The Juba Valley, an interim assessment of the irrigation suitability survey

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THE JUBA VALLEY, SOMALIA: AN INTERIM ASSESSMENT OF THE IRRIGATION SUITABILITY SURVEY

REPORT ON A MISSION FOR USAID COMMISSIONED BY THE NATIONAL RESEARCH COUNCIL BOARD ON SCIENCE AND TECHNOLOGY FOR INTERNATIONAL DEVELOPMENT (BOSTID)

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PART ONE

1.1 SUMMARY AND CONCLUSIONS

In this section, an attempt is made to summarise the body of the report, with emphasis on the main conclusions and recommendations. The numbers preceding some paragraphs refer to the relevant sections of the report.

2.1 The scope of the work of the mission was first outlined in a National Academy of Sciences contract and then put into agreed final form during discussions in Mogadishu with Sally Patton, USAID Juba (Giuba) Valley Project Manager. It was agreed that the visit should concentrate on evaluating the progress and quality of the work being provided by the Bureau of Reclamation (BuRec) team under their Participating Agency Service Agreement (PASA) with USAID. This evaluation was to include a review of BuRec documents, including the recently received request for a modification of the scope of work, and site visits in the Juba Valley.

2.2 The author flew from the Ivory Coast to Nairobi and thence to Mogadishu on March 13. After discussions in Mogadishu with the USAID Project Manager, the Director of Planning at the Ministry of Juba Valley Development, the BuRec Chief of Party and some of the team members, he drove to Bardera in the upper Juba on March 16 with two of the BuRec team soil classifiers. At Bardera, he joined a third soil classifier and the drainage engineer, made a reconnaissance survey of the east bank area as far north as the dam site, and inspected the experimental farm site on the west bank. On March 18, after a further reconnaissance of the east bank area, he drove south to Saco Uen with a member of the team, and there had discussions with the team drainage engineer prior to returning to Mogadishu through the middle and lower Juba Valley with the USAID Project Manager on March 19. On March 20, after final discussions in Mogadishu, he returned to Nairobi and thence the Ivory Coast, where the material collected was analysed and the mission report written.

2.3 The Participating Agency Service Agreement between USAID and BuRec (summarised in Appendix 2) provided for two years of work and five full-time staff to conduct a reconnaissance-grade irrigation suitability survey of the Juba and the Scebeli valleys. The scope of work stressed the need to use all pre-existing data, and stipulated that the land classes should be defined not only with regard to soil and drainage investigations, field testing and laboratory data but in terms of an economic parameter in order to make the essential division between lands which could be irrigated profitably and those which could not. Present land use was also to be shown. In the agreement, the reconnaissance-grade survey is defined with respect to the number of auger borings to be made (one per square kilometer), and the number of soil pits to be dug (one per ten square kilometers), and it was stipulated that soil descriptions be according to accepted USDA or FAO systems.

2.4 In February 1986, the BuRec Chief of Party presented a handwritten note to USAID (given in full and discussed in Appendix 3) requesting certain modifications to the original PASA agreement. These changes asked for the work in the lower Scebeli Valley to be downgraded from reconnaissance level to a pre-reconnaissance level which merely sought to separate arable from non-arable lands, and for substantial changes to be made in the guidelines which the PASA agreement had established for the main Juba Valley reconnaissance survey. Instead of one auguring per square kilometer, it in effect suggested that both the density of augurings and of soil pits and the number of soil horizons sampled merely be "adequate" to represent arable and non-arable land classes, thus in practice giving carte blanche to the survey party to do as few borings and pits and to take as few samples as they wished, and eliminating any later recourse to the agreement in the event that these were considered inadequate. Instead of the soils being described by the internationally accepted USDA or FAO methodology, they were to be described by the locally simplified BuRec economic/landuse survey system.

In a discussion of these requests, it is concluded that given the large areas to be surveyed and their inaccessibility, the original guidelines were optimistic, if not unrealistic. Assuming a core project area of 250,000 ha, the original guidelines required some 2,500 auger borings and 250 pits, from which samples had to be taken. The Chief of Party spent most of his time in Mogadishu, and the field classification had been done by one full-time classifier and two temporary ones. It is difficult to see how they could have physically completed a sampling programme of this magnitude in the time available. However, if the original agreement was not workable in practice, why did BuRec sign it? One explanation is that they did not work out the implications of the agreement carefully enough in light of what they could reasonably have been expected to know about working conditions in Somalia. The other hypothesis is that they did not consider the small print of the guidelines very binding, or at least assumed that it could relatively easily be modified, since this was an "estimated time and money document" for a survey performed at cost, and BuRec often lengthens or modifies work as needed.

Present indications are that the survey team consider that in order to finish the survey within the proposed time frame, borings will have to be about one per ten square kilometers, i.e. at only one tenth of the density originally envisaged. They contend that this will not greatly reduce the quality of the final land classification because many of the irrigable areas are relatively homogeneous. However, in a discussion of this contention, it is concluded that perhaps 20% of the irrigable land is patchy and near the river, requiring detailed work, whereas though the remaining 80% of heavier soils away from the river are outwardly more homogeneous than the alluvial soils, they nevertheless appear to differ in depth of cracking and in salinity (the latter revealed only by laboratory analyses) and since both these factors are likely to affect their irrigation suitability, a reduction in the density of the observations as proposed must reduce the quality and accuracy of the final land classification and the quantity of supporting data. Under these circumstances, would the survey still merit the term "reconnaissance-grade"?

2.5 The central section of the report describes what has been done so far, as described in the February 1986 interim report (summarised in Appendix 6) and as assessed during the mission, and then assesses what remains to be done. In practice, the survey comprises field survey work, engineering analyses and economic studies and these are interlocking. This is illustrated by the fact that delays in getting laboratory results have delayed the field classification. This in turn has held up the engineering work on distribution and drainage systems, which in turn has delayed the working out of economic parameters which - to complete the circle - are needed for the field classification.

2.5(a) After two preliminary field reviews in 1984, the Chief of Party arrived in November 1984 and field work proper began in April-May 1985 with the arrival of the land classifier and the drainage engineer. In broad terms, about half the field work was said to have been completed by March 1986. Field work had been completed in the upper Juba on both banks, and has been begun in the middle Juba between Bardera and Saco Uen but the rest of the east bank and the whole of the more inaccessible west bank remained. In the lower Juba, the intention was to do little more than extrapolate existing information on present irrigation schemes to areas outside them.

2.5(b) However, the interim report (summarised in Appendix 6) fails to include specific information on what specific areas were surveyed and when, or what exactly remains to be done. There is no mention of how the 196,100 hectares said to have been surveyed have been classified, or of how many auger borings and pits have been dug and sampled and how many analyses completed. The initial density of borings when the field work was started was never one per square kilometer, as specified in the service agreement, but was one per four square kilometers, i.e. a quarter of the specified density. Even this density, the interim report claimed, was later "determined to be unnecessary" and the realisation that the survey could not be finished on time then lead to the request that the density of observation guidelines be done away with altogether, as discussed earlier.

The writing of the interim report forced the team members to get together to discuss their work and problems. It appears that previously they had tended to work somewhat in isolation, with insufficient coordination and reference to each other (problems which still persist to a lesser extent) and that no fixed work schedule had been imposed. There also appears to have been some lack of correlation of soil classification to ensure that surveyors working independently classified soils in the same way. The organisation of the field work appeared somewhat loose and it was felt that the logistics of field supplies and the use of field bases could have been improved, possibly by the use of mobile field bases. Living standards in the field bases seemed unnecessarily spartan. Whereas it had orginally been hoped that field staff would spend two-thirds of their time in the field and one third at Mogadishu, slow turn arounds at Mogadishu resulting from administrative delays there and the need to have the budget for each individual field trip approved each time in advance lead to the fact that in practice field staff spent some half of their time in the capital. The vehicles provided were criticised for being too wide for narrow local bush tracks and for the fact that the tires were too thin to resist thorns and had frequent flats.

The technical problems in field classification concerned the interpretation of the poor drainage of the soils and their occasional salinity. The rationale for the original terms of reference is that without additional information on soil drainage and on cracking behaviour on drying, it is difficult to predict how they will behave under irrigation and whether salts can be leached to a lower layer. Many soils have very low average permeabilities. More data are needed on percent swell of clays and ratio of void to mass when cracked, time taken for cracks to close on wetting, and soil moisture contents at cracking. Field observations suggest that more or less similar soils differ in their depths of cracking. Classification also requires the interpretation of soil salinity data which are at present limited by laboratory delays, though analyses of about 80 samples show widely ranging levels of electrical conductivity up to 30 mmhos.

The findings of the team so far are compared with the irrigation suitability classifications given in the Impresit report (Appendix 4). The present team has taken a more cautious view than the Impresit classifiers and downgraded many areas. So far, they appear to have found no Class I land on recent alluvium as mapped by Impresit and believe that there is little Class I land in the valley -- possible only 5% if a liberal classification is adopted, particularly if high economic costs are taken into consideration. They estimate that some 10-15% of the land will be in Classes II and III together. These are better alluvial soils but these are patchy, with long narrow strips along rivers and no single parcels over 500-1000 ha. These lighter soils are generally left uncultivated by local farmers who prefer to plant their rainfed sorghum on the heavier soils.

A more fundamental difference from the Impresit approach concerns the fact that the BuRec team have created two new soil classes, R1 and R2, which are highly suitable and fairly suitable respectively for paddy rice. These categories have replaced much of what was classified by Impresit as Class III and as IV P (suited to pasture), and it is estimated that up to 80% of the irrigable land will be put into these two R classes. Their creation essentially reflects the doubt as to how these heavy, poorly drained and sometimes saline soils will behave when irrigated. They are suited to paddy rice because paddy rice soils are usually puddled to make them impermeable and because rice is tolerant of high levels of salinity, but to put the soils in this class effectively begs the question of how they would behave under normal irrigation with crops other than rice.

One theory mooted but not yet proved is that after the cracks in the upper part of the soil profile have closed, a system of cracks between 50-70 or 50-100 cm remains open and forms a capillary break, allowing leaching downwards and stopping a capillary rise of salt from below. The fear is that the continuous cropping twice a year demanded by economic considerations will lead to waterlogging and the closing of this zone, and that breaks in cropping might be needed to prevent this. The drainage engineer, out on only a 90-day assignment, has begun some field tests designed to study water movement and crack closing in heavy R-type soils but it is doubtful if he will be able to generate sufficient information in the time available. Additional information could be obtained, however, if the team were to carefully compare these soils with those of existing irrigations schemes in the valley.

It appears that current land use will be relatively simply mapped in about three classes of (a) cultivated land and recent fallow, (b) land under long fallow, and (c) land under bush not yet cleared or used.

2.5(c) The progress of the engineering studies as described in the interim report has been held up by lack of data on land classification figures, cropping patterns and drainage requirements (in turn held up by lack of laboratory data) so that "the scope and detail of many of the items have been reduced". Apart from the enlargement of the base maps, the irrigation engineer was expected to tackle a wide range of topics, from the study of cross drainage, river floods and flows, hydrology and water requirements, to an estimation of unit construction costs and a review of alternative irrigation schemes. Although the engineer concerned appeared both competent and experienced, he has had to postpone the design and cost estimates of the irrigation distribution and drainage systems until likely cropping patterns have been decided on and soil drainage needs known in more detail. It is noted that there is no agronomist on the team, and that despite the fact that rice looms so large in the discussion, no one appears to have thought fit to involve IRRI, the International Rice Research Institute.

2.5(d) The progress of the economic studies as described by the project economist in the interim report is considered both disappointing and disturbing. The service agreement stressed that land classes are to be defined in terms of an economic parameter, preferably net incremental irrigation benefits. However, after an elementary section on basic assumptions made (the need for roads, extension services, etc.), the section on crop selection which, deals with bananas, maize, rice, cotton and some other potential crops, contains little or nothing on costs, yields, or profits on different classes of land and only in the section on cotton is there any mention of prices. Where are the economic parameters needed for land classification? Are we to assume that the project economist, who appears to have spent little time in the field and to have had minimal contact with the land classifiers, is going to tackle these aspects in the remaining months of the survey?

2.6(a) In a final section, some observations and suggestions are tentatively put forward, beginning with an analysis of the types of difficulty met so far. First, physical difficulties are identified associated with the physical features of the valley -- its size, remoteness, and inaccessibility, particularly in the wet seasons, difficulties made worse by an unsuitable choice of vehicles and perhaps by some shortcomings in the logistical planning of the field work. Secondly, administrative difficulties were encountered. The Chief of Party complained of, and appeared wearied by, petty hassles and red tape at Mogadishu, but it is concluded that in the event these administrative delays proved unnecessarily catastrophic in the sense that they contributed to the fact that the Chief of Party, theoretically the most experienced member of the team, spent almost all his time in Mogadishu and made little or no direct contribution to the field work. This in turn must have contributed to the team falling behind schedule and failing to meet the stipulated guidelines as regards density of borings and pits and number of samples. The third set of difficulties and perhaps the most fundamental arose from the fact that BuRec signed a detailed agreement which, it is suggested, they did not study in sufficient detail before committing themselves to. The stipulations of the field mapping alone would have been almost a physical impossibility. Thus the size of the team was not adequate for the task defined, and they had to ask for the terms of the agreement to be changed.

2.6(b) The decision to be taken regarding the conduct of the rest of the survey are then reviewed. The first alternative is that the survey be completed using the downgraded methods requested by the Chief of Party. Even lightening the task in this manner appears to require the use of a helicopter in the inaccessible west bank areas, and probably a three month extension after March 1987. The second alternative is to refuse the request for downgrading and to insist that the density of one auger boring per four square kilometers more or less adhered to in the first half of the survey be maintained. It seems certain that in order to do this, the number of field classifiers will have to be increased, perhaps by keeping on one or both of the TDY field classifiers on a full-time basis as long as is needed. The use of a helicopter and a tightening up of the field organisation and the time spent in Mogadishu will also be necessary. This second alternative is preferred because it maintains the density of observations and the number of samples and analyses at a more satisfactory level. At the same time, additional soil drainage data will be needed. The economist, if the demands of the service agreement are to be met, must tackle the cost and profitability calculations to provide the economic parameters needed, and without which the classification will be based on soil properties alone with insufficient economic weighting.

2.6(c) In the final section, the possible contribution of the irrigation suitability survey is discussed in two contexts. First, it is going over an area already surveyed several times and must make full use of existing information, but when it attempts to put land into suitability classes showing increasing degrees of limitation, it is essentially expressing an opinion and hazarding a prediction. The survey seems to be expected to come up with crop and crop pattern recommendations it can hardly be expected to do without an agronomist. The second context is that it is but one of many inputs into the Juba Valley master plan. Other current inputs include studies of existing rainfed agriculture and an environmental study is due to start soon. It is said that a team of three agronomists will later make use of the irrigation suitability survey. It is suggested, however, that at least one of these agronomists come early enough to overlap with the BuRec survey. In this way, the survey team would benefit from discussions and feedback with the agronomist, who in turn would be able to define the type of soils information he needs for cropping and management decisions. There is also a strong case for urging the BuRec team to leave behind them not only the classification map but details of the location of all borings and pits, soil descriptions and analyses. They should also select sites for later experimental stations typical of defined areas of the valley.

In a broader context, it is stressed that irrigable lands and irrigation possibilities must be thought of in relation to rainfed agriculture, and both types of crop production considered in relation to animal production and other forms of activity. Only part of the valley is irrigable, and the water is enough to irrigate only part of that land at any one time. The irrigated land, which could both raise overall production in normal years and help to serve as a chusion against disaster in abnormally dry ones, must thus be viewed as complementing the remaining land and activities of the valley, and be integrated with them rather than be considered in isolation.

PART TWO

2.1 TERMS OF REFERENCE

The mission scope of work was first outlined in telex and telephone discussions with Michael McD. Dow of the U.S. National Research Council, Board on Science and Technology, then spelled out in a National Academy of Sciences contract dated 12 March 1986, and finally put into an agreed final form during discussions in Mogadishu with the USAID Juba Valley Project Manager, Sally Patton, on March 14 and 15.

The NAS contract mentioned the preparation of a paper for BOSTID which would cover:

(a) surveying available information on soils of the Juba Valley area, reviewing the current and proposed scope of work of the BuRec project to survey the soils and assess land-use potential of the Juba Valley, and advising on the adequacy of the scope of work;

(b) visiting Mogadishu to consult with officials of USAID, the MJVD (Ministry of Juba Valley Development) and the Bureau of Reclamation, including if possible field visits to the Juba Valley, including areas both above and below the dam site, and

(c) reviewing proposed plans for water quality and sedimentation studies and make recommendations concerning their adequacy for planning diversified agricultural production.

The final form of the scope of work as agreed with the USAID Project Manager in Mogadishu emphasised that the visit should concentrate upon evaluating the progress and quality of work being provided by the Bureau of Reclamation (BuRec) team under their Participating Agency Service Agreement with USAID (Appendix 2). A review of BuRec outputs and working documents, including the recently received request for a modification of the scope of work, should be included and site visits in the Juba Valley project area made, though it was agreed that in view of time limitations these should be confined to the main project area below the dam site, leaving the examination of the drawdown area earlier suggested by the NASA visiting team for a possible later visit.

The mission as carried out was able to respond to the scope of work outlines as agreed with the project manager, and to items (a) and (b) in the NASA (BOSTID) terms of reference. It was not able to include item (c) in this document, namely the assessment of the water quality and proposed ARD sedimentation studies (the latter were not made available during the mission), though the detailed assessment made of the interim BuRec report includes reference to the adequacy of the presently available soil, engineering and economic information to the planning of diversified agricultural production in the project area.

2.2 ITINERARY, MAIN ACTIVITIES AND PERSONS MET (Appendix 1)

After preliminary telex and telephone discussions with Michael McD. Dow of the US National Academy of Sciences, the author flew from the Ivory Coast to Kenya on March 8, spending four days in Nairobi during which he had discussions on the Juba Valley project with staff of ARD (Associates in Rural Development), the Land Tenure Centre and USAID REDSO/EA, as listed in Appendix 1.

On March 13, the author flew to Mogadishu, where he had discussions with Sally Patton (USAID Project Manager), Aweys Haji Yussuf (Director of Planning, MJVD), Dan Macura (BuRec Chief of Party), Dewayne McAndrew and Jack Jibson (BuRec survey team) and Robin James (Atkins Land & Water Management, who had just completed a soil survey of the experimental farm site at Bardera in cooperation with the BuRec team).

On March 16, he began a field visit to the Juba Valley by driving with Dewayne McAndrew and Jack Jibson to the Bardera field base where he met Willie Forest, Earl Dudley and Tom Crooks, soil chemist, irrigation engineer and drainage engineer respectively.

On March 17, a reconnaissance was made with Willie Forest of part of the east bank area as far north as the dam site during which soil pits, soil exposures, auger borings and land use were examined and the survey work to date discussed. Later, soil pits and auger borings on the experimental farm on the west bank recently survey in detail by Robin James were examined with Willie Forest and Dewayne McAndrew.

On March 18, a second reconnaissance of the east bank area south of that examined the day before was made with Dewayne McAndrew during which auger borings were made and soil utilisation and classification problems discussed. The same afternoon, the author drove to Saco Uen field base in the middle Juba Valley with Dewayne McAndrew, and had discussions there with Earl Dudley, project engineer. The following day, he drove south through the middle and lower Juba Valley with Sally Patton, who had joined the party the previous evening, returning to Mogadishu that night.

On March 20, final discussions on the mission were had with Sally Patton, Aweys Haji Yussuf (MJVD), and Louis A. Cohen (Director, USAID, Mogidishu), prior to returning to Nairobi that afternoon, and thence to Abidjan and Bouaké in the Ivory Coast on March 22-23, where the mission report was written.

2.3 THE PARTICIPATING AGENCY SERVICE AGREEMENT between USAID and the U.S. Bureau of Land Reclamation for the irrigation suitability survey of the Juba Valley (Appendix 2).

The original service agreement (PASA) between USAID and U.S. Bureau of Reclamation was signed in February 1984 and provided for two years of work involving five full-time BuRec staff. Notes on this document giving the main points of interest are given as Appendix 2.

The main objective of the PASA is the conduct of reconnaissance-grade studies of both the Juba and the Scebeli valleys, particular mention being made of (1) an irrigation suitability classification, (2) a study of water suitability, (3) an investigation of drainage requirements, and (4) a survey of the present land-use.

The need to use all existing data is stressed, including all data collected by other consultants or agencies on geology, water, soils, drainage, agronomy, soil-water-plant studies and economic data.

Particularly important is the stipulation that the land classes should be defined not only with due regard to soil and drainage investigations, field testing and laboratory data, but "in terms of an economic parameter, preferably net incremental irrigation benefits" which will allow the important division to be made between lands which can pay for irrigation and those which cannot. It is specifically stated that "if necessary, land classes should be downgraded to take account of negative or unsatisfactory results to the farmer".

Land drainability investigations will include a study of hydraulic gradients and possible barriers, and include field measurements of infiltration, and vertical and horizontal hydraulic conductivity. Attention will be given to present and anticipated water management practices and cropping patterns. Present land use will be determined and shown by photo overlays.

The type of survey stipulated and agreed upon is described as "reconnaissance survey". If this term is to have any meaning, it has to be defined. Under the heading "Partial listing for suggested guidelines for soil characterisation", a reconnaissance survey is defined as having boring density of "one site per square kilometer", and bores are to be done by auger to a minimum depth of 3m. In addition, one open pit will be dug every ten (square) kilometers, and soil descriptions will be according to accepted USDA or FAO systems.

As will be seen in the subsequent section dealing with requested revisions to the original service agreement, the survey team were unable to meet the suggested guidelines regarding the density of auger borings and indeed made no attempt to stick to them from the start. The initial density was one boring every four square kilometers, giving only 25% of those stipulated in the agreement, and at mid-survey a further modification was requested which, if accepted, would do away with any numerical guidelines as to boring density, since these would henceforth be merely "adequate to represent the major land forms, arable and non-arable land classes."

2.4 REQUESTED REVISIONS TO THE ORIGINAL SERVICE AGREEMENT (Appendix 3) AND THEIR IMPLICATIONS

In February, a handwritten note was given the USAID Project Manager by the BuRec Chief of Party outlining requested modifications to the original service agreement. The full text of the note, plus a commentary designed to show the proposed new text of the agreement and its effect is given in Appendix 3.

The proposed changes concern the following:

(a) the downgrading of the work on the lower Scebeli Valley from reconnaissance-grade to pre-reconnaissance-grade "to the degree necessary to differentiate arable and non-arable lands";

(b) an important change in the concept of what is to be understood, in this context, by a reconnaissance survey.

Instead of one auger boring per square kilometer, it is requested that borings merely "be adequate to represent major land forms, arable and non-arable land classes", thus in practice giving carte blanche to the survey party to do just as many or as few borings as they consider necessary, and eliminating any later recourse to the agreement in the event that these were felt inadequate.

Similarly, instead of the original one soil pit per ten (square) kilometers, the requested modification would allow pits to be located "as necessary", thus effectively removing the original guidelines.

Instead of the soils being described by international USDA or FAO systems, the locally-simplified BuRec System is requested.

Finally, the requested changes include a reduction in the number of samples to be analysed. Instead of samples being taken from all borings and pits as stipulated in the agreement, it is requested that the samples be taken "as necessary".

The total effect of these changes, if agreed to, would be to eliminate all guidelines previously agreed upon as to the number of auger borings, the number of soil pits and the number of soil samples taken, and to substitute the BuRec soil description methods for the more detailed and widely-used USDA or FAO terminologies. All these changes are in one direction, namely the lightening of the load on the team by downgrading the concept of "reconnaissance survey".

In discussing what reaction USAID should make to these proposals for change to the original service agreement, the following considerations appear to be relevant:

(a) To what extent were the stipulations of the original agreement practical given the time frame and physical survey conditions in the field?

(b) To what extent did BuRec staff regard these as being fixed or as merely provisional guidelines to be modified as circumstances dictated?

(c) What effects would the proposed changes, if agreed to, have on the final quality of the report, and what can realistically be insisted upon given the present time frame or only a short extension?

In retrospect, it now appears that the stipulations of the original guidelines in the agreement, given the vast areas to be surveyed, their inaccessibility, and the two year time frame, were optimistic if not unrealistic. The single most important stipulation was that of one auger boring per square kilometer, but the total project area, though not known with accuracy, was estimated by the Impresit report as including about 400,000 ha, coming down to about 250,000 ha at project level. Even if we assume no auguring outside the irrigable core of 250,000 ha, this equals 2500 square kilometers, thus implying that there should have been at least 2500 auger borings, and 250 pits, all of which had to be sampled. It is difficult to see how the team envisaged could have done all this in a country where field work in the six months of rains slows down or even comes to a halt in the less accessible areas. In practice, the team leader has spent nearly all of his time in Mogadishu and made little or no direct contribution to the field work, leaving only one field classifier full-time helped by two others and a drainage engineer for short periods. Unexpected transport difficulties were encountered, and the ratio of field time to time spent in Mogadishu was lower that expected. Some of these difficulties could, however, have been foreseen and overcome to some extent with better project management and administration.

If the original agreement was not really workable in practice, how come the BuRec signed it? Two hypotheses are possible. The first assumes that they did not really work out the implications of the agreement carefully enough in relation to what they might have been reasonably expected to know about working conditions in Somalia. The second assumes that they did not consider the small print of the guidelines all that binding, or at least capable of being relatively easily modified should they later appear too restrictive. Discussions with the Chief of Party, Dan Macura, are revealing on that point. He pointed out to the author that the contract was signed as an "estimated time and money document", but the survey is being performed at cost and usually BuRec lengthen or modifies contract documents as events suggest. The implication is that a survey rendered by a government agency, BuRec, to another government agency, USAID, which is at cost is different from a survey carried out by an outside contractor who charges a fee designed to return him a profit. In the first case, necessary modifications to services (which continue to be provided at cost) should be relatively easy to agree upon, whereas in the case of an outside contractor, there is more obvious need to insist on the small print of the scope of work specifications in order to get value for the agreed price.

More important are the likely effects of the proposed changes on the quality of the work and the final report if they are adopted, or the effects on lengthening the project if they are not. The Chief of Party pointed out that the field work is now approximately half-way through as a result of reducing the number of auger borings by 75% from the original one per square kilometer to one per four square kilometers, but if this had not been done it would now only be 10% done. The reason for not being able to do the remaining half in the same time is that what remains to do is in the middle section which is much more difficult and inaccessible, particularly on the far (western) bank, and in practice is more or less cut off during the rains.

Discussions in the field with Willie Forest, who has done most of the field classifying so far and who appears to have a good feel for what can in practice be done in the time available, indicated that in his considered opinion, in order to finish the work on time, it is necessary (a) to reduce the auger borings to one per ten square kilometers (i.e. to 10% of the original density in the agreement and to 40% of what has in practice been done so far), and (b) either to use a helicopter on the west bank or to extend to project by another three months (and possibly both).

The contention of the survey team is that the further reduction in the number of borings, pits and samples asked for will not appreciably reduce the quality of the final land classification because those areas unsuited to arable agriculture are quickly eliminated without the need for borings and those areas that are arable are often relatively homogeneous, so that borings beyond a certain number tend to be merely repetitive.

The claim that the arable areas are relatively homogeneous deserves careful examination. The Impresit report (Appendix 4), the paper by Forest and Barre (Appendix 5), and the more detailed interim report prepared by the BuRec team in February 1986 (Appendix 6) together suggest that :

(a) the alluvial soils near the river, perhaps 20% of the total irrigable area, are inherently varied and change over short distances, thus indicating that a relatively close grid of observations is need to map this type of land;

(b) the more extensive and generally heavier soils of the various plains away from the river, perhaps 80% of the irrigable area, are more homogeneous than the alluvial soils in outward profile morphology. Nevertheless, the analyses show variations from profile to profile in salinity and sodicity over a considerable range (from less than 1 mmho to about 30) which are not apparently related to profile morphology and which cannot be detected unless the sample in analysed. In addition, it appears that the depth of cracking in these relatively homogeneous areas varies within certain limits which are thought to be important for their utilisation, particularly as regards leaching and long-term salinisation prospects.

Thus, though the heavier soils of the plains may be less outwardly varied that the alluvial soils, differences in cracking depths, and differences in salinity which can be detected only by sampling and analysing the soil suggest that if the number of soil borings is reduced, differences which affect irrigation suitability may escape unnoticed.

It must be assumed, therefore, that the reduced soil boring, pitting and sampling densities envisaged will have an adverse effect in reducing both the quality and accuracy of the final land class classification and the amount of supporting information that will be available to justify and back up that classification. The final 1:100,000 map to be produced will be based on one observation per ten cm^2 or so instead of the one observation per one cm^2 originally envisage, and as normally accepted as an appropriate rule of thumb for reconnaissance soil mapping. Under these circumstances, can the survey still be truthfully described as of reconnaissance-grade?

What would be the consequence of insisting, not on the survey intensity guidelines spelled out in the original agreement, but on at least a continuation of the survey methods adopted during the survey so far (i.e. one auger boring per 4 km^2 grid etc.)? Such an instance would necessitate either an extension in the length of the survey, and/or a change in methods and an increase in field staff. These possibilities are considered further in the section 2.6(b) below.

2.5 WHAT HAS BEEN DONE SO FAR AND WHAT REMAINS TO BE DONE

In this section, an attempt is made to compare what has been done so far with what remains to be done. What has been done so far is assessed in terms of the information contained in the February 1986 interim report (summarised in Appendix 6) and the additional information and impressions obtained during the mission. What remains to be done is then assessed by comparing results so far with the original scope of work as set out in the Participating Agency Service Agreement (summarised in Appendix 2).

In practice, the irrigation suitability survey includes three distinct but related and interlocking fields of activity, namely

(a) **the field survey work** which aims at examining and describing soils in the field, taking and analysing selected samples, and then mapping arable irrigable land in five defined suitability classes. River water quality has also to be determined, and a map of current land-use prepared. This work is carried out by the solid classifiers and the drainage engineer.

(b) **the engineering analyses** which deal with the overall irrigation scheme to be adopted, cross drainage, hydrology and water requirements, river floods and flows and an estimation of unit construction costs. This work is done by the irrigation engineer.

(c) **economic studies** aimed primarily at developing economic parameters needed for land classification, in other words, in estimating the net economic returns of the likely crops to be grown on the various classes of land mapped and assessing profits after irrigation development and running costs have been met. This is primarily the task of the economist but he needs data supplied under (a) and (b) above.

These three groups of activities were stated above to be related and interlocking - in fact, they are unfortunately so interrelated that a delay in one of them can retard work in another, and a chicken and egg situation can be created where everybody is waiting for an input from somebody else. Thus, work on putting the arable land into classes I, II, III, R1 or R2 cannot be completed until enough laboratory analyses and field drainage investigation results are forthcoming in sufficient quantity to assess the extent to which soil chemistry and drainage characteristics are limitations to irrigated agriculture. Consequently, the irrigation engineer cannot confidently work out the distribution and drainage systems he recommends, or their likely cost, until he as the basic soil and drainage parameters for each mapping class, plus the maps showing the distribution and extent of those classes. Nor can the economist consider crop production costs unless he too has an idea of the precise nature of the limitations of each of the classes mapped and their likely effects on growing costs, yields and profitability of the crops considered. Finally, to complete the circle, the land classifiers can hardly claim that the mapping units reflect economic parameters as well as soil characteristics (as is required of them by the scope of work) if they cannot feed into their classification a costs weighting supplied by the economist. Despite the fact that in practice provisional working assumptions can sometimes be made, pending more detailed information, based on the information collected by earlier surveys such as that by Impresit, the difficulties outlined are unfortunately reflected in the results reported in the interim report, and are frequently referred to particularly in section III on land classification and in section IV on engineering analyses (Appendix 6).

(a) General progress of the survey

Before the current survey started (in May 1985) a pre-reconnaissance review of the potential study areas was made from February 20 to May 2, 1984, to assess areas apparently suited to irrigation agriculture. This review resulted in the elimination of certain areas from further consideration. In August of the same year, there was a field review by a land resource specialist and a drainage engineer to evaluate land and drainage problems and to advise on investigation procedures. It appears that a report by Tom Seddon was written which spelled out manpower needs and equipment requirements for both the camps and the laboratory, but this came out too late to be incorporated into the work plan.

The Chief of Party, Dan Macura, arrived in November 1984 (and is due to leave in November 1986), but field work did not begin until May 1985. Field work is normally expected to be limited by rains during April, May and June. Full-time staff at post at the time of the author's visit in March 1986 included the Chief of Party and the project Economist (who joined in April 1985) who spend most of their time in Mogadishu, and a land classifier (Willie Forest, arrived April 1985) and the Irrigation Engineer, Earl Dudley, who came in January 1985) who spend about half of their time in the field. In addition, three TDY (temporary) staff were also contributing to the field work: Dewayne McAndrew (on a second visit) and Jack Jibson, land classifiers, and Tom Crooks, Drainage Engineer. Everett Williams, who had been concerned with the soils laboratory, had just left the project.

In broad terms, the situation as of March 1986 as outlined verbally to the author was that about half of the field work was thought to have been completed. Field mapping had been completed in the upper Juba Valley section on both banks. In the middle Juba, a little field work had been done between Bardera and Saco Uen on the east bank but the rest of the east bank and the whole of the relatively inaccessible west bank remained. Work in the third section, the lower Juba Valley, falls into a somewhat different category since there the intention is to do little more that to extrapolate existing information available from the surveys made of current irrigation schemes to the areas away from the schemes, and no precise estimate was made of how long this would take.

(b) Progress of the field mapping, soil characterisation and soil analyses

The interim report (February 1986) fails to include any clear statement as to exactly when work was started, who was involved and for what periods, and what specific areas were surveyed and when. It states that 196,100 hectares had so far been classified on 22 map sheets but does not state the total estimated project area or what remains to be surveyed, nor does it discuss the timing of the remaining survey work. Other gaps include:

-no mention of how the 196,100 hectares said to have been surveyed have been classified (or is classification awaiting further lab analyses?);

-no mention of how many auger borings have been sampled, how many pits have been dug and sampled, and how many analyses have been completed.

At the beginning of the field work, the initial density of soil observations was one boring per four square km. It appears that it was <u>never</u> one boring per square km as given as a guideline in the service agreement. However, the progress of the field work in relation to what remained to be done brought about an increasing realisation among members of the team that even this reduced density of observations could not be sustained within the time available, and they recently suggested it be reduced henceforth to one boring per 10 square kilometers (i.e. to one tenth of the normal reconnaissance survey requirement). In the interim report, it is stated that "initially special efforts were being made to examine one site per grid" (2 x 2 km), but this was later "determined to be unnecessary due to land uniformity and the inaccessibility of certain areas." The current wish, as discussed in the earlier section on requested revisions to the original service agreement, is to do way with any fixed contractual requirement so as to leave the survey party complete discretion as to how many and how few borings they make, how many pits they dig, and how many soil samples they take.

The writing of the interim report about halfway through the life of the survey forced the team members to get together to discuss their work and problems. It was admitted to the author by one of the land classifiers that prior to that effort, they had tended to work somewhat in isolation, and without sufficient co-ordination and reference to each other. Although the report had had some beneficial results in this respect, cooperation between field staff was still insufficient. The team leader does not appear to have been directly involved in the field work, or to have made his presence felt in the field as regards the imposition of any fixed pl[illegible] of work or schedule of operations. As a result of this absence of cohesion, there appears to have been a lack of "correlation". Correlation in this sense implies that a certain discipline of coordination is imposed on individual classifiers to ensure a homogeneous approach, so that although they may be physically apart and working on different map sheets, a soil put into class III by one surveyor is put in the same class by his colleague somewhere else, and not into class II or R1.

The organisation of the field work appeared to be somewhat loose, with individuals setting off singly where they felt like it with little coordination. If ever there was any plan of work, it was certainly not discussed during the author's visit. The logistics of field supplies and the use and organisation of field bases seemed not to have been well thought out. The use of mobile field bases might have solved some of the logistical problems. Individuals seemed to make their own catering arrangements and some seemed to want to show they could live on very little. Camp standards of equipment came as a disappointment. Remembering that an army marches on its stomach and that much valuable time can be wasted by lack of organisation, it is suggested that much more serious attention should have been given to the day to day organisation of the field work and the insistence on certain minimum standards of staff welfare.

The original aim, it appears, was for the field team to work in the field for about 20 days and then to go back to Mogadishu for about 10, so that two-thirds of their total time was in the field, but administrative red tape and delays (each individual trip has to have its local currency budget approved before it can start, and diesel fuel found) so lengthened the Mogadishu stays that the final proportion of time in the field achieved was said to have been about half.

The view was frequently expressed that the vehicles (blazers) were not well suited to the task, being too wide to go down local tracks, and that their tires were too thin to resist the thorns of the local vegetation, resulting in very frequent flats.

Technically, the main problem in the field classification appears to have been exactly how to interpret the poor drainage of most of the soils and their frequent salinity in terms of assessing their irrigation suitability. The BuRec has certain guidelines but always insists that general criteria and classification guidelines be adapted to local conditions (see, for example, the paper by L.L. Resler in FAO World Soil Resource Report No 50: Land Evaluation Criteria for Irrigation).

Essentially, the putting of a tract of land into a defined irrigation suitability class is an expression of the opinion of the classifier and will reflect his knowledge and experience, so that two classifiers given the same soils and the same analytical results may not always arrive at the same land class. A general set of guidelines was agreed upon and is given in the paper by Forest and Barre, and in the interim report, but two main problems occur.

First, without more detailed information on the drainage of the heavy soils and the extent to which they crack on drying, it is difficult to predict how they will behave under irrigation and to what extent salts can, if necessary, be leached out of them or at least to a lower layer. Forest and Barre (Appendix 5) point out that hydraulic conductivities performed at seven selected areas showed very low average permeability (only 0.03 inches an hour) and that the assessment of the potential for leaching these soils can only be properly evaluated when data is available on such things as current salinity levels in the soil, the salinity of the irrigation water and the quantities to be utilised, the percent swell of the clays and their ratio of void to mass when cracked, the time taken for the cracks to close when a water is applied, and the soil moisture level at the time of soil cracking. Field observations so far suggest that more or less similar soils in the limestone plains area differ in their depths of cracking though it is not clear whether this is related to intrinsic soil properties, to vegetation or to other factors.

Secondly, the land classifier has to interpret the data on soil salinity and sodicity which are at present limited in number because of delays in the laboratory. The results of the analyses of about 80 samples presented in the Forest and Barre paper show very widely varying levels of electrical conductivity, from less than 1 to about 30 mmhos, with 24 samples out of 82 being over 16 mmhos. As the authors point out, the effect of these figures on crop growth varies with the crop. A saline soil is generally taken to have over 4 mmhos/cm at 25°C but rice gives satisfactory yields even with an electrical conductivity of over 25 mmhos in the upper 20 cm of the soil, whereas the higher figures analyses were from lower soil horizons. Soil salinity, it must be remembered, is a transient property. The figures given are for the soil under present conditions of natural vegetation and occasional rainfed agriculture. What the salinity levels are likely to be under irrigated agriculture depends partly on the soil drainage properties discussed immediately above as they affect soil leaching, partly on the methods employed and the level of management.

Of interest is the extent to which the current survey confirms or modifies the irrigation suitability classification in the earlier Impresit report (Appendix 4). The Impresit report identified 40,860 ha of Class I land, 48,905 of Class II land, and 61,850 ha of Class III land. The approach of the present team is to take a more cautious view than the Impresit report, and to downgrade many of the areas they have surveyed.

So far, the team states that they have found no Class I land on recent alluvium as mapped by Impresit. Their current impression is that there will be very little Class I land - "possibly 5% if liberal" - and that the best valley land is only Class II by U.S. standards, particularly if one takes into account economic considerations such as pumping, fertiliser and infrastructure costs. They provisionally estimate that they expect only about 10-15% of the irrigable land to be in Classes II and III together. These soils are mainly developed in alluvium of various types, and are suited to bananas and citrus, but suffer from the disadvantage that they are mainly very patchy, with long, narrow strips along the river and with no single parcels over 500-1000 ha. These better lands are largely left uncultivated in local traditional rainfed agriculture because they are considered to be too light textured, and the heavy soils are preferred for sorghum. Their natural vegetation consists of widely spaced clumps of older thorn trees. However, in the areas south of Saco Uen currently being surveyed, the team are finding in this specific area more Class II land than was mapped by Impresit.

A much more fundamental and important difference from the Impresit findings and approach concerns the creation by the present team of two new soil classes - R1 and R2. These replace much of the land that was classified as Class III and as Class IV P (suitable for irrigated pasture) by Impresit. The soil classifiers provisionally estimate that up to 80% of the irrigable land will fall into the R1 and R2 classes.

Class R1 lands are described as being highly suitable for paddy rice production and as "capable of producing relatively high yields of rice at reasonable costs". No indication is given in the interim report (Appendix 6) of the area so far put into this category, though it appears that these lands have been mapped in a variety of situations - near the river, and (mainly) in the mantled limestone plane, though they also occur in the alluvial and marine planes.

Class R2 lands are described as having a fair suitability for paddy rice but as being measurably lower than R1 lands in overall productivity. Again, the interim report gives no indication of the number of hectares so far put into this category, though it speaks of "very extensive areas" downstream from Buaale.

The creation of the R1 and R2 classes essentially reflects the doubt mentioned above as to how these soils with very poor drainage and sometimes some salinity in the subsoil will behave if they are irrigated. The Impresit team appeared to think that although mainly in Class III, they could nevertheless be used for a range of well drained crops. The BuRec team, on the other hand, question how long crops requiring drainage and not very salt tolerant could be grown on these soils and therefore suggest that they are good for rice instead. This is because paddy rice requires a poorly drained soil (paddy soils are usually deliberately puddled to make them impermeable) and is tolerant of high levels of salinity. But to put such a large area into R classes effectively begs the question as to how they would behave under normal irrigation with crops other than rice. The approach is cautious -- but if you do not happen to want all that much paddy rice, how else can these soils be used?

In the interim report, mention is made (in the section on drainage analysis - not paginated) of the theory of capillary breaks which stop the migration of salt above the 70-100 cm depth, the capillary breaks being the network of vertical plus horizontal cracks which remain open at about 50-70 or 50-100 cm even after rains or irrigation water have moistened the upper 30-50 cm of soil and closed all the cracks in that upper layer. The lower layer tends to remain open because the moist upper layer without cracks effectively seals it off. It appears that this theory was first mooted in a Russian report on the valley published in 1965. It is curious that in the 20 years since then no subsequent investigators seem to have been able to confirm or deny it. The BuRec team up to the time of the interim report (February 1986) admitted that they had not as yet carried out any drainage tests themselves and their assessment is based mainly on a review of published earlier investigations. This review plus no doubt their field observations of the soils lead them to fear that continued irrigation with inadequate dry seasons might in fact close up the cracks not only in the upper layer. but also in the middle zone which is supposed to act as the capillary break.

The considerations apply to all the heavier, more poorly drained soils of the valley, not only necessarily to those classified as rice soils. Economic considerations call for at least two crops a year, but this may not be possible if this does in fact lead to the capillary break layer closing up.

Since the writing of the interim report, the drainage engineer has begun field tests designed to show water movement and crack closing in heavy R type soils (the first test is shown in three photographs in Appendix 7). However, since he had joined the team for only a 90-day period and was near the end of his spell of duty in March during the author's visit, it appeared doubtful whether he would be able to do very much in the time available. If that is the case, how are the data required to assess drainage and the potential for leaching of these heavy soils to be generated? If the data cannot be obtained by field measurements during the survey then it is difficult to see how a cropping system can be suggested for crops other than paddy rice. These gaps in present knowledge perhaps explain why so much land is presently being classified as R1 and R2, but as pointed out two paragraphs earlier we still need to know much more about these soils to assess whether or not they can be used for other crops, and if so, how and for how long. Two approaches remain - the first is to compare the soils very carefully with existing irrigation schemes in the Juba Valley where the soils appear comparable, and the second is to conduct agronomic trials on experimental areas which have been selected as typical. The present teams should attempt to carry out the first approach within the survey period, and this might conveniently be fitted into their work on the lower Juba where most of the existing schemes occur and where their task now seems to be defined as little more than that of extrapolating existing information to areas beyond those already surveyed. The second approach, that of carrying out trials on experimental areas selected as typical, is of course much longer term, but here again the current BuRec team should be asked to carefully select sites (such as that already selected and surveyed near Bardera) which are representative of defined areas of the valley.

The agreement also called for a current land use map with overlays. The information to be shown on this map was not specified in detail. It appears that the team aim at producing a relatively simple map, based on field observations and air photos, showing (a) areas currently cultivated on and off (i.e. cultivated or under recent fallow); (b) areas under more mature fallow not recently cultivated; and (c) areas under little disturbed mature thorn bush. In the areas of the upper Juba on the east bank, the relative proportions of these three classes are of the order of

50%, 20% and 30%. The clearing and cultivation seems to have been mainly on the heavier soils, and the remaining thick bush therefore appears to indicate less heavy soils.

(c) Progress of the engineering studies

Section IV of the February 1986 interim report (Appendix 6) deals with the engineering analyses. The report gives a somewhat contradictory impression. On the one hand, it claims that "most of the engineering work is on schedule" (although there exists no work plan that details an agreed work schedule). On the other hand, it admits that "the scope and detail of many of the items have been reduced. For many of the items, the necessary data and information is not and will not be available within the time frame of the study".

This reduction in the amount of work that is expected to be accomplished is ascribed mainly to the fact that the work is dependent on having at its disposal area land classifications figures, cropping patterns and drainage requirement (all to be supplied by the classifiers) but this information has in turn been held up by the delay in supplying laboratory analyses. If these are delayed much longer, the report adds, the engineering analysis will have to be based on the data in the Impresit report. More generally, the teams had overestimated "the amount and quality of the basic data that would be available" and underestimated "the time required to generate and assemble the data".

The topics of concern in the engineering analyses range from the simple mechanical task of enlarging the base maps (satisfactorily completed) and the study of cross drainage, river floods and flows, and hydrology and water requirements, to an estimation of unit construction costs and a review of alternative irrigation schemes. There is thus certainly a very great deal for the irrigation engineer to do, and the project engineer appeared to the author to be both very experienced and very competent. However, the design and cost estimates of both the irrigation distribution system and the drainage system had to be postponed to later in the survey because they cannot be done until likely cropping patterns have been decided on and soil drainage requirements are known in more detail.

Both irrigation and drainage systems in the clay soils which constitute some 80% of the irrigable land will depend on whether crops other than rice can be envisaged, and what methods of fallow and leaching have to be incorporated into the cropping system. It is difficult to see how the present team can be expected to come up with firm recommendations on these aspects until it first has more information (not only the soil analyses but the results of field drainage tests) and in the absence of an agronomist. The absence of an agronomist from the team is noteworthy. With the emphasis on rice from the beginning, one wonders why nobody has thought fit to involve IRRI, the International Rice Research Institute.

(d) Progress of Economic Studies.

The full-time economist has spent most of his time in Mogadishu, and his treatment of what he terms in the interim report "Project Economic Studies" reinforces the impression gained from members of the field team that he has spent little or no time with them discussing the basic problem of cropping systems and costs. Cropping systems and costs and, to put it simply, whether irrigation can pay or not, are nevertheless among the most fundamental issues which the survey has to address. This was stressed in the service agreement (Appendix 2) which went out of its way to state very clearly that the land classes are to be defined in terms of an economic parameter, preferably net incremental irrigation benefits, and the most important decision will be the separation of lands which are irrigable from those which are not. In this context, irrigable lands are those lands in which the incremental benefits generated at the appropriate discount rate would exceed all costs and allow for ample incentive to the farmer.

It is not possible to separate lands which can be irrigated at a profit if it is not known what are the likely costs of production, yields, and profit to be expected from the crops envisaged. The service agreement stipulates that, if necessary, land classes should be downgraded to take account of negative or unsatisfactory results to the farm operator. As suggested in the previous section, the absence of an agronomist on the team is surprising and seems to imply that the necessary agronomic decisions can and will be taken by the existing team. To do this they will have to work in very close collaboration and also to make full use not only of existing information in reports but of the current experience of the various small and large current irrigation schemes, mostly in the lower Juba but also in other sections.

On page 12 of the section of the interim report entitled "Progress of Economic Studies" (the only section of the report which is paginated), we find the ungrammatical sentence: "The productive ability of the various land classes would be measured using crop budget", and are told that the standard measure of land productivity is net farm income. However, after a number of pages devoted to generalizations regarding basic assumptions made (the need for roads, inputs, extension services, etc.), there follows a section on "crop selection" which contains what is termed a "discussion on the relative merit of crops". This deals in turn with bananas, maize, rice, cotton and some other potential crops (cowpeas, groundnuts, soybeans, sesame), but these discussions are mostly of a very general, even elementary, nature and lack any cost estimates. The section on bananas, for example, contains some figures about production in the country as a whole but despite the fact that it is stated that "bananas will be used in this analysis to represent high-value crops which could be grown on Class I land", there is nothing whatsoever on costs, yields or profits. Most of the other crops are dealt with in a similar cursory way. It is only in the section on cotton that there is some mention of prices.

There is thus almost nothing in this section on economic studies which tackles the task of providing the necessary "economic parameters needed for land classification". Are we to assume that the project economist intends to begin to study these in the remaining months of the project? In view of the discrepancy between what was asked for and what has been provided so far, one wonders exactly how the project economist envisages his role in the survey and his relations with other members of the team and why he has not yet begun to tackle the economic parameters which both the service agreement and his own introductory statements point out are essential. This is certainly the most disappointing and disturbing section of the interim report not only because so little has been done but because it raises the more fundamental question as to whether the project economist understands what is required of him.

2.6 SOME OBSERVATIONS AND SUGGESTIONS

The time spent in Somalia was short, and no doubt some of the comments made in this section would have been much modified if further time had been available. They must be viewed in this light.

(a) An Analysis of the types of difficulty met

Any assessment of progress so far must, to be fair to the team, take into account the difficulties they have faced since they arrived in Somalia. These difficulties are essentially of three kinds.

First, the physical difficulties posed by the valley itself, its size, remoteness and lack of roads, and the fact that the field work is difficult or impossible in many areas during the wet seasons. These difficulties have been made worse by what appears to have been an unsuitable choice of vehicles and have certainly not been lessened by a certain lack of logistical planning of field work and the supplying of field bases, at which living standards were found to be unnecessarily spartan.

Secondly, difficulties were encountered of the administrative type such as is found in varying degrees in all third world countries. The Chief of Party complained at length of, and appeared to be wearied by, petty hassles and red tape at Mogadishu which affected both the field work and the laboratory analyses. Local currency budgets had all to be approved in advance and diesel authorised and obtained before the field parties could leave Mogadishu, and sometimes they were delayed and the period that they remained in Mogadishu was thus extended at the expense of the field work. But these administrative hassles were additionally and perhaps unnecessarily catastrophic inasmuch as they contributed to the fact that the Chief of Party, in theory the most experienced member of the team, spent almost all his time in Mogadishu and made virtually no direct contribution to the field work. It is difficult not to see this as one of the factors which resulted in the survey falling behind schedule and conspicuously failing to meet the service agreement guidelines as regards density of borings and pits and numbers of samples. Perhaps a greater emphasis upon field work by the Chief of Party would both advance the project and reduce the opportunities for bureaucratic entanglement. USAID, Mogadishu, appeared to be of the view that they could have themselves handled many of the problems had the Chief of Party left them to it. It is tempting to suggest that if the Chief of Party had left Mogadishu and disappeared into the valley to help with the field work, many of the hassles he complained so much about would have been dealt with by USAID, and that conversely they came his way just because he was sitting there in the ministry.

The third set of difficulties and the most fundamental in the view of the author, arose from the fact that BuRec signed a detailed agreement which, it is suggested, they did not study in sufficient detail before committing themselves to. In effect, given the physical difficulties, the size of the area, and not only the guidelines as to what constituted a reconnaissance survey but all the other requirements as to land, drainability investigations, a land use map (hardly tackled so far), and engineering analyses, it is difficult to see how all this could have been expected from a team of five which in practice in the event boiled down to only two full-time staff in the field. The stipulations for the field mapping alone, assuming a core of something like 250,000 hectares of land to be classified, required some 2,500 auger borings and 250 pits which would have been almost a physical impossibility even if half the time was not spent in the capital and there were no rainy seasons. Thus, the size of the team was not adequate to the task as defined. The almost inevitable result was that halfway through the survey, after the compilation of an interim report had forced them to take stock of the situation, they had in effect to admit defeat and ask for the guidelines in the agreement to be scrapped, the present intention being to survey the remaining areas at the rate of about on tenth of the borings originally agreed to, instead of the rate of one quarter of the stipulated borings achieved so far.

(b) Decisions to be taken regarding the conduct of the rest of the survey

Since the proposed changes represent a downgrading of the survey to something considerably less than the envisaged reconnaissance level, a decision will now have to be taken as to whether to settle for a reduced amount of information in order to finish the survey on time. This decision must look at the requirements for (a) completing the survey by March 1987 using the downgraded methods requested, and for (b) completing the survey using the methods employed during the first half of the work.

It appears that even alternative (a), which allows full discretion in the number of borings and pits, will require the use of a helicopter in the inaccessible west bank areas of the middle Juba, and Willie Forest was of the opinion that even with the helicopter, a three month extension might be needed. A three month extension would take the survey into the main rains of 1987, but might be devoted mainly to writing up the field work and to extrapolating the information already available on the lower Juba schemes to the areas outside them. It is not clear how long the latter exercise is expected to take.

Alternative (b) implies refusing the request for downgrading and insisting on the density of one auger boring per four square kilometers, etc., as carried out during the first part of the survey. The difficulty here is to assess just how difficult conditions in the middle Juba are going to be, but it seems certain that in order to complete the field work by March 1986, the number of classifiers in the field will have to be increased. This could be achieved by retaining one or both of the present TDY classifiers on a full-time basis until the conclusion of the survey, by extracting the Chief of Party from the bureaucracy of Mogadishu to mobilize, direct and aid the land classifiers in the field, by using a helicopter as discussed in the previous paragraph, and by reducing the time the field team spends in Mogadishu. On balance this is a better choice than alternative (a) because it keeps the density of observations and the number of samples and analyses at a more satisfactory level. At the same time, more serious attention has to be given to obtaining the additional soil drainage data discussed in an earlier section, and this in turn will enable the irrigation engineer to address some of the gaps he refers to in the interim report. The inputs of the economist, if the demands of the agreement are to be met, must also address themselves now to the economic parameters and cost and profitability calculations without which the separation of irrigable land from non-irrigable will be based on soil properties alone without sufficient economic weighting.

(c) The role of the survey in relation to valley development

To assess the contribution of this irrigation suitability survey to the development of the valley, it has to be seen in two contexts. The first is that it is going over an area which has already been surveyed several times since the first over-optimistic report came out in 1961 (Appendix 4). In particular, the survey represents an updating and reassessing of the survey described in the 1979 Impresit report, itself a reworking of the earlier Juba River Development Plan. There is thus much to learn from earlier work, as indicated in the service agreement, and one should try to be clear as to what exactly the BuRec team was expected to contribute. At its simplest, this survey is essentially separating land which is irrigable (i.e. irrigable at a profit) from that which is not, and subdiving the irrigable land into classes which have an increasing degree of limitation and which can therefore be expected to have increasingly higher costs and lower profits, though to some extent this is a matter still of opinion and uncertain prediction. It was stressed from the beginning that all the separations are to be based on economic parameters, which the team economist has so far failed to supply, so that in the event it seems likely that the final classification will reflect soil characteristics with scant attention to how much money, if any, any particular class can be expected to make. Not only that, but the team seems to be expected to come up with crop and cropping pattern recommendations which they can hardly be expected to do without an agronomist.

The second context is that this irrigation capability survey is but one input into the Juba Valley master plan. Other inputs are under way or are envisaged, including a German study of existing rainfed agriculture and a complex American environmental study (JESS). Of particular interest is that according to Aweys Haji Yussuf, the MJVD Director of Planning, a team of three agronomists will later come to make use of, among other things, the irrigation suitability survey. The present team, lacking an agronomist but feeling the need to envisage expected cropping patterns and to make their technical contribution by assessing soil factors which affect crop growth, have felt the need for discussions with agronomists and feedback from them. At present they feel isolated. It is unfortunate that the agronomist envisaged cannot be there now. Could the arrival of this team, or of part of it, be accelerated so as to overlap with the BuRec team?

Irrespective of whether the agronomist comes before the BuRec team leaves or not, the BuRec team should be encouraged to leave behind as full a description of the soils they have classified as possible for later use. An irrigation suitability classifier is expected to put land into a defined class, but these classes are defined in broad terms using a range of characteristics and two quite different soils can be put into the same class for quite different reasons. In that case, their management requirements may also be expected to be different. It has been a weakness of some irrigation suitability surveys, in the past that they have produced a map showing capability classes, but have not stated in detail exactly why a soil was so classified or what its precise limitations are. Thus an irrigation suitability survey contrasts with, and is in some ways much simpler than, a soil survey as carried out by the USDA. A soil survey maps and describes each individual soil and provides a range of information on its physical and chemical properties which any qualified person can interpret himself, possibly coming up with conclusions and recommendations which differ from those given in the soil survey report (facts and interpretation should in any case ideally be kept apart). The current BuRec survey is not a soil survey, and does not map, describe and assess soils. It merely expresses an opinion about the irrigation suitability of mapped tracts of land. One member of the field classifying team did in fact express the view that what MJVD needed was a soil survey and not merely an irrigation suitability survey, implying that the added detail of the former would be needed for agronomic management decisions. Be that as it may, there is a very strong case for urging the team to leave behind them maps showing the location of all borings, and all soil descriptions and analyses used in the classification for irrigation suitability. As mentioned in an earlier section, they should also select sites for later agricultural stations which are thought to be typical of defined areas of the valley.

In a broader context, it must be stressed that concern with irrigation possibilities must not diminish the need to link at the valley as a whole, both as regards the use of irrigable and non-irrigable soils, and therefore of both irrigated and rainfed agriculture, and then as regards the interrelationships between agriculture of both types and animal production and other forms of activity. This is obvious from the fact that first, only part of the valley is suitable for irrigated agriculture, and that second, the available water can irrigate only part of the irrigable land at any one time, thus allowing some rotation of irrigated land if structures permit. It appears that considerable areas of sorghum are successfully grown without irrigation on heavy lands which the current BuRec survey is likely to classify as rice lands, and in the lower Juba rainfed sesame has shown promise. Local cultivators prefer the very heavy, poorly drained soils for sorghum to the lighter river alluvial soils which the BuRec survey (as other surveys did before it) consider more suitable for irrigated agriculture than heavy clays. The author was impressed during his field trip by the fact that those heavy soils examined which had recently been harvested to sorghum were still moist in the subsoil. In years of average rainfall, rainfed sorghum production seems therefore to be good, and other rainfed crops such as sesame could no doubt be grown on a larger scale. The essential problems of the valley thus appear to be to progressively raise productivity in normal years and to guard against widespread disaster in unusually bad years. If the dam is at least partly an insurance against catastrophe in occasional bad years, then a core of irrigated land (preferably planted to a mix of cash crops, food crops and fodder and possibly in relatively small, locally-owned holdings) could provide a cushion against disaster and, viewed as an insurance policy, would not necessarily have to fulfil the same requirements of fully commercial profitability that additional cash crops would be expected to meet. Thus, the irrigated land must be viewed as complementing the remaining land and activities of the valley, and be integrated with them rather than considered in isolation, as seems to have been the case with some existing irrigation developments in the lower Juba.

PART THREE - APPENDICES

APPENDIX 1

ITINERARY AND PERSONS MET

(a) Itinerary and main events

February 15 March 6, 1986	Telex exchanges with Mike Dow, U.S. National Academy of Sciences, on scope of work and timing of mission
March 4	Telephone discussion with Mike Dow, Washington, clarifying main objectives of the mission
March 7	1600 Fly Bouaké - Abidjan 2000 Depart Abidjan airport
March 8	0800 Arrive Nairobi
March 9-12	In Nairobi. Discussions with Gus Tillman (ARD), Jim Riddell (Land Tenure Centre), Caroline Barnes (USAID, Nairobi) John Gaudet (USAID REDSO/EA); obtain Somalia visa and tickets.
March 13	1700 Fly Nairobi - Mogadishu
March 14 - 15	At Mogadishu. Discussions with Sally Patton (USAID, Mogadishu), Dan Macura, Dewayne McAndrew and Jack Jibson (all of the BuRec Juba Valley survey team), Robin James (Atkins Land and Water Management, and responsible for the detailed soil survey of the experiment farm site near Bardera), and with Aweys Haji Yussuf of the MJVD.
March 16	Drive in project Blazer, Mogadishu to Bardera. Discussion Jack Jibson en route.
March 17	At Bardera field base. Reconnaissance of part of east bank project area, examination of soil pits and auger borings, technical discussions and visit to dam site with Willie Forest, project soil classifier. Visit to west bank experimental farm site with Willie Forest and Dewayne McAndrew and examination of soils.
March 18	Reconnaissance of east bank project area with Dewayne McAndrew; drive from Bardera to Saco Uen Field base (central Juba Valley) making auger borings en route. Technical discussions with Dewayne McAndrew and Earl Dudley,
March 19	Reconnaissance of Juba Valley between Saco Uen and Buaale; drive Buaale to Mogadishu with Sally Patton.
March 20	At Mogadishu: final discussions on mission so far with Aweys Haji Yussuf of MJVD and Louis A. Cohen, P.E., Director, USAID, Mogadishu. 1530 Fly Mogadishu to Nairobi

March 21	At Nairobi. Discussion at USAID REDSO/EA.
March 22	1330 Fly Nairobi - Abidjan
March 23	1400 Fly Abidjan - Bouaké
March 24-April 1	Preparation of mission report in Bouaké
April 2-May 5	Hospitalised for ten days in Abidjan with pneumonia and subsequently convalescent in Bouaké
May 6-30	Completion of final report in Bouaké

(b) **Principal persons met**

Robert (Gus) Tillman, Senior Environmental Scientist, ARD (Associates in Rural Development Inc.), 72 Hungerford Terrace, Burlington, Vermont 05401, USA
Jim Riddell, Land Tenure Centre, University of Wisconsin, 1300 University Avenue, Madison, Wisconsin 53706
Caroline Barnes, USAID, REDSO/EA
John Gaudet, USAID REDSO/EA
Sally Patton, Juba Valley Survey Project Manager, USAID, Mogadishu
Aweys Haji Yussuf, Director of Planning, Ministry of Juba Valley Development, Mogadishu
Dan Macura, Chief of Party, Bureau of Reclamation survey team, Mogadishu
Dewayne McAndrew, Soil classifier, BuRec survey team
Jack Jibson, Soil Classifier, BuRec survey team
Robin James, Soil surveyor, Atkins Land and Water Management Ltd;, Cambridge, England (carried out detailed soil survey of Experimental Farm site near Bardera).
Willie Forest, Soil Chemist/Classifier, BuRec survey team
Tom Crooks, Drainage Engineer, BuRec survey team
Earl Dudley, Irrigation Engineer, BuRec survey team
Keith Stallard, Water Resources Engineer (Sir M. Macdonald & Partners, Ltd.), attached to Somalia Ministry of Agriculture (met at Bardera).
Louis A. Cohen, P.E., Director, USAID, Mogadishu.

APPENDIX TWO

PASA: THE PARTICIPATING AGENCY SERVICE AGREEMENT between AID and the Department of the Interior, Bureau of Reclamation (BuRec).

The SUMMARY of the PASA agreement reads as follows:

This agreement between the Agency for International Development and Department of the Interior, Bureau of Reclamation, is to assist the government of Somalia, Ministry of Juba Valley Development (MJVD) in generating current data for use in the preparation of a Master Plan for land and water resource development in the Juba Valley. The immediate objective is to conduct reconnaissance-grade water and land resource studies for the Juba Valley and the lower Scebeli Valley. A team of BuRec technical specialists in land classification, drainage, economics and project planning will undertake an investigation of arable lands downstream of the proposed Bardera dam site. The team of BuRec technical specialists in land classification, drainage, economics and project planning will undertake an investigation of arable lands downstream of the proposed Bardera dam site. The team will conduct (1) an irrigation suitability land classification, (2) a study of water suitability for irrigation, (3) investigation of drainage requirements, (4) a present land-use survey, and (5) prepare a report of finding. Based on the findings during the reconnaissance investigations, the team will prepare a scope of work for feasibility investigations of priority basin projects.

The period of funding on this PASA is from o/a 2/15/84 to o/a 2/28/86.

Total cost of the agreement was given as $1,607,405, and the **permanent resident staff** were to include, each with 24 man-months, one team leader-planning engineer, one land classifier, one drainage engineer, one economist and one soil scientist.

The scope of work is set out on pages 2-4 of the PASA, and is summarised in the following paragraphs:

The use of existing data is referred to specifically on P.2, para 3 which reads:
To achieve economies in the work programme, applicable data collected by other consultants or agencies on geology, water soil, drainage, agronomy, economic data and soil-water-plant studies, including soil surveys, will be utilised in the land resource study. Thus, the BuRec staff shall familiarise itself with all available sources of data, published reports and other relevant items of information to avoid duplication and provide for a meaningful study.

Irrigation suitability land classification and supporting investigations are described on pages 2-3. In summary, the agreement provides for a reconnaissance-grade land classification of both the Juba and lower Scebeli rivers in order to reflect suitability of land for development to diversified cropping or wetland rice production, and emphasises that "it is essential that the survey be adequately supported by the requisite economic studies, drainage investigations, field testing, laboratory characterisation and engineering planning". The land classes are to be defined in terms of an economic parameter, preferably "net incremental irrigations benefits", and the most important decision will be the separation of lands suitable for development from those that are not, and the principal task will be to delineate as a minimum, irrigable and non-irrigable lands. In this differentiation, irrigable lands would be those lands in which the incremental benefits generated at the appropriate discount rate would exceed all costs and allow for "ample incentive" to the farmer. "All costs" in this context are investment costs for project works and land reclamation, all farming costs, and OM & R costs of the project's proportionate share of the entire system. If necessary, land classes should be downgraded to take account of negative or unsatisfactory results to the farm operator.

Land drainability will be investigated in order to establish the capacity of the soils, subsoils and substrata to transmit and retain water and will include a study of available hydraulic gradients, both natural and those that can be improved by drainage works. Special attention will be paid to locating and documenting possible barriers. Field studies should include measurements for infiltration, vertical hydraulic conductivity and horizontal hydraulic conductivity. Studies shall include evaluation of present and anticipated water management practices and cropping patterns.

Soil characterisation by field and laboratory methods will assure a definitive diagnosis of soil salinity and soil sodicity (alkali) under present conditions and prognosis of these properties under future conditions, with or without the project. This will necessitate studying the agricultural experience on similar lands in Somalia.

Subsurface drainage requirements will be determined and estimated costs for the required surface and subsurface systems provided.

Present land-use in the proposed system and in impacted areas associated with the project will be determined. Required services will include air photo interpretation to identify and measure present land-use, field inspections of these areas, preparation of photo overlays showing present land use, and the tabulation of results.

Under the heading "Partial listing of suggested guidelines for soil characterisation" the following **guidelines for the reconnaissance-grade irrigation suitability land classification** are spelled out (page 4):

a. The boring density for soil examinations will be one site per square kilometer and the scale of the soil map will be 1:100,000. All bores should be done by auger to a minimum depth of 3.0 m. One open pit shall be dug every 10 kilometers to a depth of 3.0 m.
b. Additional borings on a grid or otherwise might be required to delineate between irrigable and non-irrigable land.
c. Soils will be described in the field, using internationally recognised systems [Food and Agriculture Organisation (FAO) or U.S. Department of Agriculture (USDA) Systems].
d. Soil samples should be collected from each significant horizon at all borings and pits for laboratory analysis.

APPENDIX THREE

SUGGESTIONS FOR PASA REVISIONS PUT FORWARD BY DAN MACURA, FEBRUARY 1986

Note: The following suggested revisions were given in handwritten form to Sally Patton, and subsequently passed to the author for comment on March 15. The handwritten text of Dan Macura's original note is given here in bold type, and the effects of the suggested amendments are then indicated by reference to the original text of the PASA (Participating Agency Service Agreement).

I Summary Page 1

Line 6---resource studies for the Juba Valley, and pre-reconnaissance studies for the lower Scebeli using readily available data and a minimal amount of field work.

II Scope of Work.

Line 2. Juba Valley and pre-reconnaissance of the lower Scebeli River. Irrigation suitability land classification----Juba Valley. A pre-reconnaissance land classification shall be performed on the lower Scebeli area to the degree necessary to differentiate arable and non-arable lands.

Page 3 (first paragraph)
The study shall serve to identify needs, establish opportunities and permit selection of lands for detailed development studies.
(second paragraph)
wetland rice production for typical situations.

Page 4 Reconnaissance-grade
a. The boring density for the field examination of valley soils will be adequate to represent the major land forms, arable and non-arable land classes. The scale of the product land class maps will be 1:100,000 for report purposes. All borings shall be done by auger to an average depth of 3.0 metres or identified barrier condition.
b. Hand-excavated test pits shall be located within major land class units as necessary for detailed evaluation and sampling. Test pits shall average 1m x 1m x 3m depth. Drainage evaluations will be conducted at these master site excavations for positive correlations.
c. Soils will be described in the field using the internationally accepted U.S. Bureau of Reclamation classification system.
d. Representative soil samples shall be collected from each significant horizon for laboratory testing as necessary.

I Summary Page 1
The relevant original PASA text reads:

...The immediate objective is to conduct reconnaissance grade water and land resource studies for the Juba Valley and the lower Scebeli Valley.

The suggested revision would read:

... The immediate objective is to conduct reconnaissance-grade water and land resource studies for the Juba Valley and pre-reconnaissance studies for the lower Scebeli using readily available data and supplemented by a minimal amount of field work.

The effect of the suggestion is to downgrade work on the lower Scebeli Valley from reconnaissance-grade to pre-reconnaissance-grade. This would eliminate the need for regular field work on agreed lines in that area. The intention is to extrapolate available existing information on parts of the area to the remainder of it.

II Scope of Work

The relevant original PASA text reads:

Reconnaissance-grade water and land resource studies shall be made for the Juba Valley and the lower Scebeli River area.

The suggested revision would read:
Reconnaissance-grade water and land-resource studies shall be made for the Juba Valley and pre-reconnaissance (grade studies) of the lower Scebeli River.

Irrigation suitability land classification

The relevant original PASA text reads:

BuRec shall perform an economic land classification survey adapted to local conditions of the Juba Valley and the lower Scebeli River to establish the degree and suitability of lands for sustained profitable crop production.

The suggested revision would read:

BuRec shall perform an economic land classification survey adapted to local conditions of the Juba Valley to establish the degree and suitability of lands for sustained profitable crop production. A pre-reconnaissance land classification shall be performed on the lower Scebeli area to the degree necessary to differentiate arable and non-arable lands.

The effect of the suggestion would be to further define the nature of the downgrading of the lower Scebeli work to pre-reconnaissance grade by specifying that it would be sufficient to distinguish arable from non-arable.

Page three, first para: the relevant PASA text reads:

The study shall serve to identify needs, establish opportunities and select land and water for development and maintenance.

The suggested revision would read:

The study shall serve to identify needs, establish opportunities and permit selection of lands for detailed development studies.

The effect of the suggestion is to omit the original reference to the selection of land <u>and</u> <u>water</u> for development and maintenance.

Second para, the original PASA text reads:

The land classification shall reflect suitability of land for development to diversified cropping of wetland rice production for all situations and ranges in water application and drainage control.

The suggested revision would read:
...For development to diversified cropping or wetland rice production for typical situations.....

Page 4, Reconnaissance-grade irrigation suitability classification.

The relevant original PASA text reads:

a. the boring density for soil examination will be one site per square kilometer and the scale of the soil map will be 1:100,000. All bores should be done by auger to a minimum depth of 3.0 m. One open pit shall be dug every 10 (square) kilometers to a depth of 3.0.

b. Additional borings on a grid or otherwise might be required to delineate between irrigable and non-irrigable land.

c. Soils will be described in the field, using internationally recognised systems [Food and Agriculture Organisation (FAO) or U.S. Department of Agriculture (USDA) systems].

d. Soil samples should be collected from each significant horizon at all borings and pits for laboratory analysis.

The suggested revisions would read:

a. The boring density for the field examination of valley soils will be adequate to represent the major land forms, arable and non-arable land classes. The scale of the product land class maps will be 1:100,000 for report purposes. All borings shall be done by auger to an average depth of 3.0 metres or identified barrier condition.

b. Hand-excavated test pits shall be located within the major land class units as necessary for detailed evaluation and sampling. Test pits shall average 1m x 1m x 3m depth. Drainage evaluations will be conducted at these master site excavations for positive correlations.

c. Soils will be described in the field using the internationally accepted U.S. Bureau of Reclamation classification system.

d. Representative soil samples shall be collected from each significant horizon for laboratory testing as necessary.

The effect of these suggestions is to substantially modify the original stipulations in the PASA designed to define and characterise what was understood by a reconnaissance grade irrigation suitability land classification.

In para a, a very substantial modification is suggested which would do away with the original stipulation that there be one auger boring per square kilometer, putting in its stead the vague stipulation that the boring density "be adequate to represent major land forms, arable and non-arable land classes". By making the density of boring a matter of opinion, the suggested modification in practice gives carte blanche to the survey party to do as many or as few borings as they think "adequate" and effectively eliminates any subsequent discussion or complaint which might seek to show that the final boring density was inadequate by referring to the failure to implement the original PASA definitions of accepted reconnaissance-grade survey norms.

In para b, the suggested modification does in effect for soil pits what paragraph a sought to do for auger borings, i.e., it substitutes for the original clear and verifiable stipulation that there be one hand excavated pit for every 10 kilometers (i.e. for every ten square kilometers) the loose proviso that these pits be located "as necessary", as necessary here meaning as the survey party might feel to be necessary. As in the case of the auger borings dealt with in the previous paragraph, if this amendment is accepted, the number of pits thus becomes a matter of opinion, and can no longer be enforced or argued with reference to the original PASA.

Para c suggests that instead of soils being described, as originally agreed, using either FAO or USDA terminology, they will now be described using the locally simplified BuRec classification system.

Para d seeks to modify very substantially the original PASA stipulations regarding the number of soil samples which were to be analysed. The original document stated that samples would be collected before analysis from significant horizons of <u>all</u> <u>borings</u> <u>and</u> <u>pits</u>. The suggested amendment does away with this rigid stipulation and substitutes the much looser concept that samples be collected "as necessary". Since the term "as necessary" reduces the sampling merely to a matter of opinion (or convenience), this suggestion, if adopted, would effectively remove any recourse to the PASA if the number of samples analysed was felt to fall short of expectations.

APPENDIX FOUR

NOTES ON TWO EARLIER DOCUMENTS RELATING TO THE JUBA VALLEY

(a) International Cooperation Administration, January 1961 Inter-River Economic Exploration, The Somalia River. Washington 25 DC

This substantial report of the Giuba (Juba) River Valley was published in 1961 and seems to be the first major document in English assessing the area for irrigation agriculture. The tone is rather optimistic throughout the work. "Plenty of land is available for whatever amount of water can be brought to it". On the west side, the better soils were held to be mainly on first terraces, 50 km long and up to ten wide. On the east side several river terraces were described within an area 100 km long and 16 wide.

Land was classified into six classes, following normal U.S. practice, of which classes I to IV are irrigable, V is a holding class pending further information, and VI is land considered non-irrigable. The six classes, and the areas put into the irrigable classes, were as follows:

Class I: very good land:	29,000 ha
Class II: good land:	35,000 ha
Class III: moderately good:	76,400 ha
Class IV: fairly good:	47,000 ha
Class V: land given only a cursory study due to poor access	
Class VI: non-arable land	

The report spoke favorably of the alluvial plain 8 to 30 km wide on both sides of the Giuba (Juba) River from Duguima to Ionte. The generally very low gradient was considered a problem but it was pointed out that leveling would not be difficult and that the old channels and desceks (desheks) could be used as drainage outlets.

The salinity of the Juba River was described as varying with the season, being highest at the first rise of the river volume in April-June. The salts it contains were described as being mostly gypsum.

Crops discussed as suitable for irrigation were given as including sugarcane, rice, cotton, corn, maize, legumes, beans, sorghum, groundnuts, bananas, citrus and mangoes.

The low level of water flow from January to March was described as a limitation, and the report spoke of the need to fit crops with a 90- to 120-day growing season into the peak flow periods, since the high water level of the river lasts about six months of the year.

Outlining a possible 20-year stratègy, the report emphasised:
(a) bananas as the initial mainstay in the first five year period (0-5);
(b) sugarcane as the dominant crop in the second five years (5-10);
(c) increasing amounts of animal feeds in the third period (10-15) until these become dominant in the fourth (15-20).

The main problem of the Class III and IV soils was given as their very slow drainage and low permeability. Since slopes were flattish, the tertiary drains would have to be not more than 100 metres apart and at least one metre deep. The low gradient could also be expected to lead to the silting of the drainage channels, so that clearing these would have to be envisaged every dry season. The sale of charcoal could partly pay the cost of the initial vegetation clearing.

Four main types of farms were discussed:

(1) Combination grazing and crop units with livestock using some natural range land but getting supplementary feeds.
(2) Dairy units depending mainly on feeds grown on irrigated land.
(3) Cash crop irrigated units producing bananas and sugarcane.
(4) General farm units with castor beans, sesame, legumes and a few cows.

The main dryland crop opportunities were held to be provided by corn, sorghum and sesame. The importance of good management was stressed as increasing the usefulness of the available water in the general scenario of there being plenty of land but not enough water. Other agronomic and management problems discussed included tillage, the use of fertilisers, seed improvement, the control of weeds in drainage ways, in channels, and in the field, and dangers from bilharzia, tsetse and insects in general.

(b) IMPRESIT SpA/ Democratic Republic of Somalia, State Planning Commission, October 1979.
Updating and revision of the Juba River Development Plan.
Vol I. Summary and conclusions.
Vol III. Agronomy.

This report is an updating, by the Italian firm of IMPRESIT SpA, of the earlier Juba River Development Plan. It frequently refers to the earlier plan and to the modified conclusions it presents as a result of the present study. The Scebeli River Valley is excluded from the study because of lack of water which results in its running dry at some seasons. Because of this, it is concluded that the only promising prospects are in the valley of the Juba.

The Juba Valley comprises 170,000 km^2, or some 27% of the country, and with some 800,000 people has about 26% of the total population.

The updating and revision concluded that within the valley there were about 400,000 ha of irrigable land at the general survey level, coming down to some 250,000 ha "at the project level". Some of this hectarage has already been developed, since existing banana plantations (in 1979) accounted for 21,000 ha and a sugar project, the Jilib state farm and the Mogambo project for a total of about a further 17,000 ha.

Some 20,000 to 30,000 ha are at present already irrigated by deshek agriculture, i.e. by traditional family farms making use of residual soil moisture as water retreats after the floods, but yields produced by these methods, are described as being not much higher than those obtained from rainfed agriculture.

The revised recommendations differ from the original plan inasmuch as they exclude wheat and sorghum, and the area recommended to be put under bananas and sugar cane is reduced under a "partial development hypothesis". An estimated six years would be needed for construction work and for reservoir filling prior to the start of cropping, but the next need was for a more detailed feasibility study.

The Saco Uen storage dam recommended in the original plan was considered in this revision to be too costly, and reliance was recommended on river flow regulation from Bardera reservoir instead.

Three factors were taken into account when deliminating irrigation districts:

Land classification: the best lands were to be used for a variety of crops whereas a given proportion were to be limited only to rice cultivation.
Topography: where pumping is involved, the lifting height is to be limited to fit in with elevations commanded by the two main structures, the Bardera dam and the Fanoole barrage.
Size and shape: regularly-shaped areas should be selected in order to lower investment unit costs.

Available irrigable land included:
- between Bardera and Saco Uen: 57,300 ha
- between Saco Uen and Buaale: 53,400 ha
- between Buaale and Fanoole: none
- between Fanoole and Joontoy: 112,800.

The net overall cost of developing this land was estimated at 48,300 shillings a hectare, as against an estimate of only 21,900 shillings a hectare in the original development plan. This more than doubling of estimated costs was due in part to revised estimates as regards drain spacing and other parameters.

The permanent crops recommended were bananas and grapefruit, with sugarcane to be grown only in the sugar project. The recommended seasonal crops included rice and groundnuts.

Other crops discussed included sunflower, groundnuts, soya and tobacco, and the importance of livestock was also stressed. For rainfed agriculture, suggested rotation for the DER season was groundnuts/ corn/cotton, and for the GU season, sunflower and maize,/ soya/soya and maize. Maximum maize yields attainable were considered to be unable to pay for irrigated costs.

The rice was to be flood irrigated, the sugarcane sprinkler irrigated and other crops irrigated by furrow irrigation.

APPENDIX FIVE

Notes on the paper "IRRIGATION SUITABILITY LAND CLASSIFICATION STUDIES ON THE JUBA RIVER VALLEY"
by Willie J. Forest and Kaha Mohamed Barre.

The report is undated but appears to have been written about the end of 1985. It summarises the main relief, geological and soil features of the upper, middle and lower Juba Valley, and is mainly of interest in as much as it gives descriptions of five soil profiles, and laboratory data on 80 soil samples from the upper and lower Juba Valley.

Electrical conductivity (EDe values) are given for 36 upper Juba and for 46 lower Juba soils with values ranging up to 30 and 28 mmhos respectively, and a total of 24 samples out of 82 being over 16 mmhos. Salinity and sodicity levels often increase with depth down the profile. They are highest in the marine clays, where the sodium causes dispersion, and lowest in the alluvial rice soils. It is pointed out that the effects of high salinity values vary with the crop and its salt tolerance, and tables are included showing the increase in EDe values needed to lower yields by 10% for various crops, with sesame and sugarcane being very sensitive to salinity and cotton among the least sensitive of the crops considered.

A short section considers soil drainage and the difficulties raised by the fact that soil textures for most soils below 12-18 inches are heavy. Hydraulic conductivities performed in seven selected areas showed an average permeability of only 0.03 inches per hour. Interest centres therefore on the extent of cracking during the dry season and the degree to which this enables the upper soil zone to remain low in salts through flushing during the rains or when irrigation water is supplied, and movement of the salt to a lower layer. Before this potential can be assessed however, the authors point out that properly evaluated information will be required on the following:

current salinity levels in the soil
salt tolerance of crops to be grown
the salinity of irrigation water
quantities of irrigation and rain water consumed
percent swell of clays
ratio of void to mass in cracked clays
time taken for cracks to close upon applying water
soil moisture level at time of soil cracking
cycles of drying and wetting

APPENDIX SIX

NOTES ON THE FEBRUARY 1986 INTERIM REPORT

Interim Report, Juba Valley Analytical Studies, Land and Water Resources, Somalia. February 1986
Bureau of Reclamation, U.S. Department of the Interior/Ministry of Juba Valley Development, Democratic Republic of Somalia.

The February 1986 interim report "summarises the initial findings and opinions of the Bureau of Reclamation team evaluating the land and water resources of the Juba Valley and the lower Scebeli Valley". Unfortunately, it is not paginated, and there are a number of surprising omissions: for example, there is no clear statement of when work was started, who was involved and for what periods, and what specific areas and map sheets were surveyed and when. Nor is there any discussion of what remains to be done in relation to the time available and the physical difficulties to be expected.

On the positive side the report gives (a) maps of the upper, middle and lower valley areas; (b) a map (without title) showing location of the 1:50,000 map sheets; (c) four pages of laboratory data (but without title or heading, and with no explanation or comment); (d) five chapters of text (Introduction; Development Potentials; Land Classification; Engineering Analyses; Economic Studies).

The following notes summarise and comment on the main points enumerated in these five chapters.

I. Introduction.

The report summarises eight months of field activities, and must be accepted as preliminary. The land classification is based primarily on field observations and previous reports, with little benefit as yet of soil analyses.

The elevation of Bardera dam (maximum 150 metres) resulted in the use of the 150 metre contour to limit the lateral extent of the valley at its northern end, with an appropriate reduction downstream. During the period prior to the construction and operation of the dam and in the absence of diversion structures from the dam, irrigation will, it is assumed, be by pumping from the river and a lift of 15 metres was assumed to be the economical limit. Areas of interest for irrigation development were thus considered to be those lying less than 15 metres above the river, with lands of classes I, II or III.

II. Development potentials.

With single cropping, water would be sufficient to irrigate over 200,000 ha, but with double cropping - and it is thought that the investment costs in the land would make double cropping an economic necessity - water would suffice for only 120,000 ha. It is considered that some land will have been cultivated and in turn gone out of production due to salinity problems long before all the available lands have been cultivated. Initial development will be based on pump irrigation with the anticipation of a later conversion to gravity systems. The assumption that Somali farmers will be willing to work only in daylight hours will increase the cost of delivering the required volumes of water. Although double cropping is economically necessary in relation to the high cost of development, double cropping would likely increase drainage and salinity problems since present soils data indicate that a drying period may be essential after harvest and prior to the following cultivation in order to encourage deep soil cracks. The length of this drying period has yet to be determined, and may prove to be a critical factor in planning cropping patterns. It is, however, anticipated that planned drainage evaluation tests will enable the required drying out period to be predicted.

III. Land Classification

The Juba Valley study area is contained on 41 1:100,000 map sheets, each about 36 x 56 km, giving a <u>gross area</u> of 82,000 square kilometers, though the net area is not here indicated. Field work is said to have been completed on "over half" these complete and partial map sheets, though it is not stated what percentage of the anticipated project area has been completed.

The collection of previous reports and previously available data was "basically accomplished" during the pre-reconnaissance survey "of June 2, 1984" (presumably, this is a typing error and the survey of February 26 to May 2 is meant). The Impresit classification of 1979 used U.S. Bureau of Reclamation land classification techniques and is being utilised to a great degree, since it has been found to be accurate "and effective in saving field time".

The February-May 1984 pre-reconnaissance review made possible the elimination of some areas from further consideration. Topographic maps at a scale of 1:100,000 were enlarged to 1:30,000 to match the scale of available air photos. The grids on these maps are 2 km x 2 km and all observations are located with reference to these grids. Initially, "special efforts were being made to examine one site per grid" (i.e. one observation per 4 square kilometers, not per one square kilometer as specified in the PASA). However, this was later "determined to be unnecessary due to land uniformity and the inaccessibility of certain areas" (i.e., the areas of interest were so uniform that less frequent borings were sufficient, while other areas were not of interest anyway because they were inaccessible?). Areas which are obviously non-arable because of erosion, or because hilly and/or rocky, received less attention. The field determinations of irrigation suitability will be supported by laboratory analyses and an average of four samples are taken from each described profile (however, the report gives no numerical indication of the number so far of either the "described profiles" or of samples submitted to the laboratory or actually analysed). In addition to the routine borings (number unspecified) "a number of test pits in the lower and upper Juba Valley have been excavated for detailed sampling and complete analyses by the laboratory" (but again, there is no indication of just how many test pits have been dug, or where they are, though they are claimed to be "located as to represent geomorpholocial units"). The report claims that "the methods being followed are in general in accordance with those described by the U.S.B.R. manuals" (though in one very important and fundamental aspect, they obviously are not--namely, the density of observations regarded as normal for a reconnaissance survey).

The topography of the valley is predominantly nearly level. Only limited soil data are currently available (these are dealt with in more detail in the separate report by Forest and Barre) but this data indicates a fairly wide salinity range in the soils from 1.1 to 30.1 mmhos/cm, with a tendency for the higher figures to occur in the mantled limestone plain away from the river and the lower figures in the alluvial soils near to it. The range of salinities found in lower Juba was about the same and in both cases there is a tendency for salinities to increase down the profile (the effect of these on crop growth varies with the crop concerned, but at the higher figures growth would be much reduced for most crops). The analytical methods used at the Afgoi lab are standard, but there is currently a six-month backlog of analyses as the laboratory is working at 20% of capacity.

The area has been divided into various landforms which are described. They comprise

(a) an alluvial plain on either side of the river of various riverine deposits, including levees, floodplains and river terraces, which includes good irrigable land comprising reddish light textured soils on levees and heavier clay loam to clay soils in the floodplains which have low permeability and gypsum below 1 metre;

(b) a mantled limestone plain, level to gently rolling, in which the soils developed over Jurassic limestone are deeply cracked clays with high soluble salts and exchangeable sodium in the subsoil, and the soils developed of Cretaceous limestone are less deeply cracked and generally have lower soluble salts and sodium.

(c) less extensive landforms described as an eluvial plain (Dujuma area), a marine plain in the middle and lower Juba, and a beach remnant in the lower Juba.

The field classification of the soils of the Juba Valley is "approximately on schedule", with 196,100 hectares classified on 22 map sheets. Most of this area occurs in the upper Juba Valley, with as yet little field work completed in the middle Juba. The upper and middle Juba Valley represent the new areas to be looked at, in contrast to the lower Juba Valley, where there is already considerable development along the river. There are, however, some privately owned irrigation projects in the upper Juba, while between Saco Uen and Jilib flood recession deshek agriculture is practised. Small irrigation projects (100-200 ha) and deshek agriculture are currently being studied by Agar and Hydrotechnik GmbH.

Land considered suitable for irrigated agriculture are being put into one of five classes: I,II, III, R1 and R2. Classes I to III are in decreasing order of irrigation suitability but all are generally suited for a wide variety of crops. This fact distinguished them from classes R1 and R2, since these soil classes are considered to be suitable for wetland (paddy) rice using level basin flooding, but not necessarily suitable for other crops, or at least not for long. A sixth class, the sprinkler irrigation class, was later dropped due to too limited extent. The following paragraphs summarise the extent, characteristics and main recommended uses of each of the five classes of land suitable for irrigation retained:

Class I land, represents a relatively small acreage adjacent to the Juba River. The report does not state how many hectares have been mapped in this class so far (but quotes in Impresit report as having put 40,860 ha in this class). Suitable crops are given as citrus, bananas, peanuts, cotton, sesame and vegetables.

Class II land has greater limitations than Class I soils which are likely to result in higher production costs and/or lower yields. This land has been found to occur in both the river alluvium and levee areas, but not generally in the mantled limestone plain area. On these lands, crops sensitive to salinity and sodicity, such as citrus, are less suitable than are crops such as cotton, maize, sesame, sugarcane, tobacco and pulses. Although it is pointed out that the Impresit report recognised 48,905 ha of Class II lands, no indication is given as to how much land has been put into this category so far by the BuRec team.

Class III land is measurably lower than Class II land in irrigation suitability due to a greater degree of soil, topographic or drainage deficeincies. Like the Class II lands, the Class III lands also occur primarily on the alluvial and levee areas and not in the mantled limestone plain. The Impresit report identified 61,850 ha of Class III lands but present field work indicates that the present survey will make "a large reduction" of lands put in this category (due to downgrading to the R categories).

Class R1 lands are described as being highly suitable for paddy rice production, and as capable of producing "relatively high yields of rice at reasonable costs". These lands ware found not only along the Juba River, but in the mantled limestone plain as well as the eluvial and marine plains. The essential feature is that their drainage costs are too high for crops other than rice, though they occupy positions where adequate runoff of surface water is likely to be provided by project facilities. No indication is given of the area classified so far as R1.

Class R2 lands are described as having a fair suitability for paddy rice but as being measurably lower than R1 lands in overall productivity. Typical positions include the floodplain, marine plain and shallower soils of the mantled limestone plain. The report says that "very extensive areas" downstream from Buaale fit into this category but gives no indication of the area mapped as belonging to this class.

The main features of the lower, upper and then middle Juba Valley are then described in that order.

The lower Juba Valley is between Fanoole and the Indian Ocean, and contrasts with the other sections in as much as that is considerably more developed agriculturally, with "moderate development" for many years, of bananas, sugarcane, rice and other crops. Development began on the better alluvial soils adjacent to the river and then expended outwards. The biggest developments are Fanoole, Juba Sugar and Mogambo projects, all of which have large areas designed for expansion.

Between Fanoole and Joontoy (95 km), the river gradient is very low and alluvial sediments are up to six km wide on each side of the river and generally have medium textures (loam to clay loams) favourable for irrigation. South of Jilib, however, marine sediments are exposed within the alluvium areas and these marine sediments are heavier and sometimes saline/sodic.

The upper Juba Valley is defined as lying between the Bardera dam site and Saco Uen: the first river terraces suitable for cultivation begin about 10 km south of the dam site where the valley first broadens. Two maon soil areas are distinguished: the extensive mantled limestone plain and the flood plains on either side of the river.

The mantled limestone plain has soils mainly over 2m thick, except where limestone or marl is exposed and in those local areas cut into by sheet and gully erosion, but the soils are generally heavy in texture (clay loam over clay), usually saline and sodic, and with lime and gypsum at depth.

The floodplain lands on either side of the river are between 2 and 4 km wide and are characterised by recent alluvial sediments. Soil textures are variable but are generally medium, and the soils non-saline or only slightly saline, so that the floodplains include many areas suited to irrigation.

The middle Juba Valley lies between Fanoole diversion weir and Saco Uen, and is the least developed part of the valley. Lacking all-weather roads, it is relatively isolated during the wet seasons. Between Saco Uen and Buaale (45 km), alluvial soils near the river are up to 4 km wide, and this area has many depressions (such as old meanders and river channels) which are used for the traditional flood-recession deshek agriculture. Further from the river, the mantled limestone plain soils are found, and marine sediments occur south of Buaale, but field classification by the

BuRec team had not been begun at the date of the report and was scheduled for the 1986 field seasons.

Field drainage tests have not as yet been carried out by the team and their assessment so far is based on a review of published earlier investigations and on the impressions gained in the earlier brief field reconnaissance. These indicate that, in most cases, continued irrigation will be possible only with a combination of surface or subsurface drainage and farm crop/water management. Most of the soils are heavy and have a massive, structured, non-drainable subsoil. At present, shrinking and cracking of these soils during dry seasons is thought to have prevented salt accumulation in the upper horizons. When water is applied to the dry, cracked soil, it is thought that the upper, more friable and heavily micro-fractured horizons absorb water faster than the rest of the profile, swell, and close their cracks, thus creating a moist, impermeable upper layer overlying, at 30-50 cm, a lower layer which still has some cracks and fractures, and this lower layer tends to remain open because the moist upper layer effectively seals it off. The open fractured zone, the theory goes, acts as a capillary break which prevents the rise of salt-containing water above the 70-100 cm depth. This theory was first advanced in a Russian report on the valley published in 1965. The fear, however, is that under continuous irrigation, with inadequate dry seasons, the water applied will be sufficient to close the cracks in the middle zone, which acted as a capillary break, and salt will rise from the lower layers to affect the upper part of the profile.

With year-round irrigation, buried pipe drains installed no deeper than 70-100 cm will, it is thought, be needed, but will not necessarily prevent salinity problems because of the heavy subsoil texture below 30-50 cm and the difficulty of leaching it. Even with the subsurface pipe drains, the fractures may close completely. Alternatively, crop and water management may be enough to reduce or eliminate the need for subsurface drains, but eventually waterlogging and salinity problems would lead to the irrigated plots being abandoned, with others then being brought into production in a staged development.

One crop management scheme currently thought to be promising involves a drying out fallow period during which the cracks redevelop to 70-100 cm and provide a leaching pathway to this depth so that subsequent irrigation can flush out salts from this layer. During the fallow period during which the cracks are expected to develop, it may be possible, the report suggests, to produce a rainfed crop such as sesame (but is it not in the dry seasons that these cracks normally develop?). Even so, this proposed scheme is no more than a "salt storage process" which pushes the salt into the soil below the cracked zone, from which it may rise again later at some time in the future. Faced with all this speculation and uncertainty, the interim report suggests (a) trials plots as indicators; (b) the study of similar soils in Sudan and Australia (but not, it seems, in the lower Juba Valley); (c) a literature search; and (d) onsite observations by a soil scientist and a drainage engineer. (The reader may be forgiven for wondering why suggestions (c) and (d) had not already been taken care of in the normal course of the work.)

The soils laboratory at Afgoi is being renovated and $100,000 of equipment installed.

IV. ENGINEERING ANALYSES

It is claimed that "most of the engineering work is on schedule", though what schedule is referred to, and what this is, is not clear (US AID at Mogadishu do not appear to be aware of any previously agreed schedule). However, in order to maintain this schedule, whatever it was, the report states the "the scope and detail of many of the items have been reduced. For many of these items, the necessary data and information...is not and will not be available within the time frame of this study". For the remaining phase, it will again be necessary to reduce the scope and perhaps eliminate some work items. This is mainly because the remaining engineering work requires estimates of the area land classification cropping patterns and drainage requirements. These in turn, the report points out, depend on the results of the laboratory analyses of the soil samples (though the drainage requirements also depend, surely, more on field drainage tests, as discussed in the previous section, than on lab analyses). If the laboratory analyses are delayed much longer, the report adds, the engineering analysis will have to be based on the Impresit report data, suitably modified. Another reason for the reduction in scope of work is given as "an overestimation of the amount and quality of the basic data that would be available and the underestimation of the time required to generate and assemble the data".

The remaining 16 pages of this section deal with various work items tackled, including:

- map enlargements
- estimation of unit construction costs
- review of alternative irrigation schemes
- hydrology and water requirements
- cross drainage
- river floods and flows.

The section on water requirements includes a brief discussion on the likely crops to be grown, but emphasises that these cannot be determined until the lab analyses and drainage studies are completed. For a preliminary estimate, it was assumed that the clay soils, which form 80% of the irrigable land, would be double cropped to rice, and that 80% of the area projected for development would also be double cropped rice land. The lighter levee soils, in contrast, were thought of in terms of production of six crops - bananas, sugarcane, citrus, maize, cotton and soybean - in order to estimate the probable irrigation requirement.

A knowledge of cropping patterns and drainage requirements is also needed for the design and cost estimate for the irrigation distribution system and the on-farm irrigation system. "Projected flag dates" for these have been postponed to August 1986 and November 1986 for the upper and lower valley sections respectively. Similarly, the design and cost estimate of the drainage system has been delayed for the same reasons. Both irrigation and drainage systems on the clay soils will depend on whether crops other than rice can be envisaged, and what periods of fallow and leaching are necessary.

V. PROGRESS OF ECONOMIC STUDIES

This chapter is divided into two sections. The first deals with "The economy of Somalia" and summarises the present status of agriculture in the country. This section is both very general and rather elementary. It mentions the fact that rainfed agriculture in the Juba Valley will be dealt with in a report prepared by Agrar and Hydrotech GMBH, currently being published by the MJVD, but contains little that sheds light on the progress of the BuRec studies so far.

The section deals with "Project Economic Studies" and attempts to discuss in a general way some of the crops which have been mentioned as likely to be cultivated under irrigation in the valley. It begins by stating, quite correctly, that "The development of economic parameters needed for land classification is a major thrust of economic studies" (as carried out by the team). The aim is to study crop budgets in order to determine net farm income on different classes of land.

A subsection headed "basic assumptions" outlines various assumptions underlying the crop analyses, including the availability of essential inputs, foreign exchange, all-season roads, marketing facilities, credit, and extension service, an improved seed programme, and favorable land tenure and water rights. It points out that the analysis assumes "a commercial farm operation with the state-of-the-arts inputs" and points out that, based on economics alone, irrigation units would have to be able to amortize the high irrigation development costs, i.e. they would have to pay project irrigation development costs, project annual OM and R (operation, maintenance and replacement costs) and a water charge to assist in the repayment of the Bardera dam.

Under the heading "Crop selection", what is termed "a discussion on the relative merit of crops" deals in turn with bananas, maize, rice, cotton, and other potential crops (cowpeas, groundnuts, soybeans, sesame). These discussion mostly lack any production cost estimates and thus fail to provide the "economic parameters needed for land classification" which were stated at the beginning of the section as being the "major thrust' of the exercise.

APPENDIX 7

PHOTOGRAPHS TAKEN DURING THE JUBA VALLEY FIELD TRIP

The following 21 photographs, taken in the Juba Valley, are appended as an additional annex to the report to give those not familiar with the area an impression of its soils, vegetation and relief.

1 (S8) North-east of Bardera, on the way to the dam site: cultivated fields, heavy textured, being ploughed after a crop of rainfed sorghum with animal traction (rare in this area, as most cultivation is by hand, with hoes). Note the flat relief, and sorghum residues in the foreground.)

2 (S12) North-east of Bardera, on the east bank: typical thorn bush vegetation (with goats).

3 (S11) North-east of Bardera, near photo 2: typical ravine (togga) with flattish limestone fragments in foreground. These toggas dissect the generally flattish irrigable areas.

4 (S25) Another togga in the same area. Medium thorn bush vegetation on heavy cracking clays.

5 (S14) The Juba River about 10 km south of the dam site as seen from the east bank.

6 (S16) The Juba River at the Bardera dam site, looking west.

7 (S20) Soil pit in the experimental area just to west of the river at Bardera (area selected by Robin James, in cooperation with the BuRec team, and surveyed by him). Thin, low thorn bush in background suggests recent cultivation. The profile is clay textured with a coarse angular blocky to prismatic structure and subsoil drainage once the cracks have closed appears to be very slow indeed. (Willie Forest to left, Somali helper in centre, Dewayne McAndrew to right).

8 (S21) Extending the soil pit shown in photo 7 by deep augering. The bucket-type soil auger held by Dewayne McAndrew has an extendable handle in sections. Normal field auguring is to 3m, but the auger can also be used, as here, in the bottom of a pit to extend the depth examined.

9 (S22) Another view of the experimental site shown in photographs 7 and 8. This flat area on the west bank close to Bardera, and alongside an irrigation channel, was chosen as being typical of the west bank soils in this part of the valley and surveyed in detail (by another contractor) as a possible experimental farm site. It is recommended that the BuRec team

locate several potential experimental sites, each typical of a defined area of the valley, on which later agronomic work can help to define recommendations for extension to farmers served by the station.

10 (S7) Soil pit in heavy grey-brown soil of the mantled limestone plain on the east bank north-east of Bardera (with Willie Forest). The soil has a clay loam topsoil to six inches overlying a heavy clay subsoil. A stony layer occurs at over one metre. The soil would be erosive were the gradient not so gentle. The soil has been classified as R1, i.e., well-suited to irrigated paddy rice production, but this classification implies that its long term suitability for other irrigated crops is thought to be problematical because of the poor internal drainage and the possibility of a salt build-up. Sorghum residues in the background indicate that it had recently been cultivated to rainfed sorghum. Local cultivators prefer the heavier soils for this crop.

11 (S24) East bank, east of Bardera: spoil exposure in a dry ravine (togga), showing a platy structure immediately below the topsoil and angular blocks and prisms at depth. This is a heavy, poorly drained soil, similar in many respects to that shown in photo 10, and also classified as R1 for the same reasons. (Dewayne McAndrew examines the subsoil structure: the three-inch barrel auger gives the scale).

12 (S17) A field near Bardera on the east bank selected for a drainage experiment. A trench has been dug in such a way as to isolate a column of soil 1m 50cm deep. Note flat relief and natural thorn bush vegetation.

13 (S18) A closer view of the trench and the central soil column shown in the previous photograph.

14 (S27) The following day: Tom Crooks, Drainage Engineer (not shown on photograph) has taken his investigation a step further by putting a plastic sheet round the soil column and holding it in place by refilling the trench. The next stage is to apply water from the drum to the soil surface to study its movement through the soil and to observe the way the initially wide soil cracks (see next photograph), close up on wetting, making further water penetration very slow. In general, both the land classification and the design of irrigation and drainage systems have been held up by the lack of the sort of data that this experiment was designed to generate.

15 (S19) Close up of the soil surface at the site shown in the two previous photographs. The penknife (four inches long) gives the scale. Note that there are two systems of cracks: first, a pattern of deep, wide cracks 2-4 inches wide and two to three feet apart which extend several feet into the soil, and secondly, a very superficial pattern of small surface cracks only 2-3 mm deep which merely resulted from a fall of rain the previous day. The latter are unimportant, but the deep, wide cracks

which form during the dry season (photo was taken in March at the end of the dry season and before the main April rains) are very important indeed and the way these soils crack is likely to be fundamental to their utilisation. The first rains enter these cracks and the water moves down the profile, taking with its salts in the upper layers to a lower level. Once the soil is well wetted, the cracks close, the soil becomes impermeable, and further entry of water into the profile is very slow indeed. Two important questions remain to be answered: How long must such a soil be left to dry out before the cracks form, and does this mean that under irrigation only one crop a year can be taken (at least in some years) instead of two?

16 (S26) North-east of Bardera. Dewayne McAndrew augers a heavy clay in a recently harvested sorghum field. The subsoil was found to be still moist. This shows that the sorghum crop did not utilise all the stored soil moisture available to it, and a longer-season, higher-yielding variety might have done better that particular year. However, the preceding wet season had been a good one, and in a year with a lower rainfall, the soil is probably much drier. It should be noted that the natural thorn bush vegetation, adapted to dry areas and with a deep root system, is capable of drying out a soil profile more deeply and more thoroughly than is a short-season, shallow-rooted agricultural crop such as sorghum. Conversely, a field without vegetation or crop can store subsoil moisture for long periods, a principal made use of in dry farming. In an area such as this, the amount of water stored in the soil profile and carried over from one season to the next may contribute substantially to the succeeding rainfed crop.

17 (S29) "In the middle of nowhere" between Bardera and Saco Uen: lunch break. The sparse vegetation suggests recent cultivation for sorghum. (Peter Ahn and Somali helper).

18 (S28) Between Bardera and Saco Uen, middle Juba Valley: scattered thorn bush vegetation, with two of an estimated two million camels in the country casting a supercilious eye at a passing vehicle.

19 (S30) Near Saco Uen, middle Juba Valley: low thorn bush vegetation grazed by village herds.

20 (S32) Saco Uen camp site, 7 A.M. Wednesday, March 19, 1986. (Earl Dudley, Sally Patton and a hard-working blazer which had brought drums of fuel.

21 (S31) The Juba River at Saco Uen at sundown. Women bathe and collect water (the village pump is out of action). Beyond the river, the west bank is the site of local traditional irrigation agriculture.

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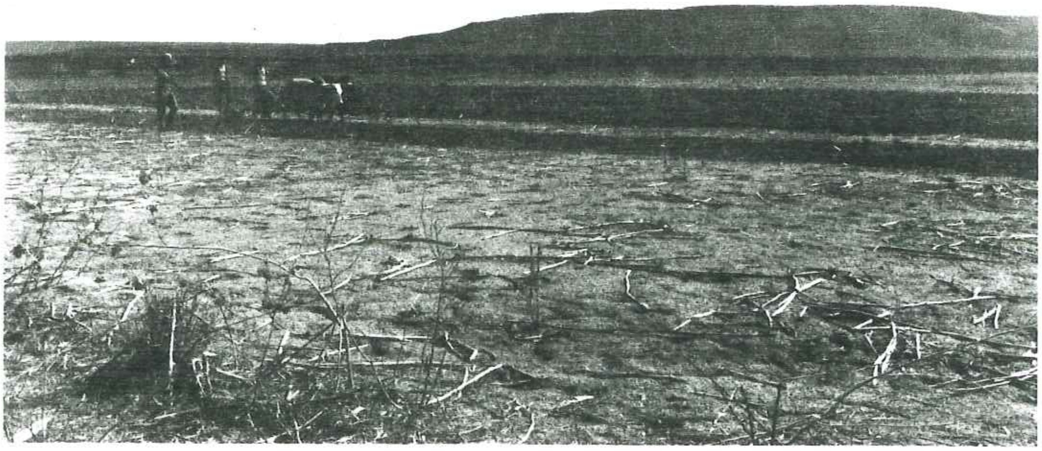

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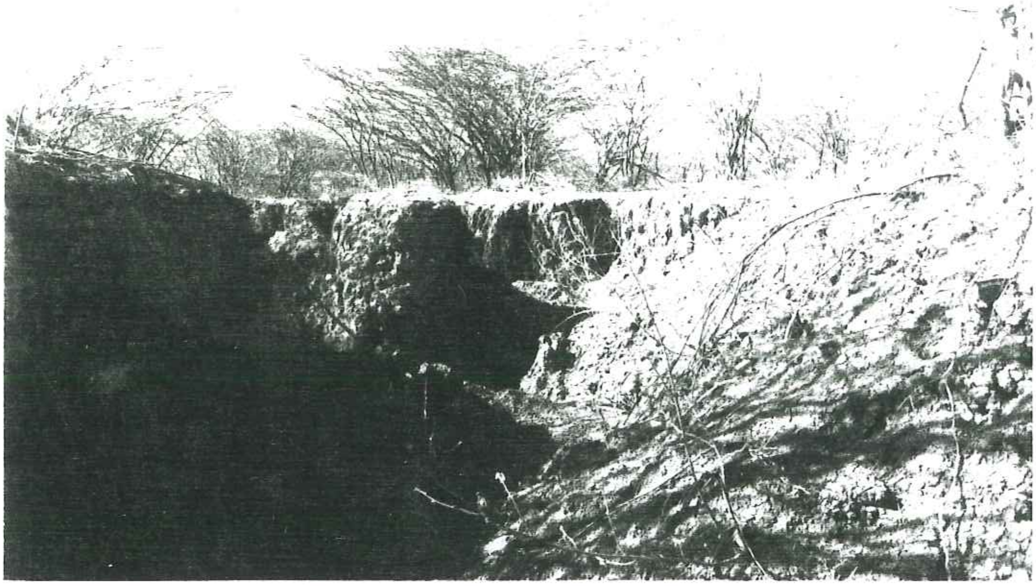

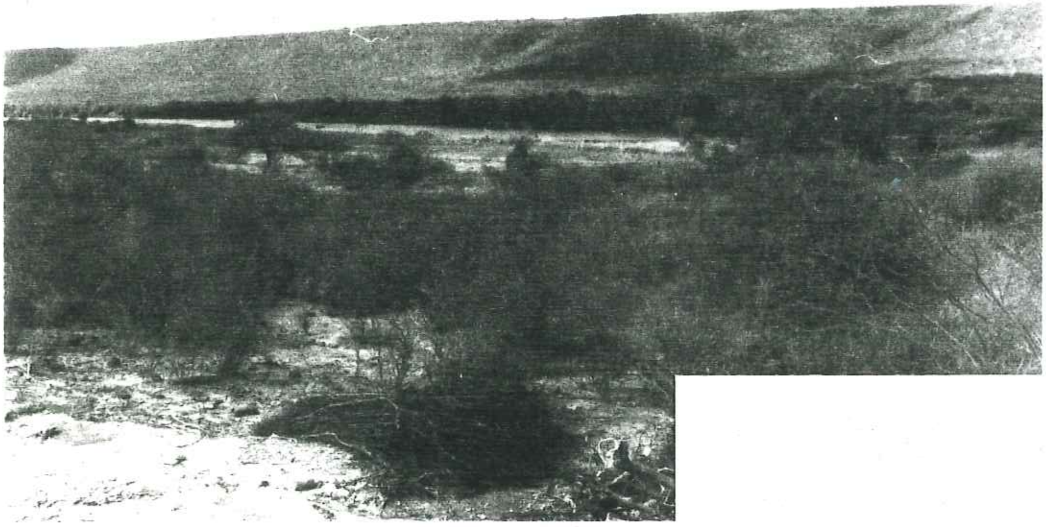

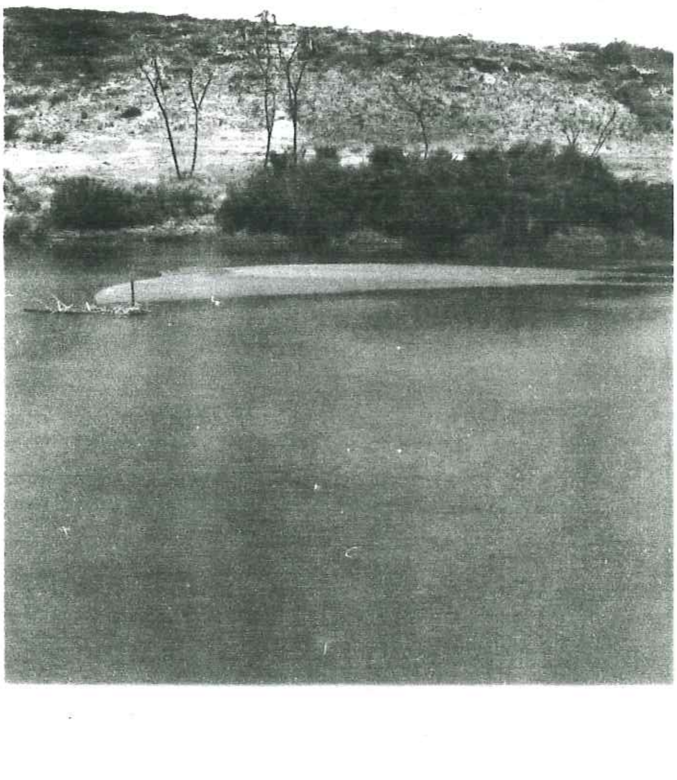


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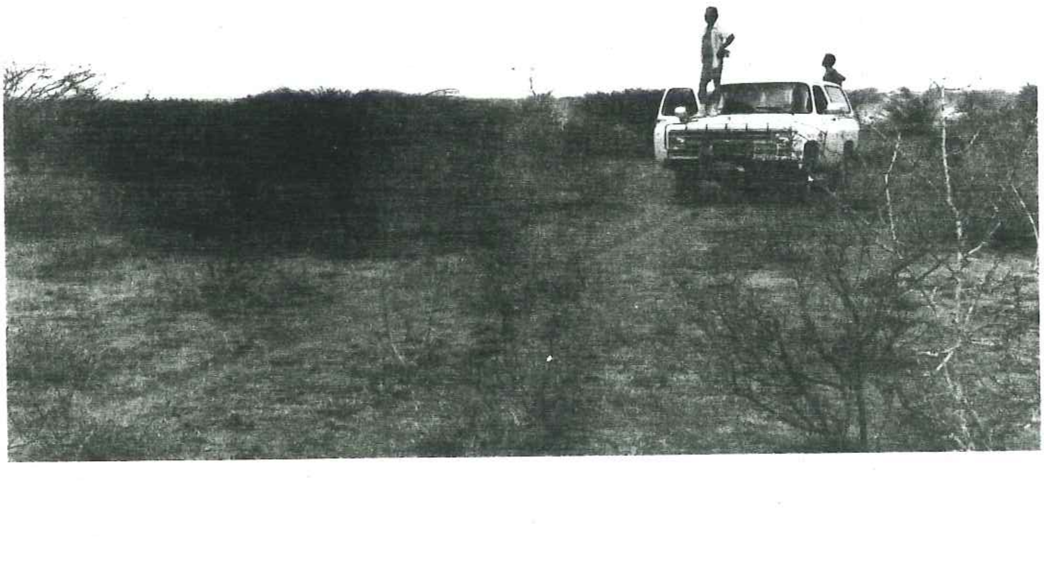
7 (S20). Soil pit in the experimental area just to west of the river at Baardheere (area selected by Robin James, in cooperation with the BuRec team, and surveyed by him). Thin low thorn bush in background suggests recent cultivation. The profile is clay textured with a coarse angular blocky to prismatic structure and subsoil drainage once the cracks have closed appears to be very slow indeed. (Willie Forest to left, Somali helper in centre, Dewayne McAndrew to right).



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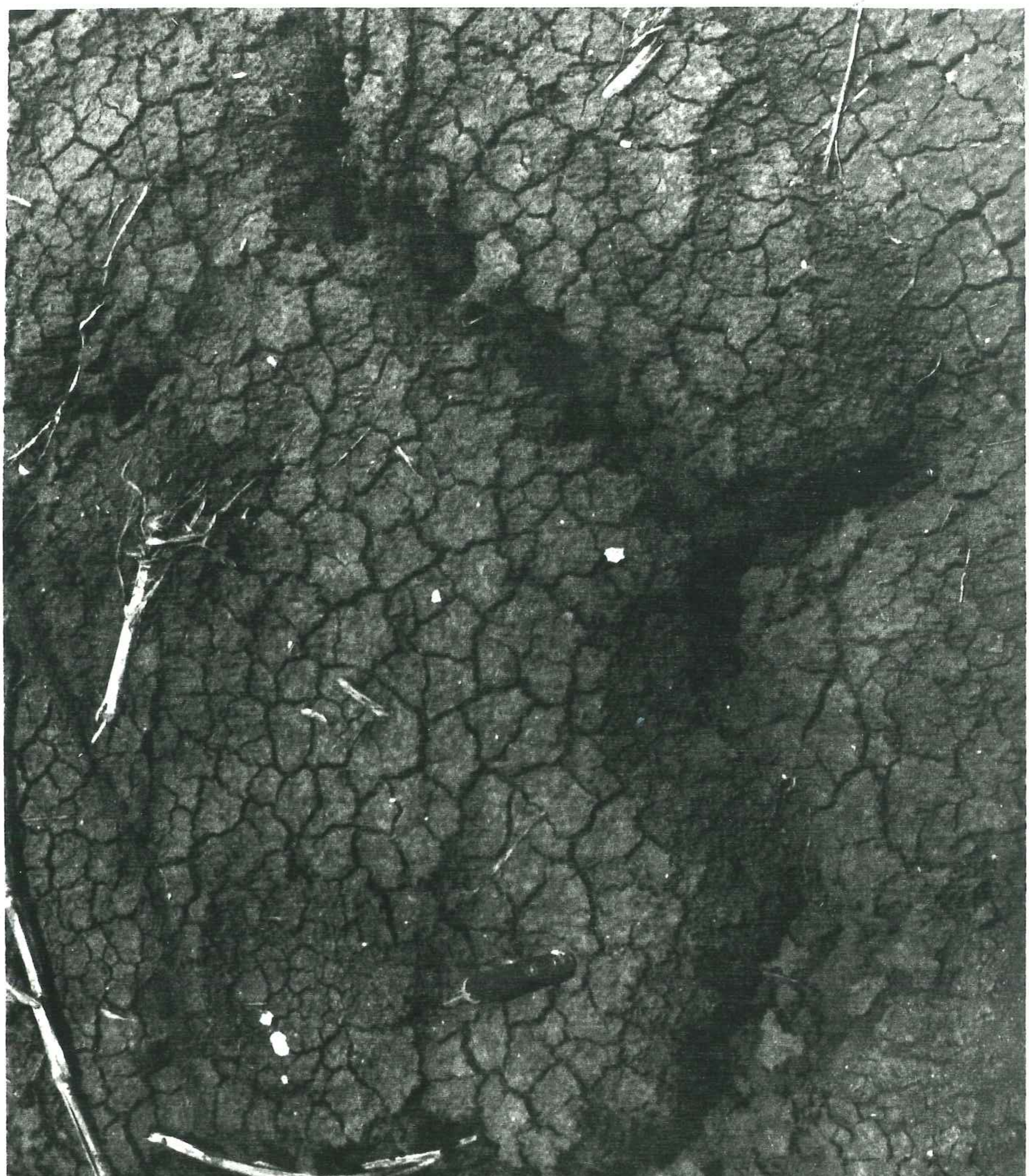
12 (S17). A field near Baardheere on the east bank selected for a drainage experiment. A trench has been dug in such a way as to isolate a column of soil 1m 50cm deep. Note flat relief and natural thorn bush vegetation.

13 (S18). A closer view of the trench and the central soil column shown in the previous photograph.

14 (S27). The following day: Tom Crooks, Drainage Engineer (not shown on photograph) has taken his investigation a step further by putting a plastic sheet round the soil column and holding it in place by refilling the trench. The next stage is to apply water from the drum to the soil surface to study its movement through the soil, and to observe the way the initially wide soil cracks (see next photograph) close up on wetting, making further water penetration very slow. In general both the land classification and the design of irrigation and drainage systems have been held up by the lack of the sort of data that this experiment was designed to generate.

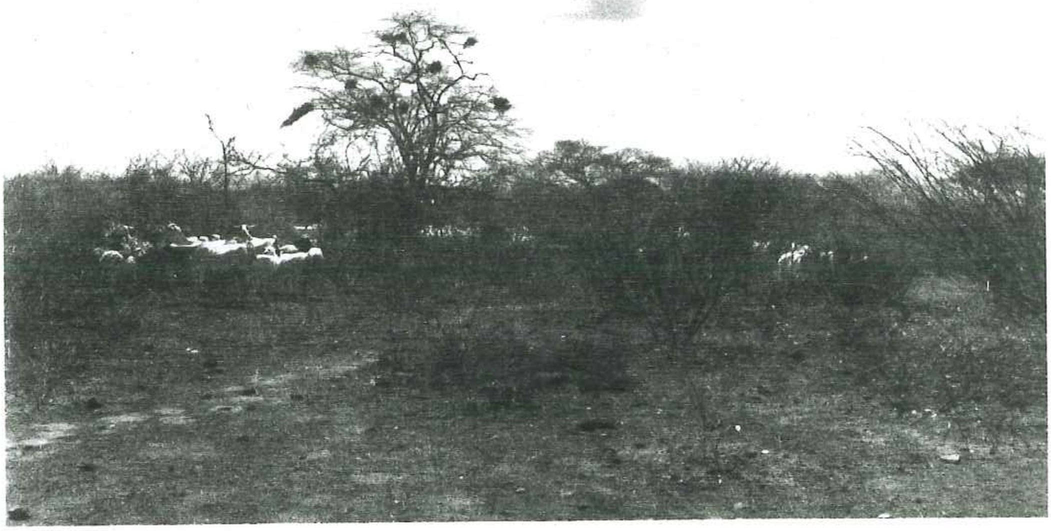


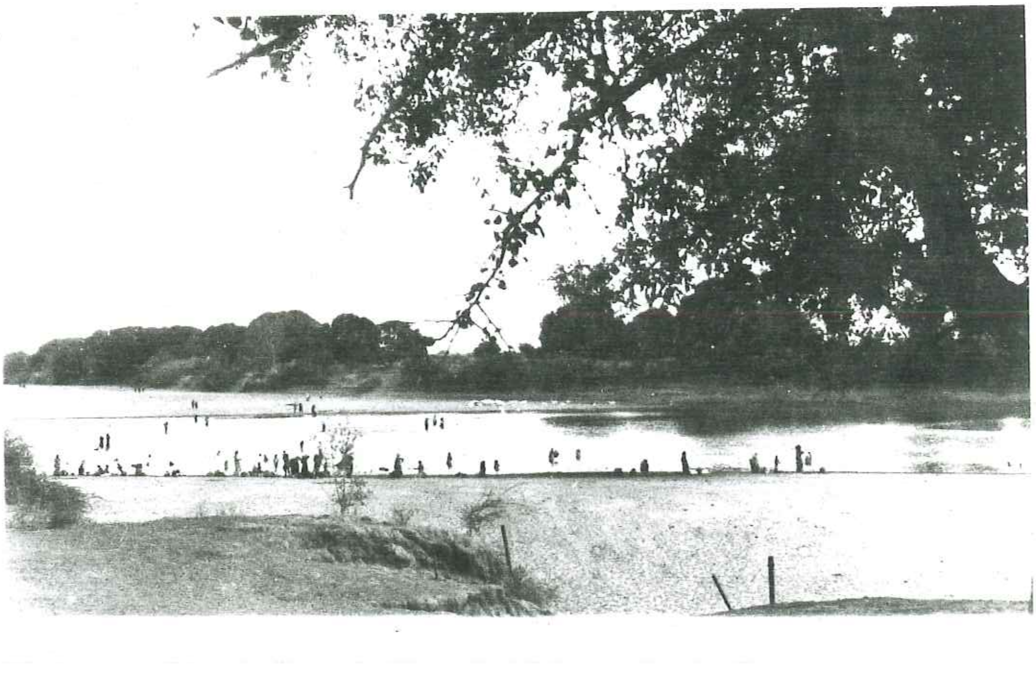
15 (S19). Close up of the soil surface at the site shown in the two previous photographs. The penknife (four inches long) gives the scale. Note that there are two systems of cracks: first a pattern of deep, wide cracks 2-4 inches wide and two to three feet apart which extend several feet into the soil, and secondly a very superficial pattern of small surface cracks only 2-3mm deep which merely resulted from a fall of rain the previous day. The latter are unimportant, but the deep wide cracks which form during the dry season (the photo was taken in March at the end of the dry season and before the main April rains) are very important indeed and the way these soils crack is likely to be fundamental to their utilisation. The first rains enter these cracks and the water moves down the profile taking with it salts in the upper layers to a lower level. Once the soil is well wetted the cracks close, the soil becomes impermeable, and further entry of water into the profile is very slow indeed. Two important questions remain to be answered. How long must such a soil be left to dry out before the cracks form, and does this mean that under irrigation only one crop a year can be taken (at least in some years) instead of two?

16 (S26). North-east of Baardheere. Dewayne McAndrew augers a heavy clay in a recently harvested sorghum field. The subsoil was found to be still moist. This shows that the sorghum crop did not utilise all the stored soil moisture available to it, and a longer season, higher yielding sorghum variety might have done better that particular year. However, the preceding wet season had been a good one, and in a year with a lower rainfall the soil is probably much drier. It should be noted that the natural thorn bush vegetation, adapted to dry areas and with a deep root system, is capable of drying out a soil profile more deeply and more thoroughly than is a short season shallow rooted agricultural crop such as sorghum. Conversely a field without vegetation or crop can store subsoil moisture for long periods, a principal made use of in dry farming. In an area such as this, the amount of water stored in the soil profile and carried over from one season to the next may contribute substantially to the succeeding rainfed crop.

17 (S29). "In the middle of nowhere" between Baardheere and Sokaw: lunch break. The sparse vegetation suggests recent cultivation for sorghum. (Peter Ahn and Somali helper).

18 (S28). Between Baardheere and Sokaw, middle Juba valley: scattered thorn bush vegetation, with two of an estimated two million camels in the country casting a supercilious eye at a passing vehicle.





19 (S30). Near Sokaw, middle Juba valley: low thorn bush vegetation grazed by village herds

20 (S32). Sokaw camp site, 7 a.m. Wednesday, March 19, 1986. (Earl Dudley, Sally Patton and a hard working blazer which had brought drums of fuel).

21 (S31). The Juba river at Sokaw at sundown. Women bathe and collect water (the village pump is out of action). Beyond the river the west bank is the site of local traditional irrigation agriculture.

Scope of Work:

Reconnaissance-grade water and land resource studies shall be made for the Juba Valley and the lower Shebelli River area. A report shall be prepared on the studies for the project and submitted to AID and MJVD. The report will cover basic data, premises, description of methods of investigation, discussion of computations and results, and pertinent conclusions and recommendations.

All studies performed shall be in sufficient scope, detail and accuracy to accomodate selection of land for permanent and profitable irrigation with the amount and kind of water available and support design of the project features.

To achieve economies in the work program, applicable data collected by other consultants or agencies on geology, water, soil, drainage, agronomy, economic data and soil-water-plant studies, including soil surveys, will be utilized in the land resource study. Thus, the BUREC staff shall familiarize itself with all available sources of data, published reports and other relevant items of information to avoid duplication and provide for a meaningful study.

The outcome of the studies should be an irrigation suitability land classification, which is relevant and adequate to needs - and not merely a soil survey or soil classification.

Work will involve performance of reconnaissance-grade water and land resource studies encompassing investigations in the fields of water quality, soils, drainage, land development requirements, water management requirements, and land-use in affirming suitability and selecting water and land for irrigation.

More specifically, the work items required include the following:

1. Irrigation suitability land classification and supporting investigations
    a) Economic correlation
    b) land drainability
    c) soil characterization by field and laboratory methods
2. Water suitability for irrigation
3. Drainage requirements and design
4. Present land-use survey
5. Report of findings

Irrigation suitability land classification and supporting investigations

BUREC shall perform an economic land classification survey adapted to local conditions of the Juba Valley and the Lower Shebelli River to establish the extent and degree of suitability of lands for sustained profitable crop production. Such land classification shall be reconnaissance-grade. The land classification shall include suitability determinations sufficient to permit selection of the project lands. The compilation and presentation of results shall be accomplished by means of standard narrative land classification reports, which include general land classification maps and pertinent data from field sheets.

All work will conform to controlling policies of AID as agreed to by the Government of Somalia, and be structured and implemented accordingly. It shall be performed in accordance with the concepts and principles of the U.S. Bureau of Reclamation system for economic land classification, but adapted to fit the specific environmental situation including economic, social, physical and legal factors existing in the area. The study shall serve to identify needs, establish opportunities and select land and water for development and maintenance.

The land classification shall reflect suitability of land for development to diversified cropping or wetland rice production for all situations and ranges in water application and drainage control. All the proven and acceptable land classification principles and components, particularly economics with respect to productivity, land development and drainage, will be highly relevant. Thus, it is essential that the survey be adequately supported by the requisite economic studies, drainage investigations, field testing, laboratory characterization and engineering planning.

The land classes shall be defined in terms of an economic parameter, preferably "net incremental irrigation benefits", and expressed in terms of economics the local ranking of land for modified use, e.g. best suited, moderately suited, marginally suited and unsuited. The most important decision will be the separation of lands suitable for development from those that are not.

For these projects, which will mainly involve land reclamation through irrigation development, drainage, improvement in on-farm water management and, if necessary, land leveling and planning and application of soil amendments, the principal task will be to identify and delineate as a minimum, irrigable and non-irrigable lands. In their differentiation, irrigable would be those lands under project conditions in which the incremental benefits generated at the appropriate discount rate would exceed the investment costs for project works and land reclamation, all farming costs, and OM&R costs of the project's proportionate share of the entire system, plus allowing for ample incentive to the farmer. However, should this differ significantly from financial analyses, the land classes should be verified and, if necessary, downgraded to take account of negative or unsatisfactory results to the farm operator.

1. Economic studies

   Economic studies and consultations with AID, the Government and other authorities shall be conducted in developing the land classification specifications.

2. Land drainability

   BUREC will establish the capacity of the soils, subsoils and substrata to transmit and retain water; amount, source, direction of movement and chemical characteristics of the water that must be transmitted; and available hudraulic gradients, both natural and those that can be improved by engineering works. BUREC will perform these services by examining and evaluating available data, and examining and appraising groundwater and land drainage characteristics and conditions. Special attention will be paid to locating and documenting possible barriers.

   The studies shall include evaluation of hydrology, geology, meteorology, groundwater, topography, soils and present and anticipated water management practices and cropping patterns. Field studies should include measurements for infiltration, vertical hydraulic conductivity and horizontal hydraulic conductivity.

3. Soil characterization by field and laboratory methods

The survey should be supported by adequate laboratory and field testing and evaluation that will assure a definitive diagnosis of soil salinity and soil sodicity (alkali) under present conditions; and prognosis of these soil properties associated with agronomic response and economic significance under future (with and without project) conditions. This will necessitate adapting and implementing meaningful procedures and studying the agriculture experience on similar lands in Somalia.

Water suitability for irrigation

BUREC will determine the suitability of the anticipated water supply for irrigation by integrating the land and water factors. In this process the land classification survey, particularly drainage, should be used to select lands that will respond favorably to a water supply of a given quality with a plan of development.

Drainage requirements and design

BUREC will determine subsurface drainage requirements for the planned cropping and method of irrigation and design and estimated costs for the required surface and subsurface drainage systems.

Present land-use survey

BUREC will perform services required to determine present land use in the proposed system and within impacted areas associated with the project. For the impacted area, the required services include: interpretation of aerial photographs of same scales as used for reconnaissance to identify and measure present land use, field inspection of the area photoidentified, preparation of photo overlays showing present land use, tabulation of results and submittal of reports on land-use studies.

Partial listing of suggested guidelines for soil characterization

1. Reconnaissance-grade irrigation suitability land classification

   a. The boring density for soil examinations will be one site per square kilometer and the scale of the soil map will be 1:100,000. All bores should be done by auger to a minimum depth of 3.0m. One open pit shall be dug every 10 kilometers to a depth of 3.0m.
   b. Additional borings on agrid or otherwise might be required to delineate between irrigable and nonirrigable land.
   c. Soils will be described in the field, using internationally recognized systems (Food and Agriculture Organization (FAO) or U.S. Department of Agriculture (USDA) systems).
   d. Soil samples should be collected from each significant horizon at all borings and pits for laboratory analysis.

2. Specifications

Preliminary specifications have been developed for the land classifier to use as a guide in determining irrigation suitability of the lands. The specifications will be finalized at the start of the investigations.

Background:

The Juba River is the largest river in Somalia, with an average annual discharge of approximately 6000 million cubic meters; however, the flow is unevenly distributed, and severe drought and flooding occur. The construction of a dam on the Juba to regulate the river flow could provide a dependable water supply for irrigation development. The generation of hydroelectric power is also a possibility. It is critical however, that the present rough estimates of irrigable land in the watershed be refined in order to better calculate the irrigation benefits to be derived from the construction of a dam.

Liaison:

Relationship of Contractor or Participating Agency to Cooperating Country and to AID

A. Relationships and Responsibilities
The BUREC team will work under the direction of the AID Project Officer and the Ministry of Juba Valley Development.

B. Cooperating Country Liaison Official
Ministry of Juba Valley Development
Aweys Haji Yuusuf, Director of Planning and Economic Development

C. AID Liaison Officials

USAID/Mogadishu Project Officer

Logistic Support:

All BUREC employees assigned to Somalia are entitled to the same privileges and support as comparable direct-hire staff. AID/Mogadishu will pay all allowances, including post differential and Sunday premium which BUREC will provide to the permanent resident staff assigned to Somalia. All allowances for travel and shipment are provided by AID/Mogadishu: BUREC will arrange for all travel and shipments originating in the U.S. while AID/Mogadishu will arrange for all travel and shipments originating abroad.

SERVICES, MATERIALS, AND EQUIPMENT TO BE FURNISHED BY THE MJVD OR OTHER SOMALI GOVERNMENT AGENCY FROM LOCAL CURRENCY ACCOUNT

A. One cook, two camp helpers, and three laborers will be provided to assist the BUREC team for the total period of the investigations.
B. A building suitable for the soil and water laboratory and office space will be furnished. The building should have a minimum floorspace of 300 square meters and should be equipped with water, drains, electricity, and air conditioning. Three qualified laboratory technicians will be provided for the total period of the investigations.

C. MJVD will furnish eleven drivers for the project vehicles for the duration of the investigations.

All participant training required in conjunction with this agreement will be implemented through Mission generated and funded PIO/P's in accordance with the policies, allowances, guidance and reporting requirements of AID Handbook 10.

The Bureau of Reclamation will assist the mission in the procurement of items of equipment listed on Attachment A. Funding will be accomplished by USAID Somalia.

Reporting Requirements:

A report will be prepared by BUREC covering the water and land resource investigations using the following general outline:

Chapter I. <u>Introduction</u>
- A. Objectives
- B. Summary of findings and conclusions
- C. Recommendations
- D. Summary data sheet
- E. Names of personnel involved

Chapter II. <u>General Description</u>
- A. Location and extent of survey area
- B. Geology and geomorphology of area
- C. Climate as related to irrigated agriculture
- D. Agricultural development

Chapter III. <u>Lands</u>
- A. Soils
- B. Topography
- C. Drainage
- D. Salinity and sodicity

Chapter IV. <u>Water</u>
- A. Sources
- B. Characteristics
- C. Leaching requirements
- D. Suitability for irrigation
- E. Quality of return flows

Chapter V. <u>Land Classification</u>
- A. General description
- B. Methods
- C. Specifications
- D. Detailed descriptions of land classes

Attachment A

Equipment, Materials and Supplies

1. Vehicles (11)
2. Spare parts and accessoried for vehicles
3. Project equipment and supplier
4. Laboratory equipment and supplies
5. Field camp supplies
6. Tools
7. Drafting equipment and calculators
8. Communications equipment
9. Consumables
10. Air freight for equipment, materials and supplies
11. Sea freight for vehicles and equipment

Attachment B:

JUSTIFICATION FOR HELICOPTER ASSISTANCE

Due to considerable pressure placed upon USAID/Mogadishu by the Ministry of Juba Valley Development (MJVD) in Somalia, USAID wouldlike to begin field work on the land classification study in the Juba Valley as soon as aerial photographs of the area are available at the end of February 1984. However, there are only two four-wheel drive vehicles which will be available for the Bureau of Reclamation land classification team, and these will be made available by the MJVD (they have not yet been purchased). Due to the lack of USAID vehicles and the fact that project vehicles to be funded by the PASA will not arrive for 6-9 months, alternative arrangements for transportation will be necessary. A helicopter is the only available alternative which can transport the project team to the field locations. USAID/Mogadishu has located a helicopter and a cost estimate for its use in the field work was obtained ($45,000). A cable was sent to Nairobi, Kenya, requesting USAID there to determine if other helicopters were available. No further information on the response from Nairobi has been obtained.

While the cost estimate appears high, the area to been studied is remote and totally inaccessible without a four-wheel drive convoy or helicopter. The area is a considerable distance from any accommodations or food, so supplies will be required for the helicopter crew as well as a considerable amount of fuel (included in the cost estimate).