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APPLICATION OF MICROCOMPUTERS TO THE GAMBIAN MIXED FARMING PROJECT

CONSULTANT REPORT

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ACKNOWLEDGEMENTS

Although this report was authored by one person, it reflects the judgment of many. I benefited greatly from ideas offered by the MFP staff at Abuko. Their frank and thoughtful observations served to strengthen the final plan. The Michigan State staff, both at East Lansing and in Dakar, Senegal, generously took time to review their own experiences. Either consciously or unconsciously, much of what I learned from their staff shaped the ultimate recommendations. Lastly, I wish to express appreciation to Dr. Jerry Eckert for both recognizing the potential microcomputers could play in The Gambia and reviewing early drafts, thereby helping to clarify issues and concepts.

ABBREVIATIONS USED IN THE TEXT

Abuko--Where the Mixed Farming Project is currently located

CRODT--Oceanographic Research Center (Dakar-Thiaroye)

CSU--Colorado State University

CSURF--Colorado State University Research Foundation

F.M.D.C.A.S.--Farm Management Data Collection and Analysis System developed by the Food and Agriculture Organization (FAO) of the U.N.

ISEDS--International School for Economic Development Studies

ISRA--Institut Senegalais de Reserches Agricoles

MFP--Mixed Farming Project

MSU--Michigan State University

SEU--Socioeconomic Unit, Mixed Farming Project, The Gambia

APPLICATION OF MICROCOMPUTERS TO THE GAMBIAN MIXED FARMING PROJECT

INTRODUCTION

Statement of the Problem

The purpose of my consultant visit to The Gambia was to examine the possible need for microcomputers in conjunction with the Mixed Farming Project (MFP). USAID is quite interested in utilizing microcomputer technology wherever it is appropriate in Third World countries. The MFP, through an extensive data collection system, has produced very large amounts of data. Recently, the mid-project evaluation noted some delays in processing these data at CSU as is presently being done.

Therefore, specific questions around which this consultancy was built included the following:

a. Could MFP data processing, analysis, and storage needs be adequately met using in-country microcomputers?
b. If yes, how does in-country microcomputer processing compare with other alternatives on a cost basis?
c. If microcomputers are economically competitive, then what recommendations are to be made with respect to:
   i. hardware
   ii. software
   iii. training needs
   iv. timing and other considerations?

In order to answer these questions, I visited the MFP project in The Gambia from May 15 to May 29, 1983. Two stops enroute provided essential information. At Michigan State University discussions were held with faculty who have had experience with using microcomputers in Senegal and in training Africans for such computer use. A stop in Dakar provided an opportunity to examine in depth the mainframe computer facilities potentially available to the project at CRODT and ISRA. The remainder of the time was spent in The Gambia in a series of discussions with MFP and PPMU personnel, USAID, and others. A preliminary report of findings was presented to Mr. Sulayman Ceesay, Deputy Permanent Secretary, MANR, during his visit of June 1983 to the CSU campus.

Mixed Farming Data Processing Needs

The MFP has generated a considerable volume of research data. The methodologies with which this data has been collected are excellent, and analysis should yield valuable results as part of the project output. The principal data sets now available for computer processing include:

a. MFP Baseline Survey: A nationwide study of selected social, economic, and agricultural parameters. Done early in the project, these data have been transmitted to CSU for processing on CSU's mainframe computer. Size = approximately 20-25,000 cards of data, drawn from 1,164 respondents.
b. Intensive Farm Management Study: This survey uses the FAO F.M.D.C.A.S. format. Administered by-weekly to 80+ farm households. Will be run for two years. The first year is completed, and coding is nearly completed for transmission to CSU. Size = 110,000 cards of data.
c. Experimental results from the work of both the maize and forage agronomist will require statistical manipulation, analysis of variance, and other forms of processing.
d. Farm budget analysis will be needed using a combination of the farm management data and on-farm trial results from the maize program.

These data and analysis needs suggest that the project requires capacity for 1) basic statistics, 2) cross-tabulations, 3) analysis of variance, 4) multiple regression and correlation, and 5) an "electronic spread sheet" on which special analytical routines can be formulated. In addition to the research program, management and reporting of expenditures and budgetary matters could be greatly streamlined using the same equipment. Finally, the expected volume of written output during the balance of the project suggests that word processing software be included.

THE PRIMARY ALTERNATIVES

Option 1 (Continue Keypunching and Processing at CSU): Survey data in the form of code sheets would be mailed to CSU where the information would be put on cards and processed according to the F.M.D.C.A.S. CSU would have to secure the software from FAO Rome and install it on the Cyber. Paul Winder, a programmer at Michigan State, who is knowledgeable about the software, may be called on to assist. An individual from the SEU will have to travel to Fort Collins to oversee the keypunching and be trained to use the F.M.D.C.A.S. programs.

Option 2 (Keypunch and Process Data at CRODT): This option is identical to Option 1 except the CRODT facilities would be used instead of CSU's. The hardware available at this site is more than adequate for the SEU's needs. An equipment list is provided in Table 1.

Table 1
CRODT'S COMPUTER FACILITY

1 IBM 4331 M1 computer with 2M byte core and 540 fixed disk storage
1 tape drive (850-1600 BPI)
1 600 LPM printer
2 matrix printers
5 3278 terminals, 6 more on order

All data will have to be entered at CRODT. There are two options for accomplishing this. One is to enter the data from keyboards at the CRODT facility. The second is a remote data entry option now being used by MSU, whereby data is entered to floppy disks using IBM 5120 machines at ISRA. (The 5120 is a predecessor to the IBM-PC.) The disks are then read by the CRODT mainframe computer for processing at a later time. The number of records involved in the Gambian MFP data (over 110 thousand) renders the use of the IBM 5120's impractical even as a means of temporaril storing information on floppy disks. It would tie up one such computer for almost six months, longer than ISRA is likely to permit.

Option 3 (Install two microcomputers at Abuko to enter and process the survey data with backup facility at CSU): Install one portable Compaq computer and an IBM-XT. This would give the SEU sufficient core memory and external storage to process the F.M.D.C.A.S. survey. All 120 thousand records will fill up no more than 40 percent of the IBM-XT's 10M byte hard disk. The availability of these computers in-country will enable the staff to eliminate certain operations and reduce travel expenses. Coding the data from the questionnaires will no longer be necessary. The information will be keyed directly to floppy disks. This means that keypunching costs at either CSU or CRODT can be avoided yielding significant savings. The facility should be outfitted with a good statistical package, a word processing program, and a data base management program. This will permit the SEU to be self-sufficient in all aspects of the project, from data entry through the analysis and the production of reports and graphics.

Cost Effectiveness

The direct cost for each alternative was estimated given the project's current four-year plan of research as it was presented to me at Abuko. The staff anticipates undertaking surveys which would result in almost 380 thousand cards. The current procedures for coding and keypunching were used to estimate the costs of continuing to use the CSU facility or switching to the CRODT computer at Dakar. The survey data is first edited on the questionnaire. It is then transcribed to coding sheets and finally sent to CSU for keypunching and processing. The installation of a microcomputer facility at Abuko would eliminate all transcription and keypunching costs since the enumerators could enter the data directly from the questionnaires to floppy disks. In addition, a facility at Abuko would reduce the costs of processing the data at either Fort Collins or at CRODT. It was assumed that a person from the staff would have to be trained to use F.M.D.C.A.S. and would therefore be required to travel to where the data was being processed. The only difference between the cost of keypunching at CSU or CRODT was the living expenses, the travel costs, and the hourly keypunching costs. It was assumed that the cost at Dakar would be half that incurred at CSU. Travel costs were estimated to be less than one-fourth.

Installing a microcomputer facility at Abuko would result in a gross savings of approximately $71 thousand when compared to the CSU option and about $44 thousand if the CRODT computer were used. These estimates are broken down in Table 2, and further refined in Enclosures A, B, & C.

Table 2
COST SAVINGS RESULTING FROM THE INSTALLATION

	CSU	CRODT
Coding Costs	$14,342	$14,342
Travel & Living Allow.	21,000	8,300
Keypunching	28,601	14,250
Cost of Mainframe Time	7,300	7,300
TOTAL SAVINGS	$71,243	$44,192

The cost of acquiring the microcomputer equipment, the supporting software, and training are estimated to be approximately $44 thousand. A summary of the expenses is provided in Table 3. More detailed estimates are provided in Enclosure D.

Table 3
INSTALLATION COSTS

Hardware	$16,050
Supplies	640
Commercial Software	1,950
Programming	9,700
Evaluation, Installation	15,360
TOTAL COSTS	$43,700

Comparison of the Alternatives in Terms of Processing Time

It is difficult to estimate the time to complete the analysis of the F.M.D.C.A.S. due to the size of the task and uncertainty regarding the installation of the program on either CSU's Cyber or CRODT's IBM 4331. However, I am prepared to venture a guess as to how the various options compare with regard to this important consideration. I am not convinced that the CRODT option will prove to be any faster than the other two. It could, in fact, prove to be the slowest. As of May of this year the facility was operating at 25 percent capacity, a good reason to seriously consider this option. However, the Michigan State effort in Senegal will likely place additional burdens on the facility in the near future, possibly at a point when the Gambia project may be competing for time. It is highly unlikely that excess capacity will persist for the four-year duration of the project. Easy access to CRODT is even more improbable during the period contemplated for MFP II, 1986-91. It would be unwise to invest substantial amounts of time training project staff to use the CRODT facility given this possibility. Data analysis may also be slowed for two other reasons. Language could prove to be a problem. More important, Michigan State is not likely to use the F.M.D.C.A.S. program but will install FARMAP instead. This brings into question the degree of commitment to the former. It may be given a lower priority. This, of course, is highly speculative but of concern nonetheless.

I estimate that the time to complete the analysis at CSU would be less that at CRODT. This option is the least uncertain of the three. Preliminary results could be obtained within four months after receiving all the data. A final report could be produced within four months thereafter.

The microcomputer option could yield preliminary results on eight farming units within one month after the installation. A full analysis of all 85 units would require approximately eight months. However, this does not preclude the production of a series of interim reports as the results are produced. The IBM's word processing capability is likely to speed up the writing and editing phase of the project, possibly shortening it by as much as two to three weeks.

Overall Evaluation

The option of continuing to process data at CSU appears to be prohibitively expensive. The CRODT option is attractive from the cost standpoint, but it may result in unacceptable processing delays. The installation of a microcomputer at Abuko is cost effective and could reduce the time required to produce reports useful to those who formulate policy. In addition, it would contribute most to training the Gambians on all phases of analysis from data entry to the ultimate analyses. Their training will likely be more thorough and impact a wider number of individuals than either of the other two options. It is, however, not without risks. The trip to Abuko raised several concerns, but I am confident that most of these proved to be ill founded or could be avoided with a modest amount of precaution.

RECOMMENDATIONS

For reasons developed above, it is recommended that the Mixed Farming Project acquire microcomputer capability along the lines evaluated as Option 3. This would include as basic units one IBM XT at Abuko, one portable Compaq (IBM-compatible) unit to meet project needs for data handling away from Abuko, and one IBM XT at CSU for backstopping work, electronic mail, and joint development of analysis. An outline of a plan to accomplish this is provided below. Observations follow on the more important elements of the plan. Finally, a discussion of risks inherent in this proposal is included.

Outline of a Plan for Installing the Facility

Step 1--Pre-Installation Tasks:

A. Equipment acquisition
B. Testing at CSU (hardware and software)
C. Simulate the tasks to be performed in The Gambia
   1) Enter, verify, check, and edit the data.
   2) Determine the amount of time to sort and recall the data.
   3) Create sample F.M.D.C.A.S. templates using LOTUS 123.
   4) Analyze the data collected for eight work units using both LOTUS 123 and MICROSTAT.
   5) Estimate the amount of time to analyze the entire survey.
   6) Apply the analysis to a set of policy issues.
   7) Test graphics and report generation features.
   8) Develop an instructional program to facilitate the installation at Abuko.
      a) overview (terms, keyboard layout, . . .)
      b) how to use LOTUS 123
      c) routine maintenance
      d) common failures and system errors
      e) use of the self-diagnostics feature
      f) simple repairs (replace a disk drive, . . .)

Step 2--First Installation at Abuko:

1) Install and test the Compaq microcomputer.
2) Instruction on how to maintain the equipment, care for diskettes, etc.
3) Preliminary instruction on how to enter survey data, create F.M.D.C.A.S. templates and produce reports.
4) Demonstrate how to analyze the data utilizing maize data as an illustration.
5) Conduct a seminar to discuss the results and suggest additional studies that could be performed.
6) Demonstrate how to interpret diagnostics, remove and replace a disk drive, etc.

Step 3--Follow Up Training and Second Installation:

A. Follow up training session at CSU to correct any problems.
B. Transport and install the IBM XT at Abuko.
C. Final training session at Abuko.
   1) Review the results of the F.M.D.C.A.S. survey.
   2) Discuss ways in which the survey could be simplified.
   3) Review important policy questions and relate them to the new survey.
   4) Discuss the need to revise the data processing templates.
D. Write up the MFP experience (adoption decision, training, and early utilization) in the form of a case study to be made available to interested persons in AID, CID, and CSU.

Choice of Equipment

The choice of hardware was dictated by the selection of the software. At this point LOTUS 123 will only work on the IBM operating system, MS DOS. The amount of internal memory and external storage required was determined by the size of the survey; 4+ million pieces of information were collected in year one alone. The IBM XT would most likely have been chosen even if LOTUS 123 were not such an integral part of installation. The reasons for this revolve around cost, maintenance, and compatibility with installations elsewhere.

1. Cost: The comparable Hewlett Packard model (HP 9816) is priced almost $4 thousand more than the IBM.

2. Maintenance: A maintenance shop exists in Dakar which is less than five hours drive from Banjul (or 25 minutes by plane). The facility is currently capable of repairing the IBM 5120 microcomputers utilized by the Michigan State staff. It will likely not be long before they develop a capability to service the new generation of IBM's and IBM mimics. A hardware maintenance and service manual is available for the IBM. It will enable the staff at Abuko to isolate problems, possibly permitting them to repair the equipment on site.

3. Compatibility with Installations Elsewhere: Both the Agricultural Economics Department at Michigan State and the Agricultural and Natural Resource Economics Department at CSU are moving to standardize their inventory of computing equipment. The former already has a small laboratory equipped with IBM's. The latter is beginning to supplement its existing laboratory facilities almost exclusively with IBM or IBM-compatible computers. This uniformity should facilitate the exchange of ideas between these institutions and between their in-country field teams.

4. Software Support: It appears that many vendors are scrambling to revamp software for the IBM line of equipment. I believe that this reflects their judgment regarding IBM's role in the industry. APPLE, the dominant force until lately, no longer enjoys the sizeable advantage regarding software support it once did. Much of whatever lead it still enjoys can be traced to programs that were produced for the model II. The Apple III, which approaches the capabilities of the XT, has for some reason been overlooked by vendors. Hence, the selection of packages for this model is still meager. The number of options is broadened if the Model III is operated in the Apple II emulation mode. However, to do so, the user must sacrifice all but 48K bytes of core memory, a fact which effectively eliminates the Model III from consideration for the volumes of analysis envisioned by MFP.

These factors weighed heavily in shaping the final selection, see Table 4. However, I recognize that different individuals using the same facts may arrive at different conclusions. Other companies such as Digital and Victor offer products which are comparable to the IBM both in price and performance. The selection of the IBM does not reflect unfavorably on these other products. It simply appears that, at least in this instance, the IBM is best suited to the task.

Table 4
EQUIPMENT LIST

August Installation

One Compaq portable microcomputer configured as follows:

256K byte core memory
Two double-density, double-sided disk drives, 320K bytes/drive

Epson FX 80 FT

DATASAVER uninterruptible power supply

The Compaq portable computer was chosen due to its size which will make it easy to transport. It should be easy to install and could be moved safely from Abuko to the PPMU in Banjul when the need arises. It is compatible with the IBM XT so that data can be entered and analyzed on either machine interchangeably.

October Installation

Two IBM XT's (512K bytes core memory) configured as follows:

5160 Model 87 System unit/keyboard
5151 Model 1 Monochrome Display
Monochrome Display and Printer Adapter
64/256K byte Memory Expansion Option
Five 64K byte Memory Module Kits

Qume Sprint 5 Letter Quality Printer

DC Hayes Modem (for the CSU installation only)

DATASAVER Uninterruptible power supply (for Abuko installation only)

Time Frame

The timing of each of the steps is critical to the success of the project. Tables 5 through 7 indicate when each task should be initiated and the estimated amount of time necessary for completion. The first installation at Abuko is the most critical. The staff at Abuko is prepared and apparently enthusiastic about the prospects of entering and processing data on site. This momentum could easily be lost in the event of a significant delay in delivery of the first piece of equipment. It would be in CSU's best interest to demonstrate its commitment to the project by placing this item highest on its list of priorities. Should the recommendations contained in this report be accepted in principle but funding not be immediately available (July 1983), then a lease-purchase option should be considered. The CSU Research Foundation (CSURF) would provide the necessary flexibility to meet the recommended date of installation while delaying the purchase until MFP project extension is funded.

The second installation in October provides a greater leadtime but is equally critical. John Haydu will be visiting CSU to undergo additional training on the IBM XT. The Mixed Farming Project's second computer must be available at this point so that it can be hand carried back to Abuko.

TABLE 5

STEP 1--Pre-Installation Tasks

A. Equipment acquisition
B. Testing at CSU (hardware and software)
C. Simulate the tasks to be performed in The Gambia
   1) Enter, verify, check, and edit the data
   2) Determine the amount of time to sort and recall the data
   3) Create sample F.M.D.C.A.S. templaters using LOTUS 123
   4) Analyze the data collected for eight work units using both LOTUS 123 and MICROSTAT
   5) Estimate the amount of time to analyze the entire survey
   6) Apply the analysis to a set of policy issues (e.g., Maize Study)
   7) Test graphics and report generation features
   8) Develop an instructional program to facilitate the installation at Abuko
      a) overview (terms, keyboard layout, . . .)
      b) how to use LOTUS 123
      c) routine maintenance
      d) common failures and system errors
      e) use of the self-diagnostics feature
      f) simple repairs (replace a disk drive, . . .)

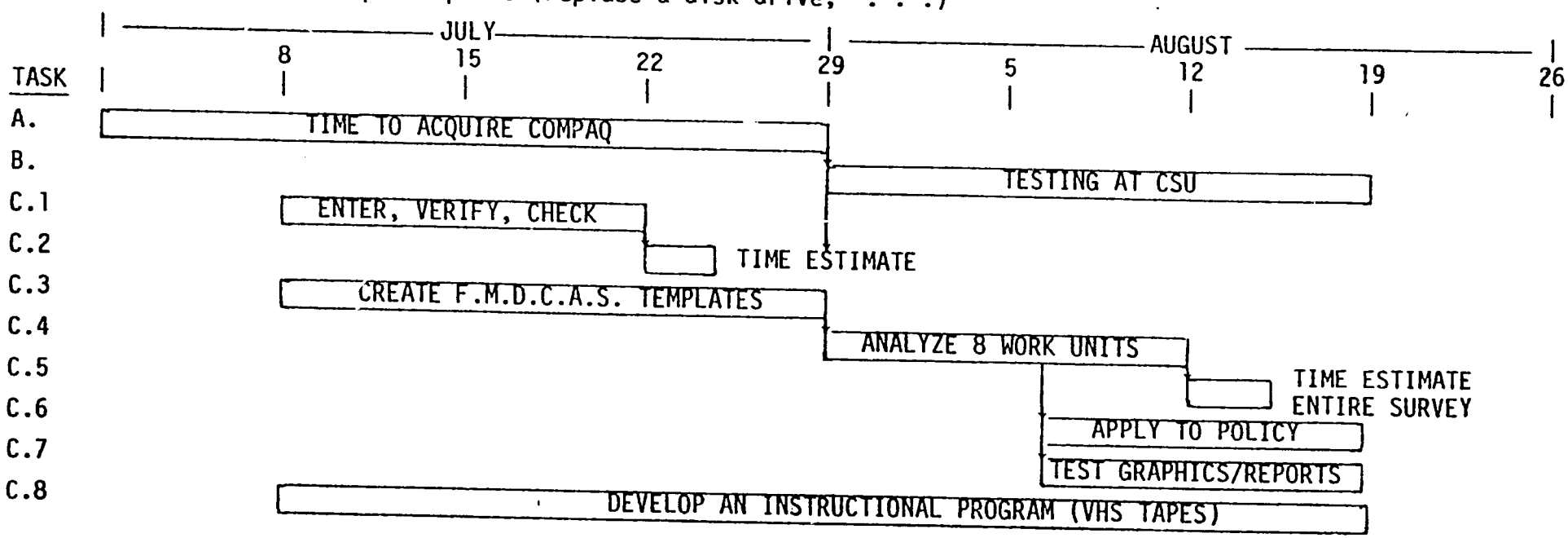


TABLE 6

STEP 2--First Installation at Abuko

1) Install and test the Compaq microcomputer
2) Instruction on how to maintain the equipment, care for diskettes, etc.
3) Preliminary instruction on how to enter survey data, create F.M.D.C.A.S. templates and produce reports
4) Demonstrate how to analyze the data utilizing the maize as an illustration
5) Conduct a seminar to discuss the results and suggest additional studies that could be performed
6) Demonstrate how to interpret diagnostics, remove and replace a disk drive, etc.

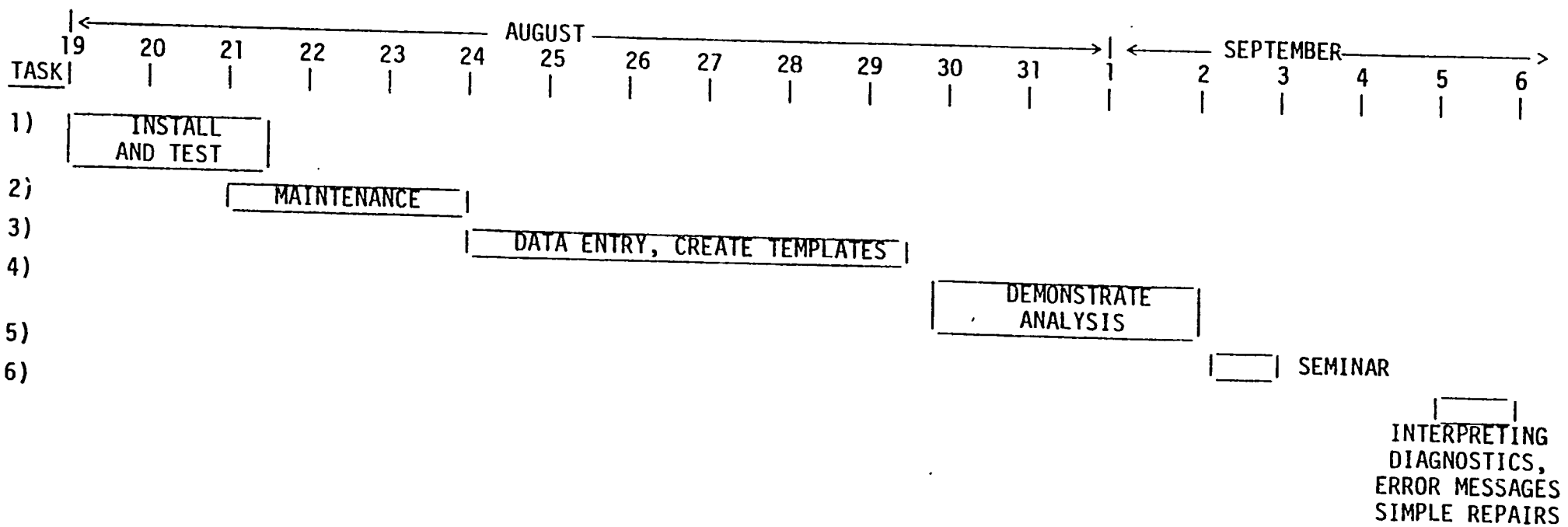
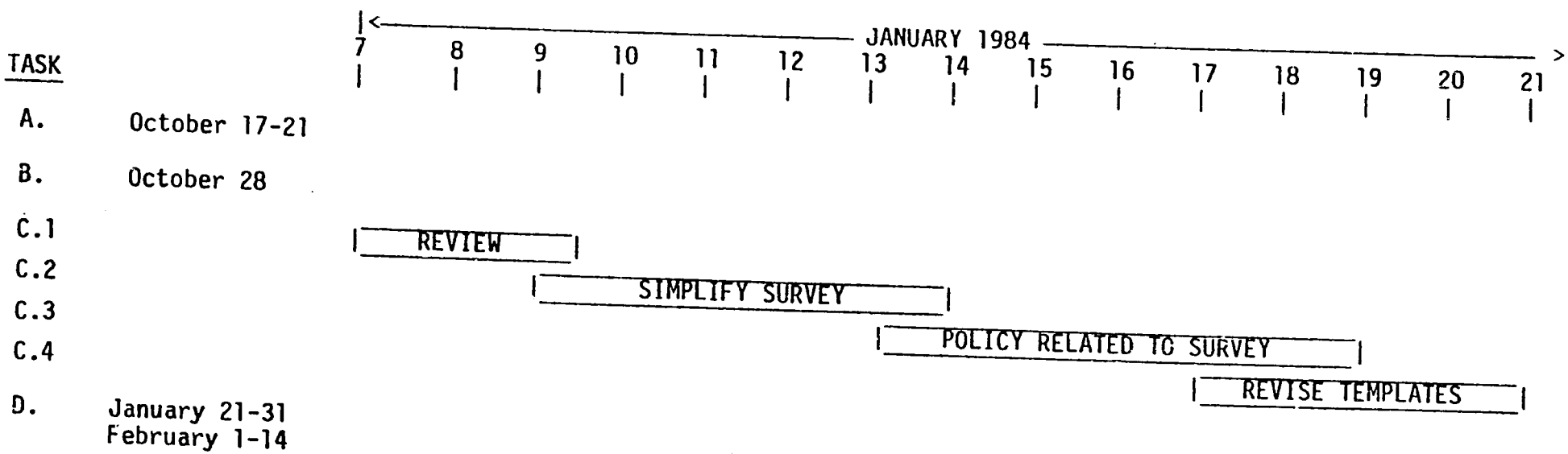


TABLE 7

STEP 3--Follow Up Training and Second Installation

A. Follow up training session at CSU to correct any problems
B. Transport and install the IBM XT at Abuko
C. Final trianing session at Abuko
   1) Review the results of the F.M.D.C.A.S. survey
   2) Discuss ways in which the survey could be simplified
   3) Review important policy questions and relate them to the new survey
   4) Discuss the need to revise the data processing templates
D. Write up the MFP experience (adoption decision, training, and early utilization) in the form of a case study to be made available to interested persons in AID, CID, and CSU



The Purpose of Installing a Backup Facility at CSU

The equipment list contains three computers, two for the Abuko site and one for CSU. There are a number of reasons for this recommendation, the most important of which are listed below:

1. Data would be sent to CSU on floppy disks so that scientists at both locations could interact in a more creative way than would be the case without the equipment. I suspect that this facility would become an integral part of the economic development program at CSU. Students and faculty would be encouraged to analyze the survey information using software identical to that available in The Gambia. Potentially useful findings would be made available to the field personnel. Having the data at CSU should also enhance the degree to which scientists at both locations would communicate. Expert advice could be obtained in a relatively short period of time at a minimal expense. I suspect that each consulting trip eliminated would result in enough savings to buy one fully equipped microcomputer. It is not at all unreasonable to expect that the proposed electronic consulting system would generate enough savings to purchase all the hardware for both sites.

2. I envision a similar electronic mail system for the purposes of tracking budgets and editing draft reports. Staff at CSU currently spend approximately three days per month coding budget items and balancing the project's books. If the expenditures and exchange rates were recorded on floppy disks, the monthly bookkeeping chores could be reduced to a few hours. The process of editing manuscripts would proceed in a similar fashion also saving considerable time and budget.

3. It is recommended that F.M.D.C.A.S. be installed on CSU's Cyber to back up the data analysis conducted at Abuko. Since all survey data will be sent to CSU in the form of floppy disks, an IBM XT would be required to transmit the data from these floppies to the mainframe's disk packs.

4. A series of VHS video tapes will be produced to assist the staff at Abuko in gaining familiarity with the new computers. Training aids devoted to such topics as routine maintenance, interpreting system messages, simple repairs, and operation of the software can be effectively produced only if the backup is installed.

5. The last reason for maintaining a backup facility at CSU is for purposes of maintenance, data security, and troubleshooting. If a significant hardware problem materializes (e.g., failure of the unit's power supply), the affected component could be swapped with the backup at CSU. Much time and effort has been thusfar expended to collect both the baseline and F.M.D.C.A.S. survey data. Backup copies should be stored at CSU. If need be, an experienced programmer could be called on to provide assistance in the event one or more disks failed to read properly.

Software Requirements

One reason for selecting the IBM XT is the substantial qualtity of excellei commercially available software that has thusfar been developed. The XT enjoys a considerable advantage over the older IBM 5120's in use in Senega' MSU incurred substantial expense in modifying the limited amount of available software. For this reason MSU is seriously considering the installation of an IBM PC-XT for research purposes, possibly reserving the 5120's for administrative tasks.

F.M.D.C.A.S. or FARMAP would require custom programming. An estimate of the costs and the anticipated time to complete the installation is presented below. In addition, it would be highly desirable to provide the SEU with several supplemental routines including a word processing program, an electronic spreadsheet, a data management program, and a statistical package.

Word Processor--Word Star. This program is very popular since it is extremely flexible and easy to use. It would allow the project to create reports in a fraction of the time that would be required without a word processor. Formats can be standardized, text inserted/deleted, and type face changed to emphasize important concepts.

Electronic Spreadsheet--LOTUS 123. The LOTUS 123 is an interrelated system of programs capable of spreadsheet analysis, data base management, graphics, and file management. It is self-prompting with easy to understand help cues. I suspect that this single program will be the most used of any recommended here, serving as a mechanism for reducing large volumes of survey data into manageable tables.

Statistics Package--MICROSTAT. This package performs all of the standard statistical tests expected from a package of this sort, e.g., cross tabulations, multiple regression, analysis of variance, data transformations, etc. The advantage it enjoys over its competitors is ease of operation and simplicity of file management. This package will be needed once the primary data reduction has been completed.

I am unaware of a linear programming package which is designed for the IBM XT. In any event it is not a high priority item and is not likely to be needed for at least 18 months, at which time such a package will almost certainly be available. The data base management program is recommended in order to design a simple system for data entry. If LOTUS 123 proves to be as efficient as first indications suggest, the data management package may be unnecessary.

Training

Training should be carried out in three steps. The first session should be held the last week in August when the equipment is installed at Abuko. It would consist of a one-week course devoted primarily to instructing coders on how to enter survey data on floppy disks. Bintu Semega-Janneh, the project's secretary will be trained to use the word processing program and to do financial reports using LOTUS 123. The statistical package

and graphics routines will be demonstrated to a small group of researchers involved in analyzing and interpreting the baseline and farm management survey data. Audio visual training material in the form of three-quarter inch beta cassettes will be made available to the project so that they can conduct refresher courses on their own. Joanne Sanni at the American Embassy was contacted to determine whether their video tape equipment could be made available to project members on a periodic basis. It appears that this will be possible and probably encouraged in that the Embassy is trying to expand utilization of this facility.

A follow-up training session will be held in late September at CSU when John Haydu visits campus during his annual leave. The purpose of this session will be to correct any problems that may have emerged during the intervening period This session will focus on the use of MICROSTAT to analyze the farm management data. The demonstrations will be performed using the farm management data entered at Abuko. The computer and software will be identical to that installed on site.

A final training session would be held in January of 1984 to help make the changes in the programs to accommodate a pared down questionnaire. It is not known at this point whether FARMAP will be available for the IBM XT or whether a new set of templates will have to be constructed using LOTUS 123. In either case, sufficient time will be allotted to insure that the project is self-sufficient in the analysis of the new survey data. Short courses in the use of statistical and linear programming packages will be held at this time. Two to three weeks would be earmarked for these purposes. This last visit is also designed to iron out any remaining hardware or software problems.

The importance of establishing an on-site data processing capability was underscored by the Michigan State staff, both at E. Lansing and in Dakar. Aside from the advantages in cost and turnaround time, they cited a more subtle reason for recommending an installation. Previous experience in Central America suggested an important improvement in research methods which stemmed from the introduction of a facility similar to that contemplated for Abuko. It was observed that automating data processing freed the researchers to begin asking important questions about the validity of the instrument being used. Instead of struggling weeks to hand tabulate the results, they began to question whether all the data collected was actually needed. As a result of their thoughtful evaluation of the questionnaire, it was pared down substantially saving the project significant data collection costs. The result was a more streamlined and manageable questionnaire. Another positive outcome resulting from the use of microcomputers was an improved quality of analysis. Researchers began to conduct more sophisticated tests and take a greater interest in the results. New questions were asked, and the overall utility of the research was enhanced. I have noticed similar tendencies in the ISEDS microcomputer laboratory at CSU. Students, like the researchers just mentioned, ask more penetrating questions and appear to understand concepts more thoroughly when exposed to computer-assisted instruction. I believe that the primary reason for this is due to the way the material is introduced. Students are asked to use an electronic spreadsheet program to solve a series of very practical problems. To do so, they must design templates, exercise them with data provided, determine how sensitive the results are

to the important variables, and relate what they have learned to formal theory. This step-by-step procedure has worked extremely well thusfar, and I believe that a similar strategy in training abroad will reap enormous dividends.

This training strategy represents a substantial departure from the approach I have seen elsewhere where students are instructed on how to use so-called canned computer programs. Such software is often more sophisticated than is warranted in a developing economy. Worse than this, however, is the tendency for trainees to be sidetracked. Since they have not written the program, they tend to be somewhat skeptical of the results and may even misinterpret the findings. They are led to focus their intellectual energies on how to tailor the software to their own facility rather than understanding its limitations or how it was put together. Perhaps the worst outcome of this process is the belief that the most capable staff need to be trained to be systems analysts or programmers, in which case they will usually be sent abroad to study. It is not at all clear, however, that this is the most efficient use of their human capital. The new generation of microcomputers is quite easy to use requiring only a brief in-country training session. Sophisticated languages such as FORTRAN and PASCAL have their place, but not at the expense of thoughtful research.

F.M.D.C.A.S. Templates

F.M.D.C.A.S. templates are data reduction routines which the staff at Abuko should develop using the F.M.D.C.A.S. manual and LOTUS 123. They are referred to as templates since electronic spreadsheet programs such as LOTUS 123 are blank until the user establishes the logical relationships for the variables. The template is simply a filter which aggregates and displays data (in this case, the F.M.D.C.A.S. survey) in a way which is consistent with the procedures built into the F.M.D.C.A.S. computer program. For example, a Net Worth Statement for the compound's work unit is readily computed from raw data. The template would be created by adding the unit's capital assets (land, permanent crops, buildings, tools/machinery, draft animals, productive animals) to changes in inventory and any net investments (birth, construction, or purchase less sale, death, or consumption). All these variables are readily identifiable on the F.M.D.C.A.S. questionnaire. All the template designer has to do is determine their locations and assemble them in the appropriate fashion, in this case adding all the capital assets, net investments, and inventory changes. Once the staff becomes familiar with the spreadsheet program, it should not take more than a few hours to complete such a template. The number of templates ultimately designed depends on the nature of the questions the staff wishes to answer. It is unlikely that all of the tables available would be desired. It is recommended that prior to developing these templates, the staff hold discussions to determine a list of studies which should be undertaken. Such a list would reflect the needs of the various ministries. The ultimate number of templates and their respective priorities should be governed by these discussions.

RISKS INHERENT IN THE PROPOSED PLAN

The proposed installation of an in-country microcomputer facility is not without risk. Problems could emerge both in the hardware and in the use of the software. Maintenance of the equipment, a reliable source of power, backup software, training as well as political considerations, if unforeseen and unplanned for, could impair the facility's effectiveness. At this point I am less inclined to be concerned about the power supply than I was prior to visiting Abuko. The power there is as reliable as anywhere in The Gambia since it is serviced by the same transmission line as that which serves the airport. If the power were to fail, a backup generator is automatically triggered. The auxilliary power is normally available within a minute of when it is needed. A small interruptible power supply (UPS) such as that described in the equipment list can operate for 15 minutes, providing a comfortable safety margin. This UPS also serves to level voltage spikes and eliminate problems regarding line frequency. Even without the UPS, I was able to operate a portable computer at Abuko for 15 hours without any major mishap. I am not so sanguine about the likelihood of success if the facility were located in Banjul, however. The power there is not as reliable; and, at this point, no backup generator is available. If one were to be obtained, it would have to be large enough to run both computers and an air-conditioning system.

The climate could be a source of trouble if air conditioning were unavailable. High humidity, heat, and dust could lead to disk input/output problems. This means that data stored on diskettes could be lost if the environment is not controlled. The Abuko facility appeared to be quite clean and cool. However, an air-conditioned, dust-proof room would certainly enhance the equipment's effective life.

Inadequate training has been often cited as a reason why computer facilities are difficult to install in developing economies. I believe that this observation applies primarily to mainframe computers and is less applicable to a microcomputer facility. Programmers and systems analysts are required for the former, whereas the latter can be operated with only lay knowledge of computing. The software selected for use in the Abuko facility is self-explanatory and self-prompting. Reliance on canned routines which require outside expertise is discouraged. This strategy places a greater burden on the in-country staff; they will have to be more self-sufficient than would be the case if the data processing were undertaken in either CSU or CRODT, Dakar. However, as was pointed out above, this self-sufficiency will yield substantial rewards both in terms of accelerating turnaround time as well as improving the quality of analysis and training. If I have a concern here, it lies in how the Abuko staff reacts to such a challenge. If it is viewed as too risky or not likely to succeed, then it will not. If the staff views it as a positive step in bringing to fruition their long and arduous efforts to collect the survey data, the facility can't be anything but a success, perhaps even a model for facilities in other parts of Africa. I posed these possibilities to the staff just prior to leaving The Gambia. They indicated a strong desire to take on the challenge, and more encouraging yet, to enthusiastically utilize the tools. They recognized that the

most difficult tasks lay behind them and that the most intellectually stimulating aspect of the project, that of seeing what the data suggests about policy, was about to begin. The staff with some training should have little trouble analyzing the survey data in-country. It would be desirable to develop a backstop option in order to reduce the pressure on the Abuko staff. I recommend that F.M.D.C.A.S. program be installed on CSU's Cyber computer. The floppy disks would be mailed to CSU for processing. This would serve to crosscheck the templates being produced at Abuko as well as insuring that the data is processed in a timely fashion in the event of an unforeseen problem with the facility.

Under certain circumstances, political and administrative problems could diminish the effectiveness of the facility. Once installed, the facility will be one of the largest in the country (in terms of internal memory). I would imagine that such an installation might be subjected to conflicting demands. It would be essential to minimize these conflicts during the early stages of the project. The equipment should be used almost exclusively to enter and analyze baseline and farm survey data. Project budgeting and word processing, although important, should be given secondary priority.

However, once the preliminary analyses have been completed, it would be unwise to maintain such a well-equipped facility independent of ministry functions. To do so could cause frictions to emerge regarding training opportunities at the Mixed Farming Unit and the Ministry of Agriculture and Natural Resources. The result may be quite detrimental to host government/AID relations. These potential problems could be avoided by integrating the computers into the PPMU once the Abuko staff are thoroughly familiar with the equipment and have completed their primary assignments. In fact, under such circumstances experience gained on the Mixed Farming Project would be viewed as a valuable asset. The Abuko staff could train others using the survey data and skills acquired in analyzing the MFP data.

The computers are likely to cause a significant change in the way the Abuko staff is organized. Fewer enumerators will be needed to translate survey data to coding sheets since this step will be altogether eliminated. The new equipment may also create some tensions within the unit if precautions are not taken. Only a few Gambians will be responsible for operating the equipment. This fact may elevate their status leading to potential jealousies and undercutting established authority. It is extremely important that the project protect against such an occurrence. This can be done by simply keeping communications open, possibly by holding weekly meetings to discuss what analyses must be performed and assign responsibilities.

The link between the analysis being carried on at Abuko and the formulation of sound public policies appears to be weak although improving at this point. This can be partly explained in that the surveys have only recently been completed, and data collection absorbed most of the unit's attention until recently. A closer tie between the work at Abuko and the needs of policymakers in government is needed in order to sustain enthusiasm for performing the statistical work at Abuko. Without a sense of importance, the momentum of the project and the excellent morale enjoyed up to this point could be lost.

ENCLOSURE A

ESTIMATE OF KEYPUNCHING COSTS AT CSU

NUMBER OF CARDS AND TIME TO KEYPUNCH
RESOURCE INVENTORY--YEAR 1

TOTAL NUMBER OF CARDS	7,820.00
NUMBER OF CARDS KEYPUNCHED/HOUR	100.00
NUMBER OF HOUR/MONTH	160.00
NUMBER OF MONTHS WITH ONE COMPUTER	.49
NUMBER OF MONTHS WITH TWO COMPUTERS	.24

NUMBER OF CARDS AND TIME TO KEYPUNCH
RESOURCE UTILIZATION--YEAR 1

TOTAL NUMBER OF CARDS	1.10E+05
NUMBER OF CARDS KEYPUNCHED/HOUR	100.00
NUMBER OF HOURS/MONTH	160.00
NUMBER OF MONTHS WITH ONE COMPUTER	6.88
NUMBER OF MONTHS WITH TWO COMPUTERS	3.44

NUMBER OF CARDS AND COST TO KEYPUNCH
RESOURCE UTILIZATION--YEAR 1

NO. OF WORK UNITS	85.00	TOT. COL.
HOUSEHOLD		
CARDS/UNI	750.00	
COL/CARD	40.00	30,000.00
CROP		
CARDS/UNI	530.00	
COL/CARD	35.00	18,550.00
OFF FARM ACT.		
CARDS/UNI	12.00	
COL/CARD	42.00	504.00
INV. CHANGES		
CARDS/UNI	6.00	
COL/CARD	45.00	270.00
LIVESTOCK		
CARDS/UNI	6.00	
COL/CARD	50.00	300.00
OFF FARM INCOME		
CARDS/UNI	6.00	
COL/CARD	40.00	240.00
	TOTAL	49,864.00
TOTAL FOR 85 UNITS		4.23E+06
TOTAL NO. OF CARDS/UNIT		1,310.00
TOTAL NO. OF CARDS		1.11E+05
NO. OF CARDS/HOUR		120.00
HOURS TO PUNCH & VERIFY		927.92
COST TO PUNCH & VERIFY		8,351.25

ENCLOSURE B

SAVINGS DUE TO THE MICROCOMPUTER INSTALLATION WHEN COMPARED WITH CSU

		Sunk Cost	
FIELD COSTS--GAMBIA			
YEAR 1 (1981-1982)			
BASELINE SURVEY 1		$6,200.00	
YEAR 2 (1982-1983)			
FARM MANAGEMENT SURVEY		8,540.00	
YEAR 3 (1983-1984)			
FARM MANAGEMENT SURVEY			$ 8,540.00
MARKETING STUDY			3,000.00
VILLAGE STUDY--SOCIAL FACTORS			2,500.00
HERDING STUDY			2,000.00
LIVESTOCK OWNERS ASSOCIATION STUDY			2,500.00
YEAR 4 (1984-1985)			
FARMAP			8,540.00
MARKETING STUDY			3,000.00
YEAR 5 (1985-1986)			
FARMAP			8,540.00
BASELINE SURVE 2			6,200.00
SUBTOTAL [1]			$44,820.00
ADJUSTMENT FOR EDITING COSTS (COMMON TO BOTH OPTIONS)			35,856.00
SUBTOTAL (AFTER ADJUSTMENT) [1]			$14,342.40
DATA ENTRY COSTS--CSU			
TRAVEL YEAR 1 (1982-1983)			2,100.00
TRAVEL YEAR 2 (1983-1984)			2,100.00
TRAVEL YEAR 3 (1984-1985)			2,100.00
TRAVEL YEAR 3 (1985-1986)			2,100.00
LIVING ALLOWANCE YEAR 1	60 DAYS [2]		3,600.00
LIVING ALLOWANCE YEAR 2	70 DAYS		4,200.00
LIVING ALLOWANCE YEAR 3	40 DAYS		2,400.00
LIVING ALLOWANCE YEAR 4	40 DAYS		2,400.00
KEYPUNCH COSTS YEAR 1	110,000 CARDS [3]		8,351.00
KEYPUNCH COSTS YEAR 2	130,000 CARDS		9,750.00
KEYPUNCH COSTS YEAR 3	70,000 CARDS		5,250.00
KEYPUNCH COSTS YEAR 4	70,000 CARDS		5,250.00
CYBER COST YEAR 1	35 RUNS		2,000.00
CYBER COST YEAR 2	35 RUNS		2,300.00
CYBER COST YEAR 3	35 RUNS		1,500.00
CYBER COST YEAR 4	35 RUNS		1,500.00
SUBTOTAL			$56,901.00
TOTAL			$71,243.40

[1] THE COST OF SCREENING THE QUESTIONNAIRES FOR ACCURACY WAS ASSUMED TO BE COMMON TO ALL THE OPTIONS AND THEREFORE COULD NOT BE CLAIMED AS A SAVINGS. THE USE OF A NUMERIC KEY PAD WAS ASSUMED TO REDUCE CODING COSTS BY 60 PERCENT.

[2] LIVING EXPENSES OF $60 PER DAY WERE ASSUMED FOR FORT COLLINS. A LESSER AMOUNT MAY BE APPROPRIATE IN THE EVENT OF PROLONGED TRAINING.

[3] DATA ENTRY AT ABUKO WOULD ELIMINATE ALL KEYPUNCHING COSTS AT CSU. THE ASSUMPTIONS UNDERLYING THE SAVINGS ARE GIVEN IN ENCLOSURE A.

SAVINGS DUE TO THE MICROCOMPUTER INSTALLATION WHEN COMPARED WITH CRODT

		SUNK COST	
FIELD COSTS--GAMBIA			
YEAR 1 (1981-1982)			
BASELINE SURVEY 1		$6,200.00	
YEAR 2 (1982-1983)			
FARM MANAGEMENT SURVEY		8,540.00	
YEAR 3 (1983-1984)			
FARM MANAGEMENT SURVEY			$ 8,540.00
MARKETING STUDY			3,000.00
VILLAGE STUDY--SOCIAL FACTORS			2,500.00
HERDING STUDY			2,000.00
LIVESTOCK OWNERS ASSOCIATION STUDY			2,500.00
YEAR 4 (1984-1985)			
FARMAP			8,540.00
MARKETING STUDY			3,000.00
YEAR 5 (1985-1986)			
FARMAP			8,540.00
BASELINE SURVEY 2			6,200.00
SUBTOTAL [1]			$44,820.00
ADJUSTMENT FOR EDITING COSTS (COMMON TO BOTH OPTIONS)			35,856.00
SUBTOTAL (AFTER ADJUSTMENT) [1]			$14,342.40
DATA ENTRY COSTS--CSU [2]			
TRAVEL YEAR 1 (1982-1983)			500.00
TRAVEL YEAR 2 (1983-1984)			500.00
TRAVEL YEAR 3 (1984-1985)			500.00
TRAVEL YEAR 4 (1985-1986)			500.00
LIVING ALLOWANCE YEAR 1	60 DAYS [3]		1,800.00
LIVING ALLOWANCE YEAR 2	70 DAYS		2,100.00
LIVING ALLOWANCE YEAR 3	40 DAYS		1,200.00
LIVING ALLOWANCE YEAR 4	40 DAYS		1,200.00
KEYPUNCH COSTS YEAR 1	110,000 CARDS		4,125.00
KEYPUNCH COSTS YEAR 2	130,000 CARDS		4,875.00
KEYPUNCH COSTS YEAR 3	70,000 CARDS		2,625.00
CRODT COMPUTER COST YEAR 1	35 RUNS		2,000.00
CRODT COMPUTER COST YEAR 2	35 RUNS		2,300.00
CRODT COMPUTER COST YEAR 3	35 RUNS		1,500.00
CRODT COMPUTER COST YEAR 4	35 RUNS		1,500.00
SUBTOTAL			$29,850.00
TOTAL			$44,192.40

[1] THE COST OF SCREENING THE QUESTIONNAIRES FOR ACCURACY WAS ASSUMED TO BE COMMON TO ALL THE OPTIONS AND THEREFORE COULD NOT BE CLAINED AS A SAVINGS. THE USE OF A NUMERIC KEY PAD WAS ASSUMED TO REDUCE CODING COSTS BY 60 PERCENT.

[2] THREE ROUNDTRIP TICKETS FROM BANJUL TO DAKAR FOR TWO TO THRFE PEOPLE.

[3] LIVING EXPENSES OF $30 PER DAY WERE ASSUMED FOR DAKAR.

[4] THE COSTS OF KEYPUNCHING AT CRODT WERE ASSUMED TO BE 50 PERCENT THAT INCURRED AT CSU.

ENCLOSURE D

HARDWARE, PARTS AND SUPPLIES		
COMPUTERS AND PERIPHERALS FOR THE GAMBIA		
COMPAQ (IBM COMPATIBLE PORTABLE COMPUTER)		$ 3,000.00
IBM XT		4,400.00
2 DOUBLE SIDED FLOPPY DISK DRIVES		
1 MONOCHROME DISPLAY		
1 10M BYTE HARD DRIVE		
1 EPSON FX 80 F1 PRINTER, 1 QUME SPRINT 5 PRINTER		2,000.00
2 DATASAVERS--MICROCOMPUTER UPS		970.00
1 HAND-HELD VACUUM		80.00
COMPUTERS AND PERIPHERALS FOR CSU		
IBM XT CONFIGURED AS THAT INSTALLED IN THE GAMBIA		4,400.00
EPSON FT PRINTER		400.00
PARTS		
1 DOUBLE SIDED DISK DRIVE		500.00
DEALERS KIT		300.00
SUPPLIES		
100 DOUBLE DENSITY DOUBLE SIDED DISKETTES		280.00
30 PRINTER RIBBONS		200.00
4 BOXES OF PAPER		160.00
SOFTWARE PURCHASE		
STATISTICAL PACKAGE--MICROSTAT		400.00
WORD PROCESSOR--WORD STAR		300.00
ELECTRONIC SPREAD SHEET--LOTUS 123		450.00
LINEAR PROGRAMMING--????		400.00
DATA BASE--????		400.00
PROGRAMMING AT CSU		
DATA ENTRY, VERIFYING AND CHECKING PROGRAM	90 HRS.	1,800.00
OBTAIN AND INSTALL F.M.D.C.A.S. PROGRAM ON THE CYBER	75 HRS.	1,500.00
REFORMATTING ROUTINE (TO INSURE THAT DATA ENTERED ON FLOPPY DISKS ARE COMPATIBLE WITH F.M.D.C.A.S.)	30 HRS.	600.00
TRANSFER BASELINE DATA FROM CYBER TO FLOPPY DISKS	30 HRS.	600.00
PROGRAMMING THAT COULD BE PERFORMED WITH MSU [1]		
INSTALL FARMAP ON THE IBM XT OR THE IBM 4331	160 HRS.	3,200.00
REFORMAT DATA FOR FARMAP	20 HRS.	400.00
REFORMATTING PROGRAM (TRANSLATE IBM XT DISKS FOR USE WITH THE IBM 4331)	80 HRS.	1,600.00
SOFTWARE EVALUATION		
PROVIDE PROJECT EXAMPLES OF HOW TO USE MICROSTAT	60 HRS.	1,200.00
LINK POLICY AND BASELINE DATA USING MICROSTAT	60 HRS.	1,200.00
WRITEUP LIMITATIONS OF SOFTWARE IN THE CONTEXT OF THE PROJECT	40 HRS.	800.00
INSTALLATION AND FOLLOWUP		
ON-SITE INSTALLATION--AUGUST		
TRAVEL		3,900.00
PER DIEM	2,100.00	
CONSULTANCY	10 DAYS	
FOLLOW UP AT CSU--SEPTEMBER	60 HRS.	
CONSULTANCY	25 HRS.	500.00
FARMAP INSTALLATION--JANUARY		
TRAVEL		5,760.00
PER DIEM	2,100.00	
CONSULTANCY	21 DAYS	
INSTRUCTIONAL MATERIALS--TAPES, ETC.[2]	120 HRS.	2,000.00
TOTAL		$43,700.00

[1] THIS TASK WOULD BE REQUIRED IN THE EVENT THAT THE ABUKO STAFF FEELS THAT THE QUALITY OF THEIR ANALYSIS WOULD BE ENHANCED BY DEVELOPING TIES WITH THE MSU STAFF IN SENEGAL.

[2] THIS MODEST EXPENSE CAN BE JUSTIFIED IN THAT A CAMERA AND RECORDER ARE ALREADY AVAILABLE. HENCE, NO EQUIPMENT NEED BE PURCHASED WITH AID FUNDS. THE MANHOURS INVOLVED IN TAPING, EDITING, AND REPRODUCING THE DEMONSTRATIONS WOULD COMPRISE THE BULK OF THE ESTIMATED EXPENSE.