Bartolo End of Contract Report

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END OF CONTRACT REPORT

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FEEDER ROAD PROJECT

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VIHIGA/HAMISI SRDP

END OF CONTRACT REPORT - VIHIGA/HAMISI SRDP

LABOR INTENSIVE FEEDER ROAD PROJECT

ROBERT H. BARTOLO, JANUARY, 1975

This report documents the accomplishments of the feeder road project over the two year period, January, 1973 - January, 1975. First a brief background of the project is given, after which the management system and each of the technical operations are discussed in detail.

I. Background.

A labor intensive road project was initially discussed in the early SRDP planning meetings in 1969 - 70. As the project design emerged, it encorperated the construction of seven farm-to-market feeder roads, totaling 65 kilometers, within Vihiga and Hamisi divisions.[1] The specific objectives of the project were as follows:

1. Experiment with alternative techniques of labor intensive road construction. The aim was to develop least-cost systems of completing the various technical operations necessary in the construction process.

2. Through a concentration on labor-intensive methods, create employment for residents of the local area.

3. Apply the labor intensive techniques developed in Vihiga/Hamisi to feeder road construction of projects in other heavily populated areas.

In the early planning period a request was made by the Government of Kenya to USAID for the latter to provide a road engineer who would be responsible for the technical planning and implementation supervision of the project. Due to innumerable delays in recruiting the engineer and to subsequent delays in aquiring the necessary commodities, e.g., hand tools, trucks, construction of the roads did not commence until June, 1973.

From June, 1973 to the present 40 kilometer of the intended 65 kilometer have been worked on; approximatley 47 % of the entire project was complete by the beginning of 1975.

A breakdown of work completed by location and specific road is as follows:

a)	Tiriki (Boyani to Jeprok)	- 62 per cent complete
b)	Tiriki (Muntsatsi - Kinu)	- 0 " " "
c)	S. Maragoli (Mbale - Magada)	- 59 " " "
d)	S. Maragoli (Vihiga - Mbihi)	- 82 " " "
e)	S. Maragoli (Tigoi - Angoya)	- 70 " " "

[1] See the positioning of the roads on the map in attachment I.

f) N. Maragoli (Mutsulyu - Viyalo) - 53 per cent complete

g) E. Bunyore (Magada - Ebulonga) - 60 " " "

h) W. Bunyore (Ebulonga - Luanda) - 0 " " "

i) W. Bunyore (Luanda - Mmicho) - 0 " " "

II. Project Results.

In constructing rural feeder roads the following operations must be carried out (see attachment 2 for the typical cross section used in the construction of the proposed feeder roads):

1. Clearing and Grubbing.

   a) bush cutting

   b) stump removal

   c) grass and top soil removal

   d) stone removal

   e) tree removal

2. Earth Work.

   a) preliminary grading (cutting and filling)

   b) final grading (shaping and ditching the road)

3. Drainage.

   a) laying culverts

   b) bulding small bridges

4. Surfacing.

   a) applying murram

   b) rolling

5. Clean-up.

In order to carry out these operations an important element is effective management of labor; testing methods of mobilizing and managing labor thus became a central component in the road experiment.

A. Recruitment of Supervisory Staff.

Supervisory staff needed for the construction work being undetaken includes overseers and headmen. The qualifications of an overseer can be summarized as follows: some knowledge of the technical operations involved in road construction, ability to supervise a labor force (including ability to deal with inter-personal relationships) and literacy in the local dialect as well as in

English. Note: the most important qualification is the second of these, i.e., ability to supervise a labor force. Given this ability technical skills can be taught in a short time. However, the converse is not true: some knowledge of technical operations without the supervisory ability is not sufficient - the latter will be infinately more difficult to teach.

The responsibilities of overseers include:

a) maintaining records of labor hired, e.g., keeping employment rolls for purposes of paying wages;

b) tabulate information for and prepare daily progress reports;

c) assigning to headmen the necessary numbers of laborers to accomplish designated tasks; and

d) seeing that the designated tasks get carried out in a specified time frame.

Headmen are primarily responsible for carrying out the instructions of the overseers. As a result, they need many of the same qualifications, though on balance their level of sophistication need not be as high. Of particular importance is the ability to inspire a high level of productivity from the workers; it is the headmen who are continually with and directly supervise the labor force.

Experience to date in recruiting supervisory staff has been mixed. Considerable difficulty has been encountered in hiring both overseers and headmen with sufficient qualifications. The inter-action of three factors appears to be the primary reason for this difficulty:

a) the labor resource needed, highly skilled supervisors, is in scarce supply throughout the country.

b) the wages offered (those comparable to MOW wages) have not provided a striking economic incentive to draw the scarce skills from alternative employment, and

c) the information concerning available supervisory employment in Vihiga/Hamisi has had limited dissemination; with wider dissemination more, better trained individuals might have come forth.

The above information suggests two possible courses of action in order to address this problem. One would be to improve the economic incentive aimed at drawing scarce supervisory skills away from other employment. The disadvantages of such an approach are obvious: a) while it might be effective for a small area such as Vihiga, it could not work on a country-wide basis, for the increased economic return would be the same throughout the economy and no incentive would exist for supervisory staff to be drawn from one area to another, and b) while the activity to which the skilled labor is drawn might be benefited, that from which it is drawn would be hurt;

there might be no net benefit to the economy. The other possible course would be to undertake intensive training for the needed skills. This approach, for the economy as a whole, seems the most reasonable.

B. Recruitment of Unskilled Labor.

.. system for the recruitment of labor was divised and found to be relatively successful. As a result, alternative approaches were not experimented with. The system, discussed below, is based on two premises: that the local social and political system would be taken into consideration in its formulation, and selection of laborers should be random, favoring no special individuals or groups. The system is as follows:

a) the roads under construction are located in five of the six locations within Vihiga and Hamisi Divisions. Laborers are chosen from the location where the construction is being performed, e.g., the roads in North Maragoli are constructed using labor from North Maragoli. This approach has two benefits: it precludes the necessity of establishing a labor camp and it spreads employment benefits over a larger number of people.

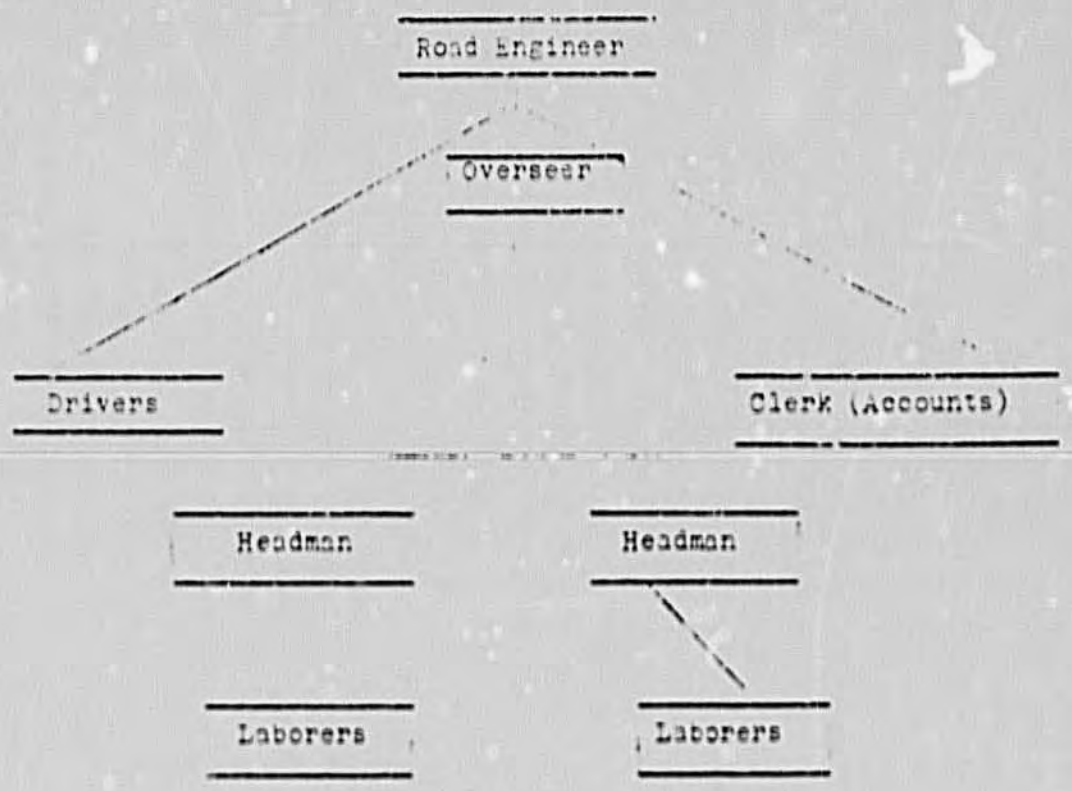
b) the system of recruiting labor has consisted of informing the chiefs of each location that on a designated day interested casual laborers could come to the chief's center to register for possible employment. During the first registration an average of 300 candidates appeared at each of the five locations.

c) laborers were chosen by the following random process: in each location numbers between 1 - 400 were written on separate slips pf paper and the slips placed in a box. Each prospective employee picked a number from the box and his name was placed on a master list opposite his chosen numbe . The lists were than given to the chiefs, and when laborers were needed they would pick the first names on the list. For example, if in South Maragoli a crew of 20 laborers were needed initially, numbers 1- 20 were chosen. Subsequent hiring involved selecti gnumbers beginning with 21 and proceeding down the list.

d) before being hired, each laborer was presented with a statement of labor policy which specified the conditions of employment (see attachment 3).

C. The Management System.

The following chart indicates the line of staff authority which exist at present.



This management structure seems appropriate, assuming the necessary quality of supervisory staff exists. Because some staff positions have been filled with individuals possessing less than the needed qualifications, the following problems have arisen:

a) Instructions from the engineer to his staff have occassionally not been carried out, thus slowing the work;

b) Due to lax labor supervision, the productivity of the casual labor has sometimes been low.

The system of labor management can be described as follows: up to 20 laborers begin the first operation (bush cutting) of a given road. When they have proceeded a specified distance (approximately 1 kilometer) a second group of laborers follows performing the second operation (stump removal). Subsequently third, fourth etc. groups follow performing their respective assigned operations. When the first group completes its task along the entire road, it may be used to begin a new operation commencing at the mouth of the road, or members of the group may be laid off.

This system of casual labor use has, on balance, proven successful. The only problem arrising directly from the system has been dissatisfantion on the part of some laborers at being laid off. It appears that the expectation of long-term employment is common irrespective of the vigorous efforts by the staff to make the conditions

of casual labor employment understand.

D. Technical Operations.

Discussed below are 1) the inputs needed for each operation listed on page two above and 2) the total cost of each operation. The labor output figures are an average for each operation of the work carried out in all five locations; those averages are the best estimates which this project has been able to generate to date for projecting resource needs in the construction of labor intensive feeder roads.

1. Inputs

a) Bush Cutting

This operation consists of cutting the existing bush within the 6 meter right of way of the proposed feeder roads. Tools required for this operation are pangas and one file. The general system used has not varied from one road to another; a crew of laborers is spread along both sides of the proposed road, each man being placed X meters from the next. One laborer clears the distance from the starting point to the point where the next nearest man to him has started. He then rotates ahead to the front of the crew to begin clearing a new section. This rotation continues until the entire length of the proposed road is cleared. Within this general system several variations have been tried. The objective has been to determine

- the optimal distance which one headman can effectively supervise and, given this,

- the distance between laborers which will assure maximum cost effectiveness. That is, too great a total distance cannot be supervised well, and it has been found that laborers placed too close together tend to engage in excessive conversation, thus slowing the work. The range of optimal spacing of labor depends on the degree of supervision required in the operation, and ranges between 20 to 30 meters.

The conclusion with regard to bush cutting is as follows: one headman can supervise well approximately 200 meters of road at one time. The most effective distance between laborers is 30 meters. Using this system the following conclusions emerge:

Optimal Crew: 1 headman and 14 laborers.

Output (the average output obtained using this

system on 5 different road segments):

One laborer can cut an average of 75 meters of bush per day along one side of the road. One headman plus 14 laborers can therefore cut approximately one kilometer of bush in two days; 30 mandays are thus required per kilometer for this operation.

Tools required: 14 pangas, one file.

b) Stump Removal

This operation entails removing the stumps of the bush cut in operation a. Tools required include mattocks, axes and shovels. The optimal system is the same as bush cutting. Thus:

Optimal Crew: 1 headman and 14 laborers.

Output: 1 laborer can remove stumps over a distance of 40 meters per day. One headman plus 14 laborers can therefore complete approximately 1 kilometer in 3.5 days; approximately 53 man days are thus required per kilometer.

Tools required: 14 mattocks, 5 axes, and 5 shovels.

c) Grass and Top Soil Removal

Tools used for the removal of grass and top soil are jembes, fork jembes and shovels. Initial difficulty was encountered when grass tended to grow back rapidly after this operation was completed. The technique used at that time was to loosen the top soil to a depth of approximatley 4" and shake out the grass and roots. Several modifications to this approach were tried and the following was settled upon: dig and throw out 4" of top soil, then loosen approximatley 9 additional inches of soil, let dry and remove any remaining grass or other unsuitable material. To date this approach has shown to be the most effective.

The general system used in this work is, again, the same as in a and b above. However, the optimal crew and distance between laborers differs. Laborers are placed at each side of the road. One laborer is responsible for removing grass and top soil from his edge to the center of the road i.e., 4 meters. He can complete 20 meters in one day. Since this operation requires more careful supervision, experience

indicates that one headman can effectively supervise 150 meters, with laborers spread 10 meters apart. Therefore:

Optimal Crew: 1 headman and 15 laborers.

Output: with one laborer completing 20 meters per day, the above crew can complete approximately one kilometer in 7 days. Thus, 112 mandays are required per kilometer.

Tools required: 15 jembes, 15 fork jembes and 15 shovels.

d) Stone Removal

One of the most difficult and in some ways most interesting problems confronted thus far has been the removal of the large stones found in Vihiga and Hamisi Divisions. Tools required for this operation include crowbars, shovels, jembes, and fork jembes. Stones within 12" of the top of the proposed roadway must be removed. Several methods to accomplish this have been used.

- Small stones (1 cubic meter and less) - dig the stone out and roll it from the roadway.

- Stones larger than 1 cubic meter - if the stone is 90% + above the surface of the road a first attempt is made to dig it out and roll it from the road. If this is not possible

  - because it is too large or more than 10% burried - the following alternative approaches are used:

  - dig a hole to one side of the stone sufficiently large so that the stone can be burried;

  - after digging the hole attempt to manually push the stone into the hole;

  - in those cases where stones have been too large to be pushed manually the following alternatives have been tried:

    - tying a rope around the stone and pulling it with the use of a truck. This has had only a limited success.

    - using a hydraulic jack. Sufficient earth is removed from the side of the stone opposite the hole so that a jack can be wedged behind the stone. It is then slowly

jacked (with the help of laborers to direct the roll of the stone) until it falls into the hole. This approach has proven to be the most successful.

- cracking stones by use of fire. Wood is placed on top of the stone and burned. When the stone becomes sufficiently hot, either a sledge hammer alone is used to crack it or it is first doused with cold water and then hammered. This method is used generally on very large stones of which a foot or less is exposed above the ground.

The average labor input used on the stones removed thus far is 6 man days per stone. The incidence of rocks, of course, varies greatly from place to place. Of the 40 kilometers on which work has already been undertaken no more than 5 have had a significant outcropping of rock. Over this distance there were an average of 30 stones per kilometer. In order to determine the labor input needed and the cost per kilometer of stone removal for any particular segment of road an assessment of the extent of the rock outcrops must first be carried out.

e) Tree Removal

Tools used for this operation include axes, mattocks, jembes, shovels, and ½" rope. Thus far two methods have been tested:

- cutting the tree down and only then removing the stump by digging around its base and cutting its roots, and

- tying a rope near the top of the tree, digging around its stump, cutting its roots, and pulling the tree over. This method involves essentially only one operation and is the most cost effective.

On the average 2 man days are required per tree when the second of these two methods is used. As in the case of stones discussed above, the number of trees per kilometer varies greatly. On the 40 kilometers worked on up to January, 1975 the average labor input used for tree removal has been 202 man days per kilometer. This input has varied per kilometer from zero to 403 man days.

f) Preliminary Grading.

This operation consists of shaping the road

so that it is level over its width and, over its length, conforms to the grade requirements of standard VI roads of MOW. To accomplish this requires a combination of cutting and filling along the proposed road. Tools needed are jembes, fork jembes, shovels, mattocks, and wheelbarrows. The general system used is the same as that described for a above. Headmen can adequately supervise 150 meters at one time, and laborers can cut and fill approximately 10 meters per day. Due, as indicated in a above, to the problems encountered when laborers are placed too close together, a distance of 20 meters between laborers has been established as the most cost-effective in most instances (given the distance that a headman can supervise). The only cases when this proceedure is not appropriate is when the cut and fill requires moving large qualities of earth.

Optimal Crew: 1 headman and 15 laborers.

Output: with one laborer able to complete approximately 10 meters in one day, this crew can complete one kilometer in 14 days. Approximately 224 mandays are thus required per kilometer.

Tools required: 15 jembes, 15 fork jembes, 15 shovels, 15 mattocks, and 3 wheelbarrows.

g) Final Grading

Included in this operation are shaping and ditching the road to its final form (as is indicated in the cross section sketched in attachment 2). The tools necessary include jembes, fork jembes, shovels and wheelbarrows, plus trucks used to roll the road after shaping is completed. The system used is identical to that described in f above, and thus the optimal crew, output, tools required and labor costs are the same.

Only a limited amount of work has been done on the subsequent operations listed as items 3 - 5 on page two, and thus no hard data can be presented. However, given that considerable has been learned over the past year concerning labor productivity, estimates which are more accurate than those made in the past can be made concerning some of the operations which are yet to be started.

- Laying culverts:

8 men will take approximately 6 days to lay one culvert.

An average of 3 culverts are needed per kilometer.

Therefore, 24 men will take 6 days per kilometer or 162 mandays per kilometer.

- Applying murram:

  Loading: 150 loads are required per kilometer using 5 to trucks.

  297 mandays are required per kilometer for excavating murram and loading trucks.

  Spreading of murram: 198 mandays per kilometer.

Summary

Given the above, average estimates of total mandays needed and labor costs per kilometer can be made.

Total mandays: 1662 per kilometer.

2. Costs.

a) Labor Costs

The labor costs component of total construction costs for each construction operation is shown in the table below. The labor input is based on the estimates given in the section above.

LABOR INPUT AND COSTS - BROKEN DOWN BY CONSTRUCTION OPERATION

OPERATION	LABOR FORCE NO. OF LABORERS	LABOR FORCE NO. OF HEADMAN	MANDAYS REQUIRED PER KILOMETER	LABOR COST PER KILOMETER[2]
A. Clearing and grubbing				
a) Bush cutting	14	1	30	152/=
b) Stump removal	14	1	53	269/=
c) Grass and top soil removal	15	1	112	567/=
d) Stone removal	12	1	130	660/=
e) Tree removal	14	1	202	1026/=
B. EARTH WORK				
f) Preliminary grading (cutting and filling)	15	1	224	1134/=
g) Final grading (shaping and ditching)	15	1	224	1134/=
C. DRAINAGE				
h) Laying culverts	8	1	162	828/=
D. SURFACING MURRAM				
i) Loading	30	3	297	1512/=
j) Spreading	20	2	198	1008/=
E. CLEAN UP				
k) Misc.	9	1	30	153/=
TOTAL			1662	8443/=

The figures shown in the table above for operation "a" thru "g" are based on experience and on one and one half year's data gathering from actual road building operations, and operations "h" thru "k" are realistic estimates largely because over the past one and one half years considerable has been learned concerning labor productivity.

[2] Labor costs are based on the following: casual laborers paid Shs. 5/= per day headmen paid Shs. 6/= per day,

Using the data from the above the table below will show the required labor input and costs for the completion of each of the proposal feeder roads in Vihiga/Kamisi SRDP Roads Project. For details see attachment 4.

REQUIRED LABOR INPUT AND COSTS FOR THE COMPLETION OF THE VIHIGA/KAMISI SRDP ROAD PROJECT. AS OF JANUARY 1ST, 1975

	PROPOSED FEEDER ROAD	LOCATION	MANDAYS REQUIRED	LABOR COST
1.	BOYANI - JEPROK	TIRIKI	3,778.5	19,255/50
2.	MUNTATSI - KINU	TIRIKI	6,648	33,772/00
3.	MBALE - MAGADA	S. MARAGOLI	5,152.5	26,257/50
4.	VIHIGA - MBIHI	S. MARAGOLI	2,887.5	14,901/50
5.	TIGOI - ANGOYA	S. MARAGOLI	being constructed by M. O.W. using heavy equipment. See conclusion 2 on page 16.	
6.	MUTSULYU - VIYALO	N. MARAGOLI	5,496	28,008/
7.	MAGADA - EBULONGA	EAST BUNYORE	5,702.1	29.058/30
8.	EBULONGA - LUANDA	WEST BUNYORE	8,642.4	43,903/60
9.	LUNADA - MMICHO	WEST BUNYORE	11,467.8	58,256/70
		TOTAL	49,774.8	253,213/10

As of December 31, 1974, 29,626 mandays have been used on the project, a total labor cost of Shs. 262,780 or £ 13, 139, and from the table above, 49,7748 mandays of work remain in order to complete the roads project by labor intensive methods, or a labor cost of Shs. 253,213/10 or say £ 12,660.

If, beginning January 1, 1975

- an average of 150 men are utilized per day[3], and
- we assume 220 working days per year, then 150 men x 220 days = 33,000 mandays of work can be completed in one year.

Therefore, to complete the project, it will require 49,775 mandays: 33,000 mandays per year or 1 year and 6 months, commencing January 1, 1975.

b) SUPERVISORY STAFF COSTS.

2 Overseers, 1½ years	£1080
1 Clerk (Accounts), 1½ years	540
2 Drivers, 1½ years	1200
Total	£2820

c) EQUIPMENT OPERATION COST.

Cost of maintenance and operation for 1½ years of:

2 diesel engine dump trucks	£2,700
1 gasoline engine jeep	900
Total	£3,600

d) COST OF MATERIAL

Construction materials include:

culverts, cement, sand, ballast, small bridges and murram.

Their costs are as follows:

culverts (building our own culverts - material = labor)	£1,850
sand, ballast and cement (for placing culverts at sites)	2,000
small bridges (estimated)	5,000
murram	11,250[4]
Total	£20,100

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[3] This average estimate of men utilized per day is based on two factors: a) the relative availability of supervisory staff and b) the optimal labor crews which the supervisory staff can manage.

[4] This figure assumes that all murram required is purchased, but some may possibly be obtained at site of work.

e) COMMODITIES

As noted above, small tools such as jembes, shovels, etc. are required for the construction of the roads. Local purchase of these commodities is approximately £ 900

In addition, the following commodities were imported from the US and financed with USAID funds:

1 jeep wagoneer

shovels

picks

wheelburrows

axes

2 dump trucks

1 calculator

The total cost of these materials is Shs. 250,000/- or £ 12,500

Total £ 13,400

SUMMARY OF PROJECT FINANCIAL REQUIREMENTS FOR COMPLETION OF THE PROJECT

a.	Cost of labor for 1½ years	£12,660
b.	Local supervisory staff for 1½ years	2,820
c.	Equipment operation cost for 1½ years	3,600
d.	Cost of construction material	20,100
e.	Commodities for 1½ years	900[5]
	Total	£40,080

TOTAL EXPENDITURES TO DATE

a.	Cost of labor for 1½ years	£ 7,500
b.	Local supervisory staff for 1½ years	1,200
c.	Equipment operation cost for 1½ years	1,800
d.	Cost of construction material	2,260
e.	Commodities for 1½ years	450
	Total	£13,210

[5] This figure does not include the cost (£12,500) of the commodities that were imported from the U.S.

TOTAL FINANCIAL COSTS FOR THE ENTIRE PROJECT

Financial requirement for completion of the project	£40,080
Total expenditure to date	13,210
Total	£53,290[6]

Therefore; the total cost per kilometer is:

£53,290 ÷ 50.9 kilometers[7] = £1050.00

III. Conclusions

The primary conclusions that can be drawn from the road construction effort can be summarized as below:

1. Probably the single most important element in a successful labor intensive road project is the quality of the supervisory staff.

2. An accurate cost estimate of constructing roads using intensive labor techniques has been established. At present one road in Vihiga is being constructed using large equipment. A comparison of costs between these two techniques will be made. It is the intention that the most cost effective methods of constructing rural feeder roads will evolve, likely methods that incorporate a combination of labor intensive and capital intensive techniques.

3. The initial estimates of both labor input and costs for the construction of the 65 kilometers of road were grossily underestimated. This report reflects more realistic estimates, given the quality of staff and the techniques used, which can be utilized in planning similar roads construction in other areas of the country.

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6 This figure does not include the cost of one of the proposed road that is being constructed by capital intensive methods and the costs for commodities that were imported from the U.S. It is intended that in the end of project report details of all actual costs will be shown.

7 Initially the project was to include the construction of 65 kilometers of road. Over the past two and half years the Kenya Tea Development Authority has assumed responsibility for the construction of approximately 7 kilometers and Tigoi - Angoya road in South Maragoli is being constructed by capital intensive method. Therefore, project road length has thus been adjusted to approximately 50.9 kilometers using labor intensive construction methods.

4. It is hoped that the techniques developed in Vihiga can be utilized in a number of diverse ways, e.g., when bottlenecks occur in the construction of roads using equipment, more labor intensive methods might be drawn upon to overcome the problems.

5. More research needs to be done in order to learn what types of hard tools are most effective in labor intensive construction work.

Attachment No. 3

VIHIGA/HAMISI SRDP
ROAD PROGRAM
LABOR POLICY

The laborers employed under the S.R.D.P. Road Program are to understand the following:

(1) They are casual laborers.

(2) They will be paid on pay day 5/- per day only for the days they have worked.

(3) Pay day is the last day of the month.

(4) A day's work is from 7:30 a.m. to 3:30 p.m. (duration of 8 hours per day). Partial days will be paid accordingly.

(5) At any time the road work can be stopped at the discretion of the Road Engineer.

(6) The Road Engineer (through the overseer or headman) will dismiss any laborers who are not fit for the job (produce poor work, drunk on the job, trouble maker, etc.).

(7) Anyone dismissed from the job will be followed-up by a memo to the Chief of that particular location.

(8) Laborers have no authority to replace their position with other laborers.

Attachment 4.

Detailed estimates for labor input and costs for the completion of each of the proposed feeder roads under Vihiga/Hamisi SRDP Road Project are shown below:

1. BOYANI - JEPROK (TIRIKI LOCATION) LENGTH: 5.5 Kilometer.

OPERATION	MANDAYS REQUIRED	LABOR COST
A. Clearing and grubbing	Work completed	
B. Earth work	Work completed	
C. Drainage	891	4554/-
D. Surfacing (Murram)		
i) Loading	1630.5	8316/-
j) Spreading	1089	5544/-
E. Clean up	165	841/50
Total	3775.5	19250/50

2. MUNTSATSI - KINU (TIRIKI LOCATION) LENGTH: 4.0 Kilometer.

Construction of this road has not been started. Therefore, using the figures shown on the table on page 12,

Total mandays required: 4 x 1662 = 6648

Total labor cost : 4 x 8443/- = 33,772/-

3. MBALE - MAGADA (SOUTH MARAGOLI LOCATION) LENGTH: 7.5 Kil.

OPERATION	MANDAYS REQUIRED	LABOR COST
A. Clearing and grubbing	Work completed	
B. Earth work	Work completed	
C. Drainage	1215	6210/-
D. Surfacing (Murram)		
i) Loading	2227.5	11,340/-
j) Spreading	1485	7,560/-
E. Clean up	225	1,147/50
Total	5152.5	26,257/50

Attachment 4 cont.

4. VIHIGA - MEIHI (SOUTH MARAGOLI LOCATION) LENGTH: 7.5 Kil.

OPERATION	MANDAYS REQUIRED	LABOR COST
A. Clearing and grubbing	Work completed	
B. Earth work	Work completed	
C. Drainage	Work completed	
D. Surfacing (murram)		
i) Loading	1633.5	8316/-
j) Spreading	1089	5544/-
E. Clean up	165	841/50
Total	2887.5	14701/50

5. TIGOI - ANGOYA (SOUTH MARAGOLI LOCATION)

This road is being constructed by capital intensive methods - see conclusion 2 on page 16.

Costing for this proposed feeder road is not available at present.

6. MUTSUTYU - VIYALO (NORTH MARAGOLI LOCATION) LENGTH: 8.0 Kil.

OPERATION	MANDAYS REQUIRED	LABOR COST
A. Clearing and grubbing	Work completed	
B. Earth work	Work completed	
C. Drainage	1296	6624/-
D. Surfacing (murram)		
i) Loading	2376	12096/-
j) Spreading	1584	8064/-
E. Clean up	240	1224/-
Total	5496	28008/-

Attachment 4 cont.

7. MAGADA - EBULONGA (EAST BUNYORE LOCATION) LENGTH: 8.3 Kil.

OPERATION	MANDAYS REQUIRED	LABOR COST
A. Clearing and grubbing	Work completed	
B. Earth work	Work completed	
C. Drainage	1344.6	6872.4
D. Surfacing (murram)		
i) Loading	2465.1	12549.6
j) Spreading	1643.4	8366.4
E. Clean up	249	11269.9
Total	5702.1	29058.3

8. EBULONGA - LUANDA (WEST BUNYORE LOCATION) LENGTH: 5.2 Kil.

Construction of this road has not been started. Therefore using the figures shown in the table on page 12,

Total mandays required : 5.2 x 1662 = 8642.4

Total labor cost : 5.2 x 8443/- = 43,903/60

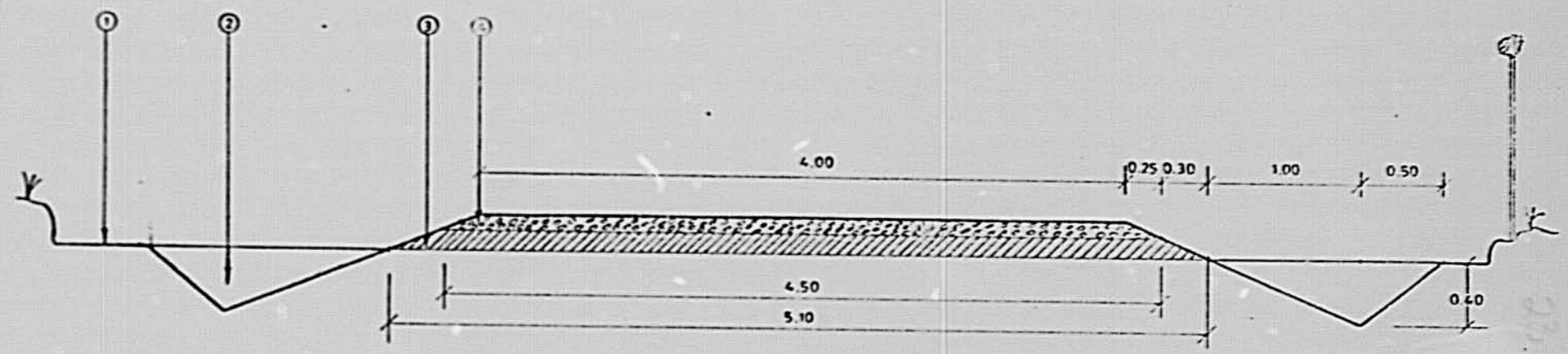
9. LUANDA - MMICHO (WEST BUNYORE LOCATION) LENGTH: 6.9 Kil.

Construction of this road has not been started. Therefore using the figures shown in the table on page 12,

Total mandays required : 6.9 x 1662 = 11467.8

Total labor cost : 6.9 x 8443/- = 58,256/70

CROSS SECTION OF ROAD



① SURFACE LEVEL AFTER REMOVAL OF TOP SOIL.

② SIDE DRAINS

VOLUME OF CUT = 1/2 x 0.40 x 1.50 = 0.30 m^3/m

BOTH SIDES VOLUME = 2 x 0.30 = 0.60 m^3/m

③ BASE COURSE

0.125 m COMPACTED FILL FROM SIDE DRAINS

VOLUME = 0.125 x 4.80 = 0.60 m^3/m

④ WEARING COURSE

0.10 m LATERITE MATERIAL (MURRAM)

VOLUME COMPACTED 4.25 x 0.1 = 0.425 m^3/m

VOLUME LOOSE 0.425 x 1.2 = 0.50 m^3/m

Attachment 2.