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REPORT ON THE COST-EFFECTIVENESS OF THE EXPANDED PROGRAM OF IMMUNIZATION IN THE REPUBLIC OF SUDAN

VOLUME II: Kordofan Region

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Resources for Child Health Project

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REPORT ON THE COST-EFFECTIVENESS OF THE EXPANDED PROGRAMME OF IMMUNIZATION IN THE REPUBLIC OF SUDAN

VOLUME II: KORDOFAN REGION

April 1989
(revised February 1990)

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ACRONYMS

CHW	Community Health Worker
DOO	District Operations Officer
EPI	Expanded Programme of Immunization
FIC	Fully Immunized Child
FTE	Full Time Equivalent
HQ	Headquarters
L	British Pound
LS	Sudanese Pound
MCH	Maternal and Child Health
NGO	Non-government Organization
PHCU	Primary Health Care Units
r	Interest Rate
RHSP	Rural Health Services Project
DOO	Regional Operations Officer

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The field visits involved extensive travel and could not have been completed without the active support and cooperation of many individuals. The tight schedule meant that many EPI staff were interviewed long after the official working day was over; the Study Team would like to express sincere thanks for the whole-hearted assistance they received while in El Obeid from:

Regional Directorate of Health:
Dr. Mirghani Suleiman Arsheen, Regional Medical Directorate Dr. Mustafa Abubakar Omer, Deputy Regional Medical Directorate

Regional EPI Headquarters:
Abdulrahman Babikir, Regional Operations Officer
Salah Al Agib, Regional Cold Chain Officer

and from the District Operations Officers whose Districts were surveyed:

El Obeid	Ahmed Abuzeid
Bara	Mahtaseem Mohamed Abdulrahman
Dilleng	Azam Hassan Dinn
Kodogli	Mohamed AlNoor Bandas
Rashad (Abu Jibeha)	Kookoo Idris Matar
	Mohamed Wida'a
(Abbasiya)	Omer Mohamed Osman
Um Rwaba	Ali Nasr

Many individuals in Khartoum also gave invaluable information about the program; a complete list of the people met during the course of the study is included in Appendix 1.

Jan Van Mannen of UNICEF/El Obeid generously provided a vehicle and driver for the Study Team, and both he and Awadhia Jubaara looked after other essential logistics such as ensuring that we could return to Khartoum on schedule, on the UNICEF plane. USAID provided two vehicles (one for the Study Team, and one for fuel and spares) and drivers to take the Study Team from Khartoum to El Obeid. Special thanks are due to the staff at the Rural Health Services Project Guest House in El Obeid, who accommodated our unpredictable arrivals with equanimity, and to the families who accommodated us at short notice during the visits to the Districts.

Finally, the Study Team would like to record their appreciation and thanks to Adam Fadhal Makhtar, the driver assigned by UNICEF for the duration of the field work, for his careful driving and skill in extracting the vehicle from deep sand and mending temperamental electrical circuitry. He worked the longest hours of all, and returned us safely to El Obeid.

EXECUTIVE SUMMARY

In March - April 1989, the cost and cost-effectiveness study of the Expanded Programme of Immunization (EPI) was undertaken in four northern regions of Sudan by the EPI and the REACH Project. In Kordofan, it was found that the annual cost of the EPI was $910,074 (LS 4,049,800) in 1988. The output achieved with these resources was a total of 560,450 doses administered. Data from the 1989 Coverage Survey showed that the Region has fully immunized 34,600 (24%) of the children under one year of age and 36,300 (25%) of eligible women with two or more doses of TT. The cost per fully immunized child (FIC), eight doses, for Kordofan Region was $23.70 (LS 105); if all of the children with eight doses had completed their immunizations before their first birthday, the coverage would have almost doubled, to 44%, and thus cost per FIC would be reduced by nearly half, to $12.91 (LS 57). Major constraints on extending coverage are the impassability of roads during the wet season, security in the south, and the narrow target age for measles immunization. Only 26% of measles doses were given to children in the target age range of nine to 11 months.

The main strategy for extending EPI services is the mobile team. Fixed facilities only provide immunization in the main town of each District and the seven day cold box strategy has been discontinued due to cessation of Council funds for transporting vaccine from rural dispensaries to Primary Health Care Units (PHCUs). Thus the majority of EPI resources were devoted to mobile teams at the time of the study.

Although a mobile team costs far more to run (on average $18,783 per year) than EPI services at a health facility ($3,972 per year), the level of output of a mobile team is nine times greater (33,400 doses per year compared with 3,900 at a health facility). Thus the average cost per dose delivered by mobile teams was $0.55 (LS 2.50), which is just over half the cost per dose for health facilities operating a fixed point strategy ($0.99 per dose, or LS 4.41). This difference in cost is largely explained by the very low level of output per staff member during fixed facility EPI sessions: the average was four doses per hour, with a range from five doses per hour to one dose every three to four hours. The hourly output per health worker on a mobile team was 12 doses, three times higher than a fixed facility. However, there was a range from 24 doses per hour to one dose per hour in the sample of seven teams.

These findings suggest that EPI services at fixed facilities are not fully operational and that the low level of output renders this strategy inefficient. More supervision of staff performance is needed, and staffing levels and number of sessions offered should be suited to the size of the target population in the catchment area served by the facility or by the mobile team immunization site (center). Thus some health facilities only need to offer services once per week while some villages do not need to be visited every month by mobile teams. The report suggests some activity indicators (such as doses given per health worker per hour) which District and Regional managers can use to achieve a better distribution of resources.

District level cost effectiveness, measured by cost per dose, varied by a factor of two ($0.86 to $1.44) in the six Districts visited. This wide range indicates that there is considerable scope for increasing efficiency in the high cost Districts, which could benefit from adopting successful approaches already developed by Districts with the best performance.

The recommendations in Chapter VI focus on ways of imposing the distribution of available resources and increasing their productivity to increase cost-effectiveness. Areas where there are health facilities could receive immunizations from these health workers, leaving the mobile teams free to visit communities with no other access to services. The optimum mixture of strategies (fixed facility, outreach, seven day cold box, mobile team) can be found after systematic planning based on information about the size of the target population in each community, an inventory of resources including those not supplied by the EPI, and possibilities for delivering vaccine by public or private transport. Staff should be assigned based on the expected workload, and their level of activity should be monitored so that the existing inefficiencies do not continue.

The sensitivity analysis in Chapter V shows that the greatest reduction in cost per FIC is achieved by raising coverage. Thus, in order to make better use of the resources devoted to EPI, utilization of services needs to increase and the number of drop outs should be reached. It is suggested that the pilot schemes for identifying and following-up eligibles in the community should be adopted as a strategy for improving utilization throughout the region.

I. INTRODUCTION

In March - April 1989, the cost and cost-effectiveness study of the EPI was undertaken in four northern regions of the Sudan. The study was conducted by the EPI/Sudan and the REACH Project. This report covers the costs of the EPI in Kordofan Region. The development of the program in Kordofan is described in Chapter II. The methodology for analyzing costs and effectiveness is described in detail in Chapter III. In brief, the approach was to use a combination of data collected during field visits by the Study Team, reports describing the program, and source documents (such as salary records and shipping reports) for information on the cost of resources used. Data on costs and outputs (doses given, days worked) were used to calculate average costs of different strategies for delivering EPI services (mobile team/fixed facility), indicators of activity (doses per EPI staff per day), and program costs at each administrative level (District/ Region). The study's findings indicate some measures that can be taken to improve the efficiency and effectiveness of the EPI in Kordofan.

A. Purpose of the Study

The study had two purposes: 1) assess the relative costs and effectiveness of the main strategies currently used for delivering EPI services (mobile teams and fixed facilities); and 2) measure costs of the program at District and Regional levels. Analysis of the strategies involves combining cost data with operational data to calculate indicators of the level of program activity. The variations in output and effectiveness found through this analysis highlight the attributes which are associated with low cost and high output. The results, presented in Chapter IV, suggest some measures which the Regional Operations Officer (ROO) and the District Operations Officer (DOO) can take to improve the effectiveness of the EPI in Kordofan.

The second area of analysis - assessing the total costs of the program at District and Regional level - allows a comparison of costs and effectiveness between Districts in Kordofan. This analysis is also used in the National Report on cost-effectiveness in the Sudan to compare distribution of resources among the regions and how those resources have been translated into outcomes, measured in terms of fully immunized children. The results for Kordofan are presented in Chapter V.

Conclusions and recommendations are given in Chapter VI.

B. Itinerary

The Study Team met in Khartoum between March 5 - 9, while questionnaires were being finalized and logistical preparations made. On March 11, the Study Team left Khartoum and drove to El Obeid via Kosti. The next day was spent in preliminary meetings, requesting data which would have to be extracted from the Regional Medical Directorate's records and the Regional EPI Headquarters (HQ) files, and drawing up the sample of places to visit. Structured

interviewing with mobile teams and DOOs began the same day. Over the next nine days, the Study Team visited six Districts, interviewing staff involved in the program. The itinerary is indicated on the map of Kordofan Region (see page 5) and full details given in Appendix 2. The Study Team returned to Khartoum by air and completed data collection from the National HQ, UNICEF, and other organizations involved in the EPI. Data processing and preliminary analysis were completed in Khartoum, and the main results of the study were presented to the Director of EPI and the Management Review Team on April 10.

II. ORGANIZATION OF EPI IN KORDOFAN

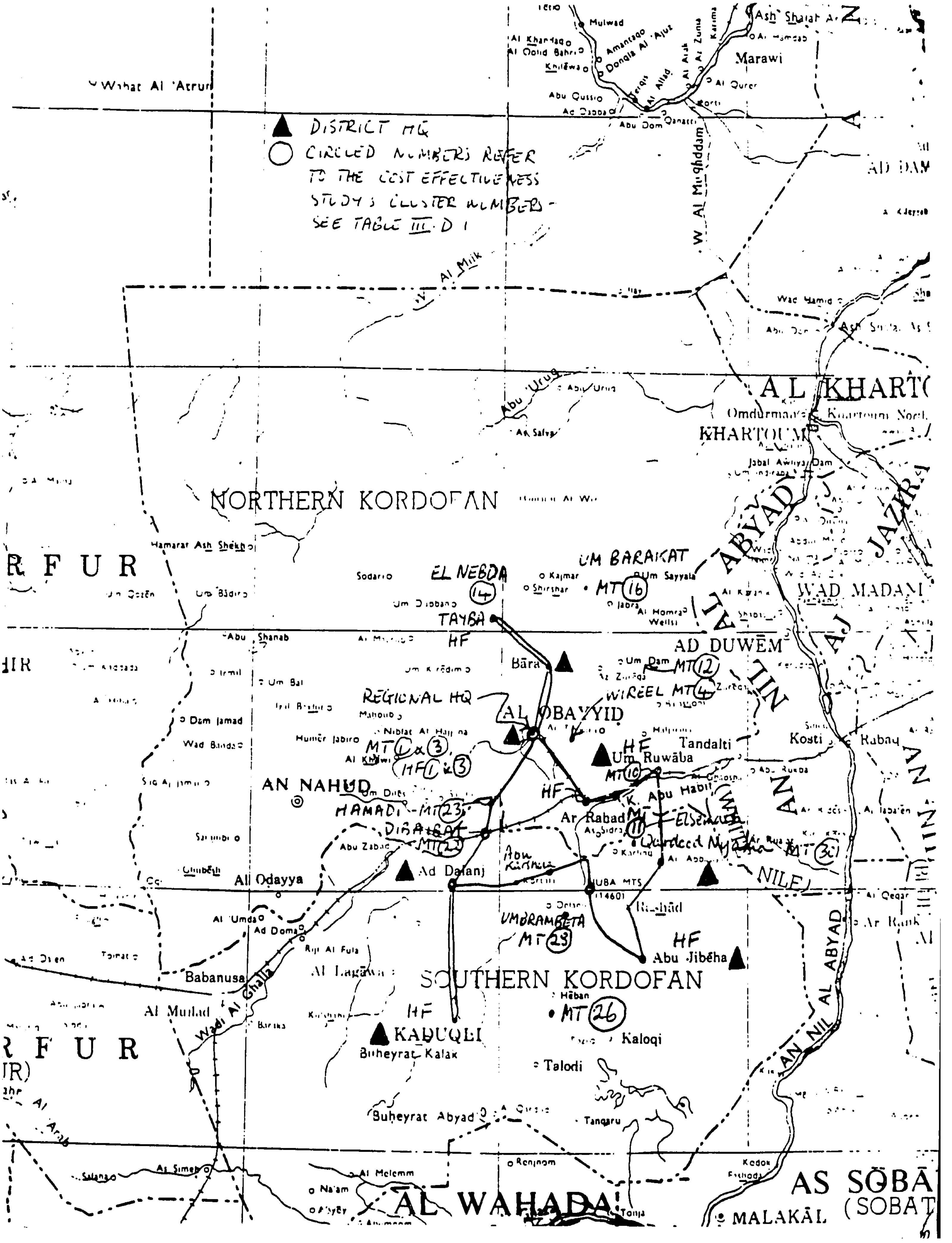
A. Background

Kordofan Region is located in central Sudan with a surface area of 380,000 square kilometers. The Region is divided administratively into two Provinces (Northern Kordofan and Southern Kordofan) and into ten Districts. The area north of El Obeid is predominantly sandy with the oases becoming less frequent as one moves north from El Obeid. It is possible to travel northeast directly to Khartoum (a journey of 9-10 hours) but only with an experienced driver and a suitable four wheel drive vehicle. The more usual route is south-east from El Obeid to Rahad, then east through Um Rwaba to Kosti, and from there north up the White Nile to Khartoum (see map). Apart from three short stretches of newly built roads, ground transportation follows sand tracks or deeply rutted or potholed routes. (El Obeid and Kadogli have airports.) The railway line runs from Kosti west to Abu Zabad and from there south-west to Babanusa. The train runs twice per week with the journey from Khartoum to El Obeid taking 24 hours. Bus connections make the same trip in about 12 hours. The area to the south of this communication line varies from grassland savannah, black cotton soil, laterite, and thick bush. South of Rahad are the Nuba Mountains, including Jebel al Dayer, the third highest peak in Sudan.

The population of Kordofan, using the 1983 census and an annual growth rate of 2.1% (estimated for Kordofan Region from the census), was estimated to be 3.6 million in 1988. Assuming that children under one year of age comprise 4% of the total population, the target group is estimated to be about 144,000. Table II.1 shows the Regional EPI Headquarter's target population for children under one year of age and for pregnant women for 1987, and estimates for 1988, for the ten Districts and the Region. About 20% (28,800) infants live in the towns of El Obeid, Kadogli, and the eight other Districts, the remainder (121,200) live in rural areas. About 100,800 infants (70% of the target group) are found distributed between 10,000 villages and an estimated 14,400 infants live in nomadic families.[1]

---

[1] It is estimated that 10% of Kordofan's population is nomadic. However, Gezira University produced a map from the 1983 census data showing 500,000 nomads in the north of Rashad District alone, and at least another 400,000 in the south, south-east, and western parts of the region. This map would suggest that the nomadic population is at least one-fifth of the total (90% of 3.6 million + 0.9 million nomads).



DISTRICT HQ
CIRCLED NUMBERS REFER TO THE COST EFFECTIVENESS STUDY'S CLUSTER NUMBERS - SEE TABLE III.D.1
Wahat Al 'Atrun
Mulwad
Marawi
Abu Qussio
Abu Dom
W. Al Muqhddam
AD DAM
W. Al Milk
Abu Urug
AL KHARTO
Omdurman
Khartoum North
KHARTOUM
Jabal Awliya Dam
NORTHERN KORDOFAN
Hamarat Ash Shekh
R F U R
UM BARAKAT
EL NEBDA
14
MT 16
Um Sayyala
Sodari
Kajmar
Shirshar
TAYBA
HF
Abu Shanab
Bara
AD DUWEM
Um Dam
MT 12
WIREEL MT 4
REGIONAL HQ
AL OBAYYID
Dam Jamad
Wad Banda
Humer Jabiro
MT 1 & 3
HF 1 & 3
HF
Um Ruwaba
Tandalti
MT 10
AN NAHUD
HAMADI - MT 23
DIBAIBAT
MT 22
K. Abu Habil
Ar Rabad
MT 11
ElSemaih
Qurdood Nyama
MT 30
Abu Zabad
Ad Dalanj
Abu Kershola
NUBA MTS (1460)
Al Odayya
Al 'Umda
Ad Doma
Rashad
UMBRAMBETA
MT 28
HF
Abu Jibeha
Babanusa
Al Lagawa
SOUTHERN KORDOFAN
Heban
MT 26
Al Muglad
HF
KADUQLI
Kaloqi
Buheyrat Kalak
Talodi
Wadi Al Ghalla
Buheyrat Abyad
Tangaru
Al Meiemm
AL WAHADA
AS SOBA
(SOBAT
MALAKAL
Kosti
Rabaq
AN NIL AL ABYAD
AL JAZIRA
WAD MADANI
NILE

TABLE II.1

KORDOFAN REGION: TARGET POPULATION BY DISTRICT

District*	1987 Under One Year	1987 Pregnant Women	Preg > Infants by	1988*** Under One Year	1988*** Pregnant Women	1988**** Total Population
Soudari	23,306	29,132	25%	23,795	29,744	594,875
Nuhud	20,625	25,820	25%	21,058	26,362	526,450
Rashad**	20,301	25,377	25%	20,727	25,910	518,175
Um Rwaba**	16,879	21,099	25%	17,233	21,542	430,825
Kadogli**	15,105	18,881	25%	15,422	19,278	385,550
El Obeid**	11,461	14,327	25%	11,702	14,628	292,550
Dilleng**	10,172	12,715	25%	10,386	12,982	259,650
Bara**	10,111	12,639	25%	10,323	12,904	258,075
Fula	6,926	8,658	25%	7,071	8,840	176,775
Abiyeh	6,257	7,821	25%	6,388	7,985	159,700
Kordofan	141,143	176,469	25%	144,105	180,175	3,602,625

* Listed in decreasing order of size.
** District was surveyed in the Cost Effectiveness Study.
*** Estimated using the annual growth rate for the region (2.1% per year).
**** Estimated assuming that Under-1s are 4% of the total population.

Note:
The target population for pregnant women is exactly 25% higher than that for infants. This differs from the method of calculation at national level, in which 10% is added to the estimated number of newborns, to allow for pregnancies that do not result in an immunizable infant. Both methods of estimation generate a higher TT target population than the formula used in many other countries, where it is assumed that most of the anticipated 10% fetal wastage will occur in the first trimester (that is, before the pregnant woman would present herself for antenatal care). Thus, in other countries the target for pregnant women eligible for TT is usually the same as the expected number of newborns.

According to Regional EPI records, Kordofan has 21 hospitals (including rural hospitals with one doctor), 34 Health Centers, 150 dispensaries run by Medical Assistants, 896 PHCUs staffed with Community Health Workers (CHWs), and approximately 113 Dressing Stations. (Maternal and Child Health [MCH] Clinics are not listed separately as it is assumed that they are included with Health Centers.)

The EPI began in 1979 at the three large towns of Kordofan. In 1985, the EPI national plan (1986-1990) stated that integration with other health services, regional management, and district level operations capacity were needed in order to improve EPI coverage and preventive health care. At that time, there was no district level cold chain or transport system which the EPI could use. By 1986, three of the ten Districts were operational and by the beginning of 1987, six Districts had a DOO and cold chain. All ten Districts are now staffed and equipped for district level operations.

The Regional Program Manager is the Regional Director of Health who has full authority to implement the EPI. Day to day operations are the responsibility of the ROO, assisted by staff responsible for vaccine cold chain and supply, cold chain equipment, transport, statistics, reports, and accounts.

The Regional EPI HQ in El Obeid directly supplies the ten Districts. This means that the administration of the program is not divided between the two provinces as it is in some other Regions. In principle, each District has a DOO but in practice some Districts have such difficult communications that for EPI operations they have two DOOs, each based in a different town (Rashad District), or two cold chain stores in the District (Um Rwaba). Two of the six Districts visited had a more complex EPI organization than the standard model of DOO plus Cold Chain Officer at District EPI HQ.

Thus, the EPI in Kordofan has to operate in a wide variety of terrain requiring flexible strategies tailored to the needs of each area. (Section II.F discusses constraints in more detail.) Outside the towns, the women and children who are eligible for EPI services are widely dispersed in numerous small settlements, each having on average fewer than one birth per month, or in nomadic families which cross the area twice per year. This poses a considerable challenge to the program in pursuing its goals.

B. Goals

The national plan for 1986-1990 set ambitious targets which would move the EPI from less than 2% coverage for infant immunizations in 1985 to 90% by 1989. The targets have since been adjusted to take into account the starting position and pace of implementation. The national target for 1989 is for 70% of infants to receive all antigens and 40% of pregnant women to receive TT.

Immunization coverage in Kordofan was estimated to be 40% in December 1988. This figure was estimated from data in the routine reporting system (number of doses divided by the target population). The Regional EPI proposal for 1989 states that the goal is to attain 70% immunization coverage

for the target population. This means that 103,000 infants and 128,800 pregnant women should be fully immunized by the end of the year. The immunization schedule is defined in the Technical Guidelines for the Sudan Child Immunization Program (September 1986). To be fully immunized, a child should receive:

1) one dose of BCG;

2) three doses of DPT from six weeks of age with a one month interval between each dose;

3) three doses of OPV from six week of age with a one month interval between each dose; and

4) one dose of Measles vaccine, after nine months of age.

This schedule should be completed before the child reaches one year of age. Those receiving these eight doses before their first birthday are FIC within the target age. (Those who complete one or more doses of the schedule after their first birthday are described in this report as fully immunized "out of target.")

For pregnant women, at least two doses of TT are needed (given at least one month apart with the second dose given at least three weeks before delivery). If the woman had already received two doses before the current pregnancy, one booster dose should be given. However, no more than five doses of TT should be given.

As can be seen from Table II.1, the target population for pregnant women is exactly 25% higher than that for infants. This calculation produces a target which is unrealistically large and consequently, coverage estimates which are based on this target will be too low (see note in Table II.1).

C. Strategies

The national level Plan to Improve EPI Coverage and Preventive Health Care (1985) laid out the needs of the program. For Kordofan, these needs include:

1) Establishing a management team at the Regional level. This team should include staff responsible for operations, cold chain, vaccine and supply, transport, and reporting.

2) Developing an operational cold chain at District level.

3) Developing a transport system which reaches to local council level, with the capacity to support outreach and mobile services for remote rural and nomadic communities.

4) Implementing a system of scheduled, fixed site or outreach activities to the level of the CHW at the PHCU providing:

   a. pre- and post-natal services;
   b. birth services (including birth registration);
   c. immunization of infants and mothers;
   d. oral rehydration;
   e. growth monitoring and nutrition education; and
   f. outbreak response.

5) developing mobile services to reach nomadic populations and communities not covered by the CHW. These services should include:

   a. birth registration;
   b. immunization of infants and mothers; and
   c. oral rehydration.

The proposed strategy of expanding immunization services as part of a general expansion of selected preventive services, and of achieving this through the existing health infrastructure was reiterated in the EPI Policy Statement and Guidelines issued the following year (December 1986). This document stated that every health facility should offer immunization as a routine service, provided by the existing staff, and that vaccinators (single function workers) were not expected to work in these fixed sites except where the workload was so heavy that the full-time staff needed assistance (pp. 3-4). Mobile teams could be used in two ways (p. 4):

1) to bring vaccine and supplies to a health worker responsible for a particular area then to assist with providing immunization services; and

2) to provide immunization services in areas without a health worker.

The Policy Statement and Guidelines has not been superseded but between 1987 and 1988 the strategy was altered. This seems to have occurred during the two acceleration phases. At the time of the Study Team's visit, the majority of resources and activity on immunization were provided through three types of mobile strategies:

1) a mobile team (two or more vaccinators, one supervisor, one driver) moving out from the District headquarters on a route which takes five to seven days to complete (usually four trips, each with a different route, are made per month);

2) outreach by staff from a fixed facility. This is found mainly in the larger towns (El Obeid, Kadogli). The vehicle drops off the staff at a "center" (school, mosque or house) with vaccines in a one day vaccine carrier; and

3) transport of vaccines in a seven day cold box (usually RCW-25) to health facilities (usually dispensaries) from where they are collected by the CHWs from the PHCUs in the area and taken to these communities in one day vaccine carriers. Animal transport is usually used between the dispensary and the PHCU.

By February 1989 this last strategy, known as the cold box (shaantah) system had ceased to operate. This was because the rural councils, who had covered the cost of transporting the vaccine from dispensary to PHCU, stopped paying for transport in September 1988. However, even the dispensaries, which have no transportation constraint since the vehicle dropped off the cold box at the facility, were now being covered by mobile teams. The medical assistants who had been providing immunization without any assistance from vaccinators, seemed disappointed and demoralized that this service had been commandeered by the mobile team.

During the fieldwork for this study, the Study Team found that few health facilities were offering immunization as an integrated, routine service. Fixed point services were found only in the towns where the District cold chain was located which was where facilities could restock their vaccine carriers on immunization days directly from the District store. The sample of fixed facilities only included one where the vaccine was stored on the premises in a refrigerator. Several health centers and dispensaries in the Region are equipped with refrigerators but are not being used for several reasons:

1) kerosene refrigerators "do not work;"
2) solar refrigerators are either out of order or not yet installed; and
3) refrigerators were not supplied by EPI and are referred to as PHC refrigerators.

From data collected during the interviews with mobile teams it was discovered that "centers" (sites) visited during the mobile teams' monthly rounds were frequently villages with a dispensary or PHCU:

Number of "centers" visited by seven mobile teams: 166
Percentage of "centers" with a health facility: 48%

The strategy for 1989 is to move into a maintenance phase, supporting integrated static services and establishing more facilities with an independent cold chain by installing solar refrigerators. A greater commitment from the community will be sought in order to find a solution to the problem of transporting vaccine from dispensary level to the PHCU. The Annual Plan for 1989 is included in Appendix 5.

D. Financing

Funding for the program comes from the Ministry of Health (salaries, buildings), the Ministry of Culture (social mobilization), District, Urban and Rural Councils (some salaries, special allowances, fuel), UNICEF (via EPI National HQ and the Regional Management Committee), and bilateral and non-government organization (NGO) support to specific projects in the Region.

The project areas receiving financial and technical support for health activities (including EPI) are:

1) Um Rwaba District: Child Survival strategy supported by Save the Children Fund/USA and USAID. The project provides two vehicles including maintenance and fuel, which are used for mobile teams or delivering vaccines. This project has found that the enumerated target population is substantially smaller than the estimates made from the 1983 census. It has also introduced birth registration by volunteers from the community.

2) The North Kordofan Child Health Project: Child Survival interventions supported by CARE International and USAID (Child Survival funds) in El Nahud and Bara districts. The project provides vehicles for transport of vaccines, mobile teams and training activities.

3) Bara, Dilleng and Abu Zabad Districts: the Rural Health Services Project (RHSP) now administered by MSCI (formerly by One America) and funded by USAID continues its support by providing fuel and per diem for mobile teams for a three month acceleration phase. It also supports PHC activities in Rahad (Um Rwaba District) by having installed a solar refrigerator and started a cold-box system. RHSP has supported two training courses in Abu Jibeha (Rashad District).

The sources and amount of funding are summarized for the Region in Section V.B.1. The movement of funds is discussed in Section V.D.

E. Outcomes

Within three years Kordofan has moved from having negligible coverage to 24% of infants fully immunized before their first birthday. (The following data are taken from the EPI National Coverage Survey, conducted in March - April 1989). The coverage figure is held down by two factors: 1) failure to reach the children soon enough (so they do not finish the series of immunizations before their first birthday); and 2) a high drop out rate between the second and third dose of DPT and OPV (trivalent Oral Polio Vaccine). Table II.2 shows the first of these effects.

TABLE II.2

COVERAGE INDICATORS FOR A SAMPLE OF 210 CHILDREN IN KORDOFAN

Antigen	% With This Antigen	% Before First Birthday	% After First Birthday
BCG	75	63	12
DPT1	79	67	12
DPT3	47	31	16
Measles	62	42	20

However, 25% of all 130 measles doses recorded were given to children younger than nine months (see Figure 2 in the Coverage Survey Report for Kordofan Region). Thus even though 42% of infants had been immunized against measles before their first birthday, only 26% were given this dose within the target age range (9 - 11 months).

If the age when doses where received is disregarded, the percentage of children aged 12 - 23 months who had received all eight doses almost doubles (to 44%). (This figure will be referred to as the percentage of FIC including "out of target.")

The drop out rate between DPT1 and DPT3 is 40%. A much larger proportion of drop outs occurs between DPT2 and DPT3 than between DPT1 and DPT2. Only 14% of children who got the first dose failed to get the second dose. However, of those who did get the second dose, 30% failed to get the third dose.

Coverage for preventing neonatal tetanus (at least two doses of TT) is 25%. The program had made one or more contacts with 39% of the eligible women, whereas it had reached at least two-thirds of the eligible children before their first birthday (see DPT1 in Table II.2).

Only three of the 30 randomly selected clusters had no EPI services. Thus, in a relatively short period of time, the program has managed to provide a high degree of access. This is a substantial achievement, given the constraints under which it has to operate.

F. Constraints

1. Settlement Patterns

Kordofan's population is 80% rural, spread out in tiny villages or in nomadic tribes who cross the region twice per year.

2. Communications

There is no longer a telephone service connecting the District towns; messages and information have to be hand-carried. There are few well maintained roads, and the life span of vehicles (four to five years) is reduced by travelling over pot-holed surfaces and rough ground.

3. Terrain

Most of Northern Kordofan has a sandy terrain. Travelling in sand is slow, vehicles are liable to get stuck, and fuel consumption is high (in one district it was reported to be 10 kilometers per gallon). Engine oil also needs to be changed more frequently. Travel through the Nuba Mountains area is also very slow because of the rocky terrain (the Study Team averaged 26 kilometers per hour in Rashad).

4. Seasonal Rainfall

From May to September the rain makes the routes through the black cotton soil impassable. The DOOs have to schedule rounds in these areas according to the season. This means that a proportion of eligible children will never be able to receive their doses on schedule. This limitation upon access is particularly acute for the measles dose, as demonstrated by the coverage survey data. Districts with this constraint will lag behind on the key indicator of performance - percent of target fully immunized before one year of age - until cold chain equipment is installed in the affected areas or until the target age for the measles dose is widened.

5. Security

The ever-changing security situation around Kadogli, and as far north as Um Brambeeta, means that scheduled services may have to be cancelled, even for villages within a 20 minute drive of District HQ.

6. Intersectoral Coordination

The District Councils, upon which the EPI was relying to provide certain categories of funding, are under the Governor's Office and the Ministry of Local Government. Decisions have been taken which resulted in a reduction of resources below the level planned in EPI's annual operational strategy. This unexpected change in funding has reduced the services since September 1988. The program is now preparing a strategy which is less vulnerable to such changes.

III. METHODOLOGY

The methodology which was developed for the study was founded on providing the EPI with practical and relevant results in order that financial and economic information about the program could be used for better planning and management in the future. The approach combined the use of operational data collected in the field by the Study Team with cost data obtained from District and Regional HQ in Kordofan, National HQ, UNICEF, and other organizations in Khartoum. This chapter describes the data collected during field visits, methods used for estimating EPI costs, sampling processes, and limitations of the methodology.

A. Questionnaires

The field data were collected using structured questionnaires which were developed and field tested in Khartoum Region. They were designed to collect information on:

1) number and type of personnel working on EPI at each level and the hours per week spent on EPI;

2) number and type of vehicles and equipment used in the last year for EPI and how many of each type was not working at the time of the interview;

3) amount of supplies (syringes, needles, Road-to-Health cards, cold chain monitor cards, etc.) used in the program;

4) number of kilometers travelled for different immunization activities (mobile team rounds, publicity, meetings and replacement of stock) and the mode of transport used in each case;

5) information on the type and quantity of fuel, oil, and other lubricants used for the program in the last year;

6) number of doses of each antigen administered to children by age (under one and one year and over) and dose, and to pregnant women by dose;

7) catchment population and number of fully immunized children;

8) number of training courses and number and type of staff trained during the last year;

9) amount of local radio and television time for EPI publicity; and

10) size and age of buildings used for EPI and percentage of time for which this space was used by the program.

The questionnaires were pretested in the National Capital Region with the help of the ROO and the DOO for Khartoum District. Through the pretest, it was determined that the reference period for number of doses, supplies and fuel should be the previous month (February 1989) instead of the previous year due to incompleteness of records and problems of recall.

B. Costing Methods

The methods used for calculating costs are those developed by Creese (1976) and revised by REACH (1988) and WHO (1988). The methodology of this study uses not only budgetary and price data, but also an analysis of the operations of the program's delivery system.

Personnel costs were based on the number of hours spent working on EPI by different cadres of health staff. Hours worked per week on EPI was divided by the number of hours in a full-time work week to estimate the number of full time equivalents (FTEs) in each staff category working on EPI. These estimates were multiplied by the monthly gross salary (including transport and working allowances, housing, and social security) for each member of staff. If exact salary data were not available, the average for that person's cadre was used. Per diem costs were based on reported monthly rates received in the field by health workers and administrative personnel. In some Districts, councils were paying additional benefits for overtime and travel allowance. Staff support, an additional payment from the EPI, was paid to some staff at Regional level. Average salaries for staff working on EPI in Kordofan are shown in Appendix 4.1.

Vaccine costs were based on the number of vials of vaccine used during February 1989, and multiplied by 12 to estimate annual doses consumed. The approach of costing vaccine consumption rather than doses administered accounts for wastage, which is a real cost to the immunization program. Stock data on doses issued (i.e. consumed) were taken from the monthly reports at District and Regional levels. For mobile teams and health facilities, stock data were not always available and vaccine consumption was estimated by the staff being interviewed. The cost per vial for each antigen was estimated from UNICEF shipping reports of all vaccines received in 1988. Since EPI National HQ receives vaccine shipments every quarter, the shipping reports for 1988 represented all vaccines needed for the Sudan in a 12 month period. Costs per vial were: BCG $0.760, DPT $0.732, OPV $0.678, TT $0.199, and measles vaccine $1.137. International freight charges, which were another 14% in addition to the value of vaccine, have not been included in the costs per vial at regional level but are included under transportation costs at National level. Details of vaccine costs are given in Appendix 4.2. Precision of the costs obtained is discussed in Section III.E.

The cost of supplies was also based on the number of each item used during February 1989 multiplied by 12 to estimate annual use. The unit price of each item (e.g. 1 cc syringe, 2 cc syringe) was multiplied by the annual quantity of that item used to obtain the total annual cost of supplies (see Appendix 4.3). There was a shortage of syringes at Regional level in Kordofan

at the time of the study. The effect of this shortage on the study's estimates is discussed in Section III.E.

Transportation cost was based on the number of kilometers travelled in the last month (or, if available, the last year), number of kilometers travelled per gallon of fuel, and the price per gallon of fuel. If data on distances travelled by the mobile team were not available (for example, the log book was out with the vehicle), the number of kilometers was estimated by tracing the mobile team's routes to obtain kilometers per month, then multiplying by the number of rounds per year which varied between five and 12. For transportation at District level, the kilometers travelled by each vehicle in the last year could usually be obtained. The DOOs were asked about the number of gallons of fuel, oil and lubricants used each month and the prices per gallon or per can; there was some variation in prices between Districts, reflecting the cost of transporting the goods to more remote areas. These data were used to estimate the annual cost of fuels, engine oil, and lubricants. Details are shown in Appendix 4.4.

The cost of maintenance and operation of vehicles was not obtained from exact records of repairs carried out. This proved to be impractical as damaged vehicles were sometimes shipped to the Regional or National HQ for repairs or vehicles were repaired with parts cannibalized from others which could have been repaired if spares had been available. Thus, maintenance costs were estimated from two sources: 1) analysis undertaken by the Cold Chain Section of National EPI HQ; and 2) the total value of spare parts purchased in 1988, divided by the total number of vehicles. This came to 23% of the annual (amortized) cost of the vehicle, excluding the cost of oils and lubricants. A separate study of vehicle maintenance costs in Niger estimated a figure of 24%, lending confidence to the method used for the Sudan. (See Appendix 4.5)

Capital investments in vehicles, buildings and equipment are made for periods longer than one year so the total purchase price should not be allocated to the year of purchase, but instead should be spread over the lifetime of the investment. Economists also adjust for the fact that money today is worth more than money in the future and therefore the purchase price of a vehicle or equipment or the construction cost of a building is not spread evenly over its lifetime. An interest rate (r) is needed to make this adjustment. For this study, r was set at 25%, which is the level of administrative charges levied on loans to Sudan from other Islamic countries. The procedure (known as amortization) used for calculating the annualized value of capital investments gives an annual capital cost which is used in estimating the total annual cost of the program. For Sudan, the useful life of capital investments was determined through discussion with EPI staff and by using data from this study's inventories which showed the proportion of vehicles which were out of order. Useful life of capital investments is estimated as follows:

1) vehicles: 5 years
2) large cold chain equipment: 5 - 10 years
3) cold boxes and vaccine carriers: 2 - 8 years.

(A sensitivity analysis in Section V.C shows the effect on costs of reducing the life of vehicles to four years.) Details of the purchase price of each type of vehicle and equipment, its life, and the annualized cost are given in Appendix 4.7. These costs are all in U.S. dollars. An exchange rate of LS 4.45 (the average of the UN rate of LS 4.40 and the official 1988 rate of LS 4.50) was used to convert the purchase price of locally procured items into U.S. dollars. A sensitivity analysis shows the effect of changing this exchange rate on program costs at Regional level (see Section V.C).

Building costs were estimated using the amount of space (square meters) utilized by the EPI, and construction costs per square meter. If the space was not used all the time for EPI, the share of time for EPI was estimated (hours per week for EPI divided by full time hours at that facility). Construction costs were amortized over the expected life of the building: fired brick and cement buildings were assumed to have a 25 year life; sun-dried brick structures (usually self-help or cooperatives) were assumed to have a 10 year life; and grass structures were assumed to last for five years. Appendix 4.8 shows the details of annual costs for buildings.

For each service delivery strategy (mobile teams and fixed facilities) and for District and Regional levels of the program, cost per dose was calculated using the total annual cost divided by the number of doses (all antigens, all ages) given per year (based on February 1989 reports).

Cost per FIC was estimated for the program at Regional level using the data from the 1989 Coverage Survey. Two figures were estimated: 1) cost per FIC for children who completed their immunization schedule of eight doses before the program's targeted age of one year; and 2) cost per FIC including "out of target" (children aged 12-23 months) who had completed their immunizations by the time they were sampled in the coverage survey. (Note that this is not the same as FIC under two years old, because none of the children surveyed had yet reached their second birthday and some were only a month or two past their first birthday.)

The number of fully immunized children was estimated by multiplying the target population from the program's information system (itself an estimate based on the 1983 census--see Table II.1) by the percentage of fully immunized children from the Coverage Survey:

$$\text{Number of FIC} = \text{Target Population} \times \%\ \text{FIC from Coverage Survey}$$

The annual cost attributable to child immunizations was calculated by using the percent of all doses that had been administered to children and taking this share of total annual cost:

$$\text{Cost of Immunizing Children} = \frac{\text{Doses Given to Children}}{\text{All Doses Given}} \times \text{Total Cost}$$

This cost was then divided by the number of FIC, to give cost per FIC:

$$\text{Cost per FIC} = \frac{\text{Cost of Immunizing Children}}{\text{Number of FIC}}$$

This approach was also used at District level and a sensitivity analysis was carried out to account for different levels of performance observed in the sample of six Districts (see Section V.C). Cost per FIC for mobile teams and health facilities required different approaches and these described in Section IV.B.

Data were entered onto Lotus 1-2-3 spreadsheets. Each cost category (personnel, vaccine, supplies, transportation, training, equipment, vehicles and buildings) had an individual worksheet and separate methods for calculating the line items within each category. The final cost figure for each category was imported into a summary table for each level or strategy. These are shown in Appendix 3, and in Chapters IV and V.

Limitations in the methodology, which emerged during the analysis, are discussed in Section III.E.

C. Sample Selection

The cost-effectiveness study was intended to sample health facilities from the same clusters that would be visited in the coverage survey. In this way the random element in choosing sites would be maintained (coverage survey clusters were selected with a probability proportional to their population) and data on costs would relate more closely to the sample coverage data.

It was not practical to collect cost data from all 30 clusters as some villages had no health services at all while others were served only by mobile teams. The sampling plan for this study had several simultaneous objectives:

1) to select 15 fixed facility sites from a sample of 30 clusters;
2) to sample from half of the 10 Districts in the Region (to get a variety of interviews from DOOs);
3) to have half urban and half rural sites; and
4) to survey half of the mobile teams.

It was known that the security situation to the south of the Region may prevent the Study Team from visiting some clusters. The first step in the selection of sites was to eliminate those places known to be inaccessible; three clusters were excluded for this reason.

The next step was to find out the travel time to each rural council on the cluster survey list. The Study Team marked the sites on a map and the ROO and DOOs provided information on travel time. Nine places that were a 10 hour drive or more from El Obeid were excluded on the basis of this information.

The aim was to perform a survey in half of the ten Districts. At this point there were still eight districts represented in the pool of possible sites so El Nuhud district, which only had one feasible cluster, was eliminated. This left three districts in Northern Kordofan and four in Southern Kordofan. Then one southern district, Dilleng, was excluded as it was close to Regional HQ. (Dilleng was later included, see below).

This process left three Districts in Northern Kordofan, and three in Southern Kordofan, with a total of 14 possible sites from the coverage survey clusters.

Several constraints which affected the final sample of Districts and clusters:

1. Travel Time

There was a possible bias in excluding more distant places, but the trade-off was between spending as many as four days to get one sampling point, or spending the time collecting data from a larger sample of more accessible sites. Nine sites were originally excluded on the basis of distance. However, after visiting the first district, the Study Team realized that their travel time was substantially slower than the DOOs' estimates and that it would not be possible to reach six districts if they visited Fula. Thus Dilleng was substituted for Fula. The number of available clusters thus increased to 16 as there were three in Dilleng and only one in Fula.

2. Urban/Rural Mix

In the sample of 30 clusters there were only five urban sites, reflecting the predominantly rural population in the Region. Two urban clusters had been ruled out on grounds of security, and one because it was 12 hours distant at the edge of the Region (i.e. was not in route to anywhere else in the study). Thus the Study Team decided to collect data from more urban health facilities even though they were not in the cluster survey.

3. Service Delivery Strategy

After two days of interviewing, it became clear that mobile teams were the main strategy for delivering immunization services. Within a rural District there was little difference in the way the mobile teams operated so data were collected on one mobile team per rural District visited. In El Obeid, a mobile team was being used within the town, organized on a different basis, so two interviews were completed in that district.

Moreover, it emerged that rural clusters with health facilities could not be classified as fixed sites as they were not currently offering immunization without the support of mobile team vaccinators. Only one rural health facility interviewed was completed as if it were a true fixed site. The data referred to November 1988, the last month when the cold box system had operated there.

Thus the sample was short of operational data on a rural fixed point delivery strategy.

4. Security

The security situation was changing quite rapidly while the Study Team was in the field. One site that was only a 20 minute drive from Kadogli had to be excluded as it was now inaccessible. For the same reason, a site in the Rashad District which was in route to the District HQ had to be skirted using a long detour. Altogether six clusters (20% of the original coverage survey sample) could not be visited. This reflects the operational difficulties facing the program in the south of the Region.

5. Difficulty in Identifying Villages

In three cases, the District staff said that there was no village in their area corresponding to the transliterated name supplied by coverage survey staff. One was resolved as a typo (El Nebda instead of El Benda). Another was settled by the coverage survey team who identified two places whose names were close to the one on the list and tossed a coin to choose which one to survey. (The two survey teams crossed paths and shared this information.) The third was listed as Gradeed, but the closest name in the area was Qardood Nyama.

When the final list of clusters surveyed for coverage was released it turned out that apart from the six substitutions for sites inaccessible due to security, there were five other clusters surveyed that did not match the names (or even the Rural Councils in two cases) on the original list. One of these five clusters was covered by the Cost-Effectiveness Study and one of the unofficial substitutions coincided with the area covered by an urban health facility surveyed by the Cost Effectiveness Study Team. Details of the concordance between the two studies are shown in Table III.1 and Appendix 2.2.

D. Descriptive Statistics of Sample

Table III.1 shows the districts visited and the type of interviews conducted. Six DOOs and seven health facilities (6 urban, 1 rural) were interviewed on site. Data on seven mobile teams were collected from the DOO and a member of the mobile team, usually at the District HQ. Nine of the 14 sites surveyed (64%) were also included in the coverage survey.

TABLE III.1

DESCRIPTIVE STATISTICS OF THE SAMPLE

Districts Visited	Interviews Conducted					
	ROO	DOOs	Health Facilities		Mobile Teams	Clusters/ Interviews
			Urban	Rural		
El Obeid	1	1	2	-	2	3/4
Bara	na	1	-	1	1	1/2
Dilleng	na	1	-	-	1	1/1
Kadogli	na	1	1	-	1	1/2
Rashad	na	1	1	-	1	1/2
Um Rwaba	na	1	2	-	1	2/3
Totals	1	6	6	1	7	9/14

The map indicates the geographic distribution of the sites visited. The four districts not visited were the two with the largest population (Soudari and Nuhud), and the two with the smallest population (Fula and Abiyeh). (Table II.1 gives the population data.)

E. Limitations of the Methodology

During the course of the study, several limitations of the methodology emerged. These are presented with a view to refining the details of data collection and analysis in future studies.

1. Sampling of Districts

Section III.C of this chapter gives details of the constraints which affected the sample selection process. It was not known until the second stage of data analysis (when costs were linked to outputs in order to estimate cost-effectiveness) that performance in the six Districts visited was better than the average for the whole Region. When Districts were selected, Regional HQ staff offered some informal information about DOOs, identifying those which were so disorganized that it would be very difficult to obtain the data needed for this study. However, this consideration was not the determining factor in selection of Districts. The finding that the sampled Districts had above average performance has been used in the analysis to suggest a standard of performance which the other Districts in Kordofan should strive to attain.

2. Denominator for Cost per Fully Immunized Child

The best available information on coverage was from the Coverage Survey conducted in March - April 1989. This sample of 210 children (7 from each of 30 randomly selected clusters) produced estimates of coverage which are accurate to within ± 10 percent. These estimates are more precise than coverage figures calculated from the regular EPI reporting system because the latter depends upon estimates of the target population whereas the coverage survey's denominator is known (n=210). The coverage survey was designed to measure coverage in Kordofan. The survey was not intended to generate District-specific coverage rates or rural/urban comparisons. A larger sample would be needed to complete this.

The cost-effectiveness data clearly indicate variations in performance between Districts and between mobile teams Coverage must also vary between the different sites visited for the cost study. The analysis explores such variations by analyzing cost per dose and output per health worker. However, the most reliable figure for FIC is that for the whole Region which has been used in the estimates of cost per FIC.

3. Changes Over Time

The Study Team calculated the cost of the resources which they inventoried and output measures (doses administered) were based on data for February and extrapolated to obtain annual figures. The Study Team learned of several details which would alter the estimated costs and cost-effectiveness indicators. These are:

a) Vehicle Breakdowns and Accidents. Transport is essential to the mobile strategy. Each week that a vehicle is out of order has a considerable effect on monthly output in the District.

b) Shortages of Essential Supplies. There was a shortage of syringes at Regional level in Kordofan at the time of the study. One cc syringes had stocked out before February and the existing stock of 2 cc syringes had been issued to the Districts during that month. Half of the Districts surveyed were stocked out of 1 cc syringes by the end of February and half had used all their stock of 2 cc syringes during the month.

c) Support from Donors and Councils. The number of vehicles and personnel funded by CARE in Bara District had decreased during the previous 12 months. Activity in the RHSP had fallen off considerably in 1988 but was beginning to increase again as the new team of advisors arrived. Local funding of transport by the Rural Councils had ceased during the period for which costs were being estimated. This put an end to the seven day cold box strategy whereby CHWs collected vaccine from a central point and gave immunizations one day per month in their communities.

d) Incentive Payments. Higher per diem payments had been authorized by Central HQ for a six month period. In Kordofan this period started in September 1988 and ended in February 1989, which was the month for which the cost study's salary data were collected.

e) Acceleration Phase. Kordofan had an extra mobile team based at Regional HQ. This team rotated to different Districts to assist with accelerated EPI activities for a limited period. Output would be approximately 50% higher than the District's usual level during the time that the extra team was there.

These variations in resources, policies and operational strategies affected both costs and the level of output. The sensitivity analyses in Chapters IV and V investigate some of the alternative cost scenarios (e.g. excluding the cost of vehicles and equipment which are out of order). The accuracy of using one month's data and extrapolating to obtain an annual figure was checked by comparing doses and vaccine costs with other sources of data. There were two sources of data. First, comparison of doses administered in February 1989, with data for 1988, indicates that the level of activity during February was 22% below the monthly average for 1988. This was probably due mainly to the shortage of syringes. Second, The estimate of annual vaccine cost using data for February 1989 was 2% higher than an estimate based on the Region's monthly reports of vaccine issued to the Districts in 1988, and 10% lower than an estimate based on vaccine issued to Kordofan in 1988 from Central HQ. Thus the methodology used produced an estimate which fell between the two alternative methods of estimating this cost.

4. Availability and Accuracy of Source Data

As explained in Section III.B, the Study Team considered that it was preferable to use data for the previous month for all sample points rather than spending a great deal of time trying to assemble exhaustive data from incomplete records for the preceding year. The disadvantage of using a narrower time period is illustrated in (3) above. The advantage is that current operational data relate to present resources, so that measures of effectiveness linking outputs and inputs are more accurate.

This study used a considerable amount of primary data collection (e.g. inventories of equipment, personnel lists) but also relied on the EPI's reporting system for information on doses and stock. Some obvious discrepancies in record keeping were spotted and resolved on site but others did not come to light until it was too late to go back and resolve the inconsistencies. For example, the number of doses counted from one mobile team's daily tally sheets from 40 villages on one monthly round came to 91% of the total doses for the District, yet two mobile teams were reported to be in operation there. Other calculations indicated that total doses in Bara are below the expected level of activity but there is no way of rechecking the monthly figures supplied by the District EPI staff. Another example is that doses of OPV were exactly the same as DPT doses. Some staff did not make a separate record of OPV doses on their daily tally sheets. OPV is given by

dropper and should not have been affected by the shortage of syringes but in February, when DPT doses were 81% of the monthly average for 1988, OPV doses were also exactly 81% of their monthly average.

Recommendations are given in Chapter VI for increasing the use of records for monitoring and management and for improving their accuracy.

5. Fixed Point Delivery Strategy

Immunization was offered by mobile teams and a few urban health facilities. No seven day cold boxes were being used for supplying CHWs in February 1989. Therefore, the estimates for alternative strategies given in the sensitivity analysis in Chapter IV are not based on operational data.

In conclusion, the methodology adopted had to be practical in terms of both the availability of the data required and time taken for collection. Estimates reported here reflect a trade-off between the most exhaustive and accurate data set that could be compiled and the best data that could be obtained within the given time frame and resources. It is felt that the estimates reported here are quite robust.

IV. RESULTS FOR ALTERNATIVE STRATEGIES

This section presents the analysis of costs for mobile teams (Section IV.A) and health facilities providing immunization services (Section IV.B). The direct costs of eight categories of expenditure are presented in order to give a cost profile of each strategy. These categories are personnel (gross salary, per diem), vaccine, supplies (needles, syringes, stationery), transportation (fuel, oil, fares), maintenance, vehicles, equipment, and buildings. The first five categories are recurrent costs. The last three are capital costs which have been amortized over the expected life of the item. (The costs in this chapter do not include any administrative overhead from District, Regional or Central level.) Appendix 4 gives details of source data on costs.

The analysis presents the average costs and examines the reasons for the wide variations in costs within the same strategy. The costs are then connected with measures of activity and coverage, so that the factors which influence performance can be highlighted. For each strategy, the following measures of output and cost-effectiveness are presented:

1) number of doses (per period; per staff);
2) cost per contact for immunization;
3) cost per FIC;
4) drop out rate; and
5) vaccine wastage rates.

These results are summarized in Section IV.C where alternative strategies are compared. Section IV.D presents a sensitivity analysis in which the cost implications of changing certain assumptions are investigated.

A. Mobile Teams

1. Average Cost of Mobile Teams

The cost profile and total cost for the sample of seven mobile teams surveyed is shown in Table IV.1. The average annual cost per mobile team is $18,783 (LS 83,584). Three-quarters of the costs are recurrent, and personnel is the largest recurrent item. Basic salaries account for 27% of total cost and per diem (the next largest recurrent item) accounts for 15%. One-quarter of mobile team costs are for capital costs. Each team has a vehicle representing 23% of total costs. The vehicle is the second largest cost category after basic salary and allowances.

Among the seven mobile teams surveyed, the annual cost varied by a factor of two, ranging from $12,491 to $23,579 (LS 55,585 to LS 104,927). Figure IV.1 presents each mobile team's costs in graphic form (also see Appendix 3.1). Some costs are relatively constant in all teams (see maintenance, vehicles and equipment) but others (personnel, vaccine, supplies and transport) vary considerably. The wide variation in costs was due to several factors:

a) the mobile team with the lowest annual cost (Kadogli) had only worked for five months in the last year so its variable costs (per diem, vaccine, supplies and fuel) were lower;

b) the mobile team with the highest cost (El Obeid Rural) spent substantially more on staff per diems (twice the average) because there were twice as many vaccinators on this team as any other rural team in the sample;

c) high per diem costs (30% above average) were found in two other districts (Bara and Dilleng) where the mobile teams made all 12 of their scheduled rounds (in Dilleng, the District Council was paying extra incentives); and

d) fuel costs (see transport) for mobile teams in Bara and Um Rwaba were higher than average. Both districts have deep sand, so fuel consumption was higher. Both Districts received extra fuel from the donors supporting projects in their areas.

These factors suggest that it is not possible to make a judgement about whether costs are "too high" without looking at the performance of each mobile team (using measures of output and productivity). These are discussed in Sections IV.A.2 to IV.A.6.

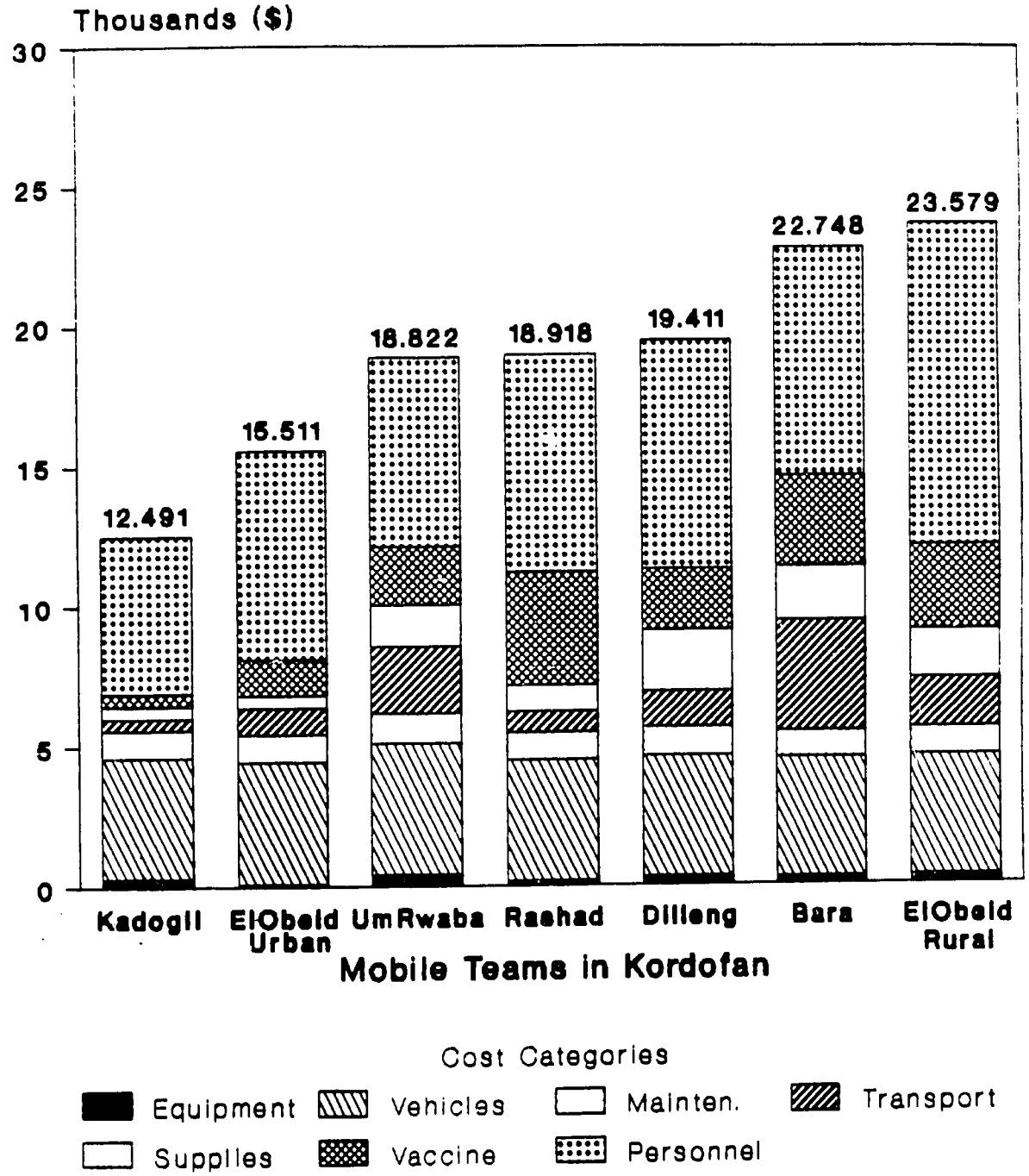
TABLE IV.1

COST OF THE EPI FOR MOBILE TEAMS IN KORDOFAN REGION

COST CATEGORY	AVERAGE COST	PERCENT	MINIMUM	MAXIMUM
RECURRENT COST				
1. Personnel		42.1%		
- Salary & Allowances	$5,033	26.8%	$4,207	$6,356
- Per Diem	$2,882	15.3%	$1,079	$5,165
2. Vaccines	$2,315	12.3%	$448	$4,040
3. Supplies	$1,295	6.9%	$427	$2,188
4. Transportation		8.7%		
- Fuel	$1,374	7.3%	$176	$3,501
- Oil	$222	1.2%	$84	$404
- Other Lubricants	$39	0.2%	$0	$67
5. Maintenance/Operations				
- Vehicle	$1,002	5.3%	$927	$1,078
- Equipment				
TOTAL RECURRENT	$14,161	75.4%	$7,875	$18,969
CAPITAL COSTS				
1. Vehicles	$4,356	23.2%	$4,229	$4,686
2. Equipment	$266	1.4%	$113	$407
TOTAL CAPITAL	$4,622	24.6%	$4,427	$5,093
TOTAL COST	$18,783	100.0%	$12,491	$23,579
AVERAGE DOSES ADMINISTERED/YEAR*	33,386	} Five rural MTs	9,190	45,492
AVERAGE COST PER DOSE*	$0.55		$0.43	$1.36

* Calculated for the five rural mobile teams with complete data on doses (excluding El Obeid Rural).

FIGURE IV.1
Cost Profiles of Seven Mobile Teams



FIGIV1MT

2. Number of Doses

Data on all doses given (by antigen, dose, and age) were extracted from the monthly reports for February 1989. These data were taken from the daily tally sheets if the monthly report was not specific to the mobile team sampled. These records were available at District level. The February figures were multiplied by 12 to obtain an annual estimate. (See Section III.E.3 for a discussion of the precision of these estimates.)

Costs per dose were estimated using the cost data presented in Section IV.A.1. Indicators of daily or hourly activity were also obtained, including doses per mobile team per day, doses per health worker (per day and per hour), and doses per village. Results are given separately for the urban mobile team in El Obeid as its mode of operation differed significantly from the rural teams which spend many nights away from District HQ.

The average number of doses given by the rural mobile teams is 3,159 per month. Since two teams (Kadogli and Rashad) did not make all of their monthly rounds the annual figure is 33,386, which is 12% lower than if all the teams had made 12 rounds. Activity indicators calculated using the number of doses are shown in Table IV.2 for the urban team in El Obeid and five rural mobile teams (El Obeid Rural was excluded as the doses data were incomplete).

2.A Cost per Dose

For the five rural mobile teams, the cost per dose averages $0.55 (LS 2.45) but varies by a factor of three, from $0.43 in Dilleng to $1.36 in Kadogli. The Kadogli team only made five monthly rounds with each round lasting only 12 days due to security problems. If it had been able to make 12 rounds, its recurrent costs would increase but the cost per dose would still have fallen by 40% to $0.80. If it had been able to visit more villages per round (i.e. to provide services for more than 12 days per month), the cost per dose would have been even lower. The reduction in cost per dose is caused by the fixed costs of equipment being spread over a larger number of doses.

The El Obeid urban team's cost per dose was three times higher ($1.39) than the average for rural teams. This is explained by the very low level of output for this team (see below).

2.B Doses per Mobile Team and per Health Worker

Table IV.2 shows that there is a wide variation in the level of output by mobile teams as a unit and by individual staff members. The average number of doses administered per day by the rural teams is 156 (this is calculated for the number of days spent out on rounds). When calculated per team health worker, the average daily dose in rural mobile teams is 52 doses, ranging from a minimum of 42 doses per health worker per day in Rashad to a maximum of 63 doses per health worker per day in Dilleng.

TABLE IV.2

INDICATORS OF ACTIVITY FOR URBAN AND RURAL MOBILE TEAMS IN KORDOFAN

INDICATOR	URBAN TEAM	AVERAGE PER RURAL TEAM	RURAL TEAMS MINIMUM	RURAL TEAMS MAXIMUM
Cost Per Dose (a)	$1.39	$0.55	$0.43	$1.36
Doses Per Mobile Team Per Day (b)	31	156	126	190
Doses Per Staff:				
Per Day (c)	6	52	42	63
Per Hour (d)	1	12	6	24
Doses Per Village Each Monthly Visit (e)	37	104	58	368

a) Total annual cost divided by total doses per year.

b) Monthly doses for the team divided by the number of days spent on rounds (away from District Headquarters) per month.

c) Doses per team per day (b) divided by the number of health workers on the team (i.e., excluding the driver)

d) Doses per staff per day (c) divided by the hours spent in immunization sessions as reported by members of the mobile team.

e) Monthly doses for the team divided by the number of villages (immunization "centers") visited per month.

The hourly rate of activity was calculated using data from the supervisors and vaccinators on the time spent on immunization as a proportion of the time spent on all tasks during the round. The average number of doses given by each health worker on the rural mobile teams is 12 per hour, with a range from eight in Rashad to 24 in Dilleng. The level of activity in the El Obeid urban mobile team was much lower. The team's daily output was 31 doses. Since there were five EPI staff on this team, the output per staff member was only one dose per hour. It would appear that one person could handle this workload.

2.C Doses per Village (center)

The level of output for the rural teams averaged 104 doses per village visited. The team with the highest output per center was Kadogli (368 doses) but was able to visit only five places due to the security situation. These centers had a larger than average population. The percentage of children's doses outside the target age (under one year of age) was 14% which was the highest of any mobile team surveyed. The high percentage our of target also reflects the effect of restricted access to services as catch-up immunization takes place.

By contrast, the lowest number of doses per village was 58 in Um Rwaba where the target group in each center was small enough so that on average, immunization was offered at three separate centers per day (60 villages were visited in 19 days). Services were well established and regularly available, and less than 1% of doses were out of the target age.

These indicators suggest that cost per dose can be lowered by:

1) making sure that all eligibles come for immunization when the mobile team visits the center which will maximize output;

2) matching the size of the mobile team to the expected level of activity (i.e. the target population) which will optimize the productivity of each health worker; and

3) visiting large villages where there are more eligibles. There is a trade-off between maximizing output and maximizing access to services and the decision should not be based on cost alone. The program will need to decide upon the strategy which best meets its objectives (see Section IV.C).

Table IV.3 links the total annual cost of each mobile team (given in Figure IV.1) with doses administered. Mobile teams have been categorized as "high cost" if their annual costs are above the average of $18,783, and as "high output" if the doses they administer per year exceeds the average of 33,386 doses. Those in the "low cost" and "low output" areas have below average costs and output respectively.

TABLE IV.3

COST, DOSES ADMINISTERED, AND COST PER DOSE FOR MOBILE TEAMS IN KORDOFAN
(Cost per Dose Shown in Parentheses)

	HIGH COST	LOW COST
HIGH OUT-PUT	Bara ($0.46) Dilleng ($0.43) Um Rwaba ($0.45)	
LOW OUT-PUT	Rashad ($0.64)	Kadogli ($1.36) El Obeid ($1.39) Urban

Note: El Obeid Rural is excluded due to incomplete data

3. Number of Contacts for Immunization

The number of contacts refers to the number of children (some of whom receive more than one dose) and women who come to immunization sessions. When compared with the number of eligibles in the target population, this variable allows an assessment of the extent of contact with the eligible population. The information system for EPI does not record the number of individual children seen (contacts) per session so an estimate of child contacts has been made by adding up the number of doses of BCG, DPT1, DPT2, DPT3 and measles vaccine. This is an overestimate to the extent that children may receive BCG and DPT1 during the same session, or measles with DPT. Doses of DPT1 have been used to estimate the number of first contacts with children. This was thought to be more representative than BCG doses because of the shortage of 1cc syringes and because the March 1989 survey showed that coverage for DPT1 was higher than for BCG (79% compared with 75%). (The coverage survey will be able to furnish more precise estimates of the percentage of children under one year of age who received at least one dose of any antigen.)

The questionnaires for mobile teams included a question on the size of the target population in the area served. However, this information was only available for villages that had been enumerated as part of an integrated health project (i.e. in part of Bara district and in Um Rwaba). Population data for all the centers visited during a mobile team's round were not available, as population data were only available for the entire District and sometimes for the main town and the councils. Thus it was not possible to estimate the percentage of eligibles which had been contacted by individual mobile teams. (See Recommendation 1.3 on establishing the size of the target population.)

3.A Children Seen per Village (Center)

On average, the rural mobile teams see 58 children per village. This varies from 33 in Um Rwaba to and 229 in Kadogli where, as mentioned above, the team is visiting the more populous places when the security situation permits). The average number of new contacts for children's first dose is 14 with a range from seven to 75. These data are shown in Table IV.4.

TABLE IV.4

NUMBER OF MONTHLY CONTACTS FOR URBAN AND RURAL MOBILE TEAMS IN KORDOFAN

INDICATOR	EL OBEID URBAN	AVERAGE PER RURAL TEAM	RURAL TEAMS MINIMUM	RURAL TEAMS MAXIMUM
Children Seen per Center	15	58	33	229
First Contacts (DPT1) per Center Center	5	14	7	75
KMS per Child Seen at Center	1.8	0.8	0.4	1.2
KMS per First Contact (DPT1)	6.7	3.2	1.4	5.2

3.B Kilometers Travelled per Contact

The rural teams have to travel an average of 0.8 kilometers per child seen at the immunization centers. This varies from 0.4 kilometers in Kadogli to 1.2 kilometers in Bara. On average, the teams travel 3.2 kilometers for each new contact. The indicator is determined both by the density of population served by the mobile teams and by the level of utilization of their services. This is well illustrated by the urban mobile team which travelled 1.8 kilometers per child seen. Even though the population density is high, the level of activity is so low (15 children seen per center) that the distance travelled per child contact is greater than in any of the other mobile teams surveyed.

Both the number of first contacts per center and kilometers per first contact are also affected by the frequency with which the mobile team visits each center. If visit are made every two or three months, then the number of newborns eligible to be immunized for the first time will be two or three times higher. Since distance travelled affects the staff's productive time and fuel costs, the indicator of kilometers per contact should be used to determine which sites could be visited less frequently than once every month. An estimate of the size of the target population at each center will be needed

to make scheduling decisions concerning the appropriate frequency of visits by a mobile team (see Recommendations 1.3 and 2.3).

4. Number of Fully Immunized Children

The EPI information system does not report the number of children who have completed their immunizations. Thus, the only source of data on the number of FIC by mobile teams was the 1989 coverage survey.

In Kordofan, 24% of infants had been fully immunized before their first birthday. Based on the coverage survey's data on the main provider of doses for each FIC, it was estimated that 20% of eligibles had been fully immunized by mobile teams. Each District's population (estimated by the EPITrack information system, see Table II.1) was then multiplied by this percentage to calculate the number of infants fully immunized by mobile teams. This amount was then the denominator for each District The cost of immunizing that number of children was taken to be the cost of the sampled team, multiplied by the number of teams in that District.

Using the coverage survey data, it is estimated that 29,181 infants in Kordofan received all eight doses from mobile teams before their first birthday. There are 18 mobile teams based in the Districts, including one which rotates through different areas in support of accelerated activities. The average cost per FIC (under one year of age) in Kordofan was $10.36.

This method produces a robust cost estimate for the Region as a whole but assumes that all mobile teams in all Districts immunize the same proportion of their target groups. Under this assumption, the cost per FIC estimated for individual teams varies from $7.36 (Kadogli) to $18.91 (Bara). The two teams with the lowest cost per FIC are those that made fewest rounds in the year (Kadogli and Rashad). The wide range in the number of doses given by each team suggests that there is also variation in the coverage levels achieved by different teams. This suggests that cost per FIC for individual teams requires coverage data specific to that District or mobile team. As stated before, however, the estimates for cost per FIC for mobile teams in Kordofan as a whole are considered to be robust.

The coverage survey also reported that if doses received after the child's first birthday are included, 44% of the sample (aged 12 to 23 months) had received all eight doses by the time they were surveyed. Using this figure, the number of children fully immunized by mobile teams rises to 53,864 and the cost per FIC (including out of target) falls to $5.61, which is half of the cost per FIC under one year of age. This large reduction in cost per FIC represents the increase in the teams' cost-effectiveness, if they can complete the immunization schedule before the child's first birthday. (Note that the target age group for immunization has been set by the National EPI in Khartoum.)

5. Drop Outs

Using the February reports on DPT, the drop out rate was calculated between the first and second dose, between the second and third dose, and overall between the first and third dose. Drop outs for pregnant women were also analyzed, using the number of doses of TT1 and TT2. Drop out rates are shown in Table IV.5, along with data on drop outs from the Coverage Survey.

TABLE IV.5

DROP OUT RATES FOR MOBILE TEAMS ESTIMATED FROM MONTHLY REPORTS, COMPARED WITH DATA FROM THE COVERAGE SURVEY (APRIL 1989)
(percentage)

DROP OUT BETWEEN:	RURAL MOBILE TEAMS	COVERAGE SURVEY
DPT1 & DPT	26	14
DPT2 & DPT3	6	30
DPT1 & DPT3	31	40
TT1 & TT2	40	35

The coverage survey's analysis of drop out rates showed that in Kordofan, 40% of children with DPT1 do not get DPT3, and that the dropout rate between second and third dose is twice the drop out rate between first and second dose. For pregnant women, 35% with TT1 do not get their second dose.

Analysis of monthly reports for their mobile teams showed that the overall drop out rate for children between the first and third dose of DPT is 31%. Forty percent of pregnant women fail to complete the schedule for TT.

Three of the five rural mobile teams analyzed (Bara, Kadogli, Rashad) show more drop outs between first and second dose than between second and third dose. This has reversed the pattern found in the coverage survey (see Table IV.5). One interpretation is that these teams were on the first month of a new set of centers (i.e. a much larger proportion of doses was DPT1 than DPT2). Another possible cause is that mothers are not bringing their children back for a second dose. This would suggest the need for supervisory action to monitor immunization technique and the quality of health education.

6. Wastage

Vaccine wastage was calculated using the monthly record of doses administered and the stock of vials used during the month.

$$\text{Wastage} = \frac{\text{Doses of Vaccine Issued} - \text{Doses Administered}}{\text{Doses of Vaccine Issued}}$$

Table IV.6 shows wastage for each antigen for the mobile teams surveyed. There is very little consistency on either the percentage of each antigen wasted, or which antigen has the lowest and highest wastage. It was difficult to ascertain how many vials had actually been used per round, even by asking how many of each antigen were packed and how many usually came back unused. Two mobile teams (Dilleng and Kadogli) had negative wastage, giving a further indication of a problem with the stock records. Thus, the lack of consistency in wastage data may be due to the lack of precision in stock records for mobile teams, rather than to real differences in wastage.

TABLE IV.6

VACCINE WASTAGE FOR MOBILE TEAMS IN KORDOFAN
(percentage)

ANTIGEN	RURAL MOBILE TEAMS	HEALTH FACILITIES
BCG	50	80
DPT	20	54
OPV	20	54
MEASLES	39	70
TT	46	57
AVERAGE COST OF VACCINE WASTAGE	$1,050	$502
..AS % OF ANNUAL VACCINE COST	50	78

From the sample of teams surveyed, it was estimated that 50% of the annual cost of vaccine issued to mobile teams was for vaccine that was discarded at the end of immunization sessions. This percentage is consistent with wastage multipliers used when estimating vaccine needs.

7. Summary of Results for the Mobile Team Strategy

The analysis of mobile team costs and output shows that it is only possible to make a judgement about whether resources are being used effectively after combining cost data with operational information. Some teams which seemed to be more "expensive" than average in the bar graph in Figure IV.1 turned out to be cost-effective in terms of cost per dose. Table IV.3 shows how the surveyed teams are distributed in a four-quadrant matrix of high and low costs and output. The features which contribute to these rankings have been identified and listed in Table IV.7. (All teams had a mixture of these features, so the combinations shown in this table do not describe particular teams, but illustrate the best and worst combinations in terms of costs and outputs.)

TABLE IV.7

MOBILE TEAMS: INDICATORS OF COST AND EFFECTIVENESS

	HIGH COST	LOW COST
	CASE 1	CASE 2
HIGH OUT-COME	Days out per month is high, with many returns to HQ Many centers, far apart, with large target pop. Kilometers (& fuel) high Large team spends time on identifying eligibles, following up drop outs	Days out per month is high, with few returns to HQ Few centers with large target population Short distances Small team of health workers High utilization by eligibles Community enumerates and follows up
	CASE 3	CASE 4
LOW OUT-COME	Size of team exceeds that needed for the workload Many returns to HQ for restocking/rotating staff Many centers, far apart, with small target pop. Low utilization Ineffective follow-up	Small team of health workers Few days per round Few rounds per year (low per diem) Few centers are visited, with small target populations Low percentage of eligibles is contacted; no follow-up

The most cost-effective scenario is Case 2, with low costs and high outcomes. However, some of the features of this case may not be consistent with the optimum use of resources. For example, the large centers may have a health facility with staff qualified to give immunizations. The short

distances may be on public transport routes, which could be used instead of the EPI vehicle for resupplying vaccine.

The least cost-effective combination of factors is Case 3. Only one component, many scattered centers with small target populations, is immutable. Other factors which contribute to high costs and low output can be altered by administrative decisions, improved rapport with the target groups, and greater motivation in the community.

The management teams at Regional and District level can use these indicators to identify both positive and detrimental features of their mobile teams' operations, and increase the effectiveness of the program by improving use of the resources allocated to the mobile strategy.

B. Fixed Facilities

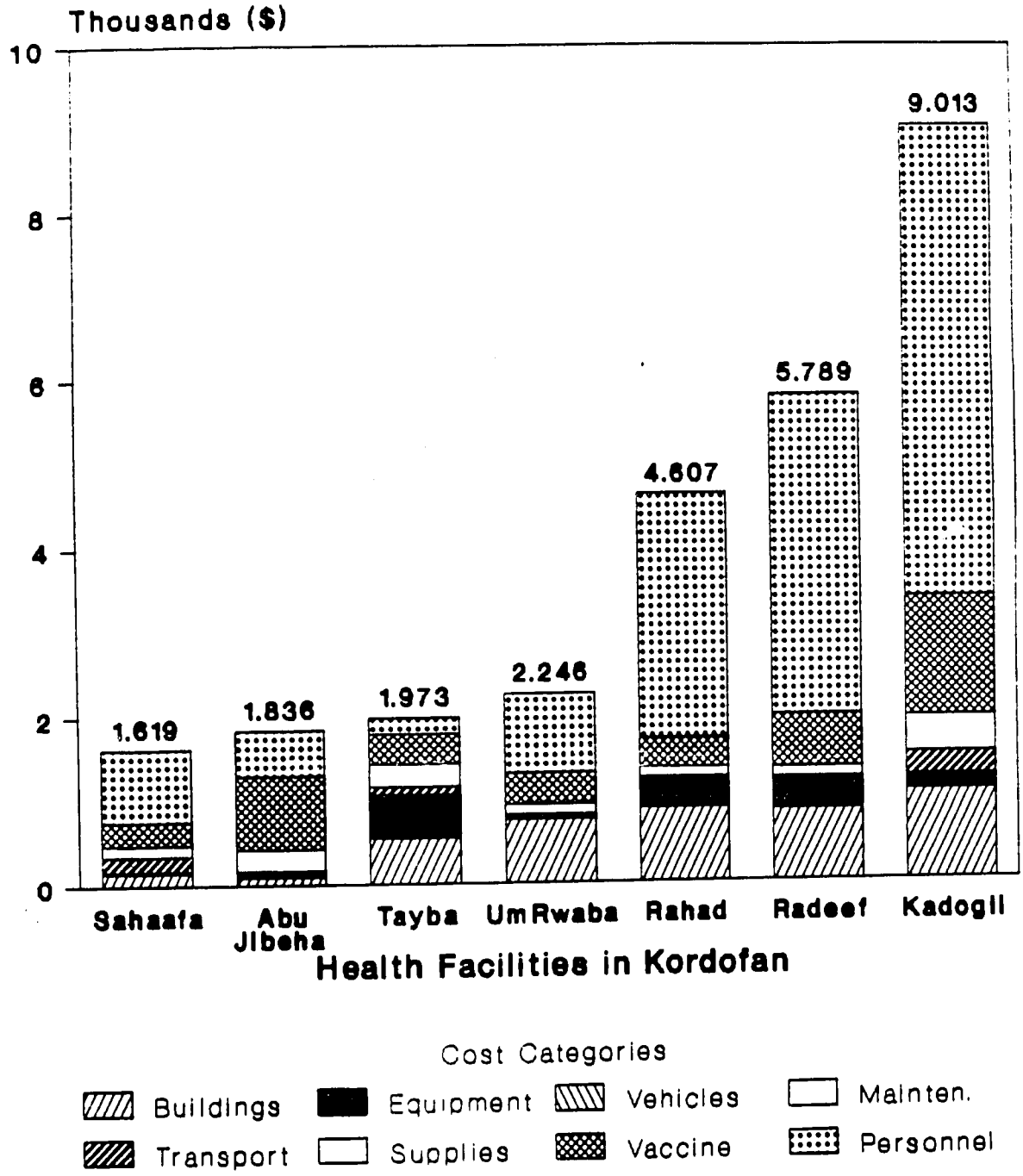
1. Average Cost of EPI at Fixed Facilities

The cost profile and average costs for the sample of health facilities with a fixed point strategy is shown in Table IV.8. The average annual cost of immunization activities at these facilities is $3,869 (LS 17,217). Almost four-fifths (78%) of the total cost is for recurrent items and one-fifth (22%) is for capital costs.

There is a six-fold difference between the lowest and highest cost health facilities ($1,619 to $9,013). This wide variation is caused mainly by differences in the number of personnel working on EPI and in the number of EPI sessions held per week. The cost profiles of the seven surveyed health facilities are shown in Figure IV.2 (these data are also shown for each facility surveyed in Appendix 3.2).

Salaries constitute the largest share (55%) of total costs. However, the percentage of costs on personnel varies widely between the sampled facilities (9% to 66%) because of differences in the number of FTE staff assigned to work on EPI. The annual cost of personnel ranges from a low of $185 (LS 823) at Tayba dispensary, which had the seven day cold-box strategy until November 1988, to a high of $5,651 (LS 25,147) at Kadogli, an urban facility offering daily services that is supplied by a vehicle from the District cold store eight kilometers away. Kadogli had five full-time vaccinators: three stayed in the health center and two went on daily outreach sessions. Only the cost of the staff working at the health center have been estimated (including three full-time cleaners). In the three large, multipurpose health centers (Rahad, Radeef, Kadogli), services are offered four to six days per week with an average personnel cost of $4,126. This can be compared with the average of $637 for the four smaller facilities (dispensary, MCH clinics) which offer services two to four days per week (staff rotate to other duties when not working at that site).

FIGURE IV.2
Cost Profiles of Health Facilities



FIGIV2HF

TABLE IV.8

COMPARISON OF EPI COSTS AMONG HEALTH FACILITIES IN KORDOFAN REGION

COST CATEGORY	AVERAGE COST	PERCENT	MINIMUM	MAXIMUM
RECURRENT COST				
1. Personnel				
- Salary, Allowances	$2,133	55.1%	$185	$5,651
- Support	$0	0.0%	$0	$0
2. Vaccines	$604	15.6%	$267	$1,416
3. Supplies	$210	5.4%	$115	$422
4. Transportation	$83	2.2%	$0	$280
5. Maintenance	$6	0.2%	$0	$45
TOTAL RECURRENT COSTS	$3,036	78.5%	$1,442	$7,784
CAPITAL COSTS				
1. Vehicles	$0	0.0%	$0	$0
2. Equipment	$212	5.5%	$20	$499
3. Buildings	$621	16.0%	$96	$1,067
TOTAL CAPITAL COSTS	$833	21.5%	$129	$1,229
TOTAL COST	$3,869	100.0%	$1,619	$9,013
DOSES ADMINISTERED/YEAR	3,906		677	7,668
AVERAGE COST PER DOSE	$0.99		$0.33	$2.91

Variations in the size and type of building used, and the amount of time it is used for EPI also contribute substantially to differences in costs between facilities (see Appendix 4.8). On average, the capital cost of physical space used for delivering EPI services is the second largest category of costs (16% of the total). However, there is a ten-fold difference between the highest building cost ($1,067) at Kadogli, a large Health Center offering daily immunization services, and the cheapest space ($96), a grass veranda (raquba) specially built on to Abu Jibeha MCH for immunization services. (The only identifiable maintenance cost was for annual repairs to this grass structure.) A sensitivity analysis in Section IV.D examines the effect on costs of allocating a standard amount for the space used at each health facility.

A third source of variation in cost is the amount of vaccine consumed. On average, vaccine accounts for 15% of total costs but the annual value of vaccine consumed ranges from $267 (Sahaafa) to $1,416 (Kadogli). In most cases, the level of daily activity is so low that only one vial needs to be opened. Thus vaccine cost is directly related to the number of sessions offered (i.e. the number of vials opened) rather than to the number of doses given (see Section IV.B.6).

There is some variation in the cold chain equipment used by different facilities but it has little effect upon total costs. For the three facilities with refrigerators (Tayba, Rahad, Radeef), the average cost of equipment is $407 (5% - 8% of total cost). For the other four facilities, which rely on cold boxes and vaccine carriers, equipment cost averages $65 (0.3% - 2.5% of total cost). Two out of the three refrigerators (at Tayba and Rahad) were solar and even though both were out of order, the amortized cost of this equipment was included as the refrigerators were awaiting repair and had not been written off. A sensitivity analysis in Section IV.D excludes the cost of equipment which is out of order.

As with mobile teams, it is impossible to assess costs without relating them to the output produced from these resources. Measures of the effectiveness of resources allocated to EPI are examined in Sections IV.B.2 to IV.B.6.

2. Number of Doses

Using the monthly reports of doses given in February 1989 and the cost data presented in Section IV.B.1, the cost per dose was estimated. Indicators of activity were calculated for the facility (doses per day) and for health workers providing EPI services (doses per FTE staff per hour).

2.A Cost per Dose

The average number of doses (children and pregnant women) given per year in the sample of health facilities was 3,906 with a range from 677 to 7,668. The average cost per dose was $0.99 (LS 4.41) with a range from $0.33 (LS 1.47) at Abu Jibeha MCH Clinic to $2.91 (LS 12.95) at Tayba Dispensary. Thus,

the cost per dose varies by a factor of eight within the sample of facilities (see Table IV.9).

2.B Doses per Day

The wide variation in cost per dose is partly determined by the number of days that the facility was open for immunization services and the hours of opening, which vary considerably. At two facilities (Um Rwaba and Rahad), sessions for women and children were held on different days, and one facility (Sahaafa) did not give any TT during the month preceding the survey. Thus, the activity indicators have been calculated separately for doses given to children and to women. Table IV.9 shows that the average number of doses given to children (on the days when sessions were held) was 21 doses per day, with a range from six to 41. For women the average was 10 doses per day, with a range from 0 to 25.

TABLE IV.9

INDICATORS OF ACTIVITY AT HEALTH FACILITIES IN KORDOFAN

INDICATOR	AVERAGE	MINIMUM	MAXIMUM
Cost per Dose[a]	$0.99	$0.33	$2.91
Child Doses:			
per Day[b]	21.3	5.9	41.1
per Hour[c]	3.6	0.8	7.4
TT Doses:			
per Day[d]	10.3	0.0	25.4
per Hour[e]	1.9	0.0	5.6
Doses/Staff per Hour[f]	3.7	0.3	5.0

(a) Total annual cost divided by total doses per year.
(b) Total doses to children (including out of target) given in a month, divided by the number of days on which child immunization sessions for children were held in a week.
(c) Child doses per day (b), divided by the number of hours for which a sessions lasted.
(d) Total TT doses given to women in a month, divided by the number of days per month on which immunization for women was offered during the month.
(e) TT doses per day (d) divided by the number of hours for which a session lasted.
(f) Doses per week, divided by the number of staff hours devoted to EPI per week. The denominator is the number of FTE staff working on EPI multiplied by the number of hours in a full-time week at that facility.

2.C Doses per FTE Staff per Hour

The average number of doses given by each person directly involved in the immunization session (i.e. excluding drivers, cleaners and guards) is 3.7 doses per health worker per hour. The busiest staff (at Abu Jibeha) give five doses per hour, whereas the least active (at Radeef) give one dose every three to four hours.

These activity indicators suggest that cost per dose can be greatly reduced by adjusting the staffing pattern at facilities to the level of activity or by increasing the volume of immunization services so that the staff are more productive. The correct management decision depends on both the size of the target population and utilization of services.

Table IV.10 links the total annual cost of each health facility with doses administered (see Figure IV.2). Facilities have been categorized as "high cost" if their annual costs are above the average of $3,869, and as "high output" if the doses they administer per year exceeds the average of 3,906 doses. Those in the "low cost" and "low output" areas have below average costs and output respectively.

TABLE IV.10

COST, DOSES ADMINISTERED, AND COST PER DOSE FOR HEALTH FACILITIES IN KORDOFAN
(Cost per Dose Shown in Parentheses)

	HIGH COST	LOW COST
HIGH OUT-PUT	Rahad ($0.98) Health Center Kadogli ($1.18) Health Center	Abu Jibeha ($0.33) MCH Clinic Um Rwaba ($0.56) MCH Clinic
LOW OUT-PUT	Radeef ($2.23) Health Center	Sahaafa ($0.77) Dispensary Tayba ($2.91) Dispensary

Note: Data for Tayba Dispensary refer to November 1988, the last month that the seven day cold box strategy operated there.

3. Number of Contacts for Immunization

The number of contacts refers to the number of women and children (some of whom receive more than one dose per visit) who come to immunization sessions per month (see Section IV.A.3 for method of calculating the number of

contacts). The population figures for health facilities' target populations are not very precise, as these data were not available for the catchment population served by each facility. Thus, estimates of the percentage of eligibles contacted are also imprecise. The need to establish the size of the target population for individual facilities is addressed in Recommendation 1.3.

3.A Percent of Children Under One Year of Age Contacted

Using DPT1 doses as indication of contact with the EPI, almost two-fifths (38%) of the infants in the facility catchment population had at least one contact with EPI services (see Table IV.11). Population data were only available for five facilities with the range in contacts with eligible children from 20% to 88%.

3.B Percent of Pregnant Women Contacted

Contacts with eligible women appeared to be considerably lower. On average, only 8% of the eligibles received any tetanus toxoid, with a range from 0 to 48%, as is shown in Table IV.11.

TABLE IV.11

CONTACTS WITH ELIGIBLES AT HEALTH FACILITIES IN KORDOFAN

INDICATION	AVERAGE	MINIMUM	MAXIMUM
FIRST CONTACTS WITH CHILDREN (DPT1) PER YEAR:			
Under One Year of Age	355	84	624
At Any Age	360	84	648
PERCENT OF CHILD TARGET CONTACTED:			
Under One Year of Age	38	20	88
At Any Age	38	20	92
FIRST CONTACTS WITH PREGNANT WOMEN (TT1) PER YEAR	124	0	624
PERCENT OF PREGNANT WOMEN CONTACTED	8	0	48

Note: Excludes Radeef (El Obeid) as target population was not known.

These indicators of the extent of contact with the target groups are much lower than the estimates from the 1989 coverage survey, which found that 67% of infants had DPT1 before their first birthday, and 39% of eligible women had TT1. The coverage survey data are calculated as a proportion of the sample size (210) and thus independent of estimates of the target population. However, they are more representative of rural populations since 25 out of the 30 clusters were rural, whereas six out of the seven facilities surveyed for costs were urban. This discrepancy may be due to the inaccuracy of data at health facility level concerning the size of the target population, but may also reflect lower uptake of services in urban areas.

4. Number of FIC

The EPI information system does not report the number of children completing their immunizations at each session, so two methods were used to calculate the number of FIC by the fixed point strategy. The first was to count the number of children under one year of age who were recorded in the facility's Registration Book as having received their last dose (usually measles vaccine) during February 1989. The second method, using the 1989 coverage survey data for the three clusters described as receiving services from a fixed site, is shown in the sensitivity analysis in Section IV.D.

Fully immunized coverage for children under one year of age, estimated from the Registration Book and data on the target population, ranged from four to 49% with an average of 18% for the five facilities with population data. The lower coverage figures obtained using this method is accounted for by two factors: 1) the estimate of the target population is too high; and 2) the number of FIC found in the Registration Book is too low as not all doses are recorded there. Of the three records which should be completed as each child is immunized, the Registration Book seems to have lowest priority, after the daily tally sheet (used for monthly reporting and EPITrack, the central computerized information system), and the Road-to-Health card (the parent-held record). The Study Team observed the staff's difficulty in finding a previously immunized child's name in the book, despite sequential numbering. The Study Team also saw that it would be extremely tedious to use the Registration Book to follow up defaulters, as children seem to be registered when they show up for their first immunization, rather than when they become eligible for services (i.e. at birth).

Therefore, the Study Team has considerable reservations about the precision of these estimates of the number of FIC. Using the Registration Book data, the average cost per FIC at health facilities is $15.91. However, the range is very wide with the highest estimate nearly 40 times larger than the lowest. It can be concluded that there is a wide range in the cost per FIC among health facilities, but the precise level of this cost cannot be determined from the available data.

5. Drop Outs

Drop out rates for health facilities, along with comparable data from the coverage survey, are shown in Table IV.12. Drop out patterns at facilities indicate that most children return for their second dose, but 16% of those do not return for their third dose. This finding is consistent with the coverage survey.

TABLE IV.12

DROP OUT RATES FOR HEALTH FACILITIES ESTIMATED FROM MONTHLY REPORTS, COMPARED WITH DATA FROM THE COVERAGE SURVEY (APRIL 1989)
(percentage)

DROP OUT BETWEEN:	RURAL MOBILE TEAMS	HEALTH FACILITIES	COVERAGE SURVEY
DPT1 & DPT	26	1	14
DPT2 & DPT3	6	16	30
DPT1 & DPT3	31	17	40
TT1 & TT2	40	24	35

Two facilities (Kadogli and Rahad) showed a negative drop out rate between DPT1 and DPT3 (i.e. they gave more third doses than first doses in February). This is not explained by catch-up immunization of children out of the target age group. For example, Kadogli reported 25% more DPT3 than DPT1 doses, and recorded that all doses were given to children under one year of age. This phenomenon is frequently found during the third month that services have ever been offered (when the first cohort ever immunized returns for its third dose), but is harder to explain at a fixed facility which has been offering sessions for many months. (See Recommendation 3 on record keeping.)

6. Vaccine Wastage

Table IV.13 shows that in the health facilities surveyed, the average wastage for each antigen ranges from 54% for DPT and OPV, to 80% for BCG. The lowest wastage was at Rahad (13% OF DPT and OPV), an urban health center holding immunization sessions for children twice per week. The highest was at Radeef (93% OF BCG), a large urban health center offering immunization six days per week (although no children were seen on the day of the Study Team's visit). The cost of the vaccine wasted is 78% of the average annual cost of vaccine used at health facilities.

TABLE IV.13

VACCINE WASTAGE FOR HEALTH FACILITIES IN KORDOFAN
(percentage)

ANTIGEN	HEALTH FACILITIES
BCG	80
DPT	54
OPV	54
MEASLES	70
TT	57
AVERAGE COST OF VACCINE WASTAGE	$502
..AS % OF ANNUAL VACCINE COST	78

7. Summary of Results for the Fixed Facility Strategy

The preceding analysis of health facilities demonstrates the need to combine cost data with operational information in order to decide whether resources are being used effectively. For example, two out of the four facilities with lower than average costs shown in Figure IV.2 had a higher cost per dose as their output was relatively low. Table IV.10 showed the distribution of facilities in a four-quadrant matrix of high and low costs and output. The most cost-effective facilities were the MCH Clinics which are smaller than Health Centers, use fewer staff, and hold immunization sessions two days per week. The features which contribute to these rankings have been identified and listed in Table IV.14. Some facilities had a mixture of these features, and the effectiveness of activities which increase utilization of EPI services can only be surmised. The combinations shown in this table show the best and worst combinations in terms of costs and outputs.

The most cost-effective scenario is Case 2 although the sample of health facilities on which this chart is based was mainly urban. In rural areas, an analysis of the seven day cold box system needs to be compared with that for fixed facilities with refrigerators in order to assess the relative merits of these two fixed point strategies. There were no facilities which fitted these categories at the time of the study.

TABLE IV.14

HEALTH FACILITIES: INDICATORS OF COST AND EFFECTIVENESS

	HIGH COST	LOW COST
	CASE 1	CASE 2
HIGH OUT-COME	Cold chain maintained at facility Resupply uses EPI vehicle Large staff spends time on enumeration & follow-up of defaulters EPI sessions occupy a large space Many sessions held, well attended	Easy access to cold store Minimal equipment Resupply by public transport Small staff Few sessions per week High utilization, follow-up done by community
	CASE 3	CASE 4
LOW OUT-COME	Cold chain equipment is out of order Resupply with EPI vehicle Large staff, low utilization, low activity EPI occupies a large space Many sessions held, poorly attended Time spent on social mobilization is not effective	Minimal equipment Small staff Resupply by public transport Low utilization by target group, low activity Passive approach to follow-up of drop outs

C. Comparison of Alternative Strategies

1. Costs and Doses Delivered by Alternative Strategies

On average, mobile teams in Kordofan cost five times more to run per year than EPI services at the average health facility. The lowest annual cost of a mobile team ($12,491) is 40% higher than the highest cost health facility ($9,013). However, the output of mobile teams is nine times higher. Table IV.15 summarizes the preceding analysis.

TABLE IV.15

COMPARISON OF ALTERNATIVE STRATEGIES USING DATA ON DOSES

	Five Rural Mobile Teams	Urban Mobile Team	Health Facilities
Average Cost per Year	$18,478	$15,511	$3,869
Doses Given per Year	33,386	11,160	3,906
Cost per Dose	$0.55	$1.39	$0.99
Doses Given by the Unit per Day of Operation	156	31	21(c) 10(w)
Doses per FTE Health Worker per Hour	12	<1	4
Minimum:	8		<1
Maximum:	24		5

(c) = children
(w) = women

These data illustrate two important points: 1) the cost of "over-staffing" or low productivity; and 2) the cost of offering immunization more frequently than is necessary for the volume of activity.

If health facilities had been open for the same amount of time and had given the same number of doses as were recorded during the study, but the number of FTE staff assigned to work on EPI had been such that the hourly activity of each health worker was five doses per hour (the maximum observed in the sample of health facilities), then the cost per dose would have fallen by 38% to $0.61.

If access to immunization in urban areas were reduced to one day per week, this change alone would have reduced cost per dose by 55% (to $0.45) assuming that the present level of utilization were maintained with this reduction in access to services (see Section IV.D).

These estimates should then be compared with the cost per dose in a fully operational rural mobile team making 12 rounds per year. After adjusting both variable costs and annual doses, the average rural mobile team's cost per dose falls from $0.55 to $0.52 if all teams make all 12 rounds. Thus, the apparent ineffectiveness of the fixed facility strategy is determined by very low output during immunization sessions at health facilities.

2. Number of Contacts for Immunization

From the coverage survey data, it is estimated that 26% of the infants who have access to health facilities or mobile teams have never been brought to an immunization session. Utilization by pregnant women is less than half that for children as 57% of those with access have never attended for TT. Without more accurate data on the number of eligibles, it is impossible to assess the relative effectiveness of the two strategies at contacting their target. (See Recommendations 1.3 and 3.1 on identifying and following up eligibles.)

3. Comparison of Cost per FIC

Using the percentage of coverage from the coverage survey, cost per FIC by mobile teams is $10.36. Using Registration Book data on the number of FIC at health facilities, the cost per FIC for the fixed point strategy is $15.91. Since the estimates of coverage for each strategy were based on different data sources, the costs per FIC should be compared with caution.

Cost per FIC at fixed facilities is 54% higher than that for mobile teams. The cost per dose is 80% higher at fixed facilities than mobile teams. In other words, the percentage difference in cost per FIC between the two strategies is smaller than the difference in cost per dose. This narrowing of the difference in cost-effectiveness measured in terms of fully immunized children reflects the greater continuity and lower drop out rates found at health facilities.

4. Comparison of Drop Outs

Drop out rates for the two strategies are shown in Table IV.16. The mobile teams' drop out rate between the first and third dose of DPT (31%) is twice the drop out rate for health facilities (17%). The mobile teams also have a larger percentage of pregnant women failing to complete the schedule for TT (40% compared with 24% at health facilities). The lower drop out rates for the fixed point strategy reflect the more continuous availability of these services.

According to the monthly reports, the drop out rate for women is higher than for children at both mobile teams and fixed facilities. The coverage survey shows the opposite, with a larger percentage of children (40%) failing to complete the DPT schedule.

TABLE IV.16

DROP OUT RATES FOR ALTERNATIVE STRATEGIES ESTIMATED FROM MONTHLY REPORTS COMPARED WITH DATA FROM THE COVERAGE SURVEY (APRIL 1989)
(percentage)

DROP OUT BETWEEN:	RURAL MOBILE TEAMS	HEALTH FACILITIES	COVERAGE SURVEY
DPT1 & DPT2	26	1	14
DPT2 & DPT3	6	16	30
DPT1 & DPT3	31	17	40
TT1 & TT2	40	24	35

5. Comparison of Wastage

A smaller percentage of vaccine is wasted by mobile teams because more doses are given per session than at the health facilities (156 doses per mobile team per day, compared with 21 doses per day at fixed facilities, see Table IV.15). If the fixed point strategy were extended without increasing the present level of activity per session, vaccine wastage would increase. However, mobile teams use a larger quantity of vaccine, so the total cost of wastage per team is higher than the cost of wastage per health facility.

It is not expected that wastage for DPT and OPV would be identical, but the data for mobile teams and health facilities show no difference in wastage for these two antigens (see Recommendation 3.3. on stock records).

6. Summary of Comparisons

Mobile teams could increase their apparent cost-effectiveness by concentrating on the largest villages and giving many doses for fewer miles travelled and fewer days away from headquarters. However, the objective of the EPI is to make services accessible to as many eligibles as possible and the larger villages are more likely to have a health facility which could provide immunization services without mobile team vaccinators. The analysis of cost-effectiveness reveals important differences in the performance of the two strategies. These comparisons identify areas for improving performance and are not intended to produce a judgement about which single strategy is better in terms of cost-effectiveness. The ultimate objective is to use all available resources as efficiently as possible, making it necessary to use a mixture of strategies, some of which are relatively expensive, in order to provide EPI services to eligibles who would otherwise have no access to immunization. The challenge for each District and Region is to allocate its resources so that they are used as efficiently and effectively as possible.

The factors associated with high and low cost, and high and low levels of output, have been identified to make a profile of the most cost effective combinations for mobile teams (Table IV.7) and health facilities (Table IV.14). It is hoped that this analysis will help the District management teams to get the optimum mix of strategies, and to monitor and improve performance within the EPI.

D. Sensitivity Analysis

This section presents the effect of alternative assumptions upon the cost estimates for mobile teams and health facilities.

1. Alternative Estimate of FIC for Health Facilities

Cost per FIC for health facilities ($15.91) was calculated for one rural and six urban facilities using data from the Registration Book. This method was used because the sampling method for the coverage survey was not intended to provide robust estimates of coverage for different strategies or for urban/rural comparisons. In fact, the population proportional sampling method used for the coverage survey produced three clusters (out of a total of 30) which were served by fixed facilities. The other clusters with access to EPI were served by mobile teams. In the final sample, five clusters were urban. Thus, the children in the coverage survey were mainly in rural areas served by mobile teams. The sample of three clusters served by the fixed site strategy is too small for reliability. Out of the 21 children in these three clusters, 14 (67%) were fully immunized (this includes those who completed their immunizations out of the target age group).

Having noted these reservations, this figure of 67% coverage was applied to all facilities with the average cost per FIC at $4.24. However, as with the figure calculated using Registration Book data, the range is very wide with the highest estimate 25 times larger than the lowest. This wide range serves to emphasize the importance of knowing the number of children fully immunized per month at each facility, and identifying the size of the target population more accurately so that the performance of each facility can be assessed.

2. Excluding Broken Equipment

Three health facilities had equipment which was out of order. The effect on their annual equipment cost is shown in Table IV.17.

TABLE IV.17

BROKEN EQUIPMENT

Health Center	Cost of Equipment Including Broken Equip.	Cost of Equipment Excluding Broken Equip.	% Reduction in: Equipment Cost	% Reduction in: Total Cost
Tayba Dispensary	$499	$333	33	8
Kadogli Health Center	$162	$151	7	<1
Rahad Health Center	$353	$222	37	3

When averaged over the seven health facilities, the overall effect of excluding the cost of broken equipment was to reduce total annual costs by $44 to $3,825 (a 1% reduction). Thus the effect on cost per dose was negligible (from $0.99 to $0.98).

None of the mobile teams had any broken equipment (which seems to accumulate at District or Regional HQ). The sensitivity analysis in Chapter V shows that broken equipment accounts for 8% of program costs at Regional level.

3. Standardizing Building Costs

Based on field visits to the health facilities, it was assumed that a space of 20 square meters would be sufficient for an EPI session. Any facility which used more than this amount of space had its building costs recalculated. Thus, all facilities except one (Abu Jibeha) had the cost of physical space reduced by this alternative assumption. The biggest effect was in Tayba, where the new figure was half the amount used in the main analysis.

Overall, the average cost of space used for EPI fell by 17% (from $621 to $513). This reduced total annual cost by 3% (from 3,869 to $3,761) and cost per dose by $0.03 (from $0.99 to $0.96).

4. Mobile Teams Making All Yearly Rounds

Two mobile teams were affected by this analysis: Kadogli (5 rounds last year) and Rashad (9 rounds last year). The variable costs for personnel, vaccine, supplies and fuel would increase as would the number of doses given per year. The changes would be as illustrated in Table IV.18.

TABLE IV.18

YEARLY COSTS FOR MOBILE TEAMS IF ALL ROUNDS WERE MADE

	Kadogli	Rashad	Average for 5 Rural Mobile Teams
Total Annual Cost Increases By:	30%	14%	7%
New Annual Cost:	$16,181	$21,664	$19,765
Cost per Dose is Reduced By:	46%	14%	5%
New Cost per Dose:	$0.73	$0.55	$0.52

The reduction in cost per dose is less dramatic than might be expected. It is likely that the number of children completing their immunizations before their first birthday would increase quite substantially, and that cost per FIC would be considerably reduced in these Districts.

5. Urban Health Facilities Offering Immunization One Day per Week

Cost calculations which are affected by changing this variable are personnel, transport, and physical space. All facilities' costs were reduced except Tayba (a rural dispensary whose costs were based on seven days of activity per month). It was assumed that the same number of doses would be administered per month. In other words utilization would be unaffected by restricting access to urban facilities to one day per week. The overall effect is shown in Table IV.19.

TABLE IV.19

URBAN HEALTH FACILITIES: CHANGE IN COSTS FOR ONE DAY A WEEK SERVICE

	Old Cost	New Cost	% Reduction in: Cost Category	% Reduction in: Total Cost
Personnel	$2,133	$491	77%	42%
Transport	$83	$29	65%	1%
Buildings	$621	$201	68%	11%
Total Cost	$3,869	$1,752	--	55%
Cost/Dose	$0.99	$0.45	--	55%

The largest reduction of total costs is in personnel (42%). The cost of using physical space for less time reduces total costs by 11%, a much larger reduction than that introduced by standardizing the amount of space used (see 3 above).

The assumption that the same volume of monthly services could be provided with the same staff per session is reasonable, as the required increase in staff productivity raises the maximum output to 19 doses per health worker per hour (one dose every three minutes). This is still only 75% of the hourly activity on the mobile team with the highest output. The health facility with the lowest staff output per hour (Radeef) would need to give two doses per health worker per hour on one day per week in order to immunize the same number of eligibles. This finding suggests that this activity indicator should be used in deciding whether to change the staffing pattern and/or the number of sessions held per week at particular facilities. Efficiency considerations would need to be balanced by the likely effect upon utilization of reducing access to services.

6. The Seven Day Cold Box Strategy

Villages with medical assistants (at dispensaries) or community health workers (at Primary Health Care Units) can provide immunizations without assistance from the mobile teams. This strategy has been in operation in several parts of Kordofan until November 1988, but was not being used at the time of this study. The strategy is as follows: staff from the District HQ drop off vaccine once per month at the center of the Health Complex (usually the dispensary) in a seven day cold box (RCW 25). A second cold box full of frozen ice packs is also dropped off. The CHWs then travel to the dispensary to pick up vaccine carriers and immunization supplies, and immunize the eligibles in their communities during the next 24 hours. The vaccine carriers are returned to the dispensary with the tally sheets, showing doses administered by antigen and age group.

Estimates of the costs of this strategy at one health complex have been prepared using data from Tayba Dispensary which is the central distribution point for 10 villages varying in size from 900 to 3,000. (The costs of covering the nomadic eligibles in the area have not been estimated.) Table IV.20 summarizes the cost estimates, details are shown in Appendix 3.4.

The annual cost of providing immunization services to the population of 16,800 in the 10 villages is $4,272. The largest costs are for personnel (25%). It was assumed that the Medical Assistant would work 28 hours per month on EPI and each CHW would spend two days each month on following up eligibles, transporting vaccine, giving the immunizations, and preparing reports. The second largest costs (24%) are for transporting the vaccine and 20% of total costs (LS 3,866 per year) are for animal transport between the village and the dispensary. These costs are based on the actual monthly expenditures for the round trip between village and actual monthly expenditure for the round trip between village and dispensary (average distance 39km), which varied between LS 25 and LS 40. The District Councils paid for animal transport but ceased to do so following an instruction from the Governor's Office.

TABLE IV.20

ANNUAL COSTS ESTIMATES FOR SEVEN DAY COLD BOX STRATEGY
AT ONE HEALTH COMPLEX
(10 VILLAGES WITH 16,800 POPULATION)

RECURRENT COSTS	NUMBER	LS	US$	ANNUAL COST US$	%
PERSONNEL					
Medical Assistant at Dispensary	1	1,113	$250		
CHWs	9	3,703	$832		
				$1,082	25%
VACCINES	10*			$665	16%
SUPPLIES	10*			$310	7%
TRANSPORTATION					
EPI Vehicle: Dist. to Disp.			$152 *		
Donkeys, Camels: to Villages		3,866	$869		
				$1,021	24%
MAINTENANCE OF EPI VEHCILES			*	$175	4%
TOTAL RECURRENT COSTS				$3,253	76%
CAPITAL COSTS					
EPI VEHICLE			*	$761	18%
EQUIPMENT					
Seven Day Cold Boxes	2		$184		
Vaccine Carriers: 1.7 litres	9		$74		
				$258	6%
TOTAL CAPITAL COSTS				$1,020	24%
TOTAL ANNUAL COSTS OF STRATEGY IN ONE HEALTH COMPLEX				$4,272	100%

* Costs of using EPI vehicle for delivering vaccine to the dispensary.

** Villages

Resumption of the seven day cold box strategy would release the mobile teams to work in areas without health personnel, and would thus widen the access to immunization services.

It has been assumed that an EPI vehicle is used to deliver the two seven day cold boxes containing vaccine and frozen ice packs. If it were possible to use the public transport system for delivering vaccine, the annual cost of the strategy would fall by 25% to $3,200 (all of the starred items in the table would be subtracted from total costs.)

The theoretical minimum cost per dose has been estimated by assuming that the medical assistant and the CHWs immunize 100% of the eligible women and children in the village. Under this assumption, 7,080 doses would be given per year and cost per dose would be $0.60 (LS 3). (If public transport were used between the District HQ and the dispensary, cost per dose would be $0.45 [LS 2]). This theoretical minimum is lower than cost per dose for health facilities and close to that for mobile teams. However, it is likely that a CHW or medical assistant, living in the community, will achieve a lower drop out rate and higher coverage than mobile teams. Thus, cost per FIC is likely to be lower for the seven day cold box strategy than for mobile teams.

V. PROGRAM COSTS AT DISTRICT AND REGIONAL LEVEL

This chapter analyzes the costs and effectiveness of the EPI at District level (Section V.A) and Regional level (Section V.B). The same eight categories of cost were calculated as for the immunization strategies but at the District level these costs include administrative overhead (e.g. for DOO visits to Regional HQ or the time taken to work out the mobile teams' schedule of visits). They also include the costs of running the cold stores (equipment, daily monitoring). Training has been added as a cost category at both levels.

Costs of some alternative scenarios are presented in Section V.C. The final section comments on financial management of the program.

A. District Level

In this section, the total costs of the EPI are estimated for a sample of six Districts in Kordofan. The cost-effectiveness at District level is assessed with reference to cost per dose, cost per FIC, drop outs, and vaccine wastage.

1. Average Costs at District Level

Six out of the ten districts in Kordofan were surveyed. Their cost profile and total annual costs are shown in Table V.1. The average annual cost at district level is $71,946 (LS 320,160), with a range from $62,377 (LS 277,580) in Kadogli to $103,925 (LS 462,470) in Um Rwaba. The highest cost district receives substantial donor funding. Excluding this district gives an average of $65,550. (Detailed costs for each District are shown in Appendix 3.3.) Recurrent costs account for 69% of the total and capital costs for 31%.

TABLE V.1

COMPARISON OF EPI COSTS, BY CATEGORY, FOR SIX DISTRICTS IN KORDOFAN

COST CATEGORY	AVERAGE	PERCENT	MINIMUM	MAXIMUM
RECURRENT COST				
1. Personnel	$30,692	42.7%		
- Salary	$1,998	27.8%	$15,424	$26,763
- Staff Support	$0	0.0%		
- Per Diem	$10,704	14.9%	$7,591	$13,292
2. Vaccine	$6,445	9.0%	$3,757	$10,018
3. Supplies	$2,712	3.8%	$1,991	$4,067
4. Transportation	$5,791	8.0%		
- Fuel	$5,201	7.2%	$2,271	$13,432
- Oil	$590	0.8%	$253	$1,213
5. Maintenance/Operat.	$2,925	4.1%	$2,342	$4,272
6. Training	$980	1.4%	$98	$1,624
7. Other	--	--		
Subtotal	$49,546	68.9%	$40,695	$70,992
CAPITAL COSTS				
1. Vehicles	$12,720	17.7%	$10,184	$18,576
2. Equipment	$7,521	10.5%	$2,662	$11,336
3. Buildings	$2,159	3.0%	$949	$3,021
4. Other	--	--		
Subtotal	$22,400	31.1%	$13,795	$32,933
TOTAL COST	$71,946	100.0%	$62,377	$103,925
AVERAGE DOSES REPORTED PER YEAR	70,486		43,360	12,044
COST PER DOSE	$1.02		$0.86	$1.44

Personnel is the largest cost category, accounting for 43% of the total. This percentage varies from 37% in Um Rwaba to 54% in El Obeid. (The figures underestimate the total cost of EPI personnel in the District as multipurpose facility-based staff who spend a small portion of their time on EPI, such as health visitors and medical assistants, have not been included.)

Personnel costs consist of basic salary including allowances and per diem. Basic salary accounts for two-thirds of personnel costs and per diem (for the mobile team staff) for one-third. The figures were calculated from actual salaries in February when per diem rates were 50% to 80% higher than in March, when the six-month period of extra incentives ended.

The second largest cost category (18%) is vehicles. Most districts have at least two assigned to them but some were broken down. (See the sensitivity analysis in Section V.C, excluding broken down equipment and vehicles.) The fuel and oils for running the District vehicles contribute 8% of total costs. Vehicle maintenance (calculated at 23% of the amortized cost of vehicles, see Appendix 4.5) is 4% of the total.

Equipment accounts for 11% of District level costs. This category includes the district cold chain (refrigerators, freezers, generators), and the cold boxes and vaccine carriers for maintaining cold chain at immunization sessions. The lowest equipment cost ($2,662) is in El Obeid, which did not have any solar refrigerators. The other six districts all had two or three solar refrigerators although none were currently in use. (See the sensitivity analysis in Section V.C which excludes the cost of this equipment.) The largest equipment cost ($11,336) is more than four times the smallest, and is found in Um Rwaba, where the equipment cost is high due to large quantities of RCW 25 cold boxes and Thermos vaccine carriers which were purchased with donor funding to support an extended outreach and seven day cold box strategy. (The sample of health facilities revealed only one facility using its own refrigerator; such equipment has not been included in District level costs as it could not be accurately inventoried.)

Vaccine costs account for 9% of the total. This share ranges from 6% to 14% among districts. There is a three-fold difference in the value of vaccine consumed ($3,757 in Dilleng, $10,018 in El Obeid) and this range is not accounted for by the size of the target population. Vaccine consumption is examined in Section V.A.5.

Supplies (needles, syringes, stationery, cold chain monitors) account for 4% of total cost with a two-fold difference between the lowest and highest figure. The cost of vaccines and supplies used should be closely linked and it would be expected that the relationship between them would be fairly constant. However, this is not the case as the ratio of vaccine costs to supply costs ranges from 1.55 (Dilleng) to 3.59 (El Obeid). This wide difference is caused partly by differences in vaccine wastage rates (see Section V.A.5) and may also be affected by differences in stock management found at the point of use during this study.

The amortized cost of the space used for District HQ represents 3% of the total. (Costs for all the physical space used during immunization sessions have not been included. This would be a highly theoretical exercise given the variety of sites used at the seven health facilities surveyed, see Appendix 4.8.)

The smallest share of District costs (1%) is taken by expenditure on training. Based on figures at Central EPI Headquarter, an average of $14 (LS 62) was spent per person trained. The number of staff attending courses (usually for one week) in 1988 varied from seven (Um Rwaba) to 102 (El Obeid). Um Rwaba had trained most of the eligible staff in earlier years.

District costs are analyzed in combination with measures of output to obtain indicators of cost effectiveness. See Sections V.A.2 - V.A.5.

2. Number of Doses

The average number of doses given during February in the six districts visited was 5,874. For the whole region (10 Districts), the February total was 46,704. This is 20% lower than the 58,740 doses projected from the District data. Thus the level of output in the four Districts not visited was lower than in the six sampled Districts.

In order to fully immunize the target group of children under one year of age, eight doses per infant must be given. The doses given to children under on year of age were tallied from the monthly reports and divided by the target population. Table V.2 shows that on the average the sampled districts gave four doses per child under one year of age. This is one-third more than the figure for the whole Region, which is three doses per child under one year of age. Thus, after comparing the volume of activity with each District's population, the sample's performance is considerably better than average. Within the sample, there is a three-fold difference in doses per eligible child: from 2.2 in Rashad to 5.9 in Um Rwaba (see Appendix 3.3A).

The number of doses given to all children was counted and compared with doses given to children over one year old. The percentage of "out of target" doses is shown in Table V.2. Again, the sampled Districts' performance is better to the extent that a smaller percentage of their effort to immunize children is spent on those over one year old (5.3% compared with 9.7% for the whole Region).

TABLE V.2

INDICATORS OF ACTIVITY AT DISTRICT AND REGIONAL LEVEL

INDICATOR	FOR SIX SAMPLED DISTRICTS IN KORDOFAN AVERAGE	MINIMUM	MAXIMUM	REGION
Number of Doses per Year	70,486	45,360	120,444	560,448
Doses to Under Ones per Pop. Under One Year	4.1	2.2	5.9	3.1
Percent of Child Doses Out of Target	5.3%	0.2%	10.2%	9.7%
TT Doses per Pregnant Woman	0.6	0.2	1.1	0.4
Cost per Dose	$1.02	$0.86	$1.44	$1.62

3. Cost per FIC at District Level

At District level the average cost per FIC under one year of age is $18.46 (with a range from $11.61 in Rashad to $22.71 in Dilleng). However, the assumption that coverage is 24% in all Districts gives the result that those with the lowest output per eligible child also have the lowest cost per dose (because their recurrent costs are lower). So this assumption gives a cost per FIC which is not specific to the level of coverage achieved by a particular District. The sensitivity analysis in Section V.C gives cost per FIC after adjusting for differences in performance between Districts and suggests that the best performing Districts (Um Rwaba and Dilleng) are currently achieving a cost of approximately $12 to $13 per FIC.

4. Drop Outs at District Level

Table V.3 shows the drop out rates for DPT (including doses to children over one year of age) for the sampled Districts and the whole Region. The drop out rate between first and third dose of DPT is 17% for the sample of Districts (with a range from -21% to 46%). Higher drop outs after the second dose were found in District level data.

For TT, the average rate for the sampled Districts was 14%, with a range from -30% to 44%. Negative drop out rates were found in Dilleng (TT) and Um Rwaba (DPT and TT). The number of second doses of TT would be larger than first doses if women who have previously received the two-dose course are being given a booster dose during a subsequent pregnancy. There is no space on the monthly reporting form to record booster doses (TT3) separately from

TT2, so they are all reported as TT2. These two Districts appear to have well established programs and their negative drop out rate for TT should not cause alarm.

The negative drop out rate between DPT1 and DPT3 in Um Rwaba is caused by more third doses being given during February. In this District, the frequency of mobile team visits to each village depends on the number of eligibles, so the negative drop out rate could be caused by catch-up immunization. The District has also started using community volunteers to register births and to follow up defaulters, so the relatively large number of third doses of DPT may be the result of this effort. (All data sources for the Region show a higher drop out rate between the second and third dose than between the first and second dose, so the pool of children ready for DPT3 should be adequate to produce the negative drop out rate observed.) A third explanation is inaccurate record keeping at the immunization sessions. This problem is addressed in Section VI, Conclusions and Recommendations.

TABLE V.3

DROP OUT RATES FOR DISTRICTS AND REGION ESTIMATED FROM MONTHLY REPORTS AS COMPARED WITH DATA FROM THE COVERAGE SURVEY (APRIL 1989)

DROP OUT BETWEEN:	SIX DISTRICTS	KORDOFAN REGION	COVERAGE SURVEY
DPT1 & DPT2	4%	-11%	14%
DPT2 & DPT3	9%	30%	30%
DPT1 & DPT3	17%	23%	40%
TT1 & TT2	14%	16%	35%

5. Wastage at District Level

Vaccine wastage was calculated by subtracting the number of doses given from the total doses in the vials used. These data are reported monthly through the EPITrack information system. For the sampled Districts and the Regions the wastage for each antigen is shown in Table V.4.

At both levels, wastage is lowest for OPV and DPT. The Districts show TT has lower wastage than BCG and Measles. These data are consistent with the Central HQ report (Sudan Cold Chain 1988) which gives the wastage figures for Kordofan (see Table V.4). Lowest wastage is for OPV, followed by DPT, TT, BCG and Measles. However, the level of wastage in this report, which was for 1988, is lower than that calculated during the cost effectiveness study which used data for February 1989.

TABLE V.4

VACCINE WASTAGE AT DISTRICT AND REGIONAL LEVEL

ANTIGEN	AVERAGE FOR SIX DISTRICTS	KORDOFAN REGION	CENTRAL HQ
BCG	68%	60%	49%
DPT	40%	57%	34%
OPV	40%	48%	31%
MEASLES	73%	69%	62%
TT	56%	71%	47%
ANNUAL COST OF VACCINE WASTAGE		$3,682	$33,473
..AS % OF ANNUAL VACCINE COST		57%	60%

The cost of wastage is the cost of what is left in opened vials at the end of an immunization session and in vials discarded under stock management procedures. This cost has been estimated by comparing the cost of doses administered with the cost of vials used. For each District, the cost per dose of vaccine wasted was calculated, ranging from $0.02 in Dilleng to $0.09 in El Obeid. If all Districts managed their vaccine stocks as efficiently as Dilleng, the Districts would reduce the cost of their vaccine consumption by an average of $2,563 (with a maximum saving of $5,748 in El Obeid). This represents a 40% reduction in the annual cost of vaccine and a 4% reduction in total program costs at District level.

B. Regional Level

1. Costs at Regional Level

At this level, costs are divided into the nine categories used in the District level analysis. A tenth category, for the cost of social mobilization, has been added. The indirect contributions of donors through project funding have also been included.

The total annual cost of EPI for Kordofan Region is $910,074 (LS 4,049,800). The distribution of costs between categories of expenditure and by the source of funds is shown in Table V.5. Recurrent costs account for three-quarters of the total, with personnel costs representing almost half (48%) of all costs. The next largest cost category is vehicles which account for 14% of EPI costs.

Personnel costs have been calculated for staff working full-time on the EPI. They do not include time spent by multipurpose staff. Data from the mobile teams and health facilities showed that multipurpose staff spend a very

small proportion of their time on EPI, as most of the work is done by vaccinators. So the omission of multipurpose staff represents a small proportion of personnel costs.

Per diem for mobile team staff and supervisory personnel accounts for 12% of program costs and 25% of personnel costs. This figure was calculated from salary data for February 1989. This was the last month of a six-month extra incentive period, authorized by the National EPI, during which the per diem was raised to LS 20.00 for supervisors (67% more than the usual LS 12.00); LS 18.00 for vaccinators (80% more than the usual LS 10.00); and LS 15.00 for drivers (50% more than the usual LS 10.00). The average monthly per diem cost during the period of increased incentives was 82% higher than when per diems were at the lower rate. Thus it is estimated that the policy of paying higher incentives cost LS 82,576.00 ($18,556.00) for the six-month period (see Appendix 4.1). The Study Team found no evidence that incentives were linked to performance.

Staff support payments to Regional HQ support staff account for less than 1% of personnel costs.

The second largest recurrent cost item is vaccine (6%), followed by fuel and oil (5%) for vehicles and generators. Vehicle maintenance (spares, labor) was calculated to be 23% of the capital cost of vehicles and amounts to 3% of total costs.

During 1988, 1,039 staff attended EPI training courses (usually lasting one week). The average cost per head was $14 (from UNICEF funds). In addition, donors funded some training activities. Total outlay on this category came to 2.5% of total program costs.

The Revolving Fund is in reality a petty cash account and is funded by UNICEF. These expenditures were just over 1% of total costs.

The cost of social mobilization was calculated from the amount of air time donated by the Kordofan Radio Station, plus administrative overhead related to the number of separate programs produced (see Appendix 4.9). This category of cost was less than one % of the total.

The largest capital cost component is vehicles (14% of total). They are all purchased with foreign exchange (84% by UNICEF and 16% by other donors). Using both the regional records and the physical inventory carried out during this study, it was estimated that there were 17 bicycles (2% of total cost) and 17 motorbikes (6% of total cost). Thus 92% of vehicle costs are accounted for by 29 four wheel drive vehicles, with an average amortized cost of $4,020 per year (over a five year life).

Equipment to support EPI activities (refrigerators, freezers, generators, voltage regulators, cold boxes, vaccine carriers, ice packs, thermometers, public address systems and cassettes) comprised 10% of the total cost at regional level.

The smallest capital cost component (3%) is buildings. Costs for the regional and district headquarters were estimated but no cost has been imputed for the sites used for immunization sessions.

Table V.5 shows the sources of funding for the program. UNICEF funds, which reach the region via the National EPI HQ and the Regional Directorate of Health, cover 50% of program costs. The largest portion of these funds are for per diem, followed by vehicles and equipment. All vaccine and supplies are also purchased with UNICEF funds.

Government funding, through three separate Ministries, covers 31% of program costs. The Ministry of Health provides 27% (for salaries, fuel, oil, and buildings). The District, Urban and Rural Councils, which administratively fall under the Ministry of Local Government and the Regional Governor, contribute 3% (for fuel, and some pay overtime and travel allowance). The Councils were previously paying the cost of transport (donkeys and camels) from dispensaries to PHCUs. The cost of this strategy is examined in Section IV.C. Radio time for social mobilization is contributed by the Ministry of Culture (1% of total costs).

The balance of funds (20%) comes from a USAID-funded project (RHSP) and two USAID supported NGOs. Where funds were used for integrated project activities, a share of funding commensurate with the proportion of time spent on EPI has been allocated.

Estimates of the effectiveness of the resources devoted to EPI are examined in Sections V.B.2 - V.B.5.

2. Number of Doses

For Kordofan Region, the number of doses per year is 560,448. Thus the cost per dose is $1.62 for the Region. This is 59% higher than average cost per dose in the sampled Districts (see Table V.2). Some of the difference is due to greater productivity in the sampled Districts, additional overhead costs that have been added in at the Regional level (i.e., equipment for the regional cold store), and the cost of social mobilization. By comparing cost per dose with doses per target for the Districts, it is estimated that the average cost per dose for all 10 Districts would be about $1.21. Thus the cost attributable to extra overhead at Regional level is $0.41 ($1.62-$1.21) per dose.

TABLE V.5

TOTAL COST OF THE EPI AT REGIONAL LEVEL IN KORDOFAN
(in US$)

CATEGORY	MOH	MIN. OF CULTURE	DISTRICT COUNCIL	EPI/ UNICEF	USAID RHSP	WHO	NGO SCF/US *	NGO CARE	TOTAL	PERCENT
RECURRENT COST										
1. Personnel										47.6%
- Salary/Benefits	205,210		11,650		92,927	0	5,882	7,511	323,180	35.5%
- Per Diem				107,367					107,367	11.8%
- Staff Support				2,899					2,899	0.3%
2. Vaccine				55,880					55,880	6.1%
3. Supplies				39,797					39,797	4.4%
4. Transportation										5.3%
- Fuel	9,922		15,153		10,229		6,774		42,078	4.6%
- Oil	5,111		1,224						6,335	0.7%
5. Maintenance/ Operations					23,929				23,929	2.6%
- Cold Chain	225								225	0.0%
- Vehicles				24,154	1,539		2,156	911	28,760	3.2%
6. Training				14,546	8,158				22,704	2.5%
7. Social Mobilization		6,431		1,573					8,004	0.9%
8. Revolving Fund				11,599					11,599	1.3%
SUBTOTAL RECURRENT	220,468	6,431	28,027	257,815	136,782	0	14,812	8,422	672,757	73.9%
CAPITAL COST										
1. Vehicles				105,017	6,693		9,372	3,960	125,042	13.7%
2. Equipment			264	86,605					86,869	9.5%
3. Buildings	25,406								25,406	2.8%
4. Other									0	0.0%
SUBTOTAL CAPITAL	25,406	0	264	191,622	6,693	0	9,372	3,960	237,317	26.1%
TOTAL COST	245,874	6,431	28,292	449,437	143,475	0	24,184	12,382	910,074	100.0%
PERCENTAGE	27.0%	0.7%	3.1%	49.4%	15.8%	0.0%	2.7%	1.4%	100.0%	

TOTAL DOSES	560,448
COST PER DOSE	1.62
PERCENT TT DOSES	10.3%
TOTAL CHILD COST	816,337
TARGET POPULATION	144,139
COVERAGE (NO. FIC)	34,449
COST/FIC	23.70

* Save the Children Fund/USA

3. Cost per FIC at Regional Level

The number of FIC under one year of age was calculated using the coverage survey estimate (24%) multiplied by the total number of eligibles in Kordofan (144,139). The share of program costs attributable to child immunization was assumed to be the percentage of all doses (women and children) that were given to children (89.7%). Thus, the cost of immunizing Kordofan children was $816,337 and the cost per child with all eight doses before first birthday was $23.70 (LS 105). This figure is higher than the average cost per FIC in the sampled Districts because: 1) Regional level costs include additional overhead; and 2) sampled Districts had above average performance. Section V.C shows the cost per FIC if all those children who had eight doses at the time of the coverage survey had received them before their first birthday (i.e. with 44% of eligibles fully immunized).

4. Drop Outs in Kordofan

Table V.3 shows data on drop outs. The drop out rate between first and third dose of DPT is 23% for Kordofan; this is about half the rate found in the coverage survey (40%), which should be comparable because both sources of data include doses given to children out of the target age group. Drop outs between second and third dose (30%) are much higher than between first and second dose (-11%). This pattern is consistent with the coverage survey data which shows that the drop out rate from DPT2 to DPT3 is twice the rate between first and second dose.

For TT, the Region's rate (16%) is half the level found during the coverage survey (35%). This discrepancy may be due to differences in the method of accounting for booster doses (TT3).

5. Wastage

The Regional reports indicate that TT has the highest wastage (71%, see Table V.4). This is at variance with data for Kordofan from the central level which show a wastage level of 47%, almost half that calculated for the cost-effectiveness study. The annual cost of wastage is 60% of the cost of vaccine ($33,473 / $55,880) for the Region. Some wastage is unavoidable but if all Districts managed their vaccine stocks as efficiently as the Districts with lowest wastage, the cost of vaccine wastage in the region would be reduced to $11,209 (at $0.02 per dose administered) and annual vaccine cost would be reduced by 40% (from $55,880 to $33,616).

C. Sensitivity Analysis

This section examines the effect on regional level costs of changing certain assumptions which affect the cost calculations. The total program costs and cost per FIC for each assumption are shown in Table V.6.

TABLE V.6

SENSITIVITY ANALYSIS:
EFFECT ON TOTAL COSTS AND COST PER FIC AT REGIONAL LEVEL

Scenario	Total Cost	Cost per FIC	% Change in Cost/FIC
Original Cost Estimates	$910,074	$23.70	-
1. Exchange Rate Changed from LS 4.45 to L 12.00 per US$	$643,181	$16.75	-29%
2. Donors' Indirect Costs Excluded	$817,147	$21.28	-10%
3. Standard per Diem Rates	$872,960	$22.73	-4%
4. Excluding Broken Equipment and Vehicles	$837,188	$21.80	-8%
5. Reducing Life of Vehicles to Four Years	$929,793	$24.21	+2%
6. Increasing Coverage From 24% to 44%	$910,074	$12.91	-46%

1. Changing the Exchange Rate

The rate of exchange used to convert the price of locally purchased items into U.S. dollars has been LS 4.45. This was the average of the UN rate (LS 4.40) and the official 1988 rate (LS 4.50). However, the official market rate of exchange at the time of the study was LS 12.00. The only cost categories which are not affected by changing the exchange rate are vaccines, supplies and vehicles. There are two major effects of changing this assumption: 1) a reduction of 29% in total program costs (see Table V.6); and 2) a change in the share of program costs funded from local and donor sources. For example, the Ministry of Health's share is reduced from 27% to 14%, whereas the donor's share increases from 69% to 84%. Thus, using an exchange rate which more closely reflects the purchasing power of each currency shows that the program is even more dependent upon outside funds than was suggested by using the rate of exchange at which donors are required to operate. However, the cost-effectiveness of the EPI increases as the cost per FIC is reduced from $23.70 to $16.75.

2. Excluding the Indirect Costs in Donor Supported Projects

The total cost presented in Table V.5 includes the indirect costs of technical assistance to the projects supported by the various donors in Kordofan. Excluding these costs has the effect of reducing total costs by 10%, and reducing cost per FIC to $21.28 (see Table V.6).

3. Using Lower per Diem Rates

During the period for which costs were collected, an extra incentive (LS 13,763 per month), was being paid to mobile team staff (see Appendix 4.1). The effect of substituting the standard per diem rates is to reduce personnel costs by $37,114 (11% of $323,180) per year. This reduces the total program cost by 4%, and cost per FIC falls by $0.97, to $22.73. Thus, the effect of paying the extra incentive was to add almost $1 to the cost of fully immunizing a child.

4. Excluding the Cost of Broken Vehicles and Equipment

During fieldwork, the Study Team recorded how many items were not working but not yet written off. In the six districts surveyed, the cost of equipment which was not working accounted for 52% of total equipment costs (with a range from 19% in El Obeid to 67% in Rashad). Vehicles which were not working accounted for 19% of total vehicle costs (with a range from 3% in Kadogli to 46% in Dilleng).

The effect upon total costs of excluding these items is to reduce Regional program costs by $72,886 (8%) and cost per FIC falls to $21.80. The share of total program costs attributed to vehicles falls from 14% to 12%, and the share attributed to equipment falls from 10% to 6%.

If equipment and vehicles were well maintained and if spare parts were available for making repairs, the level of output would most likely increase. For example, the effect on District EPI activities of having one mobile team vehicle out of order is to reduce services to about half their usual level.

This analysis also highlights the importance of making complementary investments in training and personnel when new equipment is purchased. For example, none of the 23 solar refrigerators in the Regions was actually working, yet the annual cost of this investment was 18% of equipment costs and 2% of total program costs. If technicians had been available to install these refrigerators and train staff in correct daily maintenance, then the equipment could have made a substantial contribution to expanding coverage. Without this complementary investment in personnel and training, the capital cost of solar refrigerators represented a deadweight loss during 1988.

5. Reducing Useful Life of Vehicles to Four Years

The analysis has assumed a life of five years for the four wheel drive vehicles. The effect of reducing its life to four years is that the annual amortized cost increases. The overall effect is to raise Regional costs by $19,719 (2% of the total). This increases cost per FIC by $0.51 to a total of $24.21.

6. Increasing Coverage

If all of the children with eight doses in the coverage survey had received all of their immunizations before their first birthday, coverage would have been 44%. The effect of using this figure in estimating cost-effectiveness is to reduce the cost per FIC by nearly half, to $12.91.

The coverage survey data indicate that the last dose (measles), which according to the program's immunization schedule should be given to children age 9-11 months, is frequently the missing dose that prevents a child from completing its immunizations before its first birthday. Chapter VI makes recommendations regarding revision of the immunization schedule. High drop out rates for DPT and OPV (see Table V.3) and failure to complete these doses within the target age range also result in lower coverage. For example, Table II.2 shows that although 47% of the surveyed children had received DPT3, one-third of them had this dose after their first birthday. Recommendations 3.1 and 4 in Section VI address the need to improve follow up of eligibles.

7. Cost per FIC in Each District

Using a coverage figure specific to the District, two approaches have been used to obtain a more realistic cost per FIC for each District.

First, it is assumed that coverage in the six sampled Districts averages 24% but the number of FIC in each District has been calculated based on the percentage of all doses to children under one year of age (in the six sampled Districts) given by that District. This produces the costs and ranking (from lowest to highest) shown in Table V.7.

Second, it is assumed that coverage in the six sampled Districts was higher than in the whole Region, because in these Districts there were more doses per targeted child and greater focussing of resources upon the target age group. Assuming that there is a direct connection between the number of doses given per child and the number of FIC, one can make as estimate of the percentage fully immunized in the sampled Districts. This can be done by multiplying the original cost per FIC for each District by its own figure for doses per child under one, then dividing by doses per child under one in the Region (3.15). The cost per FIC calculated in this way is shown in Table V.7 with the sampled Districts ranked from lowest to highest.

TABLE V.7

COST PER FIC FOR SIX SAMPLE DISTRICTS
USING TWO METHODS FOR ADJUSTING THE NUMBER OF FULLY IMMUNIZED CHILDREN

Number of FIC (at 24%) is Between Six Districts According to Percentage of Doses/Child* given in each District		Percent FIC per District Shared is Higher or Lower Than 24% According to How District's Doses/Child* Compares With Regions Doses/Child*.	
Um Rwaba	$15.64	Um Rwaba	$11.94
Rl Obeid	$16.35	El Obeid	$12.48
Dilleng	$17.24	Dilleng	$13.16
Kadogli	$19.49	Kadogli	$14.88
Rashad	$21.76	Rashad	$16.61
Bara	$26.27	Bara	$20.05
Average	**$18.46**	**Average**	**$14.09**

* Under one year of age

The three districts with the lowest cost per FIC all gave over five doses per child in the under one year of age target group. This approach overestimates El Obeid's performance, because although they gave a large number of doses, the drop out rate was very high (see Section V.A.4). Data on doses for the remaining three districts need further adjustment; in Kadogli and Rashad, the mobile teams did not make all of their monthly rounds, and in Bara there was a third mobile team until September 1988.

These figures give an idea of the scope for improving effectiveness in the Districts with poor performance on the productivity indicators, such as doses per eligible child.

8. Summary of Sensitivity Analysis

Table V.6 shows that by far the largest effect on reducing the cost per FIC comes from increasing the number of children who complete their immunizations within the target age. The second largest reduction is from using a rate of exchange which more closely reflects the purchasing power of Sudanese pounds in international markets rather than using the official rate at which donor contributions are exchanged.

D. Financial Management

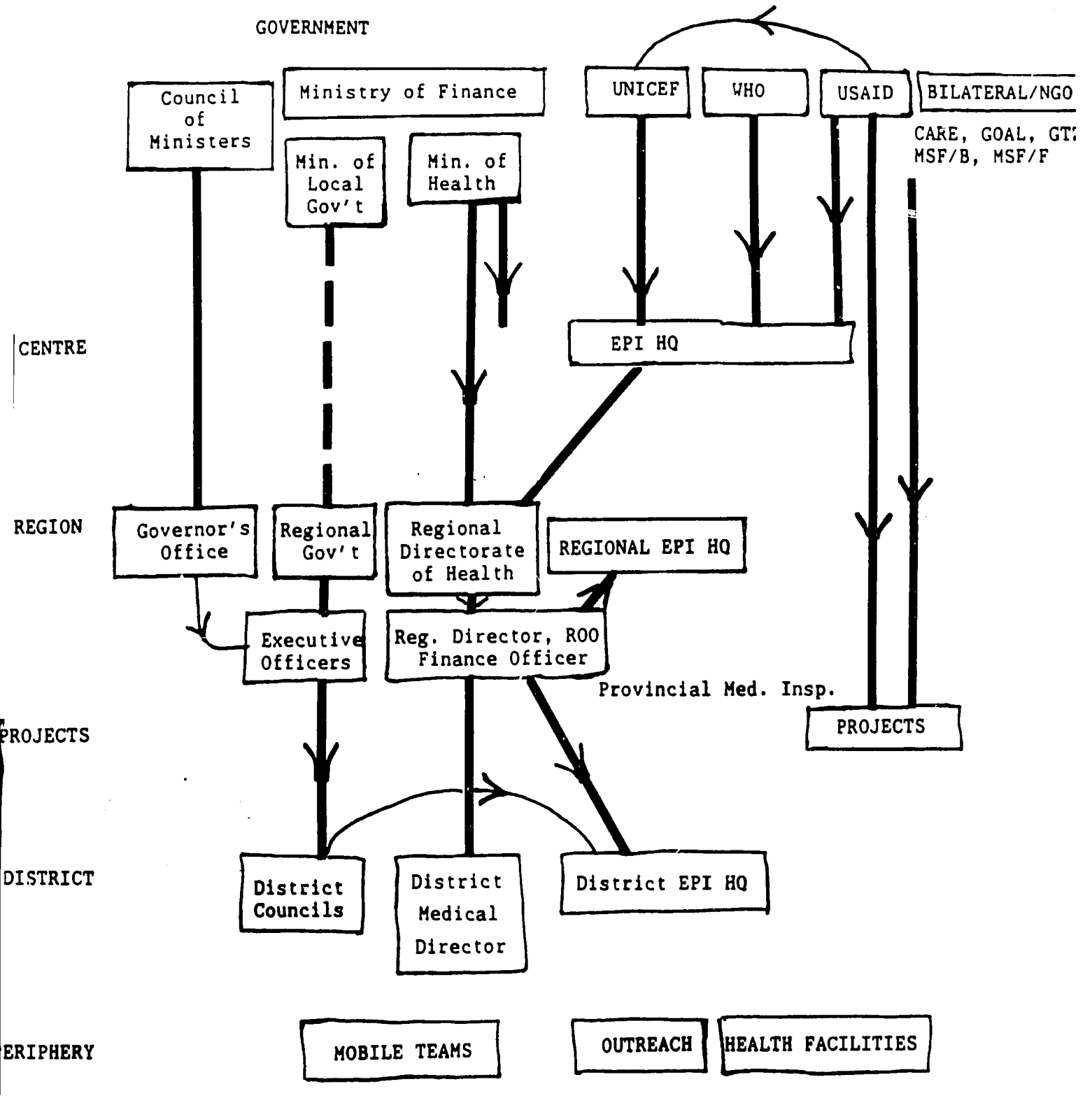
Although the cost-effectiveness Study Team was not specifically charged with evaluating financial management, their observations of accounting methods and record-keeping were that there was scope for strengthening this aspect of program management.

The sources of funds coming into the EPI are shown in Table V.5 with Figure V.1 showing the flow of funds between the levels of administration. At regional level, most of the program funding passes through the Regional Directorate of Health with 49% of the total from Central EPI/UNICEF and 27% from the Ministry of Health. Allocations of these funds to Regional HQ and to the Districts are made by a committee whose members are the Regional Director of Health, the Finance Officer from the Regional Directorate of Health, and the ROO. District Council's activities are affected by two separate bodies: the Governor's Office and the Ministry of Local Government. The executives officers at District level appear to have some discretion in allocating funds, as the extent of funding support to the EPI varies considerably between Districts. In some places, EPI staff were receiving transport allowance and overtime in addition to the per diem from Regional HQ. The amount of fuel purchased for the program by each District also varies.

In collecting information on costs, the Study Team found that record keeping systems on funding tended to be informal. Although the data on fuel, per diem, and salary expenditures were readily available at Regional level, the amounts did not tally with the data from Central HQ. Donor requirements for record keeping systems on funding did not involve a double-entry bookkeeping system and inconsistencies were not identified and corrected. The financial management of the program would benefit if a simple, standardized system were developed. For example, records on monthly per diem payments by District showed the Districts in a different sequence on each successive months, making such procedures as keeping a cumulative total (year to date) quite impractical. A standardized financial management system should be developed centrally in coordination with the Regions.

Figure V.1

SOURCES OF FUNDING FOR EPI



VI. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

The Cost Effectiveness Study of the Expanded Programme of Immunization in Kordofan Region (March - April 1989) found that the annual cost of the EPI at regional level was $910,074 (LS 4,049,800) in 1988. The output achieved with these resources was a total of 560,450 doses administered. The program's target for 1989 is to fully immunize 103,000 children before their first birthday (70% of the infants) and 128,800 pregnant women (70%). Data from the 1989 Coverage Survey showed that the Region has fully immunized 34,600 (24%) of the children under one year of age, and 36,300 (25%) of eligible women with two or more doses of TT. The cost per fully immunized child (eight doses before first birthday) for Kordofan Region is $23.77 (LS 106). If all of the children with eight doses had completed their immunizations before their first birthday, the coverage would have almost doubled, to 44%, and thus cost per FIC would be reduced substantially to $12.91 (LS 57).

Major constraints on extending coverage are the impassability of roads during the wet season, security in the south, and the narrow target age for measles immunization. Only 26% of measles doses were given to children in the target age range of 9-11 months. However, in some Districts only 1% of doses are given to children after their first birthday, indicating that the target age range is being rigorously adhered to. Because of the constraints, only a small proportion of measles doses can be provided by mobile teams within the age range set by the national immunization schedule. This schedule has been adhered to in calculating percentage and cost of FIC, and gives the impression that the program is twice as expensive per child than it would be with a higher upper limit on the age for measles immunization (see Recommendation 5).

Data from the six Districts visited show considerable variations in levels of activity. For example, the number of doses per eligible child varied by a factor of three. The effectiveness of social mobilization, health education, identifying eligibles, and following up defaulters also varied as is indicated by differences in drop out rates; there was a spread of 70% between the lowest and the highest. These factors affect the District's cost effectiveness. When measured by cost per dose, this varied by a factor of two ($0.86 to $1.44) in the six Districts visited. Such a wide range in cost per dose indicates that there is scope for increasing efficiency in the high cost Districts, especially for output per staff, as personnel is the largest cost category (see Recommendation 2).

Throughout Kordofan, the main strategy for extending EPI services is the mobile team. Fixed facilities only provide immunization in the main town of each District, and the seven day cold box strategy has been interrupted due to cessation of Council funds for transporting vaccine from rural dispensaries to PHCUs. Costs of outreach activities from facilities were not estimated. Thus costs were estimated only for mobile teams and fixed facilities, most of which were urban.

The majority of EPI resources were devoted to mobile teams at the time of the study although a mobile team costs far more to run ($18,783 per year) than EPI services at a health facility ($3,972 per year). The mobile teams' level of output is much higher at (33,400 doses per year compared with 3,900 at a health facility. Thus the average cost per dose delivered by mobile teams was $0.55 (LS 2.50), which is half that calculated for health facilities operating a fixed point strategy ($0.99 per dose, or LS 4.41). This difference in cost is largely explained by the low level of output per staff member during fixed facility EPI sessions: the average was four doses per hour with a range from five doses per hour to one dose every three to four hours. The hourly output per health worker on a mobile team was 12 doses per hour which is three times higher than at the health facilities. However, there was a range from 24 doses per hour to one dose per hour in the sample of seven mobile teams. Poor performance within the existing strategies can be improved by better monitoring using the activity indicators (see Recommendation 2), and by increasing of the community's utilization of available resources (Recommendation 4).

The task facing District managers is to reach their program goals within the available resources. Although the EPI has achieved a remarkably successful expansion in a very short time, this has been done largely through a vertical approach using a strategy which depends heavily on foreign exchange (for purchase of vehicles and fuel). Donors and NGOs presently provide 69% of funding in Kordofan. Some of the resources allocated to EPI could be used more effectively, and there are other resources available within the Ministry of Health and the community which are not being used to the full extent possible. Recommendation 1 suggests some measures which District and Regional managers can take to achieve a better distribution of resources.

The factor with the largest impact on reducing cost per FIC is high coverage. If the community responds positively to immunization services, the program's cost effectiveness increases. However, the coverage survey showed that 26% of eligible children with access to the EPI had never had any doses, and 57% of eligible women with access to immunization sessions had never received any TT. Recommendation 4 addresses the community's contribution to increasing the cost effectiveness of the program.

B. Recommendations

1. Improving Distribution of Available Resources

Planning at District level should seek the optimal mixture of strategies in order to provide immunization services to the largest number of eligibles possible. At least four distinct strategies have been used in Kordofan:

1) fixed facilities with refrigerators;
2) outreach from fixed facilities;
3) seven day cold box strategy supporting one day vaccine carriers to surrounding PHCUs; and
4) mobile teams.

To achieve the optimum mixture of strategies, District managers will need to:

1.1 Complete an inventory of available working resources including:

1) Ministry of Health facilities;
2) staff; and
3) refrigerators, (including those not supplied by EPI), indicating whether they can be used for storing vaccine and freezing ice packs.

If a refrigerator is out of order, the inventory should show what repairs and spares are needed. Assistance from the Regional Cold Chain Technician may be needed to assess the repairs and identify spare parts. Intersectoral cooperation with the veterinary services (who have some refrigerators) may also be called for.

1.2 For each village with a health facility, indicate whether it is served by public transport which could be used for resupplying vaccine. If it is not, find out whether the community is willing to cover the cost of transporting vaccine from the nearest supply point.

1.3 Establish the size of the target population in each catchment area to be served by each strategy (facility, outreach, seven day cold box, one day vaccine carrier, or mobile team).

1.4 Set the number of sessions offered per week or per month at a level which is appropriate for the size of the target population in the facility catchment area or by the mobile team immunization site (center). Thus some health facilities only need to offer services once per week, and some villages can be visited less often than every month.

1.5 Assign staff according to the expected work load per session. Ways of establishing the expected workload per health worker are discussed in Recommendation 2.1.

1.6 Let health facility staff who have been trained in EPI conduct sessions without the assistance of the mobile team vaccinators so that the team can devote its effort to communities with no health facilities.

Some Districts are already using some of these methods in their strategic planning. The result is higher staff productivity, lower vaccine wastage costs, and better use of fuel - all of which improve the effectiveness of resource use.

At Regional level, distribution of resources could then be made on the basis of the total availability of resources in relation to the size of the target population. Thus, instead of each District receiving an equal share of EPI

resources, Districts with a well established public transport system might need fewer vehicles.

2. Increasing Productivity of Resources Using Activity Indicators

2.1 For each District, or the Region as a whole, EPI managers and operations staff should establish a level of activity which is considered reasonable by both themselves and staff who work on EPI. For example, this study found that the average output during immunization sessions (excluding travel time, eating, etc.) was 12 doses per health worker per hour for mobile teams, and four per health worker per hour in facilities. This level of activity may be thought too low, as the maximum for mobile teams was 24 doses per staff per hour, and for facilities it was five doses. Another indicator that could be used is number of contacts (children or pregnant women) per staff per session (or per day, if the outreach or mobile team visits more than one center).

If the number of doses or contacts is lower than this agreed norm, it may indicate:

1) too many staff for the work load;
2) sessions are too frequent for the size of the target population (see Recommendation 1.2); or
3) utilization by the eligible groups is lower than expected.

Low utilization may be due to low uptake of services (see Recommendation 4) or high drop out. If the reporting system indicates the latter, supervisors should look into staff's immunization techniques and see how they interact with those who come for services.

2.2 Indicators of the vehicles' activity (kilometers per round, kilometers per dose administered or per contact) should be routinely checked to monitor use of this costly resource. In the present strategy, which relies upon mobile teams, every month that a vehicle is out of action has a negative effect on output. Measures which increase the vehicles' useful life (such as regular maintenance, a stock of fast moving spares at Regional level, and careful drivers) will both increase productivity and decrease costs.

In parts of Kordofan, the terrain is more suitable for animal transport than for vehicles. Camels or donkeys should be used where possible rather than needlessly straining a vehicle.

2.3 For mobile team activity, productivity can be increased by scheduling rounds which last for the full cold-life of the cold box, and thus reducing the number of trips to headquarters. If ice packs were refrozen at remote refrigerators, the range of the mobile team would be extended. Fewer trips to headquarters will lower fuel consumption and decrease the time lost in transit.

Regional staff should make sure that all District staff know the proper use of the various devices for monitoring the cold chain in the field (thermometers, ice pack indicators which show if the ice pack is too cold for DPT and TT, and cold chain time/temperature monitor cards which turn blue if exposed to unacceptable conditions). These monitors will indicate whether the cold chain is safe, and will help avoid the costs of extra trips to HQ.

2.4 Mobile team schedules have to give the staff a respite from being constantly on the move. However, the schedule should not be designed so as to maximize vaccinators' per diem. The team with the highest personnel cost had twice the usual number of vaccinators, and was rotating them between the rural and urban teams. The urban team had the lowest output per staff member in the sample. The use of activity indicators to monitor output would help avoid such inefficient use of personnel.

The scheduling system used in Um Rwaba might provide an example. In this District, a total of seven rounds are made each month by two teams. Each month, one team makes four rounds and the other makes three rounds. Thus, every other month, each team has a week off. This seems to be a reasonable arrangement, as the teams are traveling almost continuously for seven of every eight weeks.

3. Strengthening Management Systems

Cost effectiveness can be increased by using the information system to track the program's targets and outputs.

3.1 The Registration Book should be used as a birth record of eligibles, who should be registered at birth. Each month the group of infants who should be receiving immunizations can then be identified and followed up (see Recommendation 4).

3.2 The information system used for monthly reports is in terms of doses administered, yet coverage must be calculated in relation to the number of children immunized. Two additional items of information on the Daily Tally Sheet would make the task of monitoring and improving performance (measured by coverage) much easier. These items are: 1) number of children under one year of age seen at the session; and 2) number of children who completed their immunizations within the target age.

This information could then be linked with the size of the target group (see Recommendation 1.3) for each session to compare how many children had been expected and how many were in fact seen.

3.3 Stock records need to be kept more accurately in some Districts. Information about the number of doses consumed at each session would make it possible to assess vaccine utilization. For example, high consumption may be caused by small session size or careless use of vaccine.

3.4 The vehicle log books should be properly filled out and the rates described in Recommendation 2.2 should be used for monitoring use of the vehicle.

4. The Community's Response

The lowest drop out rates, highest contacts per eligible child and the lowest cost per dose was in a District which has already started a system of community birth registration. A volunteer from the village enters births, by month, in the Registration Book and follows up eligibles to remind the family that they should go for immunization. With the Registration Book arranged by month of birth, it is easier to identify children who have not received the doses on schedule. Prompt and effective follow up also reduced the drop out rate.

For rural communities with a health facility, the health worker can do the registration and follow-up himself. Alternatively, he can supervise volunteers if his own curative work schedule is heavy and if the village is large. A similar system needs to be developed for urban areas.

5. Raising the Upper Age Limit for Evaluating Measles Coverage

The upper age limit for assessing coverage for measles immunization should be extended beyond the excessively narrow three month window currently applied to calculations of FIC. Districts which appear to be withholding measles vaccine from children past their first birthday should be urged to administer this vaccine to all children up to a higher age limit (e.g. 18 months). The national schedule should be clarified on this matter.

At present only one-quarter to one-third of the measles vaccine used is administered to children (the rest is discarded). If epidemiological analysis were in favor of a two-dose schedule, this could be implemented without increasing vaccine costs. A two-dose strategy would entail an increase in the cost of supplies (syringes and needles) amounting to 0.2% of the Region's program costs.

APPENDIX 1

LIST OF PERSONS MET

APPENDIX 1

LIST OF PERSONS MET

A. In Kordofan (chronological order)

Jan van Mannen, UNICEF, El Obeid
Awadhia Jubaara, UNICEF, El Obeid
Salah Al Agib, Regional Cold Chain Officer
Dr. Mirghani Suleiman Arsheen, Regional Director of Health

Dr. Mustafa AbuBakar Omer, Deputy RMD, Director of PHC, Northern Kordofan
Dr. Palani Appan, Regional Coordinator, RHSP (MSCI/USAID) Taher Sid Ahmed, Director of Training, RHSP
Ahmed AbuZeid, DOO, El Obeid
Mansoor Bura'i, Supervisor, Mobile Team, El Obeid

Adam Al Bakar Ali, Admin. Assistant, North Kordofan Child Health Project (CARE), Nuhud
Halima Ibrahim and Semira Ismail, Vaccinators, Radeef Health Centre, El Obeid
Pamela Bolton, Child Survival Adviser, RHSP
Mohamed Wida'a, Assistant DOO, Abu Jibeha
Rashad Mohamed Al Noor Bandas, DOO, Kadogli

Ali Nasr, DOO, Um Rwaba
Mahtaseem Mohamed Abdul Rahman, DOO, Bara
Mohamed Jebralla, Medical Asst, Tayba Disp, Bara
Khogli Babaker, District Cold Chain Officer, Bara
Adil Sherif, Amin. Assistant, NKCHP (CARE), Bara

Hamdoon Abakir, Project Activity Coordinator, NKCHP (CARE), Bara Ahmed Besheer Al Fil, Medical Asst, Hamadi Dispensary Dilleng Azam Hassan Dinn, DOO, Dilleng
Alaweya Martoon, DCCO, Dilleng
Nana Omer, Vaccinator, Dilleng

Sayid Haamed, Dispensary Inspector, Kadogli District
Ihsaah Hussein Ali, Vaccinator, Kadogli
Fatima Idris Sayeed, Vaccinator, Kadogli
Zayneb Omer Kooa, Vaccinator, Kadogli
Dr. Noor Al Dinn Ahmed Sayid, Medical Inspector, Rashad

Salwa Ali Na'am, Typist/Clerk, Abu Jibeha, Rashad
Osman AbdulKareem Mustafa, Vaccinator, Abu Jibeha, Rashad Abdul Basit Angelo, Asstistant Dispensary Inspector, Rashad Kookoo Idris Matar, DOO, Abu Jibeha, Rashad
Omer Mohamed Osman, DOO, Abbasiya, Rashad

Saafania Ismail, Vaccinator, Abbasiya, Rashad
Zahara Yussif Kodi, Vaccinator, Abbasiya, Rashad
Dr. Biar Daing Head, Save the Children/USA, Um Rwaba
Amar Ali, Vaccinator, Um Rwaba
Adam Ahmed Idris, Medical Asst, El Semeigh Disp, Um Rwaba

APPENDIX I (continued)

Al Tahir Adam Mohamed, Coordinator of PHC, Rahad Area, RHSP; Dispensary Inspector, Um Rwaba
Abdul Rahman Babikir, Regional Operations Officer,
EPI Ibtesaam Ahmed, Vaccinator/Records, El Obeid
Muzamil Yussef Suleiman, Accountant, Regional EPI HQ
Haamed Osman Ahmed, Second Chief (Commercial Branch) and Announcer, Kordofan Radio Station
Mohamed Abdul Montaib, Medical Asst, Sahaafa Disp, El Obeid

B. In Khartoum (by organization)

National EPI Headquarters:
Dr. El Tayib, Director, EPI
Adam Babikir, Head, Operations Section, EPI
Mohamed Hassan, Head, Cold Chain Section, EPI
John Pott, Technical Adviser, Cold Chain
Sybil Amin, Administrative Assistant

Ministry of Health:
Khedir Khalfula Al Khedir, Chief Accountant, MOH, Khartoum Region Hamed
Hassan Hussein, Engineer, MOH Workshop
Noor Al Dinn Meysara, Vehicle Mechanic, MOH Workshop

Khartoum City Commissariat:
Yahya Fathal Jubara, Accountant

UNICEF:
Ahmed Mussana, Health Section
Michael, Shipping Reports, Supply Section
Abbas, Health Section

CARE:
Isaam Ghani, Program Coordinator
Teresa Williams, Financial Controller

Save the Children Fund/UK:
Catherine Conn

Deutsche Geselischaft fuer Technische Zusammenarbeit (GTZ): Edgar Koepsell, Renevable Energy Research Institute

Sudanese Liquid Air Company:
Kamal Abdel Magid Ahmed, General Manager

APPENDIX 2

FIELD VISITS

APPENDIX 2.1

ITINERARY OF FIELD WORK IN KORDOFAN

Date	Place	Activity	Travel Time	Km
11 March	Khartoum El Obeid	Travelling via Kosti (stuck in sand 4 times)	18 hours	750 approx
12 March	El Obeid	Preliminary meetings with UNICEF, RMD, RCCO, RHSP staff. Interview with Urban Mobile Team. Selection of sample (evening)		
13 March	El Obeid	Started interviewing DOOs from Kadogli, Rashad, UmRwaba, who were at HQ collecting supplies Bara Interview with DOO (evening)	1 hr 50 min	67
14 March	Tayba	Dispensary - Interview with Medical Assistant	1 hr 30 min	65
		Bara (stuck in sand 1 hour) Completed DOO & Mobile Team data collection	2 hr 30 min	65
		El Obeid Reached Guest House 7.30pm	1 hr 50 min	67
15 March	El Obeid	Interview with DOO Assembling Regional data Preparing for trip-fuel, water Left El Obeid at 4 pm. Hamadi Hamadi Dispensary supervises Cluster 23, ElOdeia. No fixed point EPI; no interview.	1 hr	98
		Dilleng Interview with DOO	1 hr 20 min	70
16 March	Dilleng	Mobile Team interview Visited Hospital but EPI no longer offered there.		
	Kadogli	DOO interview	3 hr	95
17 March	Kadogli	Interview with Mobile Team & Health Facility staff		
	Dilleng	collect salary data	3 hr	95
	Habeela	Evening meal, asking about security	1 hr 15 min	42
	Kortala	Stop for the night 9 pm (Area between Dilling and Abu Jibeha was not accessible due to security situation, so we travelled round two sides of a triangle.)	1 hr 10 min	38

APPENDIX 2.1 (continued)

18 March	Khor El Dalib	Morning Meal	4 hr	151
	Abu Jibeha	Interview with Cold Chain and Health Facility staff	1 hr 50 min	62
19 March	Abbasiya	Interview with DOOs, visit to Mobile Team session at a club building in town	5 hr	129
Um Rwaba		Interview with DOO and head of SCF/US project	1 hr 20 min	92
20 March		Interview with Health Facility and Mobile Team staff		
	El Semeih	Visit to Dispensary at Cluster No.11; no fixed point services, no structured interview.	1 hr 10 min	58
	Rahad	Health Facility interview and data on 2nd Cold Chain	35 min	24
	El Obeid	Return to Guest House	2 hr	73

From the schedule above, it will be seen that the travel time for the Team's Toyota Hilux Double Cab varied from 26 km per hour to 98 km per hour. This variation was due solely to the state of the roads, which ranged from a fast, graded surface covered with a layer of aggregate, to track with varying depths of ruts, to the slowest of all in the Nuba Mountains, which was rocky and steep in places. If one gets stuck in deep sand or mud, it is impossible to predict the travel time on these routes.

APPENDIX 2.2:

INTERVIEWS CONDUCTED AND CLUSTER SITES SAMPLED

a) In El Obeid, two mobile teams cover suburban sites within El Obeid town and in the surrounding rural areas of the District. Staff switch from rural to urban duties every 7 days. Two urban health centres were surveyed close to the urban clusters of Remeilla (1) and Thawra (3).

b) El Nebda, the coverage survey cluster, is within the health complex area of Tayba Dispensary. Until November 1988 the CHW at El Nebda PHCU collected vaccine once per month from Tayba Dispensary (see (d) below). Now this village is served only by the Mobile Team from Bara. (The coverage survey team substituted Um Haashem for El Nebda.)

c) This site is within the area covered by the Northern Kordofan Child Health Project, receiving support from CARE.

d) Tayba Dispensary was the supply point for a 7-day cold box system which operated until November 1988. A fixed facility interview was completed with reference to that period. This site was not one of the coverage survey clusters.

e) The Team visited the dispensary at Hamadi, but this facility and the cluster village are served only by the Mobile Team.

f) This site is within the area receiving support from the Rural Health Services Project (RHSP).

g) The urban area served by this health facility was not in the cluster survey sample.

h) This cluster was covered by a Mobile Team from Kadogli, but at the time of the coverage survey the security situation made it impossible to visit the village. Thus cost data refer to Tanjoura but coverage data refer to a different site.

i) Two clusters were covered by Mobile Teams operating from Abbasiya and Abu Jibeha.

j) An urban cluster in Um Rwaba Town was substituted by the coverage survey team; the health facility surveyed for costs probably served the same target population.

k) This site is within the area supported by the SCF/US integrated primary health care project.

l) The Team visited the Dispensary at El Semeigh, but fixed point services using a cold box and vaccine carriers stopped in February 1989; this system had been running since October 1985. No Mobile Team interview was completed.

m) This cluster was covered by one of the District's mobile teams, but the cluster was not in the round to which the MT interview data referred.

APPENDIX 3

COST PROFILES

APPENDIX 4

BACKGROUND DATA ON COSTS AND PRICES

APPENDIX 4.2

COSTS OF VACCINE

The vaccine in the Sudan's EPI is procured through UNICEF. The amount spent on vaccine was determined from the UNICEF shipping reports; all invoices raised in 1988 were included in the cost of vaccine for that year. A total of 21 shipping reports were used in this analysis.

The shipping reports show the antigen, its value, and the cost of freight, in US dollars. The supporting documents from the manufacturer show how many vials of the vaccine were dispatched, cost per vial, and any special discounts (e.g. 0.3% discount for WHO testing). These supporting documents were needed in order to separate out the cost of individual antigens, since one-third of the shipping reports were a combined invoice for two different antigens.

For each antigen, an average cost per vial and an average cost per dose was calculated. These figures were then used in the spreadsheets containing data on stock movements and doses administered, to calculate the cost of vaccine administered, and the cost of vaccine used (i.e. including the cost of wastage).

There was a complication in choosing the average costs for BCG; the first two shipments were 10-dose vials which worked out to cost almost three times more per dose than the 20-dose vials. Since all of the 10-dose BCG had already been used, the cost of BCG in 20-dose vials was used in this analysis.

Freight charges from the manufacturers to Khartoum have not been included in the calculation of the cost of vaccine at the levels of mobile team, health facility, district or region. The cost of international freight was 14% of the value of the vaccine itself.

For Kordofan Region, the annual cost of vaccine estimated by multiplying February 1989 data by 12 was $55,880. As a check upon whether this figure accurately represented annual consumption in Kordofan, the region's monthly reports of doses issued to Districts in 1988 were analyzed; records were available in Central EPI files for 7 months. The annual cost of vaccine estimated from these data was $54, 831, which is within 2% of the figure used in this report. However, data on doses issued from Central HQ to the Regional HQ in 1988 produce a higher cost figure ($62,339). This was calculated from information in the report on Sudan's EPI Cold Chain (1988) pp.3-4. The variations in these cost estimates may be caused by seasonal differences in activity in the Region.

APPENDIX 4.9

CALCULATION OF THE COSTS OF SOCIAL MOBILIZATION

1. Public Service Announcements on the Radio

Staff at Kordojan Radio Station gave the following information about the cost of conventional advertising:

- There is a booking fee of LS45 per minute for each separate advertisement (i.e. script). One booking fee per month has been assumed for the EPI in Kordojan.

- Conventional advertising costs LD90 per minute plus 4% tax.

- It was calculated that each month approximately 25 minutes of radio time was devoted to EPI messages and announcements.

Thus the monthly cost of the radio time devoted to public service broadcasts about immunization was:

Booking Fee	+	(Cost/minute x Minutes/Month)	x	4% Tax
LS45	+	(LS90 x 25)	x	1.04

APPENDIX 5

SUMMARY OF KORDOFAN REGIONAL EPI PROPOSAL FOR 1989

APPENDIX 5

SUMMARY OF KORDOFAN REGIONAL EPI PROPOSAL FOR 1989

By December 1988, vaccination coverage was estimated to be 40%, after that District Committees met together and developed a proposal for the year
1989, which is to be adopted as the Regional EPI proposal for 1989.

1. GOALS

To attain 70% vaccination coverage for target population (infants and pregnant women) by 1989 using the following strategy (District Council EPI
programming).

2. COVERAGE STRATEGY

a) Static units: supporting static units at hospitals and health centres where there is Cold Chain equipment

b) The proposed strategy is to increase vaccination centres at towns and increase the number of working days per week, EPI being integral to other health services.

c) The Solar refrigerators will increase the number of fixed Cold Chain units. During 1989, there are about 18 Solar refrigerators to be installed.

3. MOBILE TEAM STRATEGY

In the Regional EPI Proposal the term mobile teaam is used for several activities which include the following:

a) A mobile team, composed of two or more vaccinators, one supervisor and one driver. They usually have a round trip from the province or district HQ. They travel for 5-7 days giving vaccination to various types of settlements, including nomadic tribes.

b) Transport of vaccines to fixed health units. In this case 7 days cold boxes are taken by a vehicle to dispensaries. Then vaccines are further transferred to the PHCU by the community health worker himself or any member of that community. During the first 9 months of 1988, the rural councils used to pay travel expenses for those who take vaccine carriers from dispensary to PHCU).

c) Outreach from fixed facilities Mainly at the big towns e.g. El Obeid, Kadugli etc.). A car drops off vaccinators with vaccines in a one day vaccine carrier.

4. COMMUNITY INVOLVMENT

For acceleration of 1989 plan, the community should be involved in the whole managerial process. Innovative approaches are needed using different communication media. There should be health committees at village, Omudia, district and regional levels. The integration of EPI activities with health services at village and district level is crucial. The district operations officer should coordinate with:

1. Dispensary inspector
2. Medical inspector
3. Health visitor
4. Medical directors of rural and district hospitals
5. Public health inspector
6. District and rural councils administrative officers
7. Teachers
8. Religious leaders

At the regional level, the ROO (Regional Operations Officer) should work in collaboration with Kordofan local broadcast and communication and culture department.

Monitoring and Evaluation

There is a monthly meeting of district operations officers at the regional headquarters (it is planned that district health committees should meet on the 21st of every month to review their progress before attending the regional meeting. A check list was developed for weekly and monthly self-assessment for DOOs. There is also an annual coverage assessment.

5. THE ROLE OF NGOs

There are several NGOs providing regular or short term support to health(PHC) activities including EPI:

a) SCF(USA): Child Survival strategy working at Um Ruwaba district giving two vehicles including maintenance and fuel, for either mobile teams or delivering vaccines.

b) CARE(USA): The North Kordofan Child Health Project implementing child survival plan in El Nahud and Bara districts, providing vehicles for transport of vaccines, mobile teams and training activities.

c) RURAL HEALTH SUPPORT PROJECT(RHSP): Continuing its support to Bara and Dilling districts by providing fuel and per diem for mobile teams(Abu Zabad district) for 3 months. It also offers support to PHC activities in Rahad(Um Ruwaba district). It also supported two training courses at Abu Jibeiha town).

6. TRAINING AND SUPERVISION

There are several training courses regularly conducted at district and regional levels. There is no change in their regulations through 1989:

- Basic training for MA, nurses, midwives and health visitors about EPI
- Educational courses for TBA, village midwives
- Short term refresher courses for 3 day mainly for previously trained CHW
- Introductory health educational courses for community leaders and volunteers

7. ACTION PLANS AT DISTRICT LEVEL

A) Dilling District

There is no problem of transport during the rainy season.

1) Vaccination sessions should start on the 5th day of every month at: Salara rural council, Deibebat rural council, Dellamei rural council.

2) Outreach to schools. First term January-March 1989, second term October-December 1989.

   - The mobile team should deliver cold boxes(7 days) to dispensaries with Solar refrigerators or kerosene refrigerators and then conduct vaccination sessions at small villages.

   - For nomadic people they are to be served by the nearest health facilities or mobile teams during their movement from south to north.

B) Rashad District

1. Regular support to fixed health units, centres and hospitals by immunization services.

2. Conduct monthly meetings attended by:

   i) District operations officer
   ii) Dispensaries inspector
   iii) Medical director
   iv) Public health inspector to review their work

3. Health visitor should meet with village midwives(village midwives), traditional birth attendants and other health centre staff to ensure the integration of MCH/FP activities at the health centre level.

4. Intersectoral collaboration through regular meetings and nonformal discussions with health related professions.

5. Formation and organization of village health committees.

6. Mobile teams work schedule should concentrate on the southern council due to difficulty in transport durig rainy season(June-October):

a) Talodi rural council	January
b) Abu Jeibeha rural council	
c) Kalogei rural council	March
a) Um Brambeta rural council	April
b) Abu Karshola rural council	
c) Rashad rural council	June
a) Rashad town council	July
b) Nomads	
c) Abassyia town council	
d) Abassyia rural council	October

C) El Nihud District

1) Supporting immunization services at hospitals, health centres and fixed PHCU.
2) CARE(USA) will support four rural councils by providing a truck to deliver vaccines at dispensaries.
3) Mobile teams mainly to small villages with no PHCU.

D) Abyei District

1) Supporting static units at hospitals and health centres.

2) Mobile teams for PHCU working closely with health committee.

3) For nomadic tribes by mobile teams and fixed units at their route of movement.

Summer Settlements:	Dry Season
- Manteic, Dambaloya	February
- Andeil, Jangarei, Antalla May	
- Meiram, Bahar El Arab	August
Autumn Settlements:	Rainy Season
- Tibbon, Buttah September	
- Kheibat, Ganttour	October
Settlements during harvest:	January

E) El Fula District

1) Mainly to support static units and mobile teams

- Sunut rural council	January
- Lagawa rural council	
- Summer settlements of nomads	April
- Keilak lake	May
- Autumn settlements for nomads	September
- El Fula rural council	
- Lagawa rural council	October
- Fula rural council	
- Lagawa rural council	December

F) El Obeid District

The goal is to attain 75% coverage of the target population.

1) Strategy

a) Static units at health centres and hospitals giving vaccination 6 days a week.

b) Health personnel should transfer vaccines from Cold Chain to the health centres by the available means (public transport).

c) Outreach from the district headquarters to the surrounding villages and suburban settlements.

G) Um Ruwaba District

Goal is to attain 80% coverage by the end of year 1989.

1) Strategy

a) Static units at hospitals and health centres on daily basis.

b) Deliver vaccine carriers to dispensaries every month by vehicles donated from(SCF). CHWs are expected to come and collect their vaccine carriers from dispensaries and conduct immunization sessions at their villages.

c) Mobile teams.

H) Bara district

1) Static units at hospitals and health centres.

2) Delivering vaccine carriers to dispensaries.

3) Mobile teams mainly to small villages with no PHCU.

4) Involvement of the CHW by making them come to dispensaries and collect their vaccines.

I) Sodari District

1) Static units at hospitals and health centres daily activity.

2) Mobile team to cover:

a) Hamarat El Wiz rural council
b) Sodari rural council
c) Hamarat El Sheikh rural council
d) Umbadir rural council

Maintenance of the vehicle every two months.

L) Kadugli District

1) Static units at hospitals, health centres as daily activity.
2) Increase outreach units for the displaced populations (on monthly basis).
3) Mobile teams around Kadugli town.
4) Short term activities at Heiban rural council and potentially secure areas.

APPENDIX 6

REFERENCE DOCUMENTS AND REPORTS

APPENDIX 6

REFERENCES

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