
FMD	Cattle	568	Nil	Nil	Nil	Nil	Nil
CCPP	Goats	Nil	15 974	11 000	2 907	Nil	Nil

Source: Veterinary Department, Baydhábo

Under the Project, the vaccination teams are directly controlled by HQ staff and not the DVOs, as was formerly the case. The teams operate mainly in the Jilaal and Haggai dry seasons when livestock are reasonably accessible by vehicle and are concentrated around water points and in areas where sorghum stover is available for feeding. In the rainy seasons, livestock are scattered and the staff of the vaccination teams are redeployed to operate temporary seasonal clinics.

Cattle vaccinated against Rinderpest should be marked with an ear-punch, although it appears that this procedure may not always be carried out. Adequate control requires that immature stock be re-vaccinated after one year if they were less than one year at the time of first treatment. Adult cattle should therefore show at best two ear-punches. The results of a survey of 20 417 cattle in Bay Region (Table 3.3) show a low percentage of animals with two or more ear-punches.

In the absence of ear-punching, confirmation of the degree of vaccination cover can only be obtained by taking blood samples and testing levels of antibodies. This procedure is within the capacity of the Veterinary Laboratory in Mugdisho and as effective monitoring of the performance of the vaccination teams is essential, arrangements should be made to routinely test representative numbers of cattle after vaccination.

3.1.2 Curative Services

A function which is accorded high priority by the veterinary staff is the dispensing of drugs. Apart from the dispensaries in the district headquarters, there are two other permanent dispensaries at Uforow and Yaaq Braawe. A new one has been completed in Baydhabo and there are eight other dispensaries in rented accommodation at the sub-district level. Nine seasonal clinics provide wet-season work for vaccinators in the mobile team.

TABLE 3.3 SURVEY OF CATTLE VACCINATED AGAINST RINDERPEST ON THE BASIS OF EAR-PUNCHES (AUGUST 1983)[2]

Location	Number of Ear-Punches[1]								
	Cows			Bulls			Immature Cattle		
	0	1	2/3	0	1	2/3	0	1	2
Qansaxdheere	793	322	291	280	132	160	985	135	20
Berdaale	1 099	166	20	162	8	-	1 040	-	-
Buurhakaba	8 775	155	9	1 110	13	2	4 649	-	-
Uforow Road	47	10	2	1	-	1	30	-	-
Total	**10 714**	**653**	**322**	**1 553**	**153**	**163**	**6 704**	**135**	**20**
	(91.6%)	(5.6%)	(2.8%)	(83.1%)	(8.2%)	(8.7%)	(97.7%)	(2.0%)	(0.3%)

Source: *HTS 1983*

Notes:
[1] *Cattle vaccinated at less than one year of age need to be revaccinated. Thus adult cattle would be expected to have at least two ear punches and immature stock one ear punch.*
[2] *Survey conducted by three enumerators counting ear punches of cattle using wars and boreholes for watering. Total cattle observed represents approximately 5 per cent of the total cattle numbers in Bay Region.*

Prior to the Project, drugs were supplied by the MLFR, some of which were dispensed free and others were charged. The charges represent the cost price plus a percentage to cover transport, wastage etc. Under the BRADP, drugs are supplied by USAID, the revenue from which is transferred to a revolving fund to purchase replacement drugs. As these drugs must be supplied only by US companies, many of them are different from those used by MLFR, but the policy for charges is similar. Unfortunately some essential drugs are not available from US companies, notably trypanocides, and the MLFR has continued to supply them to the Bay Region.

3.1.3 Laboratory Diagnostic Services

The laboratory consists of two rooms in the Regional HQ in Baydhabo. They are poorly equipped and serviced. The laboratory, is run by one veterinarian and one veterinary assistant both of whom received one months training at the Vaccine and Serum Institute, Mugdisho in March 1982. The staff are inexperienced, have no transport and have not carried out any significant studies or surveys. Laboratory equipment ordered in January 1981 has been delivered and a second order placed in October 1982 is awaited.

3.1.4 Meat Inspection

No meat inspection per se is carried out. Two meat inspectors, one in Baydhabo and one in Diinsoor, inspect animals the day before slaughter and mark those healthy and fit for human consumption by a rubber stamp. The following morning a further inspection is made at the slaughter points to ensure that only those stamped are slaughtered. No further action is taken. Outside Baydhabo and Diinsoor, these duties are performed by available veterinary staff. There are no slaughter houses in the region although one was partially built in Baydhabo.

3.2 RANGE SERVICE

The objectives of the range component of the Project were to assist with control of grazing and range utilisation and to support integration of crops and livestock production.

These objectives were to be achieved through four Pilot Agricultural Development Units (PADUs). Each PADU was to have the potential to accommodate about 750 families with approximately 7 500 ha of cultivable land and approximately 55 000 ha of associated rangeland. Range areas were to be demarcated for rotational grazing. Alternative ways of bush clearing and reseeding with appropriate legumes and grasses were to be identified.

To implement this subcomponent, the IDA Appraisal Report (para. 4.14, IDA, 1979) stated that the regional unit of NRA would be brought under the direction of the PMU during the investment period and that it would be strengthened by an internationally recruited Range Management Specialist.

For reasons which are elaborated in Chapter 5 of this Annex, the PADUs were abandoned as impracticable. No internationally recruited specialist was assigned to the Project by USAID who await the recommendations of the Mid-Term Review on the future range programme.

The Project has nonetheless taken over the range work of the NRA (excluding forestry and wildlife) and the administration of eight range reserves. The NRA advises the Project on the opening dates (dry season) and the closing dates (wet season) of the reserves; they are normally closed 15 April to 15 July and from 15 October to 15 January, though actual timing depends on the rains. The reserves are listed in Table 3.4.

TABLE 3.4 RANGE RESERVES IN BAY REGION

District	Name of Reserve
Baydhabo	Ribo
	Idaale
Diinsoor	Safar Nooleys
	Ooka'aan
	Dheerow Saanle) near Yaaq Braawe
	Buulo Ooman)
Buurhakaba	Daabaan
	Weel Kabhan

Each reserve has at least one war built with EEC assistance and NRA has drilled 21 boreholes, mostly in the reserves. Watering is controlled by NRA staff who also collect the fees. These staff do not come under the jurisdiction of BRADP.

Range reserves each have an area of 1 000 km². They were originally demarcated by boundary markers which were maintained annually by NRA. Currently reserves are not positively identified except by paint marks on some boundary trees where boundaries coincide with main roads. The reserves are meant to be used by nomadic people and settlements are excluded. However, the reserves are accessible to both settled and transhumant owners. Some reserves are utilised as informal holding grounds for trade stock which are collected and pass through the region for export. Animals for shipping from Mugdisho pass through the reserves near Buurhakaba.

The reported administrative structure of BRADP Service in August 1983 is shown as follows:

Project Director
Head of Range Service
Deputy Head of Range Service

Accountant	Senior Range Assistant	Range Guards (80)
Secretaries (2)	Range Assistant	
Drivers (2)		
Watchmen (2)		

Each range reserve has ten guards who are paid S sh 120 each per month and WFP food rations. The range guards are responsible for monitoring the grazing around the wars and guarding the reserves in the dry season.

4

Current Plans

4.1 VETERINARY SERVICE

According to the project documents (para. 34, Annex 4, IDA, 1979) provisions were made to build 13 new dispensaries, rehabilitate 17 existing dispensaries and equip all 30 with a small yard and crush for handling animals. In fact, at the time of appraisal, there were only two existing dispensaries (i.e. housed in permanent buildings owned by the Veterinary Department) at Uforow and Yaaq Braawe; the remaining dispensaries were all rented houses constructed from local materials. This situation has not changed.

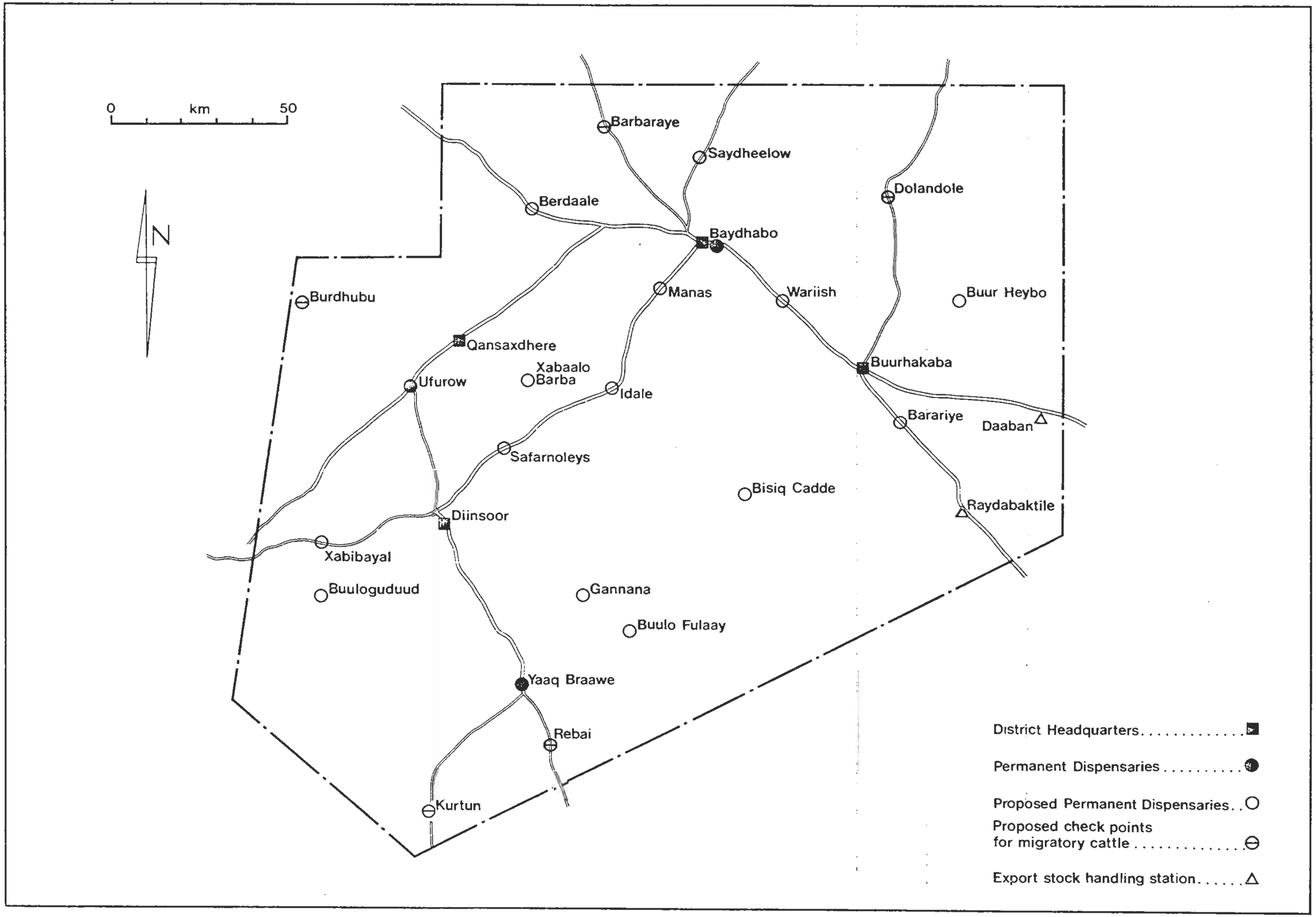
The project documents did not include new buildings at the Regional H.Q. in Baydhabo, but a new veterinary store was constructed in 1982 with PL 480 funds (cost S sh 82 000). A new dispensary in Baydhabo town near the new livestock market was completed in mid 1983, again with PL 480 funds (cost S sh 200 000). It has two rooms and a yard with a small crush and foot-bath for sheep and goats and provides a good model for similar new buildings in the Region. PL 480 funds have also been approved for 20 other foot-baths to be attached to dispensaries and for 5 facilities of similar design to the new clinic in Baydhabo. These proposed facilities have been designated "check-points" as they are principally for migratory stock which move into the Region from the Jubba and Shabeelle, Bakool and Gedo.

Under the IDA/IFAD loan agreement, Norconsult have prepared designs for a new veterinary store and laboratory and seven new dispensaries in unspecified up-country areas. The Veterinary Department has proposed 19 new dispensaries or check points (see Figure 4.1).

4.2 THE RANGE SERVICE

Plans for the development of the range work of the Project have been shelved until recommendations of the Mid-Term Review can be considered. The stores and office for the range component are included in the Norconsult building designs to be implemented in 1984.

4.1 Proposed Dispensaries and Check Points



5

Rationale for Livestock Development

5.1 ORGANISATIONAL CONSTRAINTS

5.1.1 Range Development

The range management work of the Project has been a disappointment to both the NRA and the project staff. Much of the blame for this must be with the impracticability of the original PADU concept. This has now been dropped for the following reasons:

(a) It was based on the assumption that large areas of range could be enclosed for the use of a select group of resident stock-keepers, thus denying the traditional rights of transhumants, increasing stocking rates in adjacent areas and removing the option for residents to seek grazing in other areas in dry years. In areas of low and uncertain rainfall, grazing rights are fiercely asserted by traditional users which creates difficulties in the recruitment of conscientious range guards.

(b) The PADU concept assumed that the production of animals and crops was separate and unrelated. In retrospect, it is abundantly clear that the crop and livestock management systems of the project area are both complex and closely integrated. They constitute a highly developed and intelligent adaption to the resources and opportunities of the region, with a large measure of in-built security.

(c) The highly mechanistic proposals for the allocation of land and field trials would demand managerial and technical manpower, which is presently not available, as well as a high degree of local cooperation. In this respect the so-called pilot development would not be replicable elsewhere.

Having taken over the NRA staff for the implementation of the PADUs, the Project has become saddled with an outdated NRA programme as its only range development activity. However, NRA acknowledges that range reservation, as generally practiced, does not result in increased range productivity. A preliminary review of 32 reserves in the Central Rangeland Development Project (CRDP) found that both the management system and the boundaries were vaguely defined. Little or no improvement was observed in the range reserve compared with adjoining areas (Wilkes, Somali Range Bulletin, June 1983). The reasons for this may be summarised as follows:

(a) Sites for grazing reserves were selected arbitrarily without supporting resource information.

(b) No attempt had been made to determine which pastoralists should use the reserves, when and to what intensity.

(c) Unregulated use in the open season negates the benefits of closure.

(d) Little attention had been given to the management of areas adjoining the grazing reserves.

The CRDP is developing an approach involving the formulation of a comprehensive range management plan for each district based on a detailed analysis of grazing resources and seasonal occupance by different classes of livestock. Their proposals are still in the experimental stage; they require close cooperation with users, the formation of grazing associations and a district committee to share management with the NRA. Given the manpower and budgetary resources of BRADP and its failure to develop a participatory approach, a region-wide range programme is clearly beyond the capacity of the Project. Such a programme could only be undertaken by a large sectoral project such as CRDP. Even then, the chances of success must be considered slim.

It is also recognised that techniques aimed at the reclamation of local range areas such as bush clearing, bunding, chisel-ploughing, reseeding, etc. (see paragraphs 20 - 30, Annex 4, IDA, 1979), are costly and necessarily confined to small areas, benefitting few people and of low reliability in regions of irregular rainfall. Under conditions in which access of grazing animals can be controlled, there may be economic justification, but on the open range any benefits are quickly swallowed up before they can be seen.

5.1.2 Development of the Veterinary Service

The environmental conditons in Bay Region are a serious challenge to the effective implementation of an animal disease control programme. Much of the area used by livestock is inaccessible and is covered with dense bush through which motor vehicles are unable to pass. For three to four months of the year, the few motorable tracks are closed to wheeled transport. During the dry parts of the year water for spraying is difficult to obtain. Mains electricity supplies are available only in Baydhabo and even this is uncertain due to periodic fuel shortages.

Added to those problems are the seasonal movements of the livestock which, due to the unreliability of the rains, are difficult to predict. This creates problems in the implementation of vaccination programmes and impedes the understanding of the epidemiology of animal diseases, especially parasitic diseases.

Instances are reported of owners refusing to have their animals vaccinated or agreeing to vaccination but refusing permission for the internationally accepted ear-punch. This makes vaccination difficult to monitor and therefore sustain at adequate levels.

Knowledge of the various animal diseases in the region is little better now than it was at the beginning of the Project which prevents adequate planning of disease control and placement of infrastructure.

There is a shortage of experienced veterinary staff. The veterinary faculty at Mugdisho has been open for only a few years and most veterinarians lack practical field knowledge. There is also a dearth of qualified technicians to carry out tests, maintain and service equipment and repair it when it goes wrong. All those problems add up to a serious handicap for the implementation of any successful disease control programme.

Construction of dispensaries and check points in up-country areas for the distribution of drugs is high on the list of Veterinary Department priorities. The MLFR recommends a permanent building together with a house for the dispenser recruited and trained by the Department. The Consultants are informed that, if dispensers are to be relied upon to work in remote areas throughout the year, it is better that they be selected by the community they are meant to serve. Dispensers drawn from the locality find a building of traditional construction acceptable and one could be constructed by the people for the purpose. The problem with this approach is that the Veterinary Service would lose control over drug distribution and the benefits which accrue; the flow of drugs would dry up.

5.2 ECONOMIC AND TECHNICAL CONSTRAINTS

The overall efficiency of the animal production system is a function of technical and economic efficiency. The former is frequently defined in terms of feed conversion efficiency, i.e. kg of feed utilised per kg of production. Economic efficiency may be defined as the relationship between the value of a kg of product and the cost of inputs required to produce a kg of product, e.g. the value of kg of liveweight and the cost of food, labour and medicines to produce it. Food remains the major input into the Bay Region animal production system. Technical and economic efficiency are linked through the cost of utilisation of a unit of nutrient energy in the production system.

Conversion efficiency of feed energy is influenced by several factors and declines as a greater proportion of total energy is utilised for maintenance rather than production. Overall efficiency:

- declines with age as animals grow;
- declines due to disease, e.g. caused by internal and external parasite burdens;
- is highest in adult ruminants producing milk.

Figure 5.1 illustrates the relationship between unit feed requirements per unit of product and feed prices for prevailing product prices.

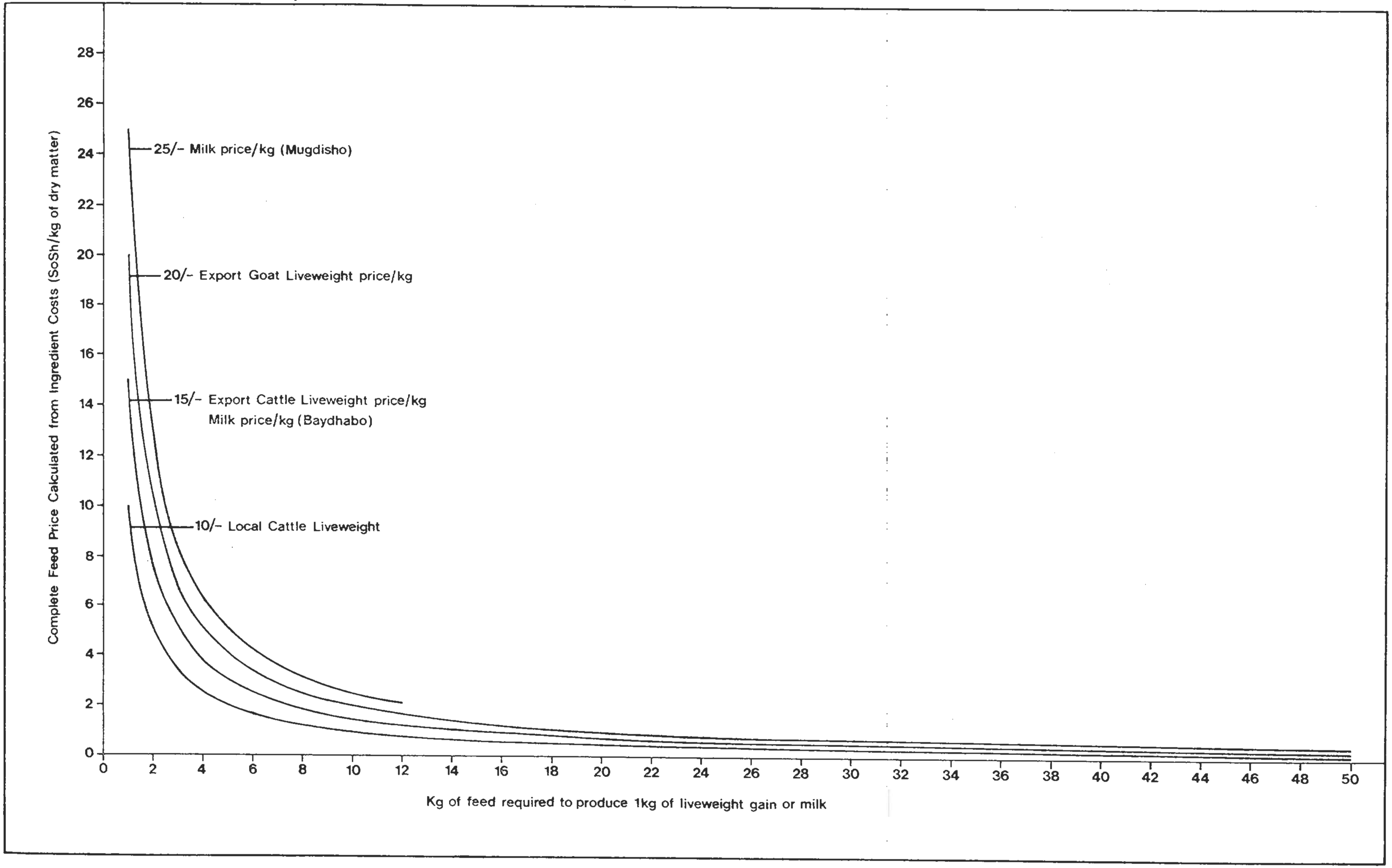
5.2.1 Intensive Meat Production

Given the technical efficiency of the local animals, the intensification of meat production would develop when the ratio between feed prices and meat prices is 1:7 or more. Thus, at a price of Ssh 15.0 per kg liveweight, intensification would be likely to occur when the cost of 1 kg of feed fell below Ssh 2.14 (see Figure 5.1). Basic grain prices in local markets in Bay Region (e.g. Baydhabo) are currently about Ssh 3.0 per kg and more costly outside (e.g. Ssh 8.0 per kg in Mugdisho). At current prices of grain and crop by-products an intensive beef system is unlikely to be profitable.

5.2.2 Extensive Cattle Production

This system was briefly described in sub-section 2.6.2. An analysis of milk and meat production under range conditions suggests that extensive milk production operates at an overall feed conversion efficiency of approximately 19 kg of feed to 1 kg of milk (Table 5.1). Growing male stock achieve comparable feed conversion efficiencies up to two years of age after which the decline in efficiency for meat production is substantial (Table 5.2). The removal of all males not required for breeding and work purposes is therefore a logical adaptation to maximum production from available nutrient resources. Similar management practises are observed in goat flocks and camel herds.

5.1 Price Relationships for: Feed/Beef, Feed/Goat, Feed/Milk.



5.2.3 Artificial Insemination

No artificial insemination service for cows exists in Bay Region. Artificial insemination facilities are available in Afgoi near Mugdisho. The main demand from the service, however, is for the supply of cross bred bulls (Sahiwal x Local Stock : Dwara). The benefits of increased milk production potential per cow through cross breeding are achieved when adequate nutrition, animal health and husbandry management can be applied. Crossbred animals are heavier than the liveweights of comparative local breeds and thus their maintenance requirements are increased. Table 2.14 shows the increased energy requirements for maintenance for dairy cows from 300 kg to 650 kg liveweight. The dairy maintenance energy requirement increase from 36 to 67 MJ of ME, equivalent to the difference in nutrient energy values between 3 kg of sorghum bran and 6.6 kg of sorghum bran.

In order to achieve increased production potential from crossbred stock the ratio between nutrient energy used for production and nutrient energy used for maintenance should improve. Table 5.3 shows that a 19 per cent increase in milk yield must be achieved for a crossbred cow of 400 kg liveweight to achieve the same energetic efficiency as a 300 kg liveweight cow (Dwara) which is fed to achieve high milk production (600 litres in a lactation). Unless substantial yield increases are achieved in milk production farmers are unlikely to use artificial insemination services. Establishment of AI services within the extensive dairy production system of Bay Region would be unlikely to yield the returns to producers to justify AI operations.

5.3 STRATEGY FOR BRADP SUPPORT TO LIVESTOCK

Given the manpower and budgetary resources of BRADP and its failure to develop a participatory approach, a region-wide range management programme is clearly beyond the Project. Further, range users are not circumscribed by the administrative boundaries of the region, which they cross as they move to the perennial water sources along the Jubba and the Shabeelle. An inter-regional range development programme could be undertaken only by a large sectoral project such as CRDP, currently being implemented by the National Range Agency in Central Somalia. It is recommended that, in these circumstances, the staff of the project range section return to their parent agency in Stage II.

The problem is to identify a programme of work which will assist stock-keepers in the region and which is within the capacity of the Project to implement. For this purpose it is necessary to return to first principles and examine the nature of the farming system and the role of livestock.

Bay Region is inhabited by settled and transhumant agro-pastoralists, the majority of whom grow a dual purpose (forage and grain) sorghum variety. Livestock are retained principally for milk production and fed on crop by-products and range plants. The feed supply from crop by-products is more sensitive than range to the amount and distribution of rainfall. In good seasons, when the crop is heavy and the water in wars remains longer, the animals are retained close to the homestead. In dry years they may remain in distant range areas.

5.3.1 Animal Feed

The livestock include both large and small ruminants, the grazing and browsing habits of which allow the utilisation of a wide spectrum of plants produced by the farm/ rangeland system. The combined system ensures levels of animal production which are superior to those which would be achieved from range alone.

The supply of animal feed, in the form of crop by-products is undoubtedly constrained by the scarcity of farm labour at critical times of the year. The planting of forage crops

TABLE 5.1 ESTIMATED FEED CONVERSION EFFICIENCY OF A COW UNDER TRADITIONAL BAY REGION EXTENSIVE HUSBANDRY PRODUCTION SYSTEM[1]

Nutrient Energy Requirements (24 months)

	MJ ME per day		Days	MJ ME Total
Maintenance	36	x	547	19 692
Maintenance and Pregnancy	59	x	183	10 797
Sub-Total				30 489
Milk Production 260 litres x 6				1 560
Total				32 049

If range feed has an average energy density of 7 MJ ME per kg Dry Matter, total energy requirement would be derived from 4 600 kg of feed.

$$\frac{4\ 600 \text{ kg Feed}}{260 \text{ kg Milk}} = 17.6 \text{ or feed conversion of about 18 to 1.}$$

Source: *Hunting Technical Services Limited, 1983. Based upon nutrient energy requirements for dairy cows. Nutrient Allowances and Composition of Feeding Stuffs for Ruminants. Booklet 2087, Ministry of Agriculture, Fisheries and Food, UK (1980).*

Notes: *Assumptions: Cow 300 kg liveweight : Calving Percentage 50.*

TABLE 5.2 ESTIMATED FEED CONVERSION EFFICIENCY OF A GROWING BEEF ANIMAL UNDER TRADITIONAL EXTENSIVE HUSBANDRY SYSTEM IN BAY REGION

	Age of Cattle						
	12m		16m		24m		30m
Liveweight (kg)	70		100		150		175
Feed Consumed (kg)		411		964		685	
Daily Gain (kg)		0.250		0.200		0.138	
Liveweight Gain (kg)		30		50		25	
Conversion Ratio (kg feed/kg gain)		14:1		19:1		27:1	

Source: *Hunting Technical Services 1983. Based upon nutrient energy requirements for beef cattle. Nutrient Allowances and Composition of Feeding Stuff for Ruminants. Booklet 2087, Ministry of Agriculture, Fisheries and Food UK. (1980).*

TABLE 5.3 PRODUCTION INCREASE REQUIRED BY A CROSSBRED COW OF 400 kg LIVEWEIGHT TO ACHIEVE EQUIVALENT EFFICIENCY OF UTILISATION OF ENERGY COMPARED TO A SOMALI DAIRY COW (DWARA) INTENSIVELY FED

Somali Dairy Cow

		MJ ME
Requirement[2] for Maintenance	36 x 182 days	6 552
Requirement for Maintenance and Pregnancy	59 x 183 days	10 797
		17 349
Milk Production Requirement	6 x 600 L	3 600
Total Energy Requirement		20 949

Milk production requirement represents 17 per cent of total energy requirement.

Crossbred Cow

Cow Liveweight 400 kg : Calving Interval 12 months		MJ ME
Requirement for Maintenance	45 x 182 days	8 190
Requirement for Maintenance and Pregnancy	68 x 183 days	12 444
		20 634
Milk Production Requirement	6 x 714 L	4 284
Total Energy Requirement		24 918

Milk production requirement represents 17 per cent of total energy requirement.

To maintain equivalent efficiencies for the 300 kg and 400 kg cows a 19 per cent increase in yield is required from 600 to 714 litres.

Source: Hunting Technical Services 1983.

Notes:

1 *Assumes cow liveweight 300 kg : Calving Interval 12 months. With the more usual calving intervals of 15 months, milk production energy would represent approximately 14.5 per cent of total energy requirement.*

2 *Requirements are derived from Table 2.13. The convention of 6 months maintenance required and 6 months maintenance and pregnancy requirement is used.*

per se is not feasible, but the usefulness of the sorghum crop should not be underestimated.

Farmers give priority to establishing the dual purpose sorghum crop. Thus in the medium term, the main opportunity for increasing the animal feed supply must lie in increasing the volume of sorghum harvested by increasing labour productivity and reducing risks from plant pests and diseases. In the latter case, plant protection will be crucial. Under special circumstances, animal power can help the farmer overcome labour bottlenecks in planting and weeding in exchange for a higher labour input at other times (e.g. storing forage, carrying forage and water to stall-fed oxen). Only those households and communities able to mobilise large amounts of labour are able to capitalise on animal power. Difficult as the research task is, the prospect of improving the animal feed supply is better on the farm than on the open range.

5.3.2 Water Supplies for Livestock

For the Project, other beneficial ways of helping range users lie in the provision of water for livestock and veterinary services. Water provision could provide a major opportunity for extending the pastoral resource, both geographically and seasonally. However, a more detailed knowledge of the availability and use of water for livestock (wars, hand-dug wells, springs) during dry periods of varying intensity is required prior to further investment in water supplies for livestock and this investigation should be part of the water supply programme in Stage II (see Annex 4). This should not detract from the recommendation that the planning development and operation of water points in range areas (i.e outside the cultivated/settled areas) be placed under the aegis of the National Range Agency. In the project term, 1984 - 1986, the water supply construction programme will be confined to the cultivated/settled areas on the clay and clay loam soils.

5.3.3 Veterinary Services

If livestock production is to be sustained at present levels a health programme is essential to reduce mortality rates and prevent a loss in food conversion efficiency.

The export trade with Saudi Arabia is expected to place demands on the Veterinary Service to comply with the International Zoo-sanitary Code (1976). Cattle must be quarantined for 21 days prior to shipment and have received vaccinations against Rinderpest, FMD, CBPP and Anthrax. On the other hand, the majority of pastoralists rear livestock primarily as a means of subsistence and request help from the Veterinary Service only in an emergency. The different requirements of subsistence producers and traders must be taken into account when proposing future animal health measures.

Of the infectious diseases threatening livestock in Bay Region, Rinderpest is the most serious. Since the JP15 campaign, Somalia has enjoyed relative freedom from the disease, but it is now present in neighbouring countries and it is vital that an adequate vaccination cover is maintained. Black-quarter is another killer disease and justifies mass vaccination along with Rinderpest. Effective preventative measures against these diseases should be the first priority. Unless an outbreak occurs, other vaccinations may be reserved for trade stock in the holding areas at Buurhakaba and Raydabaktile.

Investigation into the epidemiology of the important diseases of the area should be the second priority. According to the records of drugs dispensed, the greatest demand by livestock owners is for control of ticks, trypanosomiasis and pneumonia, foot-rot and helminthiasis in small stock. None of these problems have been studied sufficiently to allow a rational control programme to be developed. Recently a paralytic condition of camels has caused high mortalities in the Yaaq Braawe area. Stock-owners attribute it to a tick that has spread to the region within the last two years. The situation requires investigation.

There is a shortage of reliable information on the incidence, prevalence, morbidity and mortality of the important diseases. Laboratory staff are very inexperienced and unable to carry out the most basic diagnostic work. There is clearly a need for a suitably qualified veterinarian with a background in investigative work and an aptitude for training intermediate technical staff in routine laboratory procedures.

The third priority is for the rationalisation of the curative services in the region, but in many respects this must await progress on the investigatory side.

6

Livestock Proposals for Stage II

Livestock husbandry in Bay Region is closely integrated with the farm and range system. It is efficient in both technical and economic terms given the resource base and the input/output price relationships which prevail. These circumstances are not expected to change in the project term. Proposals for the livestock sector are therefore confined principally to animal health.

6.1 ORGANISATION OF VETERINARY SERVICES

In order to implement an effective health programme that would meet the priority needs described in Section 5 some reorganisation of the department would be required. At present, all four veterinarians are based in Baydhabo HQ and of the 17 trained veterinary assistants, only one is operating a dispensary. The Consultants recommend that the Veterinary Department in each district be placed under a qualified, university-trained veterinarian and that suitable housing (class C) be provided for DVOs in the district headquarters. District offices should also be upgraded.

The proposed organisation and staffing of the Veterinary Service in the region during Stage II is shown in Figure 6.1. The post of RVO currently occupied by a TA financed by USAID would be staffed by a Somali Veterinarian from the beginning of 1985 when the candidate returns from postgraduate training in the United States. At that stage a TA Veterinary Investigation Officer would be recruited. Veterinary Assistants would replace dispensers in all newly-constructed dispensaries (seven). The overall staffing in Stage II would increase by 3 veterinarians, 3 VAs 3 dispensers and 11 auxiliaries.

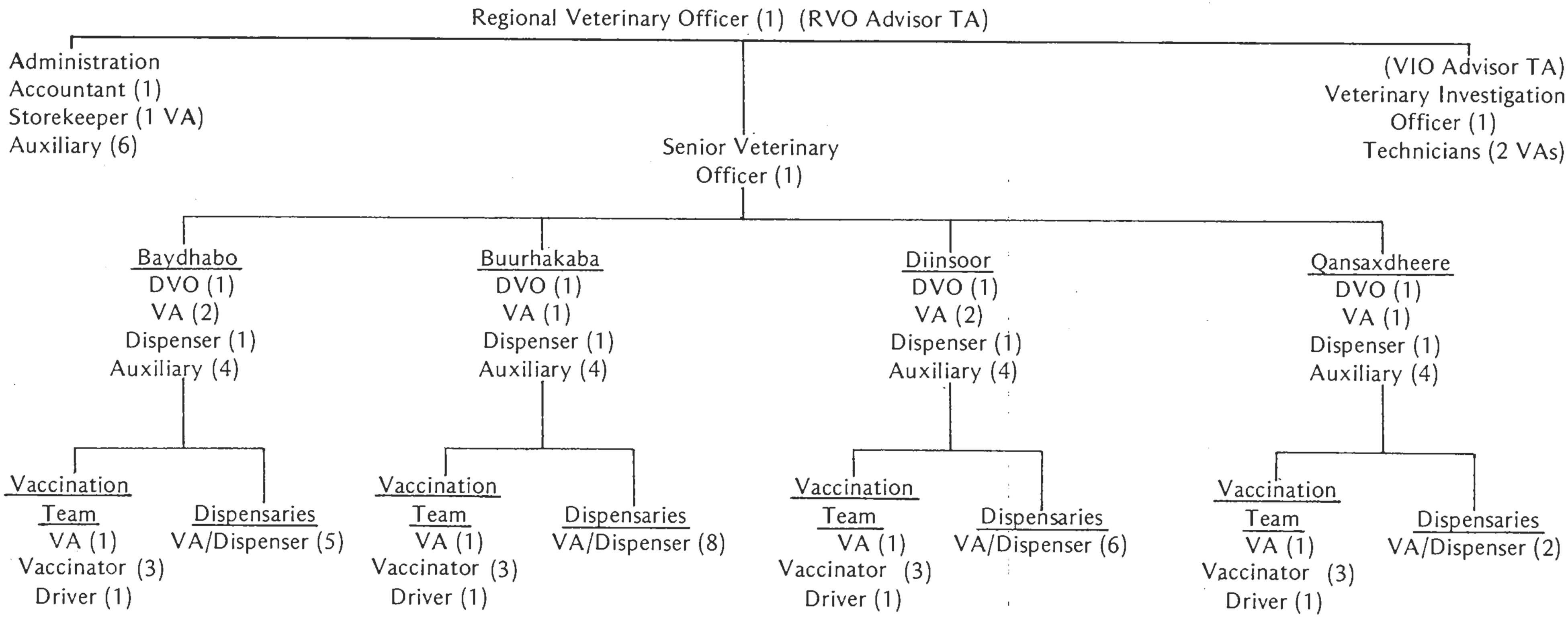
6.2 MASS VACCINATION

The two mobile vaccination teams currently attached to the Regional HQ would be redeployed so as to form four smaller teams, one in each district under the District Veterinary Officer. This should improve supervision and save time mobilising and travelling. District vaccination teams would need logistic support form HQ, two-way radio, additional transport and refrigeration plant. Vaccination equipment is already on order. Vaccine (0.25 M doses per annum for Rinderpest and Black Quarter) would be supplied by MLFR.

6.3 EXPORT STOCK HANDLING STATIONS

In view of the requirements for improved control measured for export cattle, two export stock handling stations would be provided at Dabaan and Raydabaktile, that is, one on each of the main livestock trek routes to Mugdisho. Facilities would include a vaccination and handling race, holding pens, spraying unit and an adequately equipped veterinary store with refrigerators. Trade animals would thus be partially prepared for

FIGURE 6.1 PROPOSED ORGANISATION AND STAFFING OF BAY REGION VETERINARY SERVICE 1984 - 1986



Total Staff	7	Veterinarians
	1	Accountant
	13	Veterinary Assistants
	25	VAs/Dispensers
	12	Vaccinators
	26	Other Auxiliary Staff

subsequent 21-day quarantine nearer the port. Unless cattle are trucked to the port, it would not be feasible to upgrade informal holding areas to quarantine stations. Full details of the health requirements for export stock are currently under investigation by the MLFR.

6.4 DISEASE INVESTIGATION

The Consultants recommend that Government request USAID to provide a suitably qualified veterinarian to mount an investigation into the epidemiology and incidence of the important diseases in the region. The ToR of the current expatriate veterinarian called for broad professional experience including administrative experience, but in Stage II a background in technical investigation of diseases would be required. The candidate would also be responsible for commisioning the new laboratory and training laboratory staff. Housing and transport would be provided by the Project.

If it is decided not to proceed with the construction of a new laboratory under the IDA building programme, it will be necessary to upgrade the existing two rooms by providing laboratory benches and hot water, and by supplying the following items of equipment:

- generator
- laboratory incubator
- refrigerator freezer
- drying cabinet
- bench centrifuge
- microhaematocrit centrifuge and accessories
- EEL colorimeter
- 4 McMaster slides
- a supply of reagents and media.

6.5 CURATIVE SERVICES

The Veterinary Department has plans for the operation of 19 dispensaries/check points at the sub-district level in Stage II (see Figure 4.1). Seven of these would be housed in newly constructed buildings if the IDA/IFAD funds allocated for the building programme prove sufficient. In the absence of funds for new buildings, the Department would continue to use rented accommodation or dispensaries constructed with local materials. Well-built traditional houses are spacious and cool and could make good village dispensaries. Without electricity and water, concrete and stone buildings offer few advantages over traditional designs. In addition to the operating costs (salaries, rents, materials and supplies), the Project would provide basic equipment for these dispensaries (small table, chair, small cupboard, primus stove, metal dish for sterilizing syringes).

The curative services provided in the Region would be dictated by the results of the investigation programme, but as such a programme can take two to three years before useful results are available, interim measures will be required.

6.5.1 Routine Veterinary Procedures

No change in policy is required and the investigation programme may have little bearing on many of the day-to-day health problems, e.g. attention to wounds, dystocias, etc.

6.5.2 Foot Rot

Efforts will be made to put the three existing foot-baths in the Region into operation as the implementation of a region-wide foot-bath programme will entail the solution of certain logistic problems which need to be resolved in a pilot programme.

6.5.3 Trypanosomiasis

The procedures for the use of trypanocides described in Section 2.8 should be followed. Treatment of *T. evansi* in camels with Naganol can continue as in the past until such time as more information on the epedemiology of this disease is available.

6.5.4 Parasite Control

In the semi-arid climate of Bay Region in which grazing and watering patterns are dictated by seasonal rainfall, internal and external parasite infestations are likely to be seasonal. These factors require careful study before recommendations for treatment can be made. In the near future efforts should be concentrated on the proposed villages in the Pilot Village Development programme described in the Main Report.

Parasite control treatments are currently available only through the Veterinary Department. Supplies are inadequately packaged (see Subsection 2.8.3). It is proposed that the Project assist in making appropriately packaged ectoparasite and endoparasite control treatments available through the proposed, district-level, farm input shops (see Annex 1 and Main Report). This would be accompanied by demonstrations conducted by VAs, focussing on the proposed villages in the pilot programme.

In the longer term, control treatments would best be provided through the supply channels used for the distribution of human medicines to the population of Bay Region. Importers in Mugdisho currently purchase human medicines from the major drug supply companies who also manufacture animal health products. Examples would be Loxon anthelmintic, available in tablet form manufactured by Coopers Burroughs Wellcome and Rintal anthelmintic, available in tablet form manufactured by Bayer. Ectoparasite treatments include Gammotox available in 8 g sachets manufactured by Coopers, to mix 5 or 6 litres of tick wash for hand dressing.

Demonstration of tick and worm control would be carried out by four VAs attached to the Veterinary Department under the DVOs. The Project would provide each with a motorcycle, with fuel and appropriate allowances to pursue the following Terms of Reference:

(a) Demonstrate the use of ectoparasite control measures with appropriate packaged materials for small farmers' use in villages and farming communities in Bay Region.

To include:

(i) Mixing of powder and water in a container (not used for human foods) to make tick wash solution of the correct concentration specified by the manufacturers.

(ii) Application of tick wash by cloth or sponge to animals affected to demonstrate the importance of complete dressing for effective treatment, for example ears, undertail, udder, scrotum, dewlap.

(iii) Illustrations to farmers of the relevance of tick control and its benefits with simple posters and pictures. Copies of the publication on tick control by Coopers should be requested through the commercial suppliers, one for each demonstrator. Appropriate posters are also available.

(iv) Demonstration of cleanliness and avoidance of contamination of individuals clothing, food, and water to teach general safety in use of ixodicides.

(b) Demonstrate the use of endoparasite (worm) control treatments particularly in small stock and young stock, using appropriately packaged anthelmintics by methods suitable for small farmers.

To include:

(i) Preparation and application of a drench to different classes of stock, i.e. dissolving the correct number of anthelminitic tablets in a small quantity of water in a bottle and administration to the animal avoiding choke.

(ii) Teaching farmers the relevance of worm control and its benefits with simple posters and pictures. Copies of posters and publications with illustrations on worm control should be requested from commercial suppliers.

(iii) Examination of faecal egg counts from field samples when the proposed laboratory facilities become available. Demonstration of this test to interested farmers so that they can see parasite eggs under a binocular microscope.

To monitor the application and progress of the programme each demonstrator would maintain a small daily log book. He would record daily the location of farmers where demonstrations are carried out and sample quantities used.

6.6 INTENSIFICATION OF FEEDING

Intensification for meat production from ruminants, cattle, camels, sheep and goats is unlikely to be sufficiently profitable to producers given present meat to feed price ratios in local markets. Present prices for export type animals are also unlikely to stimulate intensification of feeding. The project should, however, monitor the prices of locally available raw materials and local livestock prices to obtain better information on market trends and changes. Significant trade in by-products for feeding livestock (dairy cows) in Mogdishu has developed, i.e. trading of brans (bunshoo) and threshed sorghum heads (waago). This trade is clearly important as a source of cash income to sorghum farmers in Bay Region but the volumes traded are not known. Poultry production offers scope for intensification. The main constraint is the availability of suitable animal protein for inclusion in a mixed poultry diet.

6.6.1 Suggested Poultry Ration for Hybrid Layers

The current Bonka formula for a chicken ration is expensive due to the inclusion of cowpeas and milk powder which are used as human foods (Table 6.1). There is a requirement in local rations for a source of animal protein and where possible cheaper energy sources than whole cereals.

A feed has been formulated for a modified free range system which includes cereal, brans, sesame cake and blood meal at an ingredient cost of about Ssh 2.6 per kg. The ration (Table 6.2) is mixed dry and can be stored for several weeks.

The method of preparation of blood meal has been demonstrated at the Veterinary Department which assisted with the collection of raw materials. Blood from the slaughter area in Baydhabo is added to wheat bran available from the ADC operated grain mill. Four kg weight of fresh congealed blood (the quantity contained in a large milk powder tin; 1 700 g size can) is mixed with 2 kg of wheat bran. The resultant mixture is sun-dried by spreading thinly on a metal, cardboard or concrete surface (a corrugated iron sheet is suitable). The mixture is dried in about six hours in bright sunlight. The resultant dry blood/bran meal has

TABLE 6.1 POULTRY RATION (Bonka Formula currently recommended by AFMET)

Ingredient	Cost/kg Ssh	Proportion %	Cost/100 kg Ssh
Sorghum	4	50	200
Cowpeas	14	25	350
Sesame Meal	5	10	50
Milk Powder	40	15	600
Totals		100	1 200

1.5 kg of Bonemeal is added to this mixture

Source: AFMET 1983

TABLE 6.2 RECOMMENDED POULTRY RATION FROM LOCAL RAW MATERIALS

Ingredient	Cost/kg Ssh	Proportion %	Cost/100 kg Ssh
Sorghum (Mesego)	4	35	140
Wheat Bran (Buashoo Xamadi)	1.2	30	36
Blood Meal (Diig)	1.2	25	30
Sesame Cake (Manbaal)	5	10	50
Totals		100	256

1.5 kg of Bonemeal or Ground Limestone is added to this mixture

Source: Hunting Technical Services 1983.

TABLE 6.3 PROXIMATE ANALYSIS ESTIMATES AND PRICES OF POULTRY FEED INGREDIENTS IN BAY REGION

Feedstuff	Nutritive Values on Dry Matter Basis		
	Metabolisable Energy Mega Joules ME/kg	Crude Protein Content percent	Cost (Sept.1983) Ssh/kg
Sorghum Grain[1]	13.4	10.8	4.0
Wheat Bran[1]	11.9	18.0	1.20
Sesame Cake[1]	11.7	41.0	5.0
Blood/Bran Meal[2]	12.0	26.4	1.20
Suggested Poultry Feed Table	12.3	19.8	2.6

1. Based upon analyses of similar feeds in UK Ministry of Agriculture, Fisheries and Food Booklet No. 2087 (1980).

2. Calculated from composition of ingredients used to make sample feeds in Baydhabo August 1983. Blood obtained at no charge.

Source: Hunting Technical Service 1983.

an estimated crude protein content of approximately 26 per cent (Table 6.3). Dried blood is rich in the amino acids lysine, methionine and tryptophan which are at relatively low levels in sesame cake.

Currently blood is normally discarded from slaughtered animals. The number of slaughtered animals however limits the supply. Lungs from slaughtered animals are currently discarded and would provide an alternative source of animal protein for a poultry mash when boiled to sterilise them. Alternative animal protein like dried fish is produced in coastal regions of Somalia but supplies are not available in Bay Region.

The suggested ration would be fed under a semi-free range system and birds would have access to calcium grit and small amounts of green feed. Suitable calcium grit is available from limestone beds near the river. A laying Rhode Island type hybrid would consume approximately 117 grams of feed daily. The annual production of a hybrid would be expected to exceed 200 eggs. Returns per bird over feed costs of approximately Ssh 390 may be achieved, Table 6.4. Rearing costs with purchase price of the chicken (Ssh 10) and feed cost (Ssh 21) would be returned from the value of the cull chicken (i.e. a value of Ssh 40).

TABLE 6.4 ESTIMATED RETURNS OVER FEED COST PER BIRD FOR RHODE ISLAND RED HYBRIDS UNDER IMPROVED SEMI INTENSIVE HUSBANDRY IN BAY REGION

	Ssh
Animal Feed 365 days x 115 g = 42 kg @ 2.6 S sh/kg	110
Annual Egg Production 200 eggs @ 2.50 S sh.	500
	390
Purchase of Hybrid chicken (4 months of age)	10
Feed Cost of Rearing 8 kg x 2.6 Ssh/kg	20.8
	30.8

7

Costs

The total costs of the livestock proposals for Stage II are some Ssh 27.7 million, or US$ 1.8 million. The costs are summarised in Table 7.1 and supporting details are shown in Tables 7.2 and 7.3. The costs include allowances for contingencies and the initial purchase of spare parts, and an annual real rate of inflation of eight per cent has been used to convert from 1983 cost levels.

Costs are presented in the following Tables:

TABLE 7.1 LIVESTOCK AND VETERINARY COMPONENT

SUMMARY OF COSTS (Ssh '000)

		1984	1985	1986
Capital -	Buildings	4 699	-	-
	Agricultural Machinery	-	-	-
	Other Equipment	807	-	-
	Vehicles	1 188	-	-
	TOTAL CAPITAL COSTS	6 694	-	-
Operating -	Technical Assistance	941	2 086	1 536
	Local Salaries and Wages	1 480	1 490	1 500
	P.O.L.	453	558	558
	Spare Parts and Tyres	345	479	479
	Purchase of Stock Items	630	630	630
	Building Costs	150	240	240
	Consumable and Miscellaneous	470	470	470
	Contingencies	447	595	541
	TOTAL OPERATING COSTS	4 916	6 548	5 954
	TOTAL COSTS	11 610	6 548	5 954
	Inflation Factor for 1983/per cent	1.08	1.17	1.26
	Total Inflated Cost Including Contingencies	12 539	7 661	7 502
	US$ '000	816	499	488

TABLE 7.2 DETAILS OF CAPITAL COST ESTIMATES

				Ssh
a)	**Buildings**			
	1 Veterinary Store and Laboratory	Baydhabo	230 m²	1610 000
	1 Veterinary Office and Store	Da'aban	32 m²	224 000
	1 Veterinary Office and Store	Raydab Baktille	32 m²	224 000
	1 Holding Yard, Vaccination Race, Spray Race	Da'aban		323 000
	1 Holding Yard, Vaccination Race, Spray Race	Raydab Baktille		323 000
	7 Veterinary Dispensaries - 32 m²			1 568 000
	+ 10% Physical Contingencies			427 000
		TOTAL		**4 699 000**
b)	**Other Equipment (costs include provision for spares)**			
	2 Cooper Spray Race with engine (1 000 head/day capacity)		@ 34 600	69 200
	2 Water pump, tank, pipework		@ 16 100	32 200
	5 Kerosene Deep Freezers/Refrigerators		@ 5 200	26 000
	1 x Laboratory equipment - Generator			23 000
	Laboratory incubator			19 900
	Drying cabinet			12 700
	Bench centifuge			22 300
	Microhaematocrit centrifuge and accessories			7 200
	EEL colorimeter			10 700
	4 Mc Master slides			1 500
	Reagents and media			43 200
	20 x Dispensary equipment			
	Small Table	@ 1,200		
	Chair	@ 900		
	Small Cupboard	@ 1 900		
	Primus Stove	@ 1 200		
	Metal Dish for Sterlising Syringes	@ 700		118 000
	6 x 2 way radio base and mobile units	@58 000		348 000
		+ 10% Physical Contingencies		73 400
		TOTAL		807 300
c)	Vehicles			
	4 motor cycles	@ 32 500		130 000
	3 pickups for vaccination team	@ US$ 14 000		645 000
	1 pickup for Investigation team	@ US$ 14 000		215 000
		+ 20% Spares		198 000
		TOTAL		1 188 000
		TOTAL Capital Costs		6 694 300

TABLE 7.3 DETAILS OF OPERATING COST ESTIMATES (Ssh '000)

				1984	1985	1986
a)	Technical Assistance					
	Veterinary Advisor (remainder of contract)			941	550	-
	Veterinary Investigarion Officer	@	$ 100 000	-	1 536	1 536
		TOTAL		941	2 086	1 536
b)	Local Salaries and Wages					
	1 Regional Coordinator	@	47 000	47	47	47
	1 Deputy Coordinator	@	23 000	23	23	23
	4 District Veterinary Officers	@	24 000	96	96	96
	1 Veterinary Investigation Officer	@	24 000	24	24	24
	1 Accountant	@	19 000	19	19	19
	13 Veterinary Assistants	@	22 000	286	286	286
	25 Dispensers	@	17 000	425	425	425
	12 Vaccinators	@	17 000	204	204	204
	26 Administrative and Other Staff	@	11 000	286	286	286
	Casual Labour			30	35	40
	Night Allowances			40	45	50
		TOTAL		1 480	1 490	1 500
c)	P.O.L					
	1 Lorry	@	65 000	65	65	65
	4 Motorcycles	@	15 000	30	60	60
	11 Pick-ups	@	37 500	338	413	413
	2 Spray Race Engines	@	10 000	20	20	20
		TOTAL		453	558	558
d)	Spare Parts and Tyres					
	1 Lorry	@	112 000	112	112	112
	4 Motorcycles	@	5 000	10	20	20
	11 Pick-ups	@	31 000	217	341	341
	2 Spray Race Engines	@	3 000	6	6	6
		TOTAL		345	479	479
e)	Purchase of Stock Items					
	Veterinary Drugs (Cost offset by sales)			-	-	-
	Drugs for Demonstration Programme			100	100	100
	Drugs for Marketing Support (120 galls Coopertox @ 250)			30	30	30
	Vaccines			500	500	500
		TOTAL		630	630	630
f)	Building Costs					
	Rent			120	120	120
	Repairs and Maintenance	@	2½%	30	120	120
		TOTAL		150	240	240

Table 7.3 continued

		1984	1985	1986
g)	**Consumable and Miscellaneous**			
	Uniforms	70	70	70
	Port Charges	100	100	100
	Refrigeration Costs	70	70	70
	Office Supplies	70	70	70
	Services	60	60	60
	Miscellaneous	100	100	100
	TOTAL	**470**	**470**	**470**
	TOTAL OPERATING COSTS			
	+ 10 per cent contingencies			
	TOTAL			

APPENDIX A

SAMPLE SURVEY

Survey Sheet Goats   Location: ____________   Date: ____________

Adult 2 yr+		Growing 1 to 3 yr		Kids 0 to 1 yr	
Female	Male	Female	Male	Female	Male

	No.	%
Total Animals		
Breeding F		
Breeding M		
Growing F		
Growing M		
Kids F		
Kids M		

Survey Sheet Cattle

Location: ____________

Date: ____________

Adult 3 yr+		Growing 1 to 3 yr		Calves 0 to 1 yr	
Female	Male	Female	Male	Female	Male

	No.	%
Total Animals		
Breeding F		
Breeding M		
Growing F		
Growing M		
Calves F		
Calves M		

APPENDIX B

REFERENCES

APPENDIX B

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