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EVALUATION OF

HEALTH IMPACT OF TUBEWELL WATER SUPPLY

IN DRY ZONE RURAL COMMUNITIES,

BURMA

Report Prepared by

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MARCH 1989

A UNICEF ASSISTED PROJECT

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PREFACE

There is increasing global recognition that the environment in which children are reared determine to a great extent their general welfare and the achievement of their full growth potential. Availability of adequate safe water and access to and use of sanitary latrines determine the general environment around the homes in which children grow. There has, however, been no specific research efforts to measure the impact of water and sanitation on the general health situation of children. This was the background against which the Department of Medical Research undertook the Health Impact Study with UNICEF assistance during the period 1983-1987.

The study findings indicate the positive impact of the availability and use of household latrines on diarrhoeal diseases among children, which is further augmented by the availability of adequate water and health education activities. The study results clearly indicate the importance of ensuring the convergent delivery of water, sanitation and health education to obtain optimum results. The study also identifies areas which needs further research efforts and these should be undertaken at the appropriate time in the future.

We congratulate the research team for their accomplishment, and recommend this report to all researchers and administrators interested and/or involved in improving the overall welfare of the people and especially of children and women.

Rangoon, 28 March 1989

M. Rajan
Deputy Representative

FOREWORD

With a view to improve the health and physical quality of life of millions of people, water and sanitation programmes have been implemented in many developing countries which are being funded by donor agencies and/or national governments. International Agencies who invest and donate fund for these programmes are looking for hard evidence in the form of health benefits accruing from such interventions. Likewise, UNICEF and other donor countries investing in water supply projects and sanitation programmes in Burma are now much concerned with apparent advantages such as convenience, added comfort, disease reduction and improved health resulting from such interventions.

For this reason, the Department of Medical Research has undertaken a longitudinal follow-up study in dry zone rural communities to evaluate the health impact of tubewell water supply programme. In addition, the effect of latrine programme on diarrhoeal diseases was also studied in some villages. The study is the first of the impact evaluation studies that has ever been undertaken in Burma. As such, a great deal of importance is attached to research methodology for imparting knowledge to young scientists who are currently invloved in this field of research.

I sincerely hope that the major findings that are being highlighted in this report and the recommendations brought forward by the authors would be of great help for modification of the strategies and their adoption in the subsequent phases of Water and Sanitation Programmes in order to achieve set goals of sanitation decade in the context of Health For All by the year 2000.

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ACKNOWLEDGEMENT

The authors would like to express much appreciation to the Director General of Rural Water Supply Division, Agricultural Mechanization Department, Ministry of Agriculture and Forest, for providing the opportunity and assistance to conduct this project.

Special thanks are due to UNICEF Resident Representative and Deputy Resident Representative, Senior Project Officer and Project Officer, Water and Sanitation, UNICEF, for providing funds and necessary assistance to conduct this extensive and indepth study.

We are also grateful to Mr. K. B. Kothari, Regional Adviser, UNICEF for providing invaluable suggestions in preparing this report.

Much appreciation is due to the Members of the Study Design Group for their guidance and constructive comments throughout the study.

The encouragement and guidance provided by the Director General, Department of Medical Research, Ministry of Health is gratefully acknowledged. We are also deeply indebted to Director General, Department of Health for his continued support in data analysis and report writing. Much appreciation is also extended to the Divisional, Township and Local Authorities and the staff of the Rural Water Supply Division, AMD, who provided much help in conducting the field studies.

Thanks are also expressed to the Divisional Health Directors, Magwe, Mandalay and Sagaing Divisions and the Township Medical Officers, Magwe, Kyauk-Pa-Daung and Nga-Zun Townships and their staff for making arrangements for the field surveys.

Last, but not the least, the support and encouragement of the Project Manager Dr. Thane Toe, Deputy Director (Research), Department of Medical Research is gratefully acknowledged.

SUMMARY

A longitudinal health impact study was carried out in a number of selected rural communities of dryzone area of Burma to evaluate the impact of tubewell water supply and wherever applicable the impact of latrine facilities on set indicators diseases. A quasi experimental design was adopted and a two-way comparison was made applying internal as well as external evaluation designs, placing emphasis on the former. A total of six villages, two from each of the three townships served as experimental group (intervention group) whereas three villages, one from each corresponding township served as control group for the purpose of periodic comparison before, during and after provision of project water facilities. Interview technique and direct observation methods were applied to obtain relevant information by using pre-tested questionnaire. Physical examination was done on all family members to diagnose and record indicator diseases and laboratory investigations were undertaken for bacterial and chemical quality of water and stool examination for ascaris ova. Weekly surveillance of indicator diseases was also carried out by field supervisors in each village. Four monthly periodic seasonal surveys covering pre-intervention and post-intervention periods were undertaken during December 1983 to August 1987. The major findings of the study are highlighted below:

1. Tubewell water from the project water system was used by a large proportion of the population in four of the six study villages where the tubewell water was made available.

2. Convenience in distance travelled and time spent for fetching water was greatly affected by supply of tubewell water as the majority of the population saved considerable time for travelling shorter distances to fetch water from project water supply.

3. Affordability to spend on project water varied form village to village depending largely on the pricing policy set up by each village. From time to time the cost of water was raised due to shortage and high cost of fuel. Changes in pricing policy was the main concern of the communities.

4. Tubewell water was free from faecal coliform at the main source but usually gets contaminated during carriage, storage and water handling practices at home.

5. The impact of tubewell water alone on the morbidity rates of indicator diseases was rather marginal and there was no evidence of marked changes in villages with access to and use of tubewell water.

6. The impact of latrine facilities on the indicator diseases was more marked then tubewell water supply and villages with sanitary latrine facilities had significant reduction in incidence of diarrhoea.

7. The combined effect of tubewell water supply and latrine facilities on indicator diseases was very remarkable since villages with both of these facilities revealed significantly lower incidence of diarrhoea and other indicator diseases than those with tubewell water supply or latrine facilities only.

CONTENTS

LIST OF TABLES

Tables | Page

Tables | Page

LIST OF FIGURES AND MAPS

CHAPTER I

INTRODUCTION

Diseases related to poor water quality and inadequate or lack of excreta disposal facilities, particularly diarrhoeal diseases, are still a major health problem in the less developed countries. In Burma, the successive Country Health Programming exercises that were undertaken in 1976 and 1980, had identified diarrhoea and enteritis as number one priority health problem among the 56 priority health problems. The occurrence of high incidence of diarrhoeal diseases, especially in the rural communities, is not very surprising since only one-fifth of the rural population has access to reasonably safe water and more or less about the same propotion of population has proper facilities for human waste disposal. Other water related health problems such as cholera,amoebiasis,infective hepatitis,helminthiasis, typhoid, skin infections, trachoma and conjunctivitis are also commonly prevalent in the country, the figures for commonly prevailing diseases in children are given in Annex 1.

Improvements in water and sanitation are believed to affect health,mainly by reducing the ingestion of faecal-oral pathogens. It is anticipated that access to and use of an adequate supply of potable water would play a significant role in reducing the incidence of water-borne and waterbred diseases, most notably gastro-intestinal diseases in young children. Improved water and sanitation facilities would help break the oral-faecal route of disease transmission by reducing the level of water contamination at the source as well as at home and also by adoption of proper excreta disposal practices which would reduce the level of faecal pollution of the environment.

With a view to improving the health and well-being of many millions of people, the United Nations has launched a world-wide effort to break the faecal-oral transmission of diarrhoeal diseases by declaring the 1980s to be the International Drinking Water Supply and Sanitation Decade (IDWSSD)(1). In accordance with the national health planning process and in the context of the IDWSSD, Burma has set a national target of providing reasonably accessible safe drinking water and sanitation facilities to 50 per cent of the population by 1990. In order to achieve the national targets and to accomplish the ambitious task, specific intervention strategies have been formulated by the sectors concerned for supply of safe water and sanitation facilities to the rural and urban communities of Burma.

The Rural Water Supply Division (RWSD) under the Agriculture Mechanization Department (AMD) of the Ministry of Agricultural and Forests has prepared Plan of Action for Rural Water Supply Projects for 1982-86(2).This plan includes intervention strategies for rural water supply in dryzone area by drilling tubewells with power pumps. Similarly, the Environmental Health Programme of the Environmental Sanitation Division, (ESD) of the Department of Health, Ministry of Health includes strategic intervention activities to provide safe water and sanitation facilities to rural communities during the planned period 1982-86 (3). The need for evaluation of water and sanitation facilities has been well spelled out in each of these programmes.

It has been increasingly realised in recent years that evaluation should be an integral component of the water and sanitation programmes for evaluating the effectiveness and health impact of these programmes. Moreover, International Agencies who invest and donate money in these programmes are looking for programmes that offer concrete results. Many agencies are now looking for hard evidence to prove the health benefits accruing from such interventions.

Likewise, UNICEF and other donor countries investing in water supply projects are now much concerned with both the immediate apparent advantages such as convenience, added comfort and time saving as well as gradually appearing advantages overtime such as disease reduction and improved health. For this reason, UNICEF and the Australian Developement Assistance Bureau (ADAB) have contributed American dollar 15 million for the Dry Zone Water Supply Programme in Burma.

Although, greater attention has been paid now on the evaluation aspect of water and sanitation programmes, so far only a few studies have been carried out in Burma to evaluate the effectiveness of these programmes and most of them are rather descriptive in nature. Moreover, prospective analytic studies relating to health impact of an intervention program are also scatchy. Most of the reports currently available on the evaluation of water and sanitation programme in Burma provide descriptive information on the sources and use of water in the selected rural population, the socio-economic indicators and the knowledge, attitude and practices in relation to water related habits and other hygienic practices. Although these studies would definitely reveal some importment and useful information on the fucntioning of the facilities provided and the utilization by the community, there still is a need for an in-depth study to reveal the health impact of these programmes.

Hence, the present study had been undertaken to investigate the health impact of the tubewell water supply programme in a number of selected rural communities. However, during the initial phase of the study, with the suggestions of the Study Design Group of the Health Impact Study, latrine programme was also included for investigating the dual effect of tubewell water supply and latrine programme on the health status of these communities.

The main purpose of this study is to investigate in-depth the effect of water supply and later on the added effect of latrine facilities, on a number of indicator health conditions, particularly diarrhoea, dysentry, ascariasis, trachoma, conjunctivitis and skin infections and thereby assess the impact, if any, on the health status of the communities. It is expected that such a study will show changes in specific indicator health conditions through improvements in safe water availability, accessibility and year-round use by the population. It is also felt that the study will help in making conclusions and further recommendations for modifications of the strategies and their adoption in the subsequent phases of the Water Supply Programme. In addition, an attempt will also be made to examine the effect of latrine facilities on the set indicator diseases in some of villages.

CHAPTER II

PROGRAMME CONTEXT

1. Overview of Water and Sanitation Programme

Throughout the Country Health Programming exercises that were undertaken in 1976, 1980 and 1982, Environmental Sanitation (Environmental Health) had been identified as one of the priority health programmes in the People's Health Programmes for the third four year (1978-79 to 1981-82), fourth four year (1982-83 to 1985-86) and the fifth four year (1986-87 to 1989-90) plan periods(4,5,6). Also, in the context of the International Drinking Water Supply and Sanitation Decade 1981-90, Burma had set national target for provision of water and sanitation facilities to 50 per cent of the total population by 1990(7). Accordingly, definite and specific strategies were formulated to implement this ambitious plan.

The Rural Water Supply Division under the Agricultural Mechanization Department of the Ministry of Agriculture and Forests had set project activities related to supply of safe drinking water to dryzone rural communities through construction of tubewells to serve a population of about 3.0 million during 1982-86. Similarly, the Environmental Sanitation Division of the Department of health is also being involved in supplying safe drinking water to the Rural Health Centres and Schools mostly in the rural areas. Moreover, ESD is also responsible for providing latrine facilities to the rural communities. Techinical and material assistance for Rural Water Supply by both of these departments and Latrine Programme by ESD is being provided by Austrilian Development Assistance Bureau (ADAB), UNICEF and other bilateral agencies.

2. Project Context

The objectives set by RWSD for dryzone rural water supply are as follows:

General Objectives

- To improve the health and socio-economic conditions of the population served
- To reduce the drudgery of women and children collecting and carrying water over long distances

Specific Objectives

- To construct 600 tubewells with power pumps per year during 1982/83 and 1983/84 in the Dry Zone (Sagaing, Mandalay and Magwe Divisions)to complete the 3000 Well Project initiated in 1978/79.
- To construct 300 tube wells with power pumps during 1984/85 and 1985/86 in the Dry Zone.

Similarly, the ESD set the following objectives for provision of water supply and latrine faciliities to rural communities:

General Objectives

- To improve the health of the people by providing hygienic environment and thereby reduce the incidence of diseases such as Diarrhoea, Dysentery, Cholera, Helminthiasis and Scabies.

Service Objectives

- To increase the percentage of population served by safe water supply in rural areas from 22 percent (in 1981/82) to 26 percent (in 1985/86).
- To increase the percentage of population having sanitary latrines in rural areas from 17 percent (in 1981/82) to 30 percent (in 1985/86).

3. Implementation of water and sanitation facilities

Regarding tubewell water supply in the Dry Zone, namely Sagaing, Mandalay and Magwe Divisions, the RWSD had already initiated the project since 1978-79, and the planned target set for 1982-86 was to install 1500 new tubewells with power pumps in Dry Zone alone. Year-wise break down targets for the three divisions were, 600 wells each in 1982/83 and 1983/84 and 150 wells each in 1984/85 and 1985/86.

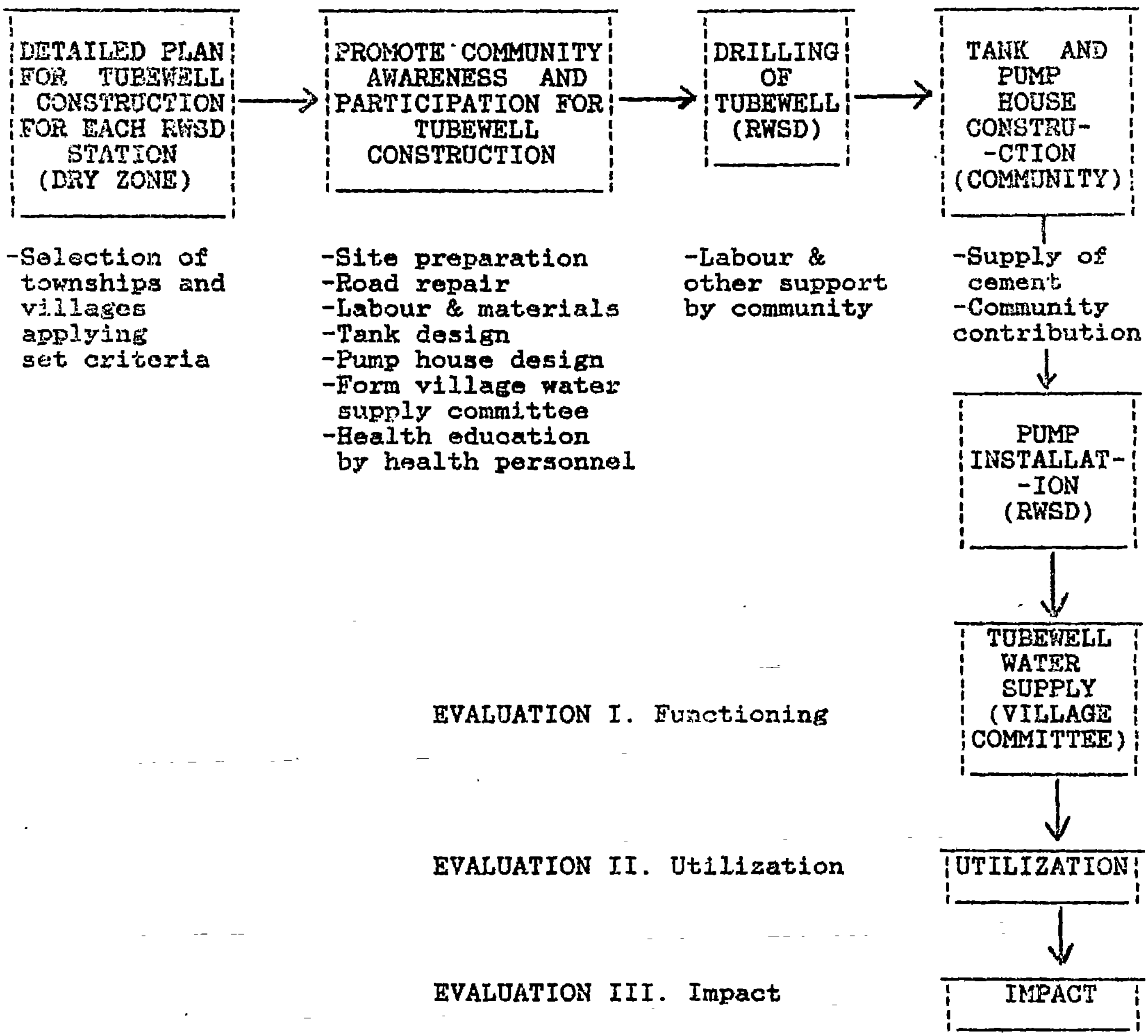
In order to fulfil the requirement of the evaluation study design, it was planned to install tubewells in 1983-84, after completion of the first year pre-intervention studies. The townships to be covered year by year for the four year planned period (1982-86) was worked out by the RWSD during 1982-83, applying certain criteria for giving priority for selection of townships in each of the three divisions in Dry-Zone. The townships assigned for intervention in 1983-84 were Magwe in Magwe Division, Kyauk-Pa-Daung in Mandalay Division and Nga-Zun in Sagaing Division.

According to the Plan of Action of Rural Water Supply Projects (1982-86) of RWSD, the selection criteria for assigning intervention (tubewell water supply)to villages in each township of Dry Zone area were scarcity of water, village with larger population and community interest. Since,it was crucial to select comparable villages which will serve as test and control groups, a different set of criteria and methods were applied for assigning intervention (tubewell water supply) to villages. Those criteria and methods were discussed and approved by the Study Design Group, the details of which are described under chapter on research methodology.

As planned, the RWSD completed drilling of tubewells in the study villages of Kyauk-Pa-Daung Township by May 1984 and building of water tank and a room for keeping power pump was completed by December 1984. Water supply from tubewell was made available in December 1984 and March 1985 for Ah-Myaung-Kan and Let-Pan-Bin respectively. However, tubewell installation in the study villages of Magwe was slightly delayed and the water was made available to the community only in Dec.1985. The situation of tubewell water supply in the study villages of Nga-Zun township is somewhat different. In Tha-Kyin village tubewell drilling was completed before March 1985 but the water tank was built only in September 1985 and water supply to the community commenced in December 1985. The worst situation is in Kala-Ywar village where the tube-well drilling was completed in August 1985, but since the community has not constructed a water tank, the new water supply system had not started at all uptill August 1987 when the last survey was undertaken. The flow diagram illustrating the implementation process of tubewell water supply activities is given in figure 1.

Concerning implementation of sanitary facilities in the study villages, a pilot sanitary latrine programme was initiated in some of the villages which had been assigned as test and control villages under health impact of tubewell water supply. The villages that are being covered under the latrine programme are Kan-Bya in Magwe, Kaing in Kyauk-Pa-Daung, Tha-Kyin and Phaung-Ka-Daw in Nga-Zun township. The latrine project was implemented in 1983-84 and by end of pre-intervention period a large proportion of the households in the above three villages had possessed latrine facilities.

Figure 1. Flow diagram illustrating the implementation process of tubewell water supply and evaluation components



CHAPTER III

EVALUATION OBJECTIVES

At the beginning, when the research protocol was prepared and eventually finalized by the Study Design Group of the project, the main objective of the study was to evaluate and analyse in-depth the effect of tubewell water supply on a number of set indicator health conditions.

The specific objectives of the study being:

(1) To compare the prevalence of water related diseases including diarrhoea, dysentery, ascariasis, trachoma, conjunctivitis, scabies and skin infections in communities before, during and after supply and year-round use of tubewell water.

(2) To observe changes in water related personal habits in communities before, during and after supply and year-round use of tubewell water.

(3) To investigate the impact of safe water usage on water related diseases, particularly diarrhoeal diseases, in the whole population as well as in children under 5 years before, during and after the supply of tubewell water.

However, during the initial phase of the study when the data on the demographic and socio-economic features, environmental sanitation and sources of water (obtained through baseline survey) were presented at the Study Design Group Meeting in December 1983, it was noted that some of the study villages were covered by a pilot sanitary latrine construction programme. Therefore, it was recommended by the Study Design Group that this study should also investigate the health impact of latrine facilities together with the tubewell water supply programme wherever applicable.

Hence, the initial objectives of the research protocol were extended to cover the effect of latrine facilities on the set indicator health conditions before, during and after the provision of latrine facilities in the selected communities wherever applicable.

CHAPTER IV

RESEARCH METHODOLOGY

The evaluation study design and methods adopted for the present study are analogous to a community intervention with test and control villages selected without randomization but by using a number of set criteria. The details of the study area, selection of villages, households and population, research design, survey methods and procedures and assessment indicators are described below.

1. Study Area

1.1 Background

Dry Zone is a vast area covering about 100,000 square kilometres and is situated in the central basin of Burma. As the name implies, it is well distinct from the other three major geographical regions of the country, namely the hilly, the delta and the coastal regions. The geographic features peculiar to the Dry Zone are that the average annual rainfall is less than 40 inches and in some places is as low as 20 inches and the climate is very hot during summer season, the temperature reaching as high as 110 degree to 112 degree F. July is generally regarded as the month of maximum rainfall and April/May as the period of extremely hot season.

The economic base of the Dry Zone is Agriculture and the principal dryland crops planted are groundnut, sesame, wheat, cotton, beans and peas, tobacco and maize. One-third of the total population of Burma lives in the Dry Zone and about 80 per cent of these are living in rural areas. Most of these rural people have to rely on the rainfall for their agricultural work.

For the past two and a half decades, the organization set up of a village in Burma was a unique situation characteristic to this country. The local government unit at the most peripheral level was a village tract council which represents 3 to 5 villages. The village tract council members were elected from each village to serve for a four year period term. In many villages, the village council members remained in the political post for more than one term because of their efficiency in providing leadership to the community. Most of these leaders could motivate and organize the community for participating in People's Health Plan as well as developemental programmes.

The apparent annual income of Kyats 2000 to 4000 per family is very low compared to many other developing countries, but it is very obvious that a rural family can lead a normal life of comfortable poverty with such an income. Most of their needs for living are fulfilled and many could spend a consideriable amount of money for charity and religious affairs.

The role of women in a rural family setting is quite obvious. Although the head of the household who are usually men, do the hard job such as ploughing, the women provide a great help in weeding, planting and harvesting. Also, the women look after the family and do the cooking, washing and care of babies and young children. Domestic water is also carried by women and it is a common practice to see women carrying water pots on their heads in the evenings.

Water shortage is still a problem in many villages of the Dryzone and there is scarcity of water for drinking and domestic use, particularly in dry season when the traditional water sources are dried up . In most villages without tubewell water supply, the villagers have to travel for considerable distances to fetch water for domestic use.

1. 2 Selection of Study Villages

According to the project implementation plan of RWSD, the townships assigned for intervention (with tubewell water supply) in 1983-84 were Magwe in Magwe division, Kyauk-Pa-Daung in Mandalay Division & Nga-Zun in Sagaing Division. Villages to be covered with tubewell water supply in each of these townships were selected initially by RWSD, applying certain common criteria such as scarcity of water, village with larger population and community interest.

In order to have comparable villages which would serve as experimental (intervention) and control (non-intervention) groups and to minimize variations in village and population characteristics of these groups under study, the following criteria were applied to select villages for inclusion in the study:

(a) The villages should be covered by the People's Health Plan and the communities must have the same access to health care facilities.

(b) Each selected township must be covered by the project plan of RWSD to supply tubewell water to a number of communities during 1983-84.

(c) The size of the population in each village should be between 1000 -1500 and the demographic and socio-economic characteristics regarding age, structure, family size, major occupation, income should be similar between experimental and control communities for comparison.

(d) The villages assigned for intervention (with tubewell water supply) and the control village (no tubewell water supply) must be within reasonable access throughout the year, but should not be too close to the main roads. The two test villages in each township should be located at reasonable distance away from each other and for comparison the control village should bear similar characteristics with that of the test village, regarding size of population, main occupation, family size and income.

(e) No likelihood of social and economic developmental projects in the near future.

(f) Absence of major endemic diseases such as malaria, cholera DHF.

(g) Population mobility should be minimum throughout the study period.

Based on the selection criteria two villages from each township were selected as experimental groups where tubewell water supply will be installed and one village was selected to serve as a control group where the community will rely only on the traditional water sources. As such a total of six villages served as experimental group (intervention group) and three villages served as control group (non-intervention group) for the purpose of periodic comparison before, during and after the tubewell water supply. The villages selected for the study are described in table 1.

Moveover, with a view to investigate the health impact of latrine facilities, with or without the tubewell water supply, some of the villages which had been covered by the pilot sanitary latrine programme were included in the study. These villages are Kan-Bya in Magwe. Kaing in Kyauk-Pa-Daung and Tha-Kyin and Phaung-Ga-Daw in Nga-zun township. The location of the study villages in each township is shown in Map 1,2 , 3 and 4 (Annex 3-6).

2. Selection of households and population

A census enumeration was undertaken in February 1983 and data relating to demographic and socio-economic features, environmental sanitation, sources of water for drinking and general use was collected to form a basis for selection of households and population. Each house was numbered and all family members in each household including under five children were listed. Since one of the inclusive criteria for the selection of villages was that the size of the population should be between 1000-1500, the total number of households in each village was about 200 and varied from village to village, the range being 167 to 191.

A 50 percent random sample of the households in each village was selected to include nearly half of the total population as well as under five children. The range of the households, population and under five children included in

Table 1. Townships and villages selected for the health impact study of tubewell water supply (1983-87)

Division	Township	Village	
		Experiment(T)	Control (C)
MAGWE	Magwe	Kan-Bya* (T1)	Si-Bin-Tha (C1)
		Kan-Ni-Lay(T2)	
MANDALAY	Kyauk-Pa-Daung	Let-Pan-Bin (T3)	Kaing* (C2)
		Ah-Myaung-Kan (T4)	
SAGAING	Nga-Zun	Tha-Kyin* (T5)	Phaung-Ga-Daw* (C3)
		Ka-Lar-Ywar (T6)	

* Villages provided with latrine facilities

the sample was 82 to 90, 475 to 640 and 76 to 90 respectively. In each of the periodic survey a response rate of more than 85 percent was achieved throughout the study period. Therefore, starting from the first periodic survey, all the family members of the sampled households were taken into the study for comparison of the set health indicators in successive periodic surveys, especially at the beginning and end of study. Similarly, throughout the pre-intervention and post-intervention periods, each survey included all under five children of the sampled households forming successive cohorts for the study. This total population sample size provides the study with adequate power (80%) for a one-tailed test at the 5% significant level to detect a 33% or larger decrease in the incidence of diarrhoea.

3. Research Design

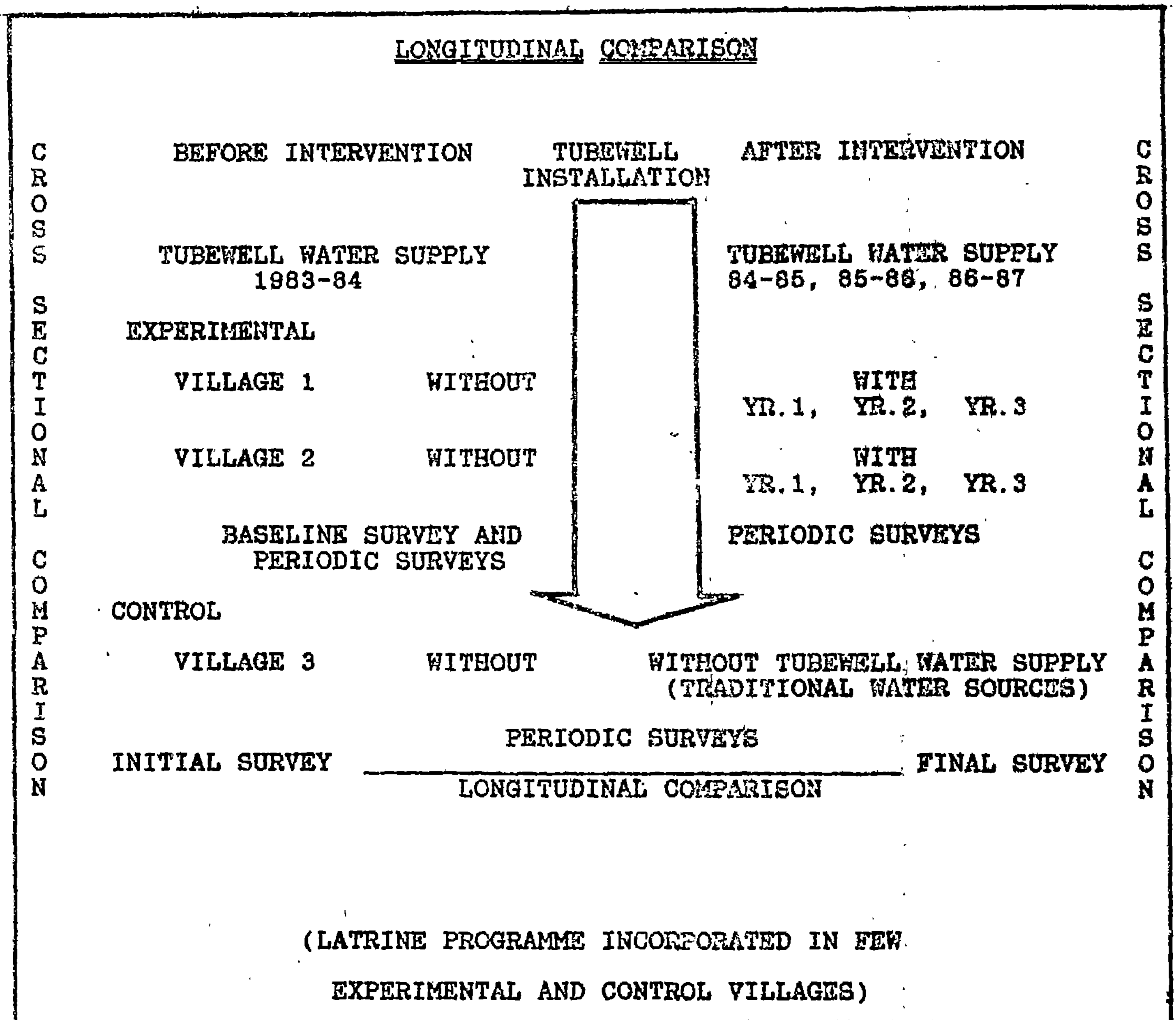
A major concern in undertaking an impact evaluation of water and sanitation facilities is the study design to be used for measuring the health impacts attributable to the project intervention. Since water and sanitation intervention provide preventive measure to an entire community, it is rather impossible to use true experimental design. Moreover, the present study focusses on a number of indicators for measuring the multiple outcomes of these interventions.

Therefore, a quasi-experimental design was adopted and comparison groups of villages were selected applying certain criteria to serve as treatment and control villages.

Although two basic approaches, namely the internal and external evaluation designs were applied for measuring the health impact of water and sanitation facilities, emphasis was placed on the former design to control the influence of the extraneous variables on the outcome variables. Moreover, for the purpose of external comparison, the main extraneous variables such as income, family size, major occupation, level of education, etc. were compared initially during the process of assigning intervention to villages as well as throughout the period of study.

The study design involved two-way comparison as illustrated in figure 2. In the first comparison, assessments of the magnitude of the project impacts are being made on the basis of comparisons of "before" and "after" project implementation in each village through assessment of selected impact indicator diseases. This enabled a longitudinal comparison of village before and after the intervention with water and sanitation facilities (Internal Comparison). This approach was adopted to overcome the influence of the extraneous variables on the outcome variables.

Figure 2. Pictorial presentation of the study design



The second involved a point in time comparison at different periods of the study where an external comparison was made between the experimental and control villages. This enabled to provide the pattern of specific indicator diseases in the two communities before, during and after the intervention. The difference in the prevalence and incidence rates of diarrhoea and other indicator diseases within each experimental villago (Internal Comparison) and between test and control villages (External Comparison) at the beginning and end of study was calculated to reveal the health impact of water and sanitation interventions.

4. Survey Methods and Procedures

The Survey methods applied for obtaining relevant information were as follows:

(a) Interview surveys

The trained interviewers conducted household survey of all sampled households to collect relevant information through interview technique using a pre-tested questionnaire. The information included in the designed format was household and demographic characteristics, socio-economic features, environmental sanitation data, sources of water,water related habits and practices, quantity of water used for different domestic purposes, prevalence of diarrhoea and other indicator diseases during the two week recall period among under five children and the general population in the two communities, namely the experimental and control villages. Direct observation method was also applied to note certain characteristics such as structure of the house, cleanliness in and around the premises of the house, animal breeding, type of latrine, storage of water for drinking and general use.

(b) Physical Examination

All the family members who were present at home at the time of undertaking each survey in the sampled households were physically examined by the medical officers of the survey teams for identifying the indicator diseases. A separate proforma and instruction sheet was used for diagnosing each disease condition through signs and symptoms of a particular disease .

(c) Laboratory Investigation

- Microscopic examination of the stool of children (under 5 years of age) from the sampled households was carried out in the field at each village and during each survey. Direct method for the presence or absence of ascaris ova was used to obtain prevalont rate among under five children.

- Water samples from main sources such as tubewell, pond, dug well, river and stream as well as from domestic water containers were collected and tested for physical chemical and bacteriological quality of water. A random of 20-25 households with under 5 children were selected for this purpose. Water samples were collected only once during each periodic survey.

Glass bottles of 250 ml capacity were used to collect about 200ml of water from various sampling points for bacteriological and chemical analysis of water. Water sample collection techniques were strictly according to WHO recommendation and laboratory technicians were trained for the above purpose. Water analysis was carried out at the villages by setting up small laboratories at an appropriate site and using portable equipments and commercially available ready made media and reagents.

In order to obtain a direct estimate of total coliforms as well as faecal coliforms, both the presumptive and confirmation procedures were applied simutaneously , using M-Endo and M-FC media and filtering and incubating the membrane filters separately at 35 degree C & 44.5 degree C respectively.

To ensure quality control, negative control were used, one with sterilized dilution water and medium and the other with only medium. The results on the typical colonies of total coliforms and faecal coliforms were obtained by applying recommended formula.

Portable Water Laboratory Kits were used for bacteriological analysis and Hach Chemical Kits for chemical quality of water.

(d) Household Surveillance

The sampled households in each village were monitored once a week by a field supervisor in each village making 4-5 visits per month throughout the study. During the visits, a household card was filled up which recorded the incidence of the selected indicators for each household members. Other relevant information regarding quantity of daily collection of water for domestic purposes, use of latrine facilities and vital events were also recorded. The recognition of indicator diseases was made through certain diagnostic criteria which are based mainly on the signs and symptoms that could be easily recognized by the Field Supervisors, who were trained to undertake this task. Trained interviewers visited the field site each month to verify accuracy of the observation.

5. Assessment of indicator diseases/conditions

The primary health indicators included in the study were the incidence and prevalence of diarrhoea. Other water related diseases such as dysentry, ascariasis, trachoma, conjunctivitis,scabies and skin infections were also used for measuring the impact of water and sanitation interventions.

Incidence of these indicator diseases was obtained through weekly surveillance by Field Supervisors. Prevalence of the above key variables was assessed during each periodic survey through physical examination and by household interview surveys. The prevalence of these indicator diseases was recorded by the Medical Officers of the household survey teams for the occurrence of these during the 24-hours period preceeding the survey. The interviewers obtained the prevalence of these diseases for the 14 days period preceeding the survey.

Two-weeks prevalence of diarrhoea (or a specific indicator disease) is defined as the number of episodes of diarrhoea occurring (i.e., starting or continuing) during a 2 weeks period. The relevant question asked to obtain this information was, "How many of the family members (or children under 5 years) have had diarrhoea in the past two weeks preceeding the survey."

Two weeks incidence is defined as the number of episodes of diarrhoea (or an indicator disease) started in the past two weeks including today.

Recognition of diarrhoea was made through a common definition i.e., 3 or more abnormally loose stools, in any 24-hours period.

Indicators used for assessment of health impact of the tubewell water supply and latrine facilities are summarized in Table 2.

Table 2. Indicators for assessment of health impact study of the tubewell water supply and latrine facilities.

ASSESSMENT OF		INDICATORS	METHOD TO BE USED			
		MORBIDITY RATE (INCIDEN-CE, PREVA-LENCE)	WEEKLY SURVEIL-LANCE	QUESTION-NAIRE/ OBSERVATION (PERIODIC SURVEY)	PHYSICAL EXAMINATI-ON (PERIODIC SURVEY)	LABORAT-ORY INVESTI-GATION (PERIOD-IC SURVEY)
A.	Water Related Diseases					
	1. Diarrhoea	*	*	*	*	
	2. Dysentry	*	*	*	*	
	3. Ascariasis	*	*	*	*	Stool for Ascaris Ova
	4. Trachoma	*	*	*	*	
	5. Conjunctivits	*	*	*	*	
	6. Scabies/staph infection	*	*	*	*	
B.	WATER QUALITY					
	1. Totalcoliform and faecal coliform					Membr-ane filter Techni-que
	2. Chemical contents					Hach Chemical Analysis
C.	WATER RELATED HABITS & PRACTICES					
	1. WaterQuantity Used		*	*		
	2. KAP survey	Score sys:		*		
	3. Personal Hyg.					
	a) Bathing habit	Score sys:		*		
	b) Washing habit			*		
	c) Cleanliness			*		
	4. Environmental sanitation	Score sys:				

6. Management of Research, Field Work and Data Analysis

The terms of reference for the evaluation study were established in January 1982 and a draft research protocol was prepared. Preliminary visit to a few sites of the tubewell water supply project was made in March 1982 to facilitate in planning the field work. The terms of reference of the study and focus of the evaluation was discussed by the Study Design Group and the research protocol was finalized in June 1982. Subsequently, in July to December 1982, preparatory activities regarding recruitment of project staff to undertake field studies; training of staff in interview techniques and observation methods, laboratory procedures and conduct of household surveys; pretesting of questionaire and forms were undertaken. The baseline survey was carried out in February 1983 and four-monthly periodic seasonal surveys covering pre-intervention and post-intervention periods were undertaken during December 1983 to August 1987.

An activity schedule was prepared to undertake baseline and periodic surveys during different seasons of the longitudinal study. Initially, a baseline survey was undertaken in February 1983 to draw detailed maps of each village indicating the households and various characteristics of the village, demographic and socio-economic features, environmental sanitation , sources of water and prevalence of the set indicator diseases. As part of the pre-intervention component of the study, three surveys were conducted during 1983-84 to cover three distinct seasons, namely winter, summer and monsoon. The relevent information obtained during pre-evaluation period served as a basis for comparing the set variables and indicator diseases at each point of the season with the corresponding season of the post-evaluation studies.

The post-intervention period covered three years starting from 1984-85 and in each year three surveys were conducted in the same months as for pre-intervention periods to reveal changes of indicator diseases and set variables at different points of season in the subsequent years after intervention. The detailed activity schedule is given in Annex 2.

The survey team, headed by the study manager and comprising of one senior statistician, six medical officers, six research assistants (interviewers) and five laboratory technicians visited and conducted field surveys in the selected villages of the three townships according to the pre-planned activity schedule. Each field survey comprised of interview survey supported by observation.Six field teams, each comprising of a medical officer and an interviewer were assigned to sampled households in a randomized fashion. The study manager and the senior statiscian made spot checks of the team work for verifying the completeness and accuracy of the information collected through interview and observations. One week time was spent for travelling and undertaking the field work in each township.

Data Analysis

The data collected on the pre-coded form was directly entered into an IBM Personal Computer AT for analysis. CRISP(Crunch Interactive Software Package) software package was used for determining frequency distribution, mean, proportion and for bivariate and multivariate analysis.

The statistical approach utilized for analysing and determining differences and changes overtime in experimental group of villages after the intervention and observing differences in the experimental and control groups before, during and after the supply of tubewell water and wherever applicable latrine facilities is based on the following design:

Experimental Design

Type of village	Before Intervention Pretest	Stimulus	After Intervention Post-test	Difference
Experimental village (Project Area)	01	X	02	01 - 02= dt
Control village	03	-	04	03 - 04 = dc

This design accounts for both the internal comparison (within-village comparison of impact indicators before and after intervention in experimental villages) as well as external comparison (between-village comparison of indicator diseases between experimental and control villages). The bulk of the statistical analysis performed for this impact study provide level of significance of change overtime in health impact indicators in intervention villages as well as by comparison with non-intervention villages. These differences were calculated by using conventional procedures for the comparison of outcome variables (i.e rates, means, proportions) derived from the sample surveys. The test of significance applied in determining the level of significance of change were z-test,chi-square test and factorial analysis.

7. Methodological issues

In recent years, it has been increasingly emphasized that the use of quasi-experimental design in evaluating the impact of water and sanitation facilities is inappropriate because of methodological problems inherent to such designs. The most common problems that are being encountered relates to comparability of treatment and control groups, sample size required, the specificity and sensitivity of defining the disease status and failure of recording exposure status, resources required and time consummed in undertaking such studies. In this regard, the followings are considered as some important methodological issue relevant to this study.

(a) The main issue is related to the matching of treatment and control group of villages and ability to control the exposure of comparison groups to confounding factors.

This problem was overcome by emphasizing on internal comparison design and evaluating changes in impact indicators among sub-population as well as among users and non-users of the facilities in the same village. In this way, the problem of differential exposure to exogenous factors was minimized. Moreover, in the external comparison design where comparison was made between study and control villages, the main extraneous variables were monitored throughout the study for comparing major differences between the two groups.

(b) Since the study intented to examine trends and group differences as a whole , the sample size was based on the total population and not on the vulnerable age group (i.e under five children). Therefore the sample of under five children may be inadequate for observing difference in the health impact indicators and detecting the specified reduction at a 5% significant level.

The primary aim of the study was to examine the impact of water supply and sanitation facilities in the community as a whole and as such a random sampling procedure was applied to include enough sample of the village population to represent the whole community. Moreover, the health impact was measured through commonly prevailing indicator diseases in these communities and the relevant data was collected by periodic cross-sectional surveys as well as weekly surveillance throughout the study period.

(c) It is also felt that the specificity and sensitivity of the information may also be affected because the study applied two-week recall method for collection of information on indicator diseases as well as on usage of facilities.

The interview survey was undertaken by six teams, each comprising of one medical officer and a trained interviewer to ensure the completeness and accuracy of data collected during periodic surveys. Moreover, an interviewing survey was supported by observation method and physical examination to improve the quality of data. Spot checks were made to verify the accuracy of the information. The specificity and the sensitivity of responses obtained by interview surveys were also validated between interviewers and between surveys. In addition, personnel turnover was very low in undertaking the longitudinal study.

CHAPTER V

FINDINGS

The findings of the present study are presented under four broad headings as follows:

A. General characteristics of the study population

B. Accessibility and use of water and latrine facilities

C. Knowledge, attitude and practices related to use of water and latrine facilities

D. Health impacts of water and latrine facilities

A. GENERAL CHARACTERISTICS OF THE STUDY POPULATION

1. Study Population

The total number of households, population and under five children included in the study was based on a 50 percent random sample of the households in each experimental and control village. All the under five children of the sampled households in each village were included since the beginning of the study as well as throughout the study period to form successive cohorts of children for making comparison within each village and between test and control villages. The sample size of households, population and children were comparable at the beginning and at different periods of the study.

Table 3 provides the total households and population and the sampled households and population by each village. The six experimental villages with tubewell water supply are coded as T1 to T6 whereas the control villages with only traditional sources are coded as C1 to C3.

TABLE 3. Total and sampled households and population by village at the beginning and end of the study

VILLAGE & VILLAGE CODE	TOTAL HOUSEHOLDS & POPULATION			SAMPLED HOUSEHOLDS & POPULATION		
	HOUSE--HOLDS	POPUL--ATION (ALL AGES)	<5 CHILDREN	HOUSE--HOLDS	POPUL--ATION (ALL AGES)	<5 CHILDREN
KAN-BYA (T1)	174	1106	158	85	550	76
KAN-NI-LAY (T2)	179	1207	167	87	560	80
SI-BIN-THAR (C1)	167	1095	158	82	480	82
LET-PAN-BIN (T3)	173	1114	162	85	490	82
AH-MYAUNG-KAN (T4)	188	1231	188	90	620	90
KAING (C2)	170	1110	165	83	475	80
THA-KYIN (T5)	190	1266	191	90	640	93
KA-LAR-YWAR (T6)	186	1245	182	90	608	88
PHAUNG-GA-DAW (C3)	173	1143	171	85	502	84

The sample size of households, population and under five children largely depended upon the size of the village, larger samples being obtained in villages of Nga-Zun township.

The surveyed population varied slightly from survey to survey in each village, with a response rate of nearly 90 percent in each survey. The total population and children surveyed at the beginning and end of the study is shown in table 4. It could be observed that the population has remained consistent over the period with higher response rates at the end of the study in almost all the studied villages.

TABLE 4. Surveyed population at the beginning and end of study

STUDY VILLAGE & CODE		BEGINNING OF STUDY (1984)		END OF STUDY (1987)	
		POPULATION (ALL AGES)	CHILDREN (<5 YEARS)	POPULATION (ALL AGES)	CHILDREN (<5 YEARS)
KAN-BYA	(T1)	494	71	487	73
KAN-NI-LAY	(T2)	490	71	526	79
SI-BIN-THAR	(C1)	426	71	458	80
LET-PAN-BIN	(T3)	422	72	480	76
AH-MYAUNG-KAN	(T4)	560	76	610	81
KAING	(C2)	420	70	444	72
THA-KYIN	(T5)	560	72	600	81
KA-LAR-YWAR	(T6)	510	71	563	77
PHAUNG-GA-DAW	(C3)	445	72	435	72

The age and sex composition of the surveyed population bear similar pattern with that of the national population structure. In general, the population below 5 years of age constituded about 15 percent of the total population, whereas those between 5-14 years comprised of about 35 percent and the remaining were above the age of 15 years. This distribution pattern remained consistent throughout the study although slight increase in under five population was observed at the end of the study. Age and sex composition for villages in Magwe is shown in Figures 3 and 4, and the respectives percentages for Kyauk-Pa-Daung and Nga-Zun are given in annex 3 and 4.

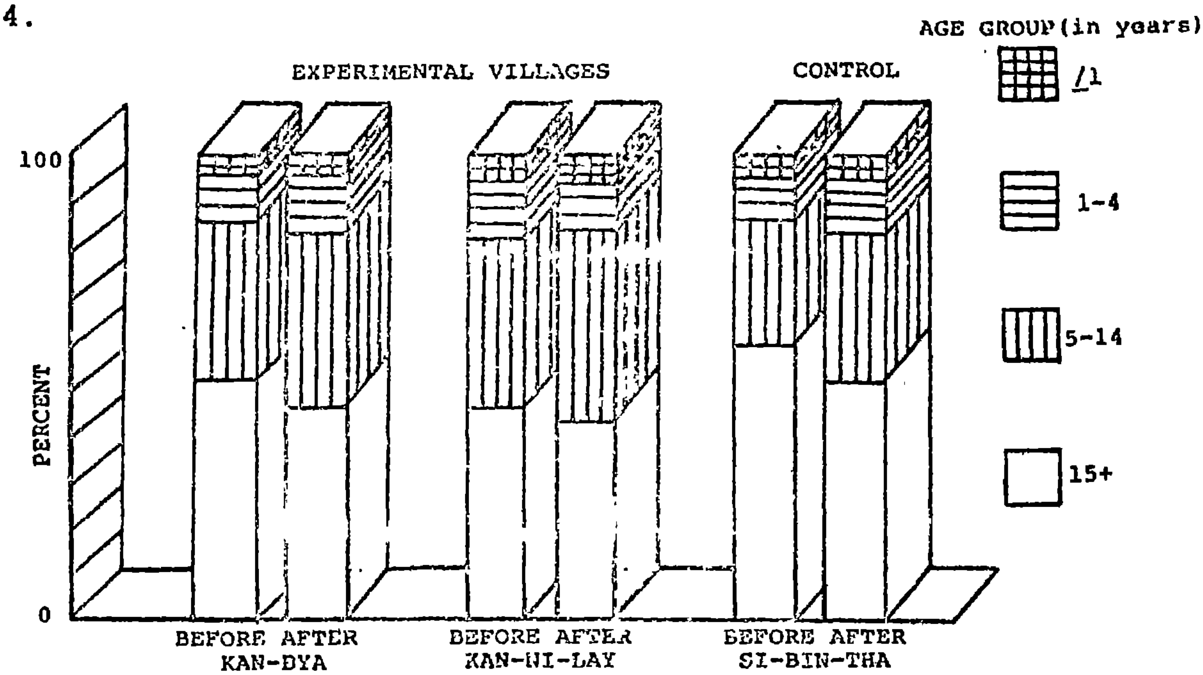


FIGURE 3. PERCENT OF MALE POPULATION BY AGE GROUP IN MAGWE.

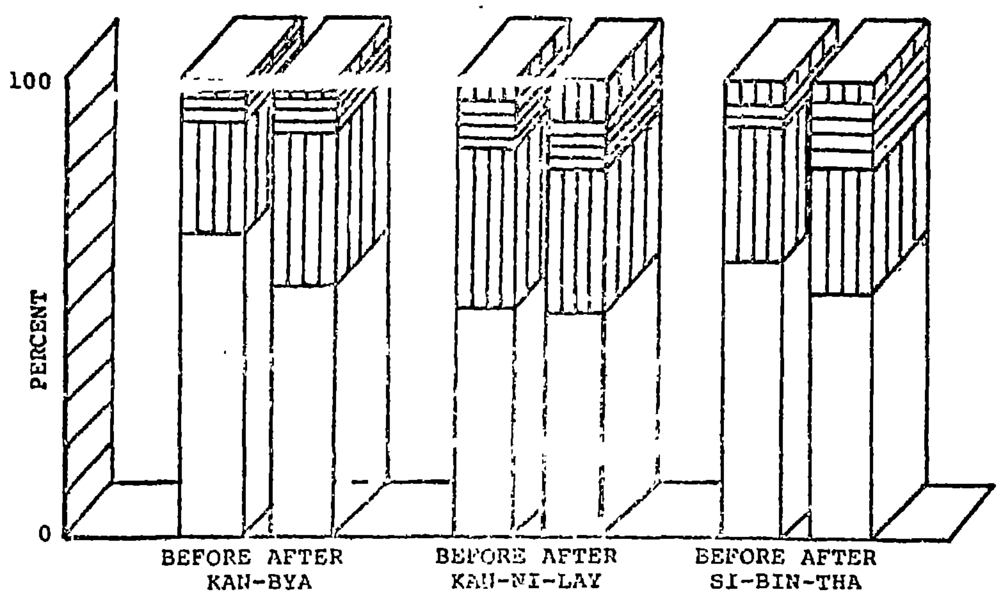


FIGURE 4. PERCENT OF FEMALE POPULATION BY AGE GROUP IN MAGWE.

2. Family Size

A large proportion of the families in each of the experimental and control villages of the three selected townships have 4-6 family members throughout the survey periods. The second largest group being the families having 7-9 family members, followed by less than the 3 group and 10 and above group which together comprised of about 20 per cent. The mean family size varies from village to village and from survey to survey, the range being 6.1 to 6.9. Village-wise comparison of family size at the beginning and end of study in each township is given in table 5.

TABLE 5. Village-wise comparison of family size at the beginning and end of study

VILLAGES	FAMILY SIZE (NUMBER OF PERSONS)							
	<3		4 - 6		7 - 9		10 +	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
KAN-BYA	11.0	9.0	53.7	47.4	25.6	33.3	9.7	10.3
KAN-NI-LAY	12.2	11.8	48.0	42.0	28.6	39.5	11.2	6.7
SI-BIN-THA	12.4	12.7	56.6	45.6	23.7	32.9	7.3	8.8
LET-PAN-BIN	5.3	6.1	62.7	59.3	26.7	27.7	5.3	6.9
AHMYAUNGKAN	5.9	4.5	58.8	50.0	29.4	39.8	5.9	5.7
KAING	13.2	6.3	39.3	45.0	41.0	42.5	6.5	6.2
THA-KYIN	5.8	4.5	55.8	49.4	32.6	37.1	5.8	9.0
KA-LAR-YWA	8.5	4.5	48.8	54.5	28.1	33.0	14.6	8.0
PHAUNGGADAW	15.0	6.3	43.8	41.8	31.2	44.3	10.0	7.6

3. Occupation

The main occupation of the surveyed population in all villages both by head of the household as well as by working population was Agriculture and this pattern remained consistent throughout the study period. The distribution pattern of other occupation like traders, small scale sellers, government employees, ad hoc jobs and unskilled labourers vary from village to village and from survey to survey largely depending on the season and time when other occupational activities were available. These occupational groups together comprised of about 20 per cent. Village-wise comparison of occupational groups between experimental and control communities is shown in annex 5 to 7 (figures 9 to 11).

4. Level of Education

The educational status of the communities in the experimental and control villages of each township showed similar pattern of level of education throughout the study period with some variations from survey to survey. A large proportion of the study population (about 50-70 per cent) falls into the category of primary level education and about 5 - 10 per cent attained middle school education. It was interesting to note that the illiteracy rate was markedly reduced during the subsequent surveys in all the villages, except Kan-ni-lay village. This change was due to a Literacy

Programme which was implemented during 1983-85. Moreover, the proportion of the pre-school age group was also comparatively higher during the subsequent period of the evaluation study. Annex 8 to 10 (figures 12 to 14) show the comparison of the educational status of the communities during the beginning and end of study.

5. Annual Family Income

The annual family income of the surveyed communities varied from village to village in the same township and between different surveys. The reason being that since the main occupation of the population was agriculture the income depended much on the yield of the crop as well as the market price at different time of the season. In general, most of the families had an annual income between Kyats 2000 to 4000, within a range of about K200 -300 per month. Only a minor proportion of the families had income more than K 4000 or less than K 2000. The annual average per capita income is comparatively less than the national figure which is about US$ 150 (nearly Kyats 1000). Although there are some variations in the percentage distribution of families with different income groups, no remarkable change was noted to reveal the increase or decrease of family income over the period of study.

Table 6 shows the distribution of families by different income groups during the beginning and end of study.

TABLE 6. Percent of households by annual family income at the beginning and end of study

VILLAGES	ANNUAL FAMILY INCOME (IN KYATS)					
	LESS THAN K.2000		K.2000-4000		K.4000 & ABOVE	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
KAN-BYA	25.6	17.9	43.9	64.1	30.5	18.0
KAN-NI-LAY	28.6	39.5	54.5	51.9	16.9	8.6
SI-BIN-THA	2.6	1.3	39.5	41.7	57.9	57.0
LET-PAN-BIN	33.3	28.4	45.4	50.6	21.3	21.0
AH-MYAUNGKAN	50.6	33.0	36.5	55.7	12.9	11.3
KAING	52.6	23.8	34.6	52.5	12.8	23.7
THA-KYIN	23.3	23.6	46.5	65.2	30.2	11.2
KA-LAR-YWA	19.5	22.7	47.6	56.8	32.9	20.5
PHAUNGGADAW	25.0	22.8	32.5	64.6	42.5	12.6

6. Housing and Environmental Sanitation

A large proportion of the houses were built with locally available materials such as bamboo, thet-ke, htan-let in all the study villages. Only a few houses were built as permanent or semi-permanent structures. This feature was consistant throughout the study period as illustrated in table 7. The level of cleanliness within each household was assessed

TABLE 7. Village-wise comparison of type of housing in villages of Magwe township.

TYPE OF HOUSING	KANBYA(T1)		KAN-NI-LAY(T2)		SIBINTHA(C1)	
	BEGIN. OF STUDY	END OF STUDY	BEGIN. OF STUDY	END OF STUDY	BEGIN. OF STUDY	END OF STUDY
PUCCA BUILDING (PERMANANT STRUCTURE)	4.8	2.8	3.6	1.2	3.8	2.5
WOODEN HOUSE (SEMI-PERMANANT)	24.1	20.8	23.2	32.1	11.3	10.0
BAMBOO HOUSE (TEMPORARY)	71.1	76.4	73.2	66.7	84.9	87.5
TOTAL %	100%	100%	100%	100%	100%	100%

through the presence of dust, flies, litter and general cleanliness of the house through direct observation. It was observed that only a few households had acceptable level of cleanliness and the majority were categorized as either fairly satisfactory or unsatisfactory. The level of cleanliness remained unchanged throughout the study period, although some changes were noted from unsatisfactory to fairly satisfactory situation in the subsequent surveys, in almost all the villages (Table 8).

TABLE 8. Percentage distribution of the houses with level of cleanliness in study villages of Magwe township

CLEANLINESS WITHIN THE HOUSES	KANBYA(T1)		KAN-NI-LAY(T2)		SIBINTHA(C1)	
	INTERVENTION		INTERVENTION		INTERVENTION	
	PRE- 83-84	POST- 86-87	PRE- 83-84	POST- 86-87	PRE- 83-84	POST- 86-87
SATISFACTORY *	12.8	20.0	3.6	4.7	0.0	7.1
FAIRLY SATISFACTORY **	43.6	57.3	42.8	69.7	67.9	80.0
UNSATISFACTORY ***	43.6	22.7	53.6	25.6	32.1	12.9
TOTAL %	100%	100%	100%	100%	100%	100%

* = Clean and tide
** = No dust, no flies, no litter but looks untide
*** = Presence of flies, dust, litter, etc.

7. Breeding of Animals

Breeding of animals such as cows, buffaloes, horses, pigs, sheep and goats was a common feature in all the study villages and about 50 to 60 per cent of the households bred animals, usually cows and buffaloes, the number of animals bred per household vary from 5 to less than 10. During the subsequent surveys after intervention, the percentage of households who bred animals was increased, and also the quantity of animals bred per household was increased. This finding was common to all the villages, both experimental and control communities. Table 9 gives the percentage distribution of households breeding animals by type and by village at the beginning and end of study.

TABLE 9. Percent of households breeding animals by village during different periods of the study

STUDY VILLAGES	PERCENT OF HOUSEHOLDS BREEDING ANIMALS	
	BEGINNING OF STUDY	END OF STUDY
KAN-BYA	64.5	66.7
KAN-NI-LAY	58.9	62.9
SI-BIN-THA	62.2	71.4
LET-PAN-BIN	66.7	75.4
AH-MYAUNG-KAN	57.8	70.0
KAING	63.0	73.5
THA-KYIN	75.0	77.1
KALAR-YWAR	78.0	71.4
PHAUNG-GA-DAW	69.5	68.7

B. ACCESSIBILITY AND USE OF WATER AND LATRINE FACILITIES

1. Sources of water in the study villages during pre- and post-intervention periods.

1.1 Main sources of water

Throughout the pre-intervention period, almost all the main water sources for drinking as well as for other domestic use were surface water sources such as pond, dug well , river, stream and canal, which are being constantly exposed to contamination by all means. Main sources of traditional water for drinking and general use vary from village to village. In Magwe, the main water source in the exprimental village during pre-intervention was pond whereas in the control village it was mainly dug well. Similarly, the main water source in the experimental villages of Kyauk-Pa-Daung was pond, while the control village relied on water from canal, which supplied water for cultivation from a large dam.The main source of water in the selected villages of Nga-Zun was dug well, although water from river and pond was used to some extent.

During the post-intervention period, when the tubewell water supply was made available to the communities of the six experimental villages, a remarkable change was noted in the utilization of water for drinking and domestic purposes. Communities previously relying on traditional water sources switched on to tubewell water supply after the intervention. This change was significantly remarkable in Kan-Bya of Magwe Township and Let-Pan-Bin and Ah-Myaung-Kan

TABLE 10. Percent of households by main source of drinking water (Dry Season)

VILLAGES		PRE-INTERVENTION (TRADITIONAL WATER)	POST-INTERVENTION		MAIN SOURCES OF TRADITIONAL WATER
			TRAD. WATER	TUBEWELL WATER	
KANBYA	(T1)	98.8	1.2	98.8	POND
KANNILAY	(T2)	100.0	45.2	54.8	POND+DUG WELL
SIBINTHA	(C1)	100.0	100.0	-	DUG WELL/ RIVER
LETPANBIN	(T3)	83.3	2.8	97.2	POND
AHMYAUNGKAN	(T4)	100.0	0.0	100.0	POND/ RAIN WATER
KAING	(C2)	100.0	100.0	-	CANAL
THAKYIN	(T5)	100.0	97.9	2.1	DUG WELL
KALARYWA	(T6)	100.0	100.0	-	DUG WELL/ RIVER
PHAUNGGADAW	(C3)	100.0	100.0	-	DUG WELL/ POND/RIVER

T1 to T6 = Study villages with tubewell water supply
C1 to C3 = Comparison villages without tubewell water supply

of Kyauk-Pa-Daung Township, where nearly cent percent of the households changed their water source from traditional to tubewell water supply after the intervention. However, the situation remain unchanged in Tha-Kyin and Ka-Lar-Ywa(test) villages, where the communities relied mainly on traditional water even after tubewell installation. The main reason for an exclusively low use of tubewell water in Tha-Kyin village was due to availability of ample supply of water from traditional sources at all time and at no cost. Similarly, because of availability of water from nearby dug wells in Ka-Lar-Ywa village,the community placed very low priority for building a water tank for supply of tubewell water. Since the new water system was not in operation at any time of the post-intervention period, the community utilized the traditional water source only. Table 10 clearly illustrates the differences in use of water facility before and after tubewell water supply. It could also be observed from this table that the control villages relied mainly on traditional sources throughout the study.

1.2 Distance travelled to collect water from main sources

The distance travelled to fetch water from main sources varied from village to village and during different periods of the study depending upon the water source available at a particular time. In the study villages of Magwe and Kyauk-Pa-Daung townships, a high proportion of the households had to travel far distances (more than 500 yards) for collecting water and this proportion was reduced considerably to less than 500 yards and even less than 100 yards when the project water supply was made available to the experimental villages. Marked changes in the reduction of distance were observed in all the test villages of the above two townships. This change in distance reflects the

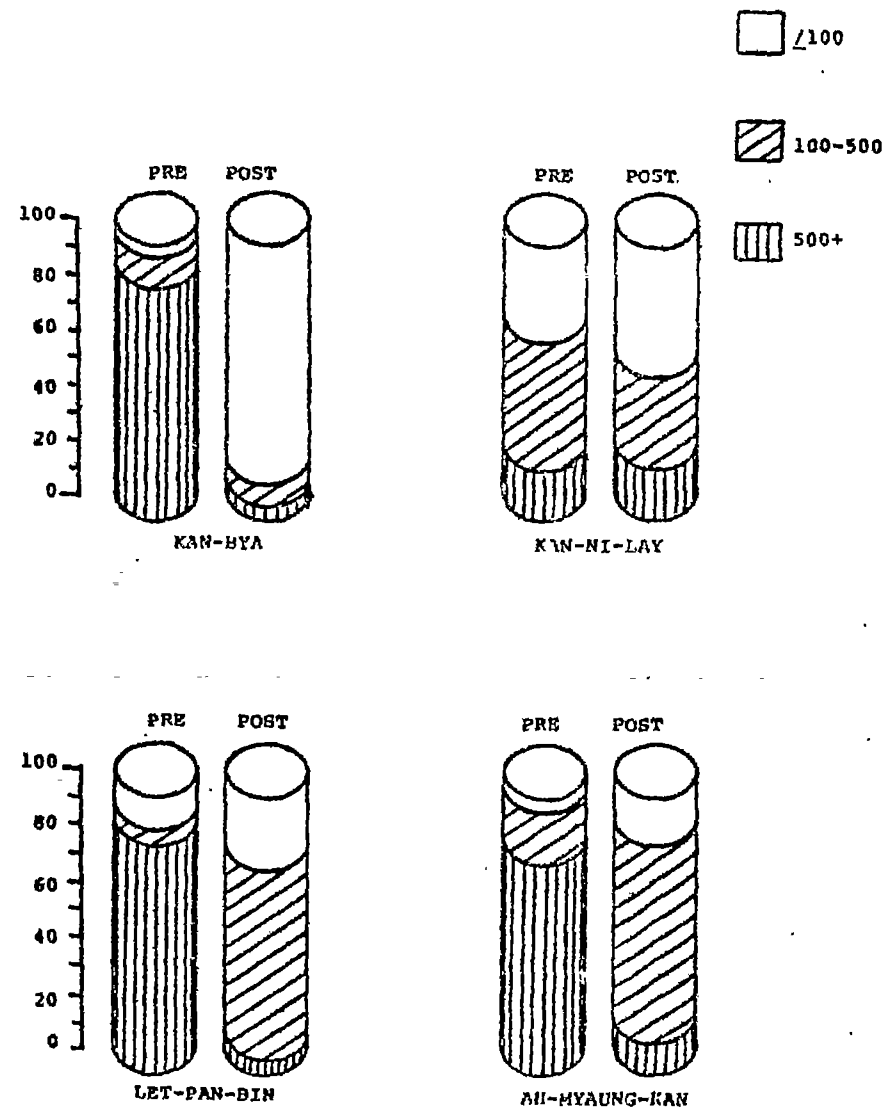


FIGURE 15. PERCENT OF HOUSEHOLDS BY DISTANCE TRAVELLED FOR FETCHING WATER FOR DOMESTIC USE DURING PRE- AND POST-INTERVENTION PERIODS.

importance of drilling tubewell at a close distance than any other water source in all of these villages. No marked changes in distance were observed in the comparison villages of Nga-Zun, obviously because the tubewell water was not utilized.

Variations in distance in other test and control villages were also observed to some extent but these changes were mainly due to variability in the availability of traditional sources of water. Figure 15 shows the changes in distance affected by tubewell water supply in the experimental villages of Magwe and Kyauk-Pa-Daung township.

1.3 Time spent for fetching water

On the whole, the average time spent per household for carrying water was less than two hours and generally one of the adults in family, usually a female had to spend about two hours a day for carrying water for household use. The common way of collecting water was by a bullock cart loaded with a wooden barrel and sometimes by an earthen pot carried on head. During the pre-intervention period, the time spent for carrying water varied from season to season, more time being spent in Summer for travelling far distances.

After project water supply, the effect of distance and season on the use of tubewell water supply was observed in Kan-Bya, Let-Pan-Bin and Ah-Myaung-Kan villages. In these villages, the distance travelled and the time spent was considerably reduced after availability and use of tubewell water supply, particularly in the dry season. Hence, the

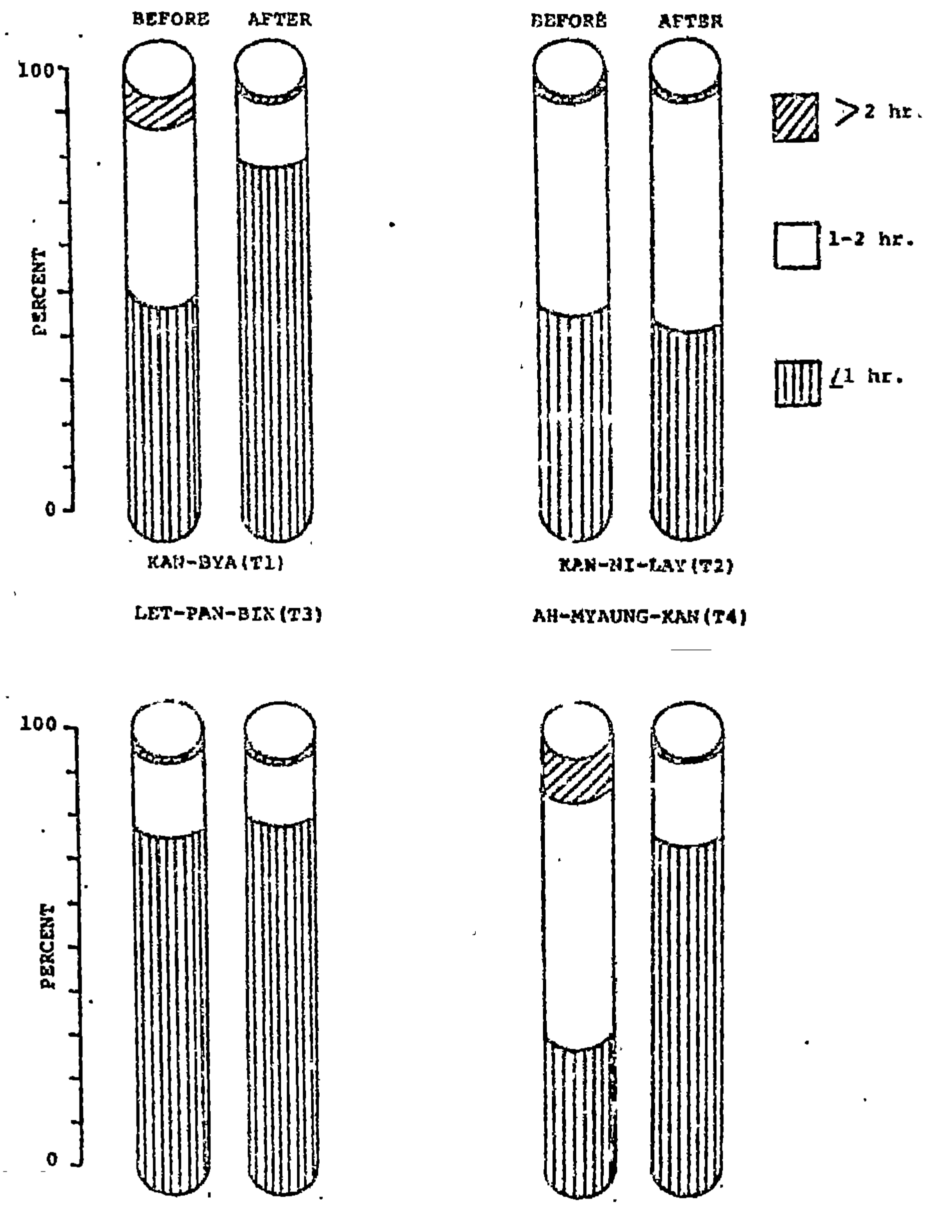


FIGURE 16. PERCENT OF HOUSEHOLDS BY TIME SPENT FOR FETCHING WATER.

proportion of households who spent more than 2 hours daily to collect was greatly reduced. So also, the proportion of households spending between 1 to 2 hours a day was also reduced to less than one hour.

Since the proportion of households utilizing traditional water sources was considerably larger in Kan-Ni-Lay than other test villages the distance and time was affected only to some extent. Slight variations in time spent was also noted in other villages, but these changes were merely affected by seasonal differences in the availability of water from traditional water sources. Figure 16 comparatively shows the differences in time spent for fetching water during pre- and post-intervention periods in the study villages.

1.4 Amount of water carried per day

In general, a large proportion of the families carried more than 40 gallons of water per day for different purposes including drinking, cooking, washing, bathing and for animal use. The amount of water used for drinking and cooking was usually 10-20 gallons per day, where as 20-30 gallons was used for washing and bathing. It was a common practice in almost all the villages to save washed water from kitchen use for feeding the animals. This pattern was only slightly affected after the project water supply, the proportion of the households utilizing more than 40 gallons per day being slightly higher than the pre-intervention period. The main reason being that the community had to pay for obtaining water from the tubewell and therefore the majority of the households restricted to their usual needs of water quantity. Figure 17 compares the pre- and post-intervention situation regarding volume of water carried per day.

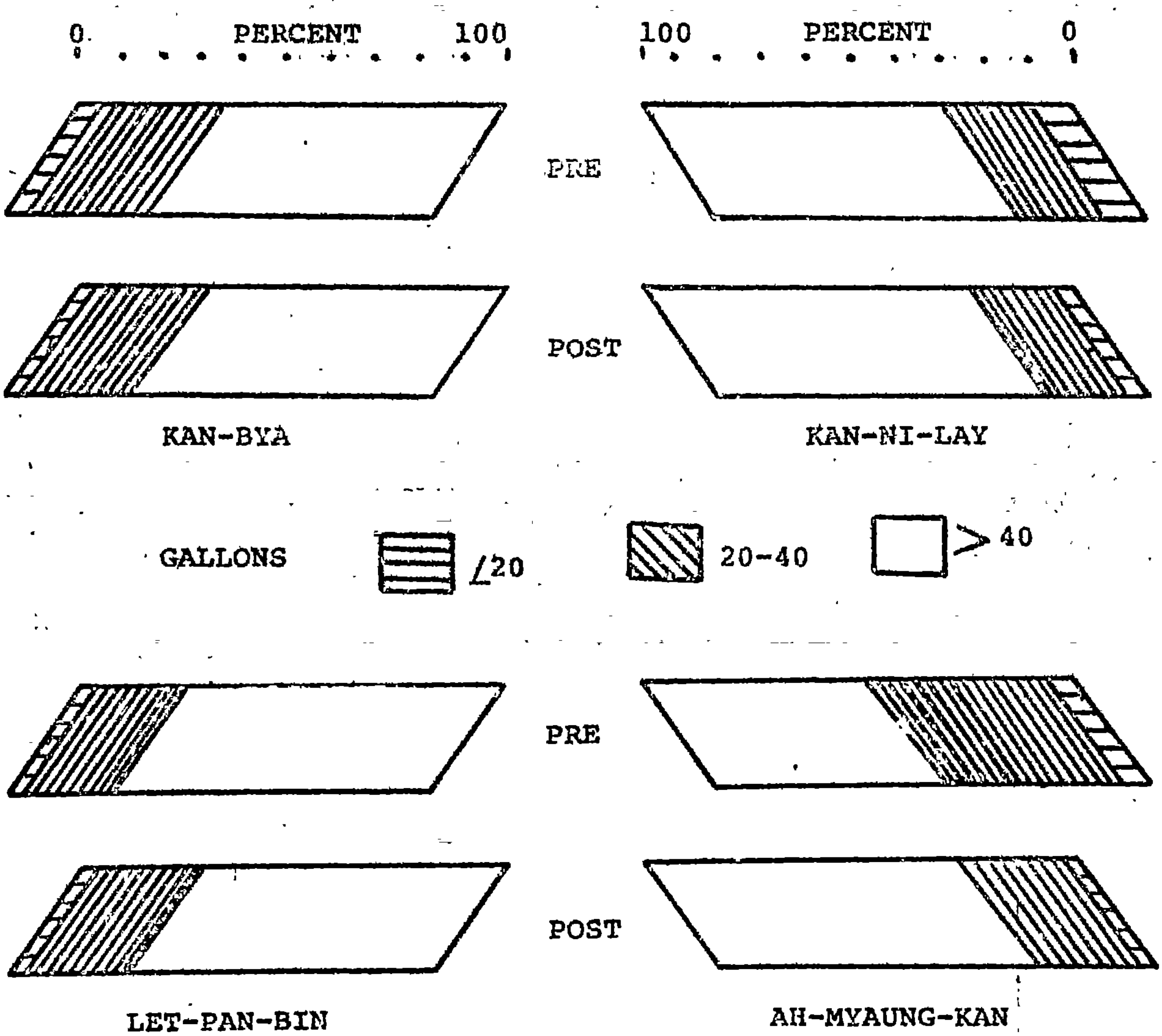


FIGURE 17. PERCENT OF HOUSEHOLDS BY AMOUNT OF WATER FETCHED PER DAY BEFORE AND AFTER TUBEWELL WATER SUPPLY.

1.5 Storage of water

Storage of water for longer periods was not a common practice in any of the study villages. Generally, most of the families carried water daily and stored for daily use or for a few days only. Only a negligible proportion of the households stored water for longer periods, particularly in Summer. This practice remain unchanged throughout the study period.

1.6 Affordability of project water supply

In communities, where the project water supply was made available during the post-intervention period, the main purposes of using tubewell water was drinking as well as other domestic purposes such as cooking, washing and bathing. Tubewell water was also used for animals but to lesser extent. This pattern was observed in all the test villages from Magwe as well as from Kyauk-Pa-Daung.

Regarding monthly household expenditure for obtaining tubewell water, the cost per household varied from village to village depending upon the pricing policy set up by each village. In Kan-Bya and Kan-Ni-Lay villages, the cost of one barrel of water was reasonably kept as low as possible and the poorer people had to pay less than the well-to-do families of the villages. As such, majority of the families had to spend less than Kyats 40 per month for using tubewell water (Figure 18).

On the other hand, the system of payment for water supply was not adjusted according to the income of the families in Let-Pan-Bin and Ah-Myaung-Kan villages of Kyauk-Pa-Daung township. Moreover, the cost of one barrel of water was as high as K1.50 to K2.50. Therefore a considerably high percentage of the households had to spend more than K40 per month. Key informant interviews with the local leaders and head of the households revealed that a change in pricing

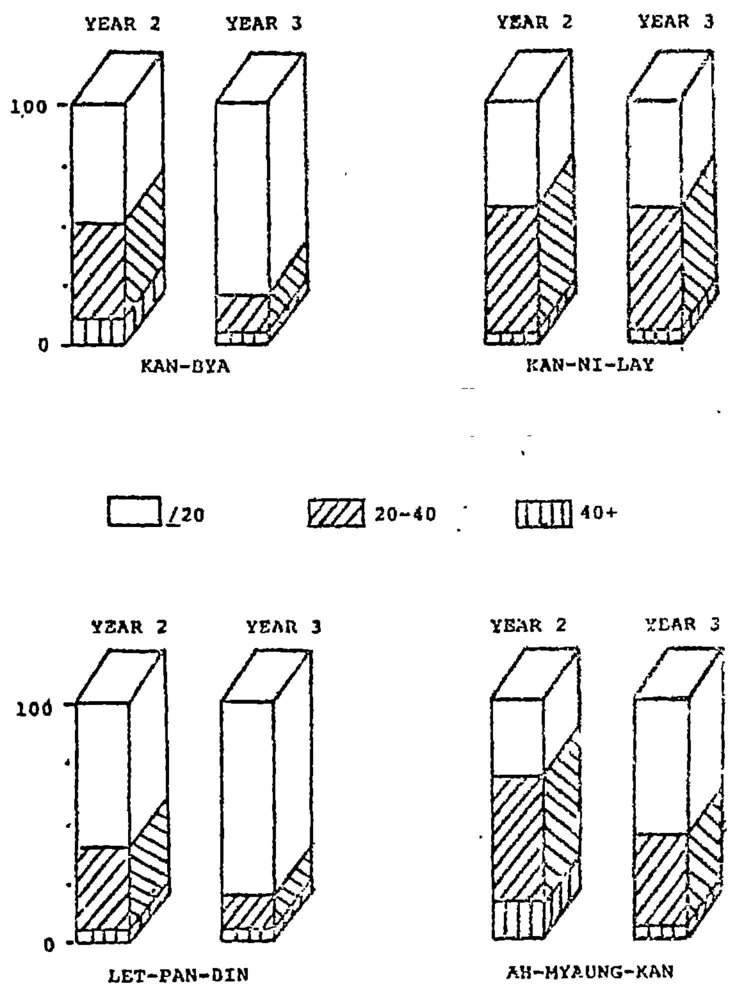


FIGURE 18. PERCENT OF HOUSEHOLDS BY MONTHLY EXPENDITURE FOR CONSUMING TUBEWELL WATER DURING DIFFERENT PERIODS OF THE STUDY.

policy should be considered for adjusting price of water according to the income of the families and affordability to spend on water.

2. Water Quality

The bacteriological and chemical quality of water from main sources, drinking pots and other domestic containers was monitored throughout the study period during successive periodic surveys by determining the total and faecal coliforms as well as important chemical constituents of water using portable kits and commercially available ready made media and reagents. A sample of 10-12 households was randomly selected to represent a 20 percent sample of the originally sampled households for periodic monitoring of water quality before and after tubewell water supply. The procedures applied for collection and testing of water from different sources were according to methods recommended by WHO[2]. Water samples from the main sources of the respective village were also analysed for bacterial and chemical quality. Water samples were collected only once during each periodic survey. The findings on water quality are described below: -

2.1 Bacteriological Quality of Water

As described earlier, the main sources of water for drinking and other domestic purposes were surface water sources such as pond, dug well, river, stream, canal and spring during the pre-intervention period. As such, nearly three-fourth of the water samples, both from main sources and domestic containers, were highly contaminated with faecal coliform in all the surveyed villages the mean value varying from 150 to 200 organisms per 100 ml (Table 11). Similarly, almost all the water samples showed high count of other coliforms during pre-intervention period.

TABLE 11. Village-wise comparison of level of contamination by faecal coliform organisms before and after water supply

VILLAGES	BEFORE WATER SUPPLY			AFTER WATER SUPPLY		
	MAIN WATER SOURCE	PER-CENT (+)	MEAN FC PER 100ml	MAIN WATER SOURCE	PER-CENT (+)	MEAN FC PER 100ml
KAN-BYA	POND (30)*	73.3	202	TUBEWELL(30)*	20.0	40
KAN-NI-LAY	DUG-WELL (25) (SPRING)	80.0	192	DUG-WELL (31) /POND	51.6	110
SI-BIN-THAR	DUG-WELL (28)	71.4	186	DUG-WELL (28)	64.3	171
LET-PAN-BIN	POND (30)	66.7	106	TUBE-WELL(30)	34.5	72
AH-MYAUNG-KAN	POND (30)	73.3	153	TUBE-WELL(30)	39.3	95
KAING	CANAL (30)	70.0	147	CANAL (30)	36.7	87
THA-KYIN	DUG-WELL (30) /RIVER	80.0	187	DUG-WELL (30) /RIVER	73.3	193
KA-LAR-YWAR	DUG-WELL (28) /RIVER	77.0	195	DUG-WELL (30) /RIVER	82.1	218
PHAUNG-GA-DAW	DUG-WELL (25) /STREAM	76.0	174	DUG-WELL (30) /STREAM	80.0	186

* Figures in parentheses represent number of water samples examined
\+ Positive

However, after tubewell water supply, the percent of water samples positive for faecal coliform was remarkably reduced in villages using tubewell water. So also, the mean faecal coliform count was reduced to a large extent in these villages. But the positive rate and mean faecal coliform count in the remaining villages relying on traditional water were not affected except in Kaing (C2) village where a considerable decrease was noted. The main reason being that Kaing village had attained a high percentage of proper excreta disposal facilities.

The bacterial quality of water by main sources during pre and post-intervention periods is illustrated in table 12. It could be observed that a high percentage of the water samples taken from various sources were contaminated with faecal coliforms when the community was relying on traditional water sources alone. Obviously, the water consumed from these sources also showed higher positive rates as well as mean count of faecal coliform organisms. A remarkable change was noticed after tubewell water supply. The main sources of tubewell water were free from faecal coliforms at different periods of the study (Table 12). Similarly, the percent of water samples positive for faecal coliform and the mean faecal coliform count were considerably reduced in villages using tubewell water, particularly in

TABLE 12. Comparison of faecal coliform distribution by source of water in study villages before and after use of tubewell water

STUDY VILLAGES	BEFORE WATER SUPPLY			AFTER WATER SUPPLY		
	WATER SOURCE (SAMPLING POINT)	PER-CENT (+)	MEAN FC PER 100ml	WATER SOURCE (SAMPLING POINT)	PER-CENT (+)	MEAN FC PER 100ml
KAN-BYA	POND (6)*	83.3	140.0	TUBEWELL (6)*	0.0	0.0
	D.P (12)	66.6	185.0	D.P (12)	16.6	33.3
	G.U.C (12)	75.0	208.0	G.U.C (12)	33.3	62.5
KAN-NI-LAY	DUG-WELL (SPRING) (5)	100	320.0	TUBEWELL (4)	0.0	0.0
	D.P (10)	70.0	140.0	D.P (12)	50.0	108.3
	G.U.C (10)	60.0	180.0	G.U.P (11)	63.6	127.3
LET-PAN-BIN	POND (6)	50.0	100.0	TUBEWELL (5)	0.0	0.0
	D.P (12)	66.6	91.6	D.P (12)	41.7	75.0
	G.U.C (12)	75.0	125.0	G.U. (12)	41.7	100.0
AH-MYAUNG-KAN	POND (6)	50.0	150.0	TUBEWELL (6)	0.0	0.0
	D.P (12)	75.0	141.6	D.P (11)	45.5	104.5
	G.U.P (12)	83.3	166.6	G.U. (11)	54.5	136.4

D.P = DRINKING POT
G.U.C = GENERAL USE CONTAINER
G.U.P = GENERAL USE POT

* Figures in parentheses represent number of water samples examined
\+ Positive

Kan-Bya (T1), Let-Pan-Bin (T3) and Ah-Myaung-Kan (T4) villages. However, the expectation that the quality of water for drinking and other domestic use will be improved after safe and potable supply of tubewell water was fulfilled only partially, because nearly half of the water samples showed high faecal coliform count even after tubewell water supply. The reason being that the domestic water for drinking and cooking gets contaminated during carriage, storage and use for different purposes.

2.2 Chemical Quality of Water

The physical and chemical quality of water before and after tubewell water supply in surveyed villages of Magwe is shown in table 13. Similar findings were also observed in villages of other townships. According to the guideline values, it was observed that colour and turbidity levels of water samples from the three villages were much higher than the set values of WHO, at the beginning of the study when the water from the traditional sources was utilized. Water from pond showed considerably higher values of colour and turbidity than the dug well and canal water; colour values ranging from 240-500 units and turbidity units ranging from 20 to 160 being noted from pond water samples from Kan-Bya (T1) and Ywa-Daw-Gyi (T2). Almost all the traditional water sources gave normal range of values of pH, Sulphate, Chlorides, iron and total hardness.

All the tubewell water sources showed normal range of values of colour and turbidity and as such was highly acceptable for drinking. The mean values of chloride were considerably higher in tubewell water, but were within the

TABLE 13. Physical and chemical quality of water before and after tubewell water supply in selected villages of Magwe

PHYSICAL & CHEMICAL INDICATORS	KAN-BYA (T1)		KAN-NI-LAY (T2)		SI-BIN-THA (C1)	
	MEAN VALUES		MEAN VALUES		MEAN VALUES	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
COLOUR (UNITS)	254.6	0.0	390.8	0.0	40.8	33.8
TURBIDITY (FTU)	51.6	3.7	96.5	3.5	8.9	6.7
PH	8.1	7.5	7.3	7.1	8.1	7.5
SULPHATE (Mg/l)	12.6	28.2	7.8	6.5	23.8	33.4
CHLORIDES (Mg/l)	23.4	80.7	22.7	42.1	53.7	31.1
IRON (Mg/l)	0.11	0.11	0.14	0.32	0.03	0.04
TOTAL H. (Mg/l) (Cal. + Mag.)	15.7	32.2	8.7	17.5	34.8	37.0
TOTAL SAMPLES (N) SOURCE OF WATER	25 POND	25 TUBEWELL	25 POND	24 TUBEWELL	22 D.W	24 TUBEWELL

TOTAL H. = TOTAL HARDNESS (Calcium+Magnesium) D.W = Dug Well

lower limit of permissible level recommended by WHO. Some people preferred traditional water for drinking because the tubewell water was slightly salty in taste. But the majority of the people used tubewell water for drinking and other purposes in villages where the tubewell water was made available. Tubewell water samples from Kan-Ni-Lay (T2), Let--Pan-Bin (T3) and Ah-Myaung-Kan (T4) also gave higher values of Iron content, the values being higher than the WHO guideline value of 0.3 mg/l.

3. Access to and use of latrine facilities

3.1 Access to latrine facilities

It has been described earlier in Chapter II that a pilot sanitary latrine programme was initiated in some of the villages which had been assigned as test and control villages. The villages that were covered under this programme by 1983-84 were Kan-Bya (T1) in Magwe, Kaing (C2) in Kyauk-Pa-Daung and Tha-Kyin (T5) and Phaung-Ga-Daw (C3) in Nga-Zun Townships.

The overall situation of possession of sanitary latrine facilities by each village is given in table 14. It would be observed from table 14 that among all the study villages of Magwe, Kan-Bya had a high proportion of households possessing latrine facilities during subsequent periods of intervention.

The typical example of a good latrine programme was observed in Kaing village. A very high percentage of the households possessed VIP type pit latrines throughout the study period. The interest and enthusiasm of the Township Medical Officer, the support provided by the local authorities and the full participation of the community were some of the outstanding features which resulted in the success of the latrine programme in Kaing village. Table 14 provides the figures for the possession of latrine in the study villages of Kyauk-Pa-Daung. It was noted that only a

TABLE 14. Percent of households with sanitary latrine facility at the beginning and end of study

VILLAGE & VILLAGE CODE		BEGINNING OF STUDY	END OF STUDY
KAN-BYA	(T1)	27.3	87.1
KAN-NI-LAY	(T2)	6.2	18.0
SI-BIN-THA	(C1)	8.2	16.8
LET-PAN-BIN	(T3)	21.2	23.8
AH-MYAUNG-KAN	(T4)	23.1	27.7
KAING	(C2)	26.0	87.2
THA-KYIN	(T5)	27.0	78.3
KA-LAR-YWAR	(T6)	16.5	39.5
PHAUNG-GA-DAW	(C3)	3.6	52.5

small proportion of the households had latrine facilities in Let-Pan-Bin and Ah-Myaung-Kan villages at the beginning and end of the study. These features enable to undertake an evaluation study on an independant basis to determine the effect of water and latrine programmes separately i.e. health impact of latrine facilities in Kaing and impact of water in Let-Pan-Bin and Ah-Myaung-Kan villages.

In the study villages of Nga-Zun township, Tha-Kyin had a high coverage of latrine programme and as such a large proportion of the families possessed latrine facilities by the end of the study. But in Ka-Lar-Ywar and Phaung-Ga-Daw, only about half of the sampled households had access to latrine facilites during post-intervention period, the figures being slightly higher in the latter village.

3.2 Use of latrine facilities

With the possession of latrine facilities, almost all the family members except infants and very young children used latrine facilities regularly. This feature was common to villages where the latrine programme was successfully implemented. Table 15 gives the percent of population using latrine facilities at the beginning and

TABLE 15. Percent of population by users of latrine facilities at the beginning and end of study

VILLAGE & VILLAGE CODE		BEGINNING OF STUDY	END OF STUDY
KAN-BYA	(T1)	32.6	82.1
KAN-NI-LAY	(T2)	9.2	18.1
SI-BIN-THA	(C1)	17.8	27.1
LET-PAN-BIN	(T3)	26.5	25.2
AH-MYAUNG-KAN	(T4)	23.0	28.7
KAING	(C2)	36.7	87.2
THA-KYIN	(T5)	30.4	79.5
KA-LAR-YWAR	(T6)	26.7	38.9
PHAUNG-GA-DAW	(C3)	3.8	53.8

end of the study. It could be observed that a remarkably high proportion of the population used latrine in Kan-Bya (T1), Kaing (C2) and Tha-Kyin (T5) villages, the percentages being 82.1, 87.2 and 79.5 respectively. A considerable increase in population using latrine facility was also noted in Phaung-Ga-Daw (C3) village. In the remaining villages, there was only a slight increase in latrine facility as well as population using latrine.

C. KNOWLEDGE, ATTITUDE AND PRACTICES RELATED TO WATER AND SANITATION FACILITIES

Evaluation of changes in knowledge, attitudes and practices related to use of water and sanitation facilities as well as water and sanitation associated diseases was assessed through periodic interview surveys supported by direct observation method. The level of personal hygiene of each family member was assessed through a three point score system on certain personal practices such as bathing, washing hands, cleanliness of face, eyes, hands and dress. All the sampled households in each village were included for the study. In each household, the respondant was usually a housewife or an elderly female or male. The findings on knowledge, attitude and practices are described below.

1. Knowledge

1.1 Knowledge on prevention of diarrhoea/dysentery by washing hands before eating meals

Nearly half of the population of each village responded that washing hands before eating meals could prevent diarrhoea and dysentery. Slightly higher percentages were observed in all the villages at the end of the study (Table 16). The knowledge and understanding of the community regarding importance of hand washing on disease occurence is fairly satisfactory, but in real practice hand washing was not done properly. Among the main reasons for washing hands before meals, a reasonably high proportion was in favour of afraid of contacting diseases.

TABLE 16. Percent of respondants who strongly agreed that diarrhoea could be prevented by washing hands before meals

STUDY VILLAGES	WASHING HANDS BEFORE MEALS PREVENTS DIARRHOEA	
	BEFORE	AFTER
KAN-BYA	45.4	54.2
KAN-NI-LAY	40.7	61.7
SI-BIN-THA	48.3	65.9
LET-PAN-BIN	50.8	67.8
AH-MYAUNG-KAN	43.1	69.3
KAING	55.3	51.3
THA-KYIN	45.5	54.0
KA-LAR-YWAR	53.0	67.1
PHAUNG-GA-DAW	54.7	63.6

1.2 Response of family members concerning drinking of raw water can cause diarrhoea

Majority of the respondants in all the villages gave their expression that drinking raw water can cause diarrhoea (Table 17), and this respond was expressed by both the test and control villages at the beginning as well as at the end of the study, the figures being slightly higher after intervention. The importance of drinking boiled water in the form of plain tea was understood and practiced by about one-third of the respondants. However, a large proportion of the families consumed raw water in spite of the understanding that raw water can cause diarrhoea. Therefore, it could be stated that the understanding of the community in this regard was rather poor and differs from the real practice.

TABLE 17. Response of household member regarding drinking of raw water on diarrhoea (percent)

STUDY VILLAGES	DRINKING RAW WATER CAUSES DIARRHOEA	
	BEFORE	AFTER
KAN-BYA	75.2	72.7
KAN-NI-LAY	59.6	69.4
SI-BIN-THA	84.3	81.1
LET-PAN-BIN	68.9	87.7
AH-MYAUNG-KAN	76.1	88.3
KAING	64.7	71.8
THA-KYIN	67.0	81.7
KA-LAR-YWAR	66.3	97.6
PHAUNG-GA-DAW	94.0	80.6

1.3 Knowledge regarding use of latrine can prevent diarrhoea

In general about 50 percent of the respondants in all the surveyed villages were in favour of the expression that using latrine can prevent the occurrence of diarrhoeal diseases. This feature was noted in the beginning as well as at the end of study, the percentages being higher for the latter (table 18). Even though many households possessed latrine facilities and used them regularly, in villages covered by latrine programme, the response was more or less

TABLE 18. Percent of respondants who agree that use of latrine can prevent diarrhoea

STUDY VILLAGES	USING LATRINE PREVENT DIARRHOEA	
	BEFORE %	AFTER %
KAN-BYA	51.6	56.6
KAN-NI-LAY	51.7	64.5
SI-BIN-THA	47.6	73.6
LET-PAN-BIN	56.7	78.1
AH-MYAUNG-KAN	55.6	77.0
KAING	45.8	48.9
THA-KYIN	35.9	56.6
KA-LA-YWA	47.6	68.0
PHAUNG-GA-DAW	52.7	61.8

same as those without the facility. This reflects that the importance of latrine facilities on diarrhoeal diseases was not well understood by many of the families , where infact the majority utilized the latrine facility in villages with latrine programme.

2. Practices

2.1 Hand washing practices

The interview survey supported by direct observation revealed that adults and older children of each family washed their hands before eating meals, but the

TABLE 19. Percent of population by hand washing practices before eating meals

STUDY VILLAGES	BEFORE		AFTER	
	WASHED WITH WATER ONLY (COMMON BOWL)	WASHED WITH SOAP & WATER	WASHED WITH WATER ONLY (COMMON BOWL)	WASHED WITH SOAP & WATER
KAN-BYA	88.2	3.9	89.5	6.0
KAN-NI-LAY	90.6	1.0	87.5	2.6
SI-BIN-THA	90.7	0.8	89.0	0.7
LET-PAN-BIN	92.0	1.0	92.7	0.0
AH-MYAUNG-KAN	85.2	0.0	93.1	0.0
KAING	95.3	0.0	94.2	0.0
THA-KYIN	88.2	3.4	92.1	0.0
KA-LAR-YWA	94.8	0.0	91.6	0.0
PHAUNG-GA-DAW	93.9	0.0	92.1	0.0

method of hand washing was rather superficial as most of them soak their hands in a common container. This practice was common to all the surveyed villages. Only a negligible proportion of the family members washed their hands thoroughly with soap and water before eating meals. Table 19 shows that this practice remained unchanged overtime.

Similarly, hand washing after using toilet was not a common practice in all the villages because majority of the population used papers, sticks, leaves and other means for cleansing after defaecation (Table 20). Hence, an exclusively large proportion of the population did not wash

TABLE 20. Percent of population by method of cleansing after defaecation at the beginning and end of the study

STUDY VILLAGES	BEFORE		AFTER	
	STICK, PAPER, CLOTH	WASH WITH WATER	STICK, PAPER, CLOTH	WASH WITH WATER
KAN-BYA	98.0	2.0	93.6	6.4
KAN-NI-LAY	100.0	0.0	99.7	0.3
SI-BIN-THA	99.7	0.3	98.0	2.0
LET-PAN-BIN	100.0	0.0	97.5	2.5
AH-MYAUNG-KAN	98.9	1.1	100.0	0.0
KAING	99.2	0.8	96.8	3.2
THA-KYIN	95.0	5.0	97.5	2.5
KA-LAR-YWA	98.5	1.5	100.0	0.0
PHAUNG-GA-DAW	97.7	2.3	99.5	0.5

their hands at all after using toilet, the main reason given by the respondants was that their hands do not get dirty because they use sticks, papers, etc. Table 21 provides the figures for hand washing practices after defaecation at the beginning and end of the study. Slight improvment was noted in Kan-Bya and Kaing villages.

Although the community understood and expressed the importance of hand washing, in real practice hand washing was not done properly by a large proportion of the population. It was noted throughout the study period that water supply and latrine programme were provided without any specific health education message to these villages. Therefore, the knowledge of the community in the use of water and sanitation facilities was rudimentary to affect any change in water related practices.

TABLE 21. Percent of population by hand washing practices after defaecation

STUDY VILLAGES	BEFORE		AFTER	
	NOT WASHED	WASHED WITH WATER	NOT WASHED	WASHED WITH WATER
KAN-BYA	88.7	11.3	86.4	13.6
KAN-NI-LAY	90.4	9.6	98.9	1.1
SI-BIN-THA	91.8	8.2	96.3	3.7
LET-PAN-BIN	86.4	13.6	91.7	8.3
AH-MYAUNG-KAN	97.2	2.8	97.9	2.1
KAING	81.9	18.1	78.9	21.1
THA-KYIN	87.5	12.5	91.7	8.3
KA-LAR-YWA	99.5	0.5	99.8	0.2
PHAUNG-GA-DAW	95.7	4.3	100.0	0.0

2.2 Household water treatment practices

In spite of the understanding that drinking raw water can cause diarrhoea, more than 50 percent of the families used raw water from traditional sources for drinking without any treatment. The proportion of the population drinking raw water increased at the end of the study, particularly in villages where tubewell water supply was used for drinking, namely in Kan-Bya (T1), Let-Pan-Bin (T3) and Ah-Myaung-Kan (T4) villages (Table 22). In the

TABLE 22. Percent of population using raw and boiled water for drinking during different periods of the study

STUDY VILLAGES	BEFORE		AFTER	
	RAW WATER	BOILED WATER (PLAIN TEA)	RAW WATER	BOILED WATER (PLAIN TEA)
KAN-BYA (T1)	57.2	42.8	81.6	18.4
KAN-NI-LAY (T2)	67.6	32.4	68.6	31.4
SI-BIN-THA (C1)	50.2	49.8	55.8	44.2
LET-PAN-BIN (T3)	51.7	48.3	85.3	14.7
AH-MYAUNG-KAN (T4)	46.3	53.7	81.6	18.4
KAING (C2)	59.4	40.6	55.7	44.3
THA-KYIN (T5)	65.2	34.8	65.4	34.6
KA-LAR-YWA (T6)	89.5	10.5	79.8	20.2
PHAUNG-GA-DAW (C3)	71.0	29.0	67.2	32.8

remaining villages, this practice remained consistent till the end of study . Again, the understanding of the families about the ill-health of raw water differed from the real practice where infact the raw water was consumed by a large proportion of the population.

In general, about half of the population also had the practice of taking boiled water in the form of plain tea, which is usually a common practice of the rural population. With the availability of good quality clean water for drinking after tubewell water supply, there was a considerable decrease in the proportion of population who used boiled water in the beginning. This change was noticed in villages such as Kan-Bya, Let-Pan-Bin and Ah-Myaung-Kan villages which received tubewell water supply during the subsequent periods.

2.3 Bathing practices

Bathing practices vary from village to village and from season to season depending upon the availability of water. During the summer season of the pre-intervention period, when the community had to rely on traditional water sources, about 60-80 percent of the population bathed daily in both the study and comparison villages. This practice remained unchanged during the post-intervention period after the project water supply, except in Let-Pan-Bin where some increase in the practice of daily bathing was noted (Table 23).

It was also observed that frequency in bathing depended on the availability of water from traditional sources, particularly in monsoon when more people bathed regularly because of ample supply of water. Obviously, when there was scarcity of water, people bathed less frequently, even in villages where tubewell water supply was made available.

TABLE 23. Percentage distribution of population by bathing practices

STUDY VILLAGES	BEFORE		AFTER	
	NO DAILY BATHING	DAILY BATHING	NO DAILY BATHING	DAILY BATHING
KAN-BYA	31.3	68.7	29.8	70.2
KAN-NI-LAY	34.5	65.5	30.1	69.9
SI-BIN-THA	25.2	74.8	27.5	72.5
LET-PAN-BIN	23.9	76.1	8.5	91.5
AH-MYAUNG-KAN	35.1	64.9	33.7	66.3
KAING	25.8	74.2	30.5	69.5
THA-KYIN	29.3	70.7	25.3	64.7
KA-LAR-YWA	28.8	71.2	29.5	70.1
PHAUNG-GA-DAW	19.3	80.7	19.5	80.5

2.4 Personal Hygiene

The level of personal hygiene was assessed through three point score system applying set scores for a number of individual hygiene conditions such as bathing, hand washing before meals and after defecation, cleanliness of face, eyes, nose and hands. It was noted that the majority of the individuals (60 to 90 percent) had fair personal hygiene and only a negligible proportion had good personal hygiene at the beginning of study. Villages with higher percentages of

TABLE 24. Level of percent hygiene of the study population at the beginning and end of the study

STUDY VILLAGES	BEFORE		AFTER	
	FAIR %	POOR %	FAIR %	POOR %
KAN-BYA	92.4	6.6	93.7	6.3
KAN-NI-LAY	69.0	31.0	73.6	23.0
SI-BIN-THA	64.4	34.1	93.7	6.3
LET-PAN-BIN	73.4	25.8	96.0	1.8
AH-MYAUNG-KAN	73.5	25.8	77.7	22.3
KAING	84.5	14.7	94.3	5.7
THA-KYIN	92.6	7.4	79.1	20.9
KA-LAR-YWA	61.4	36.8	83.0	16.6
PHAUNG-GA-DAW	87.7	11.7	76.9	21.4

poor personal hygiene were Kan-Ni-Lay(T2), Si-Bin-Thar (C1), Let-Pan-Bin (T3), Ah-Myaung-Kan (T4) and Ka-Lar-Ywar (C3). Only slight changes were observed in the subsequent surveys, with the proportion of fair group remaining more or less consistent (Table 24). As discussed earlier, the health education package was not a part and parcel of the water and latrine facilities and as such there was no motivation of the community for making a change in day-to-day hygienic practices.

D. HEALTH IMPACT OF WATER AND LATRINE FACILITIES

As mentioned earlier in Chapter IV, the present study applied two basic approaches, namely the interval and external evaluation designs for measuring the health impact of project facilities, emphasis being placed on the former design. The magnitude of the project impact is being made on the basis of comparisons of "before and after" project implementation in each experimental village as well as between experimental and control villages. This enables an analysis based on internal comparison and also an external comparison. In addition, further analysis is being attempted between user and non-user of water and latrine facilities in each village. The results on each of these comparisons are presented below.

1. Analysis based on internal comparison design

1.1 Diarrhoea

(a) Diarrhoea among under five children

Village-wise comparison of prevalence of diarrhoea in under five children revealed that this rate has significantly declined in Kan-Bya (T1) village in both wet (monsoon) and dry (winter) season after tubewell water supply, the changes at the two points of the study being significant ($P < .03$). A considerable decrease in this rate was also noted in Kan-Ni-Lay (T2), Let-Pan-Bin (T3) and Ah-Myaung-Kan (T4) villages, the percentage of reduction being 20.7, 25.4 and 18.2 respectively. This change may have resulted from the availability and use of improved water supply by a large proportion of the community

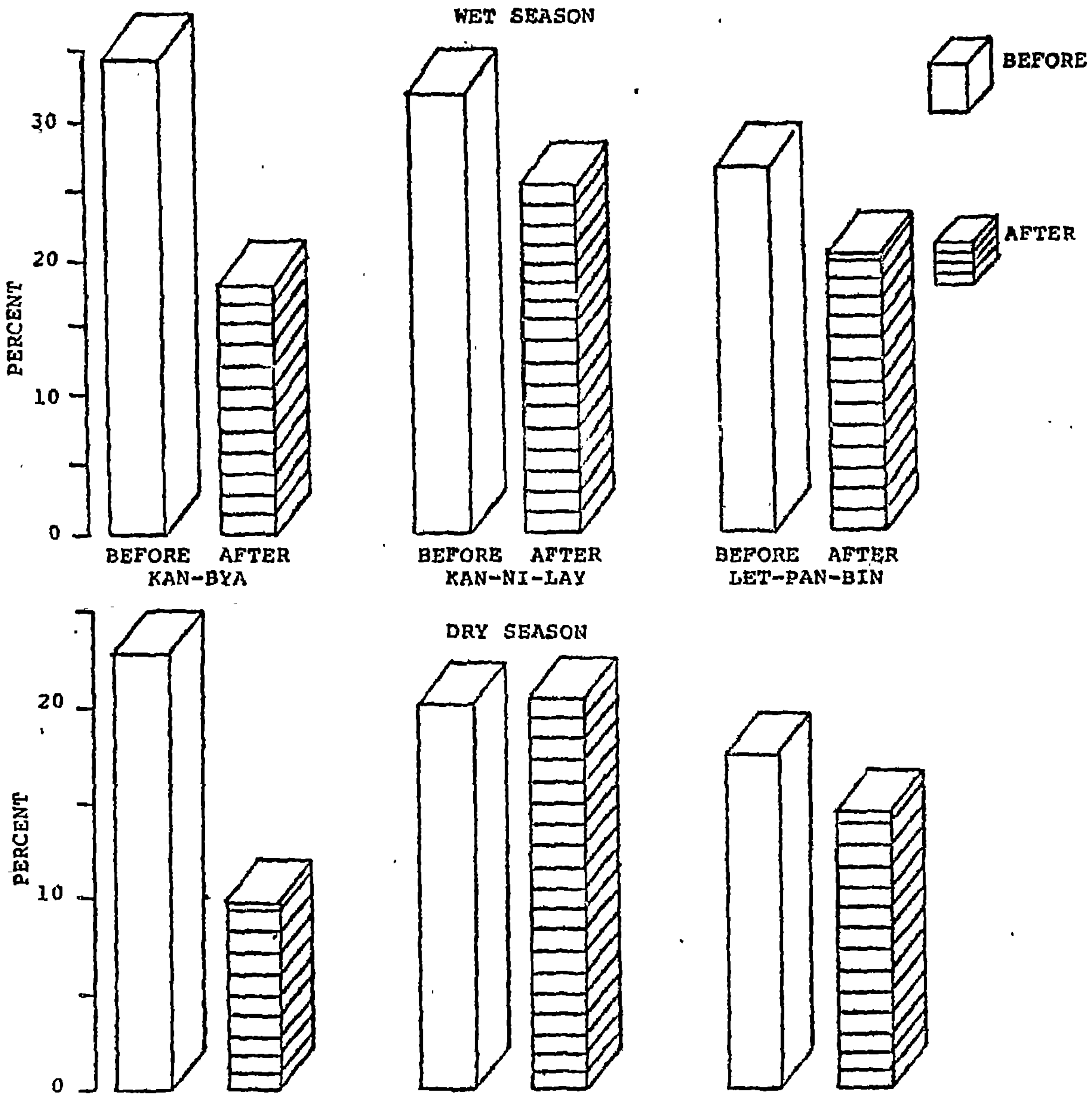


FIGURE 19. VILLAGE-WISE COMPARISON OF PREVALENCE OF DIARRHOEA IN UNDER FIVE CHILDREN BEFORE AND AFTER PROJECT WATER SUPPLY.

after tubewell installation. This will be explored further in the subsequent sessions of this report. The prevalence of diarrhoea in children below 5 years of age remained consistent in both the seasons and throughout the study period in the test villages (T5 and T6) of Nga-Zun township, where the community had no access to project water supply. Figure 19 and 20 illustrates village-wise differences in the seasonal prevalence of diarrhoea in under five children before and after tubewell water supply.

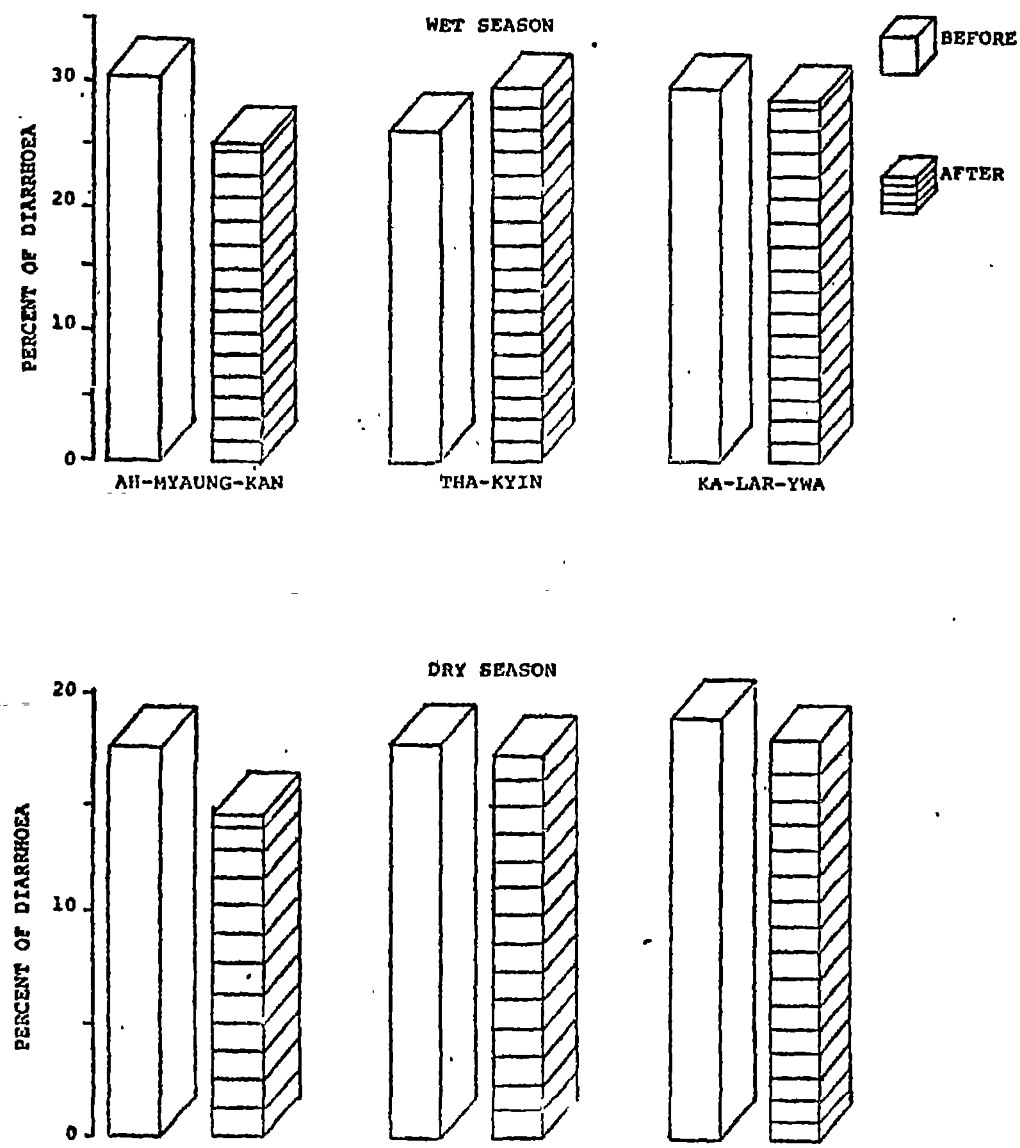


FIGURE 20. VILLAGE-WISE COMPARISON OF PREVALENCE OF DIARRHOEA IN UNDER FIVE CHILDREN BEFORE AND AFTER WATER SUPPLY.

As regards incidence of diarrhoea in children of the same age group, the differences observed were similar as prevalent rate. There was a significant reduction of this rate in Kan-Bya (T1) village in both the seasons (P < .03), whereas Kan-Ni-Lay (T2), Let-Pan-Bin (T3) and Ah-Myaung-Kan (T4) comparatively had lower rates of reduction during monsoon season, the percentages being 24.3, 29.6 and 20.0 respectively. No evidence of changes was noted in the other two study villages of Nga-Zun. Table 25 compares the differences observed in seasonal incidence of diarrhoea in under five children before and after project water supply.

Table 25. Comparison of incidence of diarrhoea in under five children before and after tubewell water supply in the study villages

TUBEWELL WATER SUPPLY VILLAGES	WET SEASON BEFORE(84) %	WET SEASON AFTER(87) %	DRY SEASON BEFORE(84) %	DRY SEASON AFTER(87) %
KAN-BYA (T1)	31.4	14.9 *	19.7	7.1 *
KAN-NI-LAY (T2)	29.6	22.4	16.7	17.4
LET-PAN-BIN (T3)	23.3	16.4	14.5	11.7
AH-MYAUNG-KAN (T4)	27.0	21.6	14.8	14.5
THA-KYIN (T5)	23.3	26.6	16.4	15.6
KA-LAR-YWA (T6)	26.4	25.3	15.8	12.2

* = P < .03

These findings were supported by another striking feature in the annual incidence of diarrhoea among under five children. A highly significant reduction ($P < .002$) was observed in the number of episodes per child year in Kan-Bya (T1) village, the figures being 4.1 episodes at the beginning and 1.9 episodes at the end of the study. Compared to Kan-Bya, this rate was only slightly decreased in T2, T3 and T4 villages. In the remaining test villages (T5 and T6), the episode per child year was as high as 3.9 and remained consistent throughout the study as well as at the end of study. Table 26 compares the changes in annual incidence of diarrhoea in under five children before and after tubewell water supply.

Table 26. Comparison of annual incidence of diarrhoea in under five children before and after tubewell water supply

EXPERIMENTAL VILLAGES	BEFORE TUBEWELL WATER SUPPLY			AFTER TUBEWELL WATER SUPPLY		
	NUMBER OF CHILDREN	TOTAL EPISODES	EPISODE/ CHILD YEAR	NUMBER OF CHILDREN	TOTAL EPISODES	EPISODE/ CHILD YEAR
KAN-BYA	71	281	4.1	73	139	1.9*
KAN-NI-LAY	71	261	3.8	75	218	2.9
LET-PAN-BIN	72	246	3.4	73	175	2.4
AH-MYAUNG-KAN	76	235	3.1	75	198	2.6
THA-KYIN	72	242	3.4	77	304	3.9
KA-LAR-YWA	71	278	3.9	77	288	3.7

* = $P < .002$

(b) **Diarrhoea by age groups and sex**

The percentage distribution of prevalence of diarrhoea by age groups and sex before and after tubewell water supply is shown in table 27. The most commonly affected age group with high rates of prevalence of diarrhoea in both the sexes was under five children. The impact of project facilities was observed in both the sexes in this group, the rates being comparatively lower at the end of study than the beginning in T1, T2, T3 and T4 villages, particularly in Kan-Bya (T1) village. The distribution pattern of prevalence of diarrhoea by age groups was similar in T5 and T6 villages but there was no evidence of reduction of this rate in under five population at the end of study.

Both the sexes were more or less equally affected and sex preponderance was not a common feature in the occurrence of diarrhoea. The prevalent rate of diarrhoea in age groups 5-14 and above 15 was comparatively low, particularly in the latter age group. Table 27 shows that the main age group affected by intervention is under five years and the prevalence of diarrhoea in other age groups remained unchanged overtime.

(b) Diarrhoea by all ages

Village-wise comparison of prevalence and annual incidence of diarrhoea in all ages revealed that these rates were significantly reduced in Kan-Bya (T1) village only, the respective figures being 6.9 percent and 0.82 episode per person year at the beginning and 4.1 percent and 0.44 episode at the end ($P < .05$ for both the rates). A slight decline in these rates was also noticed in T2, T3 and T4 villages whereas T5 and T6 showed

Table 27. Percentage distribution of prevalence of diarrhoea by age groups and sex before and after intervention (Villages using tubewell water)

VILLAGES		0-4 YEARS BEFORE (84)	0-4 YEARS AFTER (87)	5-14 YEARS BEFORE (84)	5-14 YEARS AFTER (87)	15 & ABOVE BEFORE (84)	15 & ABOVE AFTER (87)
KAN-BYA	(M)	31.7	20.0	2.6	2.2	1.6	0.0
	(F)	37.9	15.1	5.4	5.3	1.8	0.8
	(T)	34.3	17.8	3.7	3.6	1.7	9.4
KAN-NI-LAY	(M)	27.9	20.9	5.6	3.7	3.3	4.0
	(F)	37.9	30.6	3.4	5.1	3.4	5.1
	(T)	31.9	25.3	4.5	4.3	3.3	4.6
LET-PAN-BIN	(M)	26.5	20.5	4.9	4.7	0.7	0.8
	(F)	26.3	18.9	3.0	4.9	0.7	2.3
	(T)	26.4	19.7	4.1	4.8	0.7	1.6
AH-MYAUNG-KAN	(M)	32.0	16.3	6.5	3.4	2.1	1.5
	(F)	34.6	24.2	6.0	6.3	1.5	1.8
	(T)	32.9	24.7	6.3	4.8	1.8	1.7

slight increase in these rates. Table 28 compares overall prevalence and incidence of diarrhoea in the study villages.

The decline of overall prevalence and incidence of diarrhoea in all ages as a whole was mainly due to the reduction of prevalence and incidence rates in under five children which was largely affected by intervention of project facilities. As discussed earlier the rates in other groups were not affected by intervention. Figure 21 comparatively show the differences in seasonal prevalence of diarrhoea in all ages before and after tubewell water supply.

Table 28 . Village-wise comparison of prevalence and incidence of diarrhoea in all ages before and after water supply

STUDY VILLAGES	PREVALENCE(PERCENT) BEFORE(84)	AFTER(87)	INCIDENCE(EPISODE/PERSON YEAR) BEFORE(84)	AFTER(87)
KAN-BYA (T1	6.9	4.1*	0.82	0.44*
KAN-NI-LAY (T2	8.0	7.6	0.68	0.64
LET-PAN-BIN (T3	5.7	5.4	0.70	0.55
AH-MYAUNG-KAN(T4	7.0	5.9	0.71	0.62
THA-KYIN (T5	5.0	5.8	0.63	0.70
KA-LAR-YWA (T6	5.3	6.8	0.70	0.80

* = P< .05

(d) Diarrhoea by level of personal hygiene

The level of personal hygiene was assessed through a three-point score system on a number of personal variables and was categorized as poor, satisfactory and good on the basis of total score for each individual. Two-week recall period was used for obtaining the prevalent rate of diarrhoea by level of personal hygiene of each individual at the beginning as well as during subsequent periodic surveys. Table 29 shows the differences in prevalent rate of diarrhoea by level of personal hygiene before and after intervention. It could be observed that there is a considerable reduction of this rate in the group possessing satisfactory level of personal hygiene than the poor group in all study villages except T5 and T6 villages where the rate has remained consistent overtime. Since the majority of the population in all

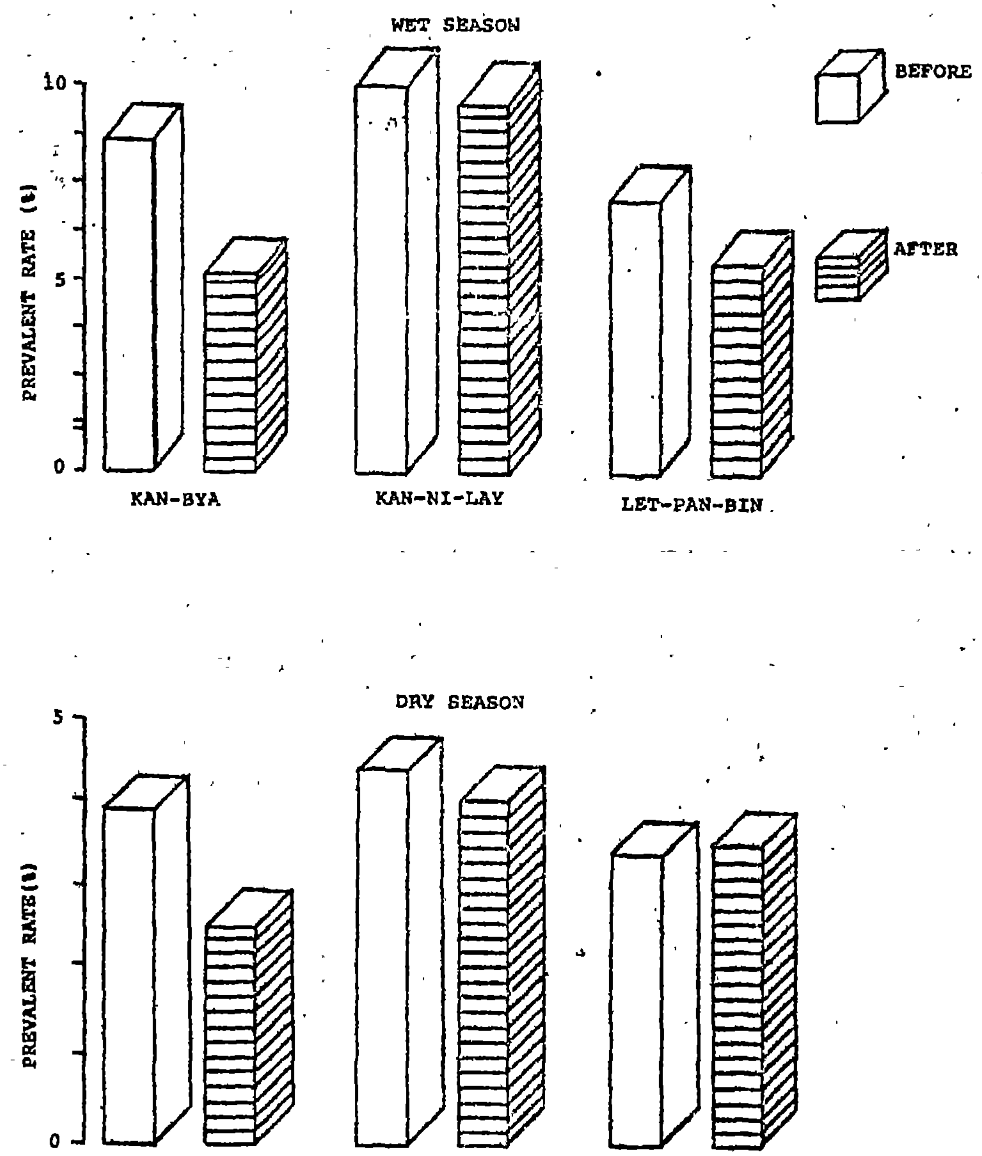


FIGURE 21. SEASONAL PREVALENCE OF DIARRHOEA IN ALL AGES BEFORE AND AFTER TUBEWELL WATER SUPPLY IN STUDY VILLAGES.

the study villages had satisfactory level of personal hygiene at the beginning and because there was no improvement in the level of personal hygiene at the subsequent periods, the reduction in prevalence rate in this group did not reflect the true affect of improvement in hygienic practices.

Table.29 Comparison of percent prevalence of diarrhoea by level of personal hygiene before and after intervention

STUDY VILLAGES		<5 BEFORE	<5 AFTER	ALL AGES BEFORE	ALL AGES AFTER
KAN-BYA	(T1)**	35.6	14.5	6.6	4.5
	***	33.3	33.3	12.9	11.1
KAN-NI-LAY	(T2)**	29.3	17.3	6.2	4.2
	***	37.9	44.0	12.0	19.3
LET-PAN-BIN	(T3)**	25.5	17.3	4.5	4.9
	***	30.0	26.1	9.1	7.9
AH-MYAUNG-KAN	(T4)**	27.6	14.0	4.8	4.0
	***	33.3	38.9	13.2	9.3
THA-KYIN	(T5)**	26.3	36.7	5.3	4.9
	***	25.0	19.4	10.7	11.1
KA-LAR-YWA	(T6)**	35.7	29.2	5.6	7.0
	***	26.7	27.3	4.7	6.1

** = Satisfactory *** = Poor

1.2. Dysentery

The seasonal incidence of dysentery among under five children remarkably declined in Kan-Bya (T1) village, the percentage of reduction being 39.4 and 34.3 in wet and dry seasons respectively. There was no evidence of marked changes in the seasonal rates in other study villages. Likewise, the incidence of dysentery in all ages was considerably reduced in Kan-Bya village, particularly in wet season. Table 30 and 31 illustrates the differences in the seasonal rates of dysentery before and after intervention.

Table 30. **Village-wise comparison of seasonal incidence* of dysentery among under five children before and after intervention**

STUDY VILLAGES	WET SEASON BEFORE(84)	WET SEASON AFTER(87)	DRY SEASON BEFORE(84)	DRY SEASON AFTER(87)
KAN-BYA (T1	28.2	17.1	16.9	11.1
KAN-NI-LAY (T2	29.1	30.4	22.5	22.3
LET-PAN-BIN (T3	23.0	19.7	23.6	19.7
AH-MYAUNG-KAN(T4	19.2	22.2	23.7	27.2
THA-KYIN (T5	23.3	25.8	16.2	20.5
KA-LAR-YWA (T6	21.1	24.7	16.0	18.8

* = Seasonal incidence based on weekly surveillance during monsoon and winter seasons

It was also noted that the annual incidence of dysentery among children below 5 years of age remained consistent in all the study villages expect in Kan-Bya (T1), where a 25 percent reduction was observed, the figures being 1.7 and 1.3 episodes per child year at the beginning and end of the study respectively. The episode per child year varied from village to village,the range being 1.3 to 2.0 before intervention and 1.6 to 1.9 epsodes after intervention.

Table 31. Within-village comparison of seasonal incidence* of dysentery in all ages before and after project intervention

STUDY VILLAGES	WET SEASON % BEFORE(84)	AFTER(87)	DRY SEASON % BEFORE(84)	AFTER(87)
KAN-BYA (T1	10.5	6.9	5.8	4.9
KAN-NI-LAY (T2	13.7	14.3	7.2	8.1
LET-PAN-BIN (T3	9.3	10.2	9.7	7.9
AH-MYAUNG-KAN (T4	8.2	8.7	8.6	9.2
THA-KYIN (T5	8.0	7.8	7.7	8.1
KA-LAR-YWA (T6	8.8	8.3	7.3	8.2

* = seasonal incidence based on weekly surveillance during monsoon and winter

1 3 Eye infection

The annual incidence of eye infections including trachoma and conjunctivitis, remained consistent throughout the study, with some variations from period to period. The number of episodes per child year ranged from 1.3 to 1.8 at the beginning and 1.2 to 1.9 at the end of study. A noticeable change from 1.5 to 1.2 was observed only in Kan-Bya village. Similarly, no evidence of marked changes was noted in the annual incidence of eye infections in all ages, the number of episode per person year being remaining consistent at 0.6 to 0.7. Table 32 reveals the incidence of eye infections by village before and after the project water supply.

Table 32. Episode per child and person year of eye infection by village before and after water supply in study villages

STUDY VILLAGES	< 5 CHILDREN BEFORE	AFTER	ALL AGES BEFORE	AFTER
KAN-BYA (T1	1.5(104)	1.2(89)	0.7(344)	0.6(281)
KAN-NI-LAY (T2	1.6(116)	1.7(137)	0.6(284)	0.6(316)
LET-PAN-BIN (T3	1.3(94)	1.4(105)	0.5(228)	0.6(311)
AH-MYAUNG-KAN(T4	1.8(140)	1.9(153)	0.7(416)	0.7(394)
THA-KYIN (T5	1.5(112)	1.7(129)	0.6(328)	0.7(394)
KA-LAR-YWA (T6	1.6(116)	1.8(135)	0.7(336)	0.7(383)

Figures in parentheses represent number of episodes

1.4 Skin Infections

Like eye infections, the overall incidence of skin infections including staphylococcal infection and scabies was relatively higher in all the communities throughout the study, the episode per person varied from village to village, the highest being 0.9 episode and the lowest 0.6 episode. This pattern remained consistent at the end of study with slight reduction in T1, T2, T3 and T5 villages. Similarly, the annual incidence of skin infections in under five children was reduced to some extent in T1, T3 and T5 villages, the percentage of reduction being about 20 percent in all of these villages. Table 33 compares the incident rate in children and all ages at the beginning and end of study.

Table 33. Annual incidence of skin infections by village before and after water supply

STUDY VILLAGES	< 5 CHILDREN		ALL AGES	
	BEFORE E/C	AFTER E/C	BEFORE E/C	AFTER E/C
KAN-BYA (T1	1.8(124)	1.4(101)	0.6(284)	0.5(245)
KAN-NI-LAY (T2	2.1(158)	2.3(138)	0.9(418)	0.8(421)
LET-PAN-BIN (T3	2.1(154)	1.6(120)	0.7(316)	0.6(280)
AH-MYAUNG-KAN(T4	2.3(178)	1.8(145)	0.8(426)	0.8(417)
THA-KYIN (T5	1.9(141)	1.8(137)	0.7(364)	0.6(381)
KA-LAR-YWA (T6	1.6(118)	1.6(126)	0.6(301)	0.6(342)

Figures in parentheses represent number of episodes

E/C = Episode / Children

1.5 Ascaris Infection

The number of stool samples of under five children examined and the percent positive for Ascaris lumbricoides is shown in table 34. It could be observed that generally about half of the children were infected with this infection at the beginning of the study and more or less a similar proportion were found to be infected in all villages after project intervention. Only slight changes were noted in Kan-Bya (T1) village with a 15 percent reduction of the infection after intervention.

Table 34. Percent prevalence of ascaris infection in children below 5 years at the beginning and end of the year

STUDY VILLAGES	BEGINNING OF STUDY *	**	END OF STUDY *	**
KAN-BYA (T1	65	52.3	63	44.4
KAN-NI-LAY (T2	62	58.1	68	60.3
LET-PAN-BIN (T3	61	55.7	65	48.4
AH-MYAUNG-KAN(T4	62	64.5	64	56.7
THA-KYIN (T5	62	48.4	67	53.1
KA-LAR-YWA (T6	63	65.1	61	60.9

* Number of stool samples examined
** Percent positive

2. Analysis based on external comparison

2.1 Diarrhoea

Comparison of prevalence and incidence of set indicator diseases between study and control villages has been attempted to reveal differences in these indicator diseases before and after project intervention. Analysis based on external comparison was made between villages in each township as well as between the three townships selected for the study.

Comparison of diarrhoea rates between test and control villages of Magwe township revealed that the prevalence and incidence rates of diarrhoea in under five children as well as in all ages significantly reduced in Kan-Bya(T1) village than the control village where these rates remained more on less consistent throughout the study. The difference in prevalence and incidence of diarrhoea in under five children was very striking and compared to the control village (C1), these differences are highly significant ($p<0.01$). This remarkable change in Kan-Bya may have resulted from the availability of tubewell water supply as well as sanitary latrine facilities which were the main differences between the villages after project intervention. As described earlier in section A of this chapter, other characteristics of the two villages remained consistent overtime.

It was also observed that there was no remarkable difference in diarrhoea rates between Kan-Ni-Lay (T2) and Si-Bin-Tha (C1) villages, although slight decline in these rates was noted in both the villages, particularly during wet season. The main reason for having no change in Kan-Ni-Lay(T2) village was due to the fact that only half of the population utilized tubewell water supply and the remaining proportion relied on traditional water sources. Moreover, the majority of the households did not possess latrine facilities throughout the study. Therefore the incidence of diarrhoea has remained consistent even after the supply of tubewell water in this village. Figure 22 compares the differences in diarrhoea rates between test and control villages during wet and dry seasons before and after project intervention.

Village-wise comparison of prevalence of incidence of diarrhoea between study and control villages of Kyauk-Pa-Daung revealed that the diarrhoea rates after intervention were significantly lower in Kaing (C2) village than the tubewell water supply villages, namely Let-Pan-Bin (T3) and Ah-Myaung-Kan (T4) villages. The prevalent rates of diarrhoea in under five children

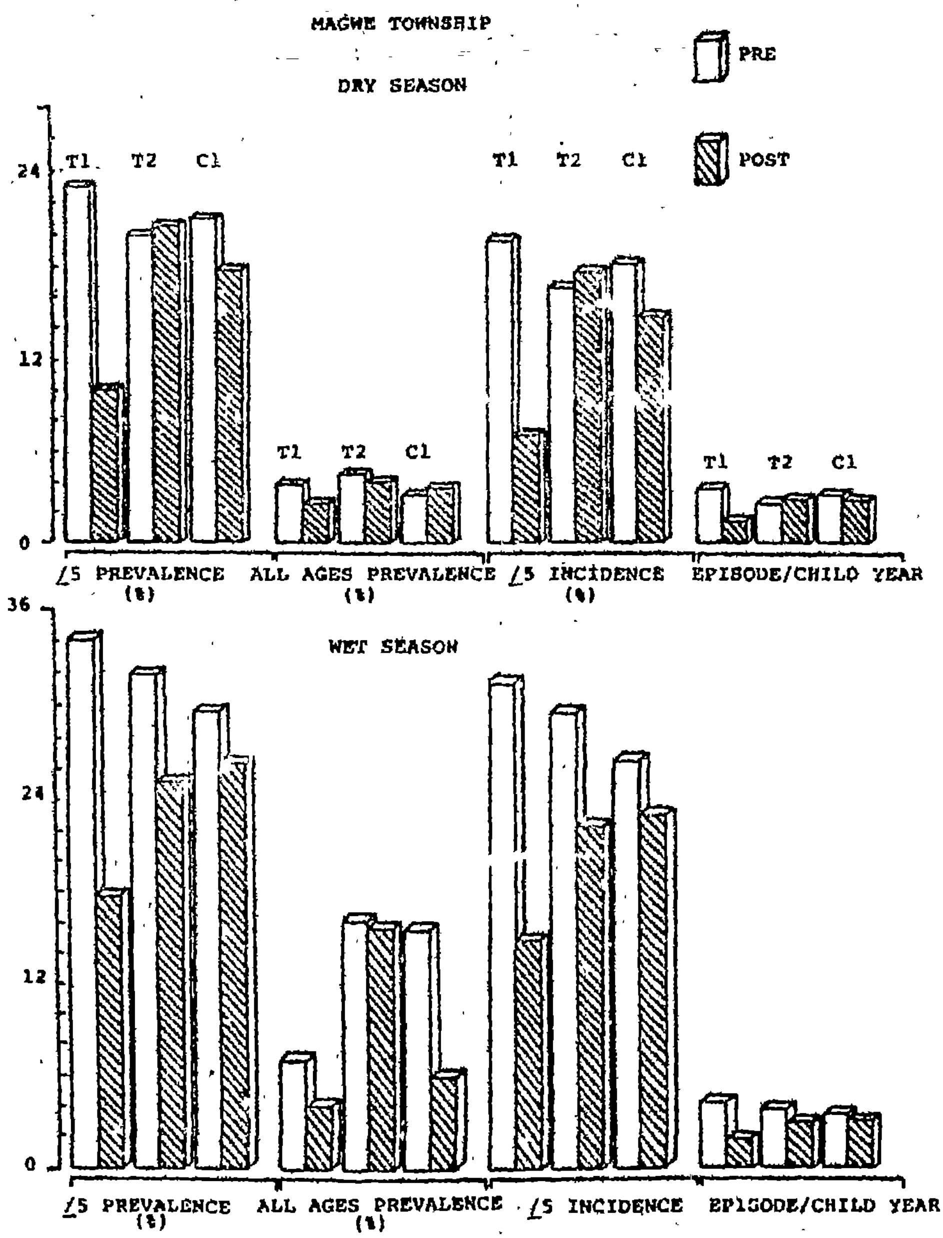


FIGURE 22. COMPARISON OF DIARRHOEA RATES BETWEEN STUDY AND CONTROL VILLAGES BEFORE AND AFTER WATER SUPPLY IN MAGWE.

and all ages as well as the seasonal and annual incidence of diarrhoea were significantly reduced in Kaing village in both the seasons at the end of the study ($p<0.05$ for all the rates). Figure

23 comparatively shows the differences in diarrhoea rates between study and control villages before and after intervention in Kyauk-Pa-Daung.

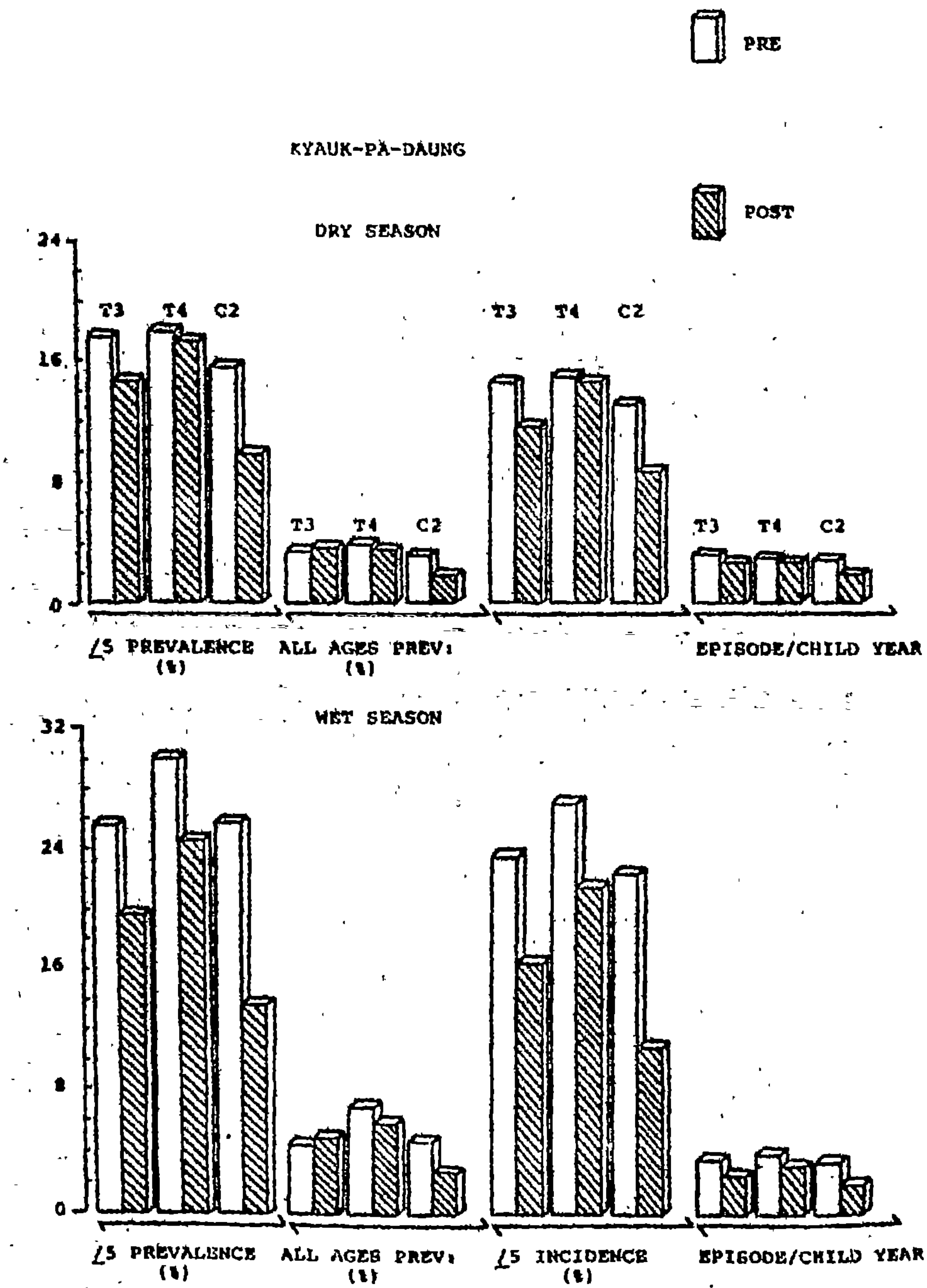


FIGURE 23. COMPARISON OF DIARRHOEA RATES BETWEEN STUDY AND CONTROL VILLAGES BEFORE AND AFTER INTERVENTION IN KYAUK-PA-DAUNG.

A considerable decrease in diarrhoea rates was also observed in the study villages (T3 and T4), but the differences in these rates before and after intervention were not significant. The differences in diarrhoea rates and percent of reduction is shown in Table 35.

Table.35 Comparison of diarrhoea rates between study and control villages in Kyauk-Pa-Daung

VILLAGES	RATES	BEFORE **	AFTER **	DIFFER-ENCE + -	PERCENT REDUC-TION
LETPANBIN (T3)	<5 PREVALENCE	26.4	19.7	-6.7	-25.4
	<5 INCIDENCE	23.3	16.4	-6.9	-29.6
	EPISODE/<5 CHILD YEAR	3.4	2.4	-1.0	-19.4
AHMYAUNG-KAN (T4)	<5 PREVALENCE	30.2	24.7	-5.5	-18.2
	<5 INCIDENCE	27.0	21.6	-5.4	-20.0
	EPISODE/<5 CHILD YEAR	3.9	3.2	-0.7	-17.9
KAING	<5 PREVALENCE	25.7	13.9	-11.8	-45.9*
	<5 INCIDENCE	22.6	11.1	-11.5	-50.9+
	EPISODE/<5 CHILD YEAR	3.3	1.9	- 1.4	-42.4+

** = INTERVNETION * = P<0.05 + = P<0.01

The significant reduction of diarrhoea rates in Kaing (C3) village may have resulted from an exceptionally high coverage of sanitary latrine facilities in this village whereas the decrease in these rates in the study villages could be due to avalability of potable water from the project water system.

The pre- and post-intervention status of diarrhoeal diseases has remained unchanged in the study and control villages in Nga-Zun township. The prevalence and incidence rates of diarrhoea in children below 5 years and all age group have remained more on less consistent with only slight variations from survey to survey throughout the study period. Since these villages did not have any access to tubewell water supply throughout the study period, it is quite obvious that there would be no change in the incidence of the indicator diseases. However, a large proportion of the population in Tha-Kyin(T5) and Phaung-Ga-Daw(C3) villages became to possess and used latrine facilities in the post-intervention period. The impact of latrine facilities on diarrhoea would be elaborated later in this chapter on user and non-user of project facilities. Figure 24 illustrates the diarrhoea rates in the two communities during pre- and post-intervention periods.

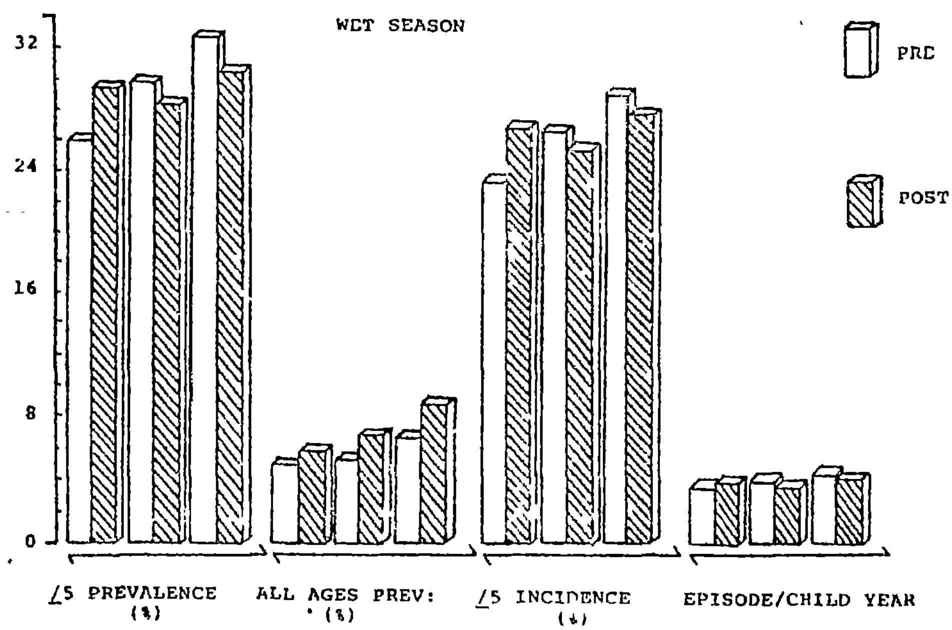


FIGURE 24. COMPARISON OF DIARRHOEA RATES BETWEEN STUDY AND CONTROL VILLAGES BEFORE AND AFTER INTERVENTION IN NGA-ZUN.

Township-wise comparison of diarhoea rates between pre- and post-intervention periods revealed significant changes in the prevalence and incidence of diarrhoea in Magwe and Kyauk-Pa-Daung townships, the rates being significantly reduced in the test village (T1) than the control village (C1) in the former and the reverse situation in the latter, where the control (C2) village had a significant decline in diarrhoea rates than the test villages (T3 and T4). Table 36 compares the incidence of diarrhoea between villages in each township as well as on township-wise basis before and after intervention.

Table.36 Comparison of incidence of diarrhoea between test and control villages of each township before and after water supply

TOWNSHIP	VILLAGE	<5 INCIDENCE (MONSOON) BEFORE 84	AFTER 87	EPISODE/CHILD YEAR BEFORE 84	AFTER 87
MAGWE	KAN-BYA (T1)	31.4	14.9*	4.1	1.9*
	KAN-NI-LAY(T2)	29.6	22.4	3.6	2.9
	SI-BIN-THA(C1)	26.4	23.3	3.4	3.0
KYAUK-PA-DAUNG	LET-PAN-BIN (T3)	23.3	16.4	3.4	2.4
	AH-MYAUNG-KAN(T4)	27.0	21.6	3.9	3.2
	KAING (C2)	22.6	11.1*	3.3	1.9*
NGA-ZUN	THA-KYIN (T5)	23.3	26.6	3.4	3.9
	KA-LAR-YWA(T6)	26.4	25.3	3.9	3.7
	PHAUNG-GA-DAW(C3)	28.8	27.7	4.3	4.1

* = P<0.01

Further analysis was made to determine the significant differences in diarrhoea rates between test and control villages in Magwe and Kyauk-Pa-Daung townships where the project facilities were made available to the communities. It was observed that in Magwe, the difference in prevalence and incidence of diarrhoea in under five children during dry season was highly siginificant between Kan-Bya (T1) and Si-Bin-Tha (C1) villages (P < .01). But the difference in these rates during monsoon was not signigicant. So also the seasonal prevalence and incidence of diarrhoea in all ages during both the seasons were not significantly different between the two villages. Table 37 compares the decline in incidence and prevalence of diarrhoea in the two communities of Magwe.

Table 37. Comparison of diarrhoea rates between study and control village after project intervention in Magwe

DIARRHOEA RATE	STUDY KAN-BYA %	COMPARISON SI-BIN-THA %	PERCENT REDUCTION (+/-)	STATISTICAL SIGNIFICANCE z value	p value
<5 PREVALENCE (W)	9.7	17.6	-44.9	17.5	<.01
<5 INCIDENCE (W)	7.1	14.7	-51.7	7.5	<.01
ALL AGES PREV:(W)	2.5	3.3	-24.2	0.8	NS
<5 PREVALENCE (M)	17.8	26.3	-32.3	1.3	NS
<5 INCIDENCE (M)	14.9	23.3	-36.1	1.3	NS
ALL AGES PREV:(M)	4.1	5.9	-30.5	1.2	NS

W = Winter M = Monsoon NS = Not Significant

Similarly, the statistical significance of the difference in diarrhoea rates was also observed between Kaing (C2) and the test villages (T3 and T4) in Kyauk-Pa-Daung township, the former village having significantly lower rates than the latter villages. Comparison of the diarrhoea decline rates between the two communities after project intervention revealed that the reduction in these rates in Kaing (C2) village was highly significant than the test villages ($P < .01$). Table 38 compares the diarrhoea decline rates in Kaing (C2) and Ah-Myaung-Kan (T4) villages after project intervention.

Table 38. Comparison of diarrhoea rates between study and control villages after project intervention in Kyauk-Pa-Daung

DIARRHOEA RATE	STUDY A-M-K %	COMPARISON KAING %	PERCENT REDUCTION (+/-)	STATISTICAL SIGNIFICANCE z value	p value
<5 PREVALENCE (W)	17.3	9.7	-43.9	1.3	NS
<5 INCIDENCE (W)	14.5	8.3	-42.8	6.1	<.01
ALL AGES PREV:(W)	3.3	1.9	-42.4	1.7	NS
<5 PREVALENCE (M)	24.7	13.9	-43.7	10.8	<.01
<5 INCIDENCE (M)	11.1	21.6	-48.6	10.4	<.01
ALL AGES PREV:(M)	5.9	3.8	-35.6	3.1	<.01

W = Winter   M = Monsoon   NS = Not Significant
A-M-K = Ah-Myaung-Kan village

2.2 Other indicator diseases

The post-intervention status of other indicator diseases such as dysentery, eye infection, skin infection and ascariasis in the study and control villages of Magwe remained unchanged except in Kan-Bya (T1) village where a considerable reduction in these diseases was observed after project intervention. Comparison of the post-intervention disease rates between the study and control villages revealed that all the indicator diseases are remarkably low in Kan-Bya (T1) village than the control village, the percent of reduction being about 30 percent in each of the indicator disease rate. But these differences between the two communities were not significant (Table 39).

Table 39. Comparison of post-intervention disease rates between study and control villages in Magwe

DISEASE INDICATOR	RATE	STUDY KAN-BYA	CONTROL SI-BIN-THA	PERCENT REDUCTION (+/-)
1. DYSENTRY	<5 Episode/Child Year	1.3	2.0	-35.0
	<5 Incidence % (Wet)	17.1	23.7	-27.8
	Episode/Person Year	0.5	0.7	-28.6
2. EYE INFECTIONS	Episode/Child Year	1.2	1.8	-33.3
	Episode/Person Year	0.6	0.8	-25.0
3. SKIN INFECTIONS	Episode/Child Year	1.4	2.0	-30.0
	Episode/Perosn Year	0.5	0.8	-37.5
4. ASCARIS INFECTION	<5 Prevalence	44.4	64.6	-31.3

Regarding changes in indicator diseases after project intervention in Kyauk-Pa-Daung, a somewhat different picture was observed compared to Magwe. The reduction in these rates were more marked in the control village (Kaing) than the test villages. Comparison of the post-intervention disease rates between the study and control villages revealed that these rates were comparatively low in the control village, the percent of reduction in dysentery and eye infections being about 25 percent. But the difference in these rates between the two communities was not significant. Table 40 compares the disease rates between study and control villages after project intervention. In Nga-Zun township, there was no evidence of any marked difference in these rates between test and control villages.

Table 40. Comparison of disease indicator rates between study and control villages after intervention in Kyauk-Pa-Daung

DISEASE INDICATOR	RATE	STUDY KAING C2	CONTROL A.M.K T4	PERCENT REDUCTION (+/-)
1. DYSENTRY	<5 Episode/Child Year	1.8	1.3	-27.8
	<5 Incidence % (Wet)	22.2	16.7	-24.8
	Episode/Person Year	0.7	0.5	-28.6
2. EYE INFECTIONS	Episode/Child Year	1.9	1.4	-26.3
	Episode/Person Year	0.7	0.6	-14.3
3. SKIN INFECTIONS	Episode/Child Year	1.8	1.6	-11.1
	Episode/Person Year	0.8	0.7	-12.5
4. ASCARIS INFECTION	<5 Prevalence	56.7	50.8	- 5.9

A-M-K = Ah-Myaung-Kan village

3. Analysis based on comparison groups with water and latrine facilities

Further analysis has also been made to examine the extent of observed differences in diarrhoea rates by each project facility. As discussed earlier in this chapter the impact of tubewell water supply and latrine facilities is being observed in villages where these facilities were made available to a large proportion of the population after project intervention. Out of the two villages which had significant reduction in diarrhoea rates, one Kan-Bya had tubewell water and latrine facilities whereas the other village (Kaing) had a good latrine programme. the question arises out of these results is that which of the two facilities has had the impact on diarrhoeal diseases in Kan-Bya. There is no doubt of the dual effect of water and latrine facilities on diarrhoea but the result of the latrine facilities in Kaing village is equally encouraging . Analysis on this aspect is being made on the findings so far obtained and there is still a need for multivariato analysis to analyse water related determinants of diarrhoea as well.

3.1 Tubewell wator villago versus traditional water village

Before tubewell water supply, both the study and control villages relied on traditional water and hence the prevalence and incidence of diarrhoea at the beginning of the study were quite comparable , although some variations existed between village to village in each township. After tubewell water supply, the diarrhoea rates have significantly declined in Kan-Bya (T1) village of Magwe and only some decline in the study villages of Kyauk-Pa-daung. Tubewell water was not made available in villages of Nga-Zun throughout the study and therefore the diarrhoea rates have remained unchanged. However, the control village in Kyauk-Pa-Daung shows significant reduction in diarrhoea rates which may have resulted from an ideal latrine programme during post-intervention period. Other control villages had more or less similar pattern of diarrhoea rates during post-intervention period. Table 41 compares the diarrhoea rates between study and control villages before and after tubewell intervention .

Table 41. Comparison of diarrhoea rates between villages with and without tubewell water supply before and after project intervention

TOWNSHIP	RATE	STUDY VILLAGE (WITH TW WATER) BEFORE (NO TW)	STUDY VILLAGE (WITH TW WATER) AFTER (WITH TW)	CONTROL VILLAGE (WITH TRAD WATER) BEFORE	CONTROL VILLAGE (WITH TRAD WATER) AFTER
MAGWE	<5 Incidence % (Wet)	31.4	14.9*	26.4	23.3
	<5 Prevalence% (Wet)	34.3	17.8*	29.6	26.3
	All ages Prevalence% W	6.9	4.1*	7.5	5.9
KYAUK-PA-DAUNG	<5 Incidence % (Wet)	27.0	21.6	22.6	11.1*
	<5 Prevalence% (Wet)	30.2	24.7	25.7	13.9*
	All ages Prevalence% W	7.0	5.9	5.7	3.8*
NGA-ZUN	<5 Incedence % (Wet)	23.3	26.6 (NO TW)	28.8	27.7
	<5 Prevalence% (Wet)	26.0	29.6 (NO TW)	32.9	30.6
	All ages Prevalence% W	5.0	5.8 (NO TW)	6.5	8.7

* = Significant reduction
TW = Tubewell TRAD = Traditional

3.2 Comparison between users and non-users of latrine facilities

The impact of latrine facilities on diarrhoea was more convincing than the tubewell water supply. Even in village with tubewell water supply the percent of reduction of diarrhoea in all ages was more remarkable in latrine users than non-users after project intervention. In Kan-Bya, where both the facilities were made available the percent of diarrhoea in all ages after intervention was 3.5 for users of latrine facilities and 7.2 for non-users. However, no change in diarrhoea rate was observed in non-users before and after tubewell water supply. This finding is in support of the marked effect of latrine facility on diarrhoea than the tubewell water supply.

Similarly, the rate of reduction of diarrhoea in users of latrine facility was distinctly observed in Kaing village after latrine programme, the prevalence of diarrhoea in all ages being 3.1 for users and 7.0 for non-users of latrine facility. This finding is also in favour of the impact of improved latrine facility on diarrhoea. Figure 25 comparatively shows the differences in diarrhoea rates between users and non-users of latrine facility before and after intervention.

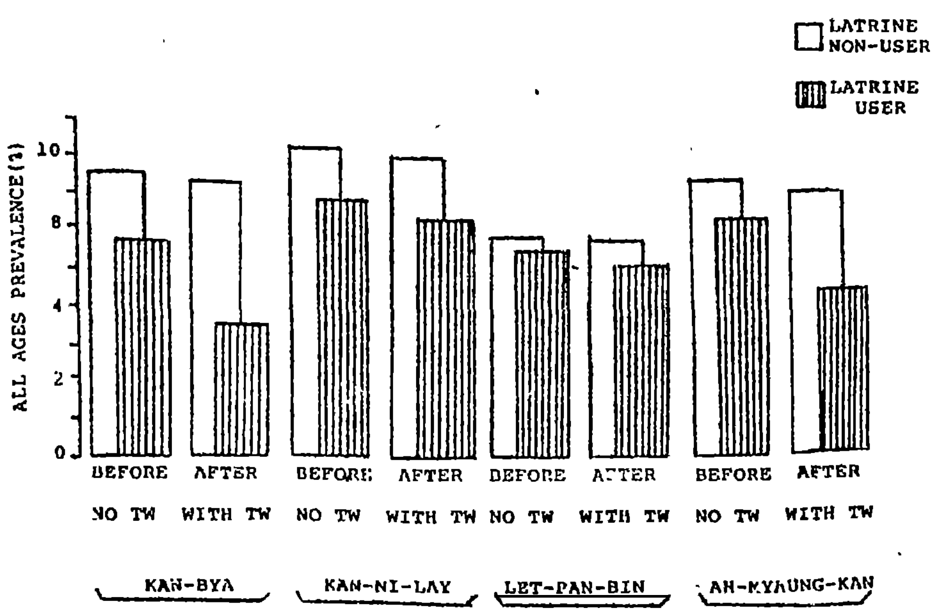


FIGURE 25. COMPARISON OF DIARRHOEA PREVALENCE IN ALL AGES AMONG USERS AND NON-USERS OF LATRINE FACILITY IN VILLAGES WITH TUBEWELL (TW) WATER SUPPLY.

The above findings revealed that significant changes have taken place in two villages, one with both water and latrine facilities and the other with only latrine facility. Villages having tubewell water showed some reduction in diarrhoea rates but these changes were not significant. On the other hand latrine facility alone seemed to have considerable impact on diarrhoea than tubewell water supply system alone.

In order to demonstrate the effect of each of these facilities on diarrhoea, factorial analysis was done taking into consideration the main outcome effects and the underlying factors interacting on the outcome variable. The first involved a factorial analysis of three main factors including villages with and without tubewell, season - dry and wet and before and after intervention. An example of factorial analysis is given in annex 11. It was observed that the reduction in the prevalence and incidence of diarrhoea in tubewell water supply village after intervention was highly significant, F value being 24.8 ($<.01$ at 1 and 16 degrees of freeedom). It was also noted that there was no interaction between main factors being analysed.

The second analysis involved village with and without latrine facility, users and non-users of latrine and before and after intervention . The test revealed in latrine users than non-users, the F value being 6.52 ($P <.05$ at 1 and 9 degree's of freedom). the full account of this test is given in annex 12.

Both these tests point out that tubewell water and latrine facilities have impact on diarrhoea rates. Further analysis was attempted to observe differences in diarrhoea rates among users and non-users of latrine facility in tubewell water supply village (Kan-Bya) which have an exceptionally high coverage of latrine facility. It was observed that there was a remarkable reduction of diarrhoea rate among users of latrine facility compared to non-users even after tubewell water supply.

Similar observations made in Kaing village which had a good latrine programme revealed that the prevalence of diarrhoea in users of latrine facility had remarkably lower rate than the non-users of latrine facility in the same village. Figure 26 comparatively shows the prevalence of diarrhoea in all ages among users and non-users of latrine facility before and after intervention in Kan-Bya (T1) and Kaing (C2) villages.

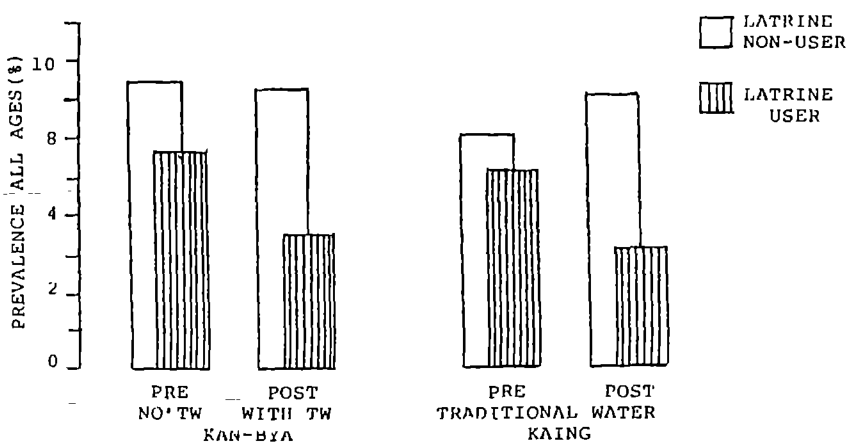


FIGURE 26. COMPARISON OF PREVALENCE OF DIARRHOEA AMONG USERS AND NON-USERS OF LATRINE FACILITY IN VILLAGES WITH AND WITHOUT TUBEWELL (TW) WATER SUPPLY.

These findings point out that tubewell water supply has only a marginal impact on diarrhoea whereas latrine facility has greater impact on diarrhoea than tubewell water supply. The dual effect of water and latrine facilities on diarrhoea is more encouraging than only one facility.

CHAPTER VI

DISCUSSION

It is generally believed that adequate safe water supply and concurrent improvement in excreta disposal faclities would lead to dramatic reduction in diarrhoea morbidity and mortality, and ultimately result in improvement of the health status of the community. With a view to improve the health and physical quality of life of millions of people, water and sanitation programmes have been implemented in many developing countries with a large amount of inputs from international and bilateral agencies.

In the past two decades, many studies have been undertaken to demonstrate the hard evidence of health benefits occuring from water and sanitation interventions. Most of these studies have attempted to associate water supply and sanitation facilities with improvement in health status. The result of many of these studies are rather ambiguous. Some of the studies relating to health impact evaluation of improved water and sanitation facilities have shown strong positive results whereas others have inconclusive results or the reverse of the expected benefits.

A number of published studies are being reviewed to compare the results of these studies with the findings of the present study. The results of these evaluation studies are

TABLE 42. EVALUATION STUDIES ON THE EFFECT OF WATER AND SANITATION FACILITIES ON DIARRHOEAL DISEASES

YEAR OF STUDY & COUNTRY	INDICATOR USED	TYPE OF COMPARISON	AGE GROUPS (MONTHS)	BEFORE INTERVENTION LEVEL	AFTER INTERVENTION LEVEL	PERCENT OF CHANGE (±)
1976 BENGLADESH	DIARRHOEA PER 1000	TW Vs Non TW	ALL AGES	3.2	7.5	+134 NS
1977 BENGLADESH	DIARRHOEA/DYSENTERY PERCENT POSITIVE	GROUND Vs TW	0-12 12-120	4.3 4.7	3.4 5.8	- 21 - + 23 -
		SURFACE Vs TW	0-12 12-120	9.1 11.0	3.4 5.8	- 63 - - 47 -
1977 BENGLADESH	DIARRHOEA/1000	OTHER Vs TW	ALL AGES	117.7	133.5	+ 13 -
1978 COLUMBIA	DIARRHOEA PREVALENCE	UNPIPED Vs PIPED	0-72	42.4	45.3	+ 7 NS
1978 GUATEMALA	DIARRHOEA PREVALENCE/1000	UNPIPED Vs PIPED	ALL AGES	39.7	39.5	- 1 NS
1977 INDIA	DIARRHOEA INCIDENCE PER 100 PER YEAR	WELL Vs TAPS IN HOME	0-60	21.5	23.5	+ 9 NS
		STREET Vs TAPS	"	36.8	23.5	- 36 P ∠.01
	SHIGELLA INCIDENCE PER 100 PER YEAR	WELL Vs TAPS IN HOME	"	10.3	6.0	- 42 P ∠.00
		STREET TAPS Vs HOME TAPS	"	15.3	6.0	- 61 P ∠.00
1963 GUATEMALA	DIARRHOEA INCIDENCE PER 100 PERSON PER YEAR	PUBLIC Vs PRIVATE FAUCET	0-60	38.9	32.4	- 1 NS
		WITHOUT Vs WITH PRIVACY	"	22.4	16.8	- 25 P ∠.01
	SHIGELLA % POSITIVE	COMMUNITY Vs PRIVATE WATER SUPPLY	0-120	9.4	6.3	- 33 P ∠.05

TW = TUBEWELL

summarized in table 42. It could be observed that only a few studies have shown significant reduction in diarrhoea and dysentery rates resulting from project intervention relating to water and sanitation.

Most of these published studies illustrates that water supply alone have only a marginal impact or no impact on diarrhoea and dysentery. A few of the studies reveals the reverse of the expected benefits with increase in diarrhoea rates after water supply. In particular, these features are being reported by studies undertaken in Bangladesh (8,9,10). Similar findings are also described in studies conducted in Columbia and Guatemala (11,12). The impact of water supply seems to be significantly greater in localities with private faucet at house than other systems of water supply. This finding is particularly illustrated in studies undertaken in India and Guatemala (13,14). The present study shows similar results indicating that villages receiving tubewell water alone have no remarkable reduction in diarrhoea rates.

Another striking feature observed in one of these reference studies conducted in Guatemala (15) is that communities with latrine facilities have siginificantly lower rates of diarrhoea in children under twelve years than those without the facilities. Our findings also distinctly pointed out that compared to tubewell water village, villages with latrine

TABLE 43. FINDINGS OF THE PRESENT STUDY ON THE IMPACT OF WATER AND LATRINE FACILITIES ON DIARRHOEA/DYSENTERY (1984-87, BURMA)

TYPE OF COMPARISON	INDICATOR	AGE GROUPS (YEARS)	BEFORE INTERVENTION (1984)	AFTER INTERVENTION (1987)	PERCENT REDUCTION (+/-)	STATISTICAL SIGNIFICANCE
TUBEWELL + LATRINE Vs NO TW + NO LATRINE	DIARRHOEA INCIDENCE					
	TEST	∠5	31.4	14.9	-52.5	P∠.01
	CONTROL	"	26.4	23.3	-11.7	NS
	DYSENTERY INCIDENCE					
	TEST	∠5	28.2	17.1	-39.4	NS
	CONTROL	"	22.5	23.7	+ 2.8	NS
TW + LATRINE Vs TW ONLY	DIARRHOEA PREVALENCE					
	TW + LATRINE	∠5	34.3	17.8	-48.1	P∠.05
	TW ONLY	"	31.9	25.3	-20.7	NS
TW ONLY Vs LATRINE ONLY	DIARRHOEA INCIDENCE					
	TW VILLAGE	∠5	27.0	21.6	-20.0	NS
	LATRINE VILLAGE	"	22.6	11.1	-50.9	P∠.01
LATRINE USERS Vs NON-USERS IN VILLAGE WITH TW	DIARRHOEA PREVALENCE					
	LATRINE USERS	ALL AGES	5.6	3.5	-37.5	NS
	LATRINE NON-USERS	"	7.5	7.2	-4.0	NS
LATRINE USERS Vs NON-USERS IN VILLAGE WITH TRADITIONAL WATER	DIARRHOEA PREVALENCE					
	LATRINE USERS	"	5.2	3.4	-26.9	NS
	LATRINE NON-USERS	"	6.0	7.0	+14.3	NS

TW = TUBEWELL NS = NOT SIGNIFICANT

facility have signficant reduction of diarrhoea rates. The findings of the present study are summerized in Table 43 to highlight the main features resulted from water and latrine intervention. It could be observed that villages having tubewell water with latrine facility and latrine facility alone have siginificant effect on the incidence of diarrhoea in children below five years.

The level of diarrhoea rates before and after intervention vary from country to country. The pre-intervention level of these rates seems to be comparable in studies undertaken in Columbia, Guatemala, India and Burma. Table 44 summerizes the pre and post levels of diarrhoea rates by type of comparison in selected countries. The impact of water and sanitation facilities on diarrhoea is convincingly observed in the last three countries namely Guatemala, India and Burma.

Observations are also being made on the two health impact studies undertaken in Bangaladesh (16) and Burma. The former study takes into account the effect of hand-pump water, sanitary latrine facilities and health education programme on the incidence of diarrhoea as well as other indicator diseases in two communities with and without the facilities. The results are very encouraging and there was a considerable reduction of diarrhoea and dysentery rates among under five children in the subsequent years of the study after intervention. The progressive impact was clearly observed if the age group was considered on a yearly basis. The prevalence of ascaris infection, however,

TABLE 44. Comparison of the effect of water and sanitation facilities on diarrhoea in selected countries

YEAR OF STUDY & COUNTRY	TYPE OF COMPARISON	INDICATOR USED	AGE GROUP YEARS	BEFORE INT: LEVEL	AFTER INT: LEVEL
1977 BANGLADESH	SURFACE VS TW	DIARR:/DYS: % POSITIVE	<1 1-12	9.1 11.0	3.4 5.8
1977 BANGLADESH	OTHER VS TW	DIARRHOEA/1000	ALL AGES	117.7	133.5
1978 COLUMBIA	UNPIPED VS PIPED	DIARRHOEA PREVALENCE	<6	42.4	45.3
1978 GUATEMALA	UNPIPED VS PIPED	DIARRHOEA PREVALENCE/1000	ALL AGES	39.7	39.5
1977 INDIA	STREET VS TAPS	DIARRHOEA INCIDENCE PER 100 PER YEAR	<5	36.8	23.5*
1963 GUATEMALA	PUBLIC VS PRIVATE FAUCET	DIARRHOEA INCIDENCE PER 100 PER YEAR	<5	38.9	32.4
	WITHOUT VS WITH PRIVACY	DIARRHOEA INCIDENCE PER 100 PER YEAR	<5	22.4	16.8*
1989 BURMA	TW+Latrine VS No TW+No Latrine	DIAR: INCIDENCE TEST	<5	31.4	14.9*
		CONTROL	<5	26.4	23.3
	TW VS LATRINE	DIAR: INCIDENCE TEST	<5	27.0	21.6
		CONTROL	<5	22.6	11.1*

INT: = INTERVENTION

TW = TUBEWELL

* = P < 0.01

remained unchanged. It was assumed that the effect of these measures, so far was mainly through the convenience of the facilities. It is well interpreted that a greater impact can be achieved overtime if exclusive use of the improvements and better hygienic practices are adopted. Table 45 comparatively shows the findings of the two studies. It could be observed from Table 45 that similar findings are also being reported in the present

TABLE 45. Comparison of findings of health impact studies undertaken in Bangladesh and Burma.

STUDY PERIOD & COUNTRY	TYPE OF COMPARISON	INDICATOR (<5 AGE GROUP)	AFTER INTERV: COMPARISON/STUDY		PERCENT REDUCTION
			COMPARISON	STUDY	
1980-83 BANGLADESH (ICDDR) TEKNAF HEAL--TH IMPACT STUDY	HANDPUMP WATER + WATER SEALED LATRINE + SANITARY HEALTH EDUCATION Vs NO SUCH FACILITIES	DIARRHOEA INCIDENCE	25.7	21.6	- 16.0
		DYSENTERY INCIDENCE	12.3	11.1	- 9.8
		ASCARIS PREVALENCE	65.2	69.9	+ 6.7
1984-87 BURMA DRYZONE HEALTH IMPECT STUDY	TUBEWELL+SANITARY LATRINE Vs NO TW + NO LATRINE	DIARRHOEA INCIDENCE	23.3	14.9	- 36.1
		DYSENTERY INCIDENCE	23.7	17.1	- 27.8
		ASCARIS PREVALENCE	64.6	44.4	- 31.3
	TUBEWELL Vs LATRINE	DIARRHOEA INCIDENCE	11.1	22.6	+ 50.9*
		DYSENTERY INCIDENCE	16.7	22.2	+ 24.8
		ASCARIS PREVALENCE	50.8	56.7	+ 10.4

study. A considrerable reduction in all of these rates was observed during subsequent periods and at the end of the study in villages having both the tubewell water and latrine facilities than the comparison villages. Similar features were also observed in villages with latrine facility alone than in villages with tubewell water supply alone, the incidence of diarrhoea being significantly low in the latrine villages.

Other indicator diseases such as dysentery, eye infection, skin infection and ascariasis were also affected and a considerable decline was noted in village with tubewell water and latrine facilities. But the decline in these diseases was not significant.

The decline in diarrhoea rates may also have resulted from improved quality of water in the villages with tubewell water supply. It was clearly pointed out that a remarkable change in quality of water has occurred in these villages after project water supply. The main sources of tubewell water were free from faecal coliforms and at the same time the percent of water samples positive for faecal coliform and the mean faecal coliform were considerably reduced in villages using tubewell water. But nearly 50 percent of the samples taken from drinking water pots and domestic containers were found to be contaminated with faecal coliform bacteria. Therefore the expectation that improved quality of water would bring down the incidence of diarrhoeal diseases had materialized only to some extent. The main reason being that the communities receiving tubewell water had not been made aware of the possible ways of contamination of water during collection, storage and subsequent use at home. Similar findings are being reported by Ryder et al(17) in a study on the childhood health effects of an improved water supply system on a remote Panamanian Island.

Is is indicated that water use habits and practices are closely linked with bacterial quality of water and although the project water at the main source is free from faecal coliform a large number of families still show contaminated water at home. The findings on the evaluation of changes in knowledge, attitude and practices related to use of water and sanitation facilities have shown that the knowledge and understanding of the communities of the importance of disease transmission through some common daily practices is rather rudimentary. The knowledge is in contrast of the real practices. The understanding and the usual practices have remained unchanged overtime. It is therefore very likely that the changes so far occurred in the disease rates are mainly through the convenience and use of the facilities rather than any dramatic changes in knowledge and practices. As described earlier, the main reason for having no improvement in knowledge and practices was because of lack of health education package for motivation of the community in making changes in hygienic practices related to use of water and sanitation facilities. The Teknaf Health Impact Study also describes similar observations and emphasizes the need for continuous health education not merely to transfer knowledge to mothers but to translate mother's knowledge to effective practice.

With the availability of project water after tubewell installation, communities previously relying on traditional water sources switched on to tubewell water supply and nearly cent percent of the households utilized tubewell water after intervention in experimental villages of Magwe and Kyauk-Pa-Daung townships. However, a number of difficulties were encountered during the initial stages prior to tubewell installation. The common features applicable to almost all the villages in implementing project water supply were as follows:

(a) Slight delay in drilling tubewells in the study villages by RWSD was mainly due to some difficulties in making arrangements with the authorities at divisional and township levels.

(b) The supply of cement for constructing water tank was delayed due to shortage of cement and transportation difficulties.

(c) The lack of interest by the local leaders and the community in making timely arrangements for obtaining cement and raising funds to construct water tank.

(d) Villages having good leadership had effective community involvement in establishing and promoting water and sanitation facilities than villages without such leadership.

Regarding the reliability and functioning of water facility, it was noted that there was no major breakdown of the system but partial stoppages for shorter durations were observed in all the villages except Kan-Bya due to the following reasons.

(a) Shortage of fuel as woll as high cost of diesel oil for operation of the power pumps was the main reason of the partial stoppages from time to time.
(b) Availability of water from traditional water sources particularly during monsoon, mainly for the other domestic use.

Affordability to pay for project water supply largely depended upon the prizing policy set up by each village. The most appropriate system was practised in Kan-Bya (T1) and Kan-Ni-Lay (T2) villages in Magwe, the cost of water being kept as low as possible and the poorer people paying less than the well-to-do families of the village. Such a policy has to be considered in general for future intervention programmes of water supply.

The tubewell water point was at a close distance than any other water source in all of these villages. As such greater convenience was achieved concerning distance to be travelled and time spent for fetching water. However, the amount of water carried per day by each family remained more or less consistant even after tubewell water supply. It is very likely that the families in each village restricted to their usual needs of water quality because they had to pay for obtaining water from the tubewell.

In short, the findings of the present study as well as similar other studies indicated that the convergent effect of water supply and latrine facilities is much more convincing than water supply alone. Moreover, specific health education measures should be incorporated in to these programmes for achieving greater impact on water-borne and water-related diseases. This issue emphasized the importance of coordinated efforts in implementing water and sanitation programmes.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Longitudinal studies relating to health impact of water and sanitation facilities have never been undertaken in this country. It has been increasingly emphasized that the true effect of such interventions remains difficult to estimate. However, the present study has attempted to reveal the effect of water supply and wherever applicable the effect of latrine facility on diarrhoea and number of indicator conditions in selected rural communities of dry zone area in Burma.

Based on the major findings that are being highlighted in this report, the following conclusions are brought forward.

1. Health impact of water and sanitation can be greatly achieved if the community is made aware of the facilities and the health importance of correctly utilizing these facilities. Basically, the concern, interest and motivation of the community is essential for achieving the expected benefits.

2. Community tends to utilize available traditional water sources because of high cost of water from the project water supply.

3. Drilling of water point close to the village and much nearer than traditional water sources was the key point in having greater convenience for distance travelled and time spent in fetching water.

4. Provision of safe and potable water alone seems to have only a marginal impact on diarrhoeal diseases and it is presumed that improved water supply alone is less likely to bring about significant health impact.

5. Safe water at the main source gets contaminated during carriage, storage and handling for domestic use. It is very likely that water use and water handling practices play an important role in such contamination.

6. Provision of improved water supply together with sanitary latrine facility has significant beneficial effect on diarrhoea and other indicator diseases and thereby resulting in improved health status of the community.

7. Sanitary latrine facility alone has greater impact than tubewell water supply.

8. The effect of latrine facility on diarrhoea is convincingly observed in users of latrine facility than non-users even in villages with water supply.

It is recommended that:

1. Since the success of water and sanitation projects largely depends upon the interest and awareness of the community of these facilities, it is essential that the community should be motivated prior to project implementation for achieving active participation in the project

2. Specific health education measures should be incorporated in water and sanitation programmes for improving hygienic practices related to use of water and latrine facilities

3. An acceptable pricing policy should be considered for adjusting cost of water supply according to the income of the families

4. Fuel should be made available free or at a minimum cost for continuous functioning of the tubewell water system

5. Periodic checking should be made for early recognition of minor defects of the power pump and for maintaining the efficiency for longer periods

6. Convergent effort should be made to implement water and sanitation facilities simultaneously and a package approach should be made to include health education programme.

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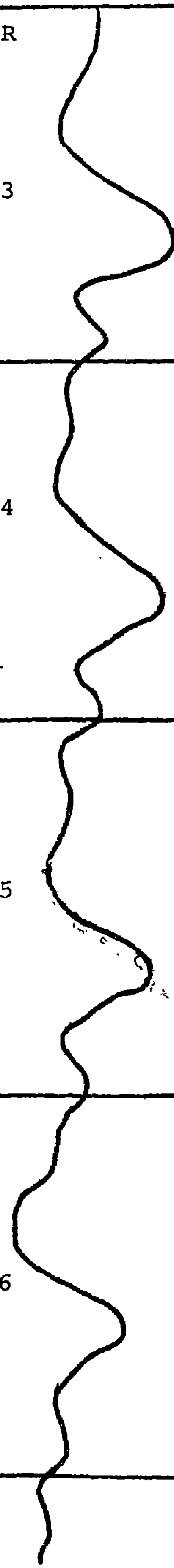
ANNEX 1.

THE LEADING CAUSES OF DISCHARGES AND DEATHS FOR THE INFANT AND CHILD AGE GROUPS IN HOSPITAL (1984)

(PERCENT OF TOTAL ADMISSIONS)

UNDER - 1		1 - 4 YEARS		5 - 14 YEARS	
1. ILL-DEFINED INTESTINAL INFECTIONS	22.8	1. ILL-DEFINED INTESTINAL INFECTIONS	13.9	1. MALARIA	22.6
2. PNEUMONIA	14.8	2. MALARIA	12.6	2. ILL-DEFINED INTESTINAL INFECTIONS	5.3
3. OTHER DISORDERS ORIGINATING IN THE PERINATAL PERIOD	6.1	3. PNEUMONIA	12.1	3. OTHER VIRAL DISEASES	3.7
4. OTHER DISEASES OF RESPIRATORY SYSTEM	5.6	4. OTHER DISEASES OF RESPIRAOTRY SYSTEM	6.7	4. PNEUMONIA	3.6
5. MALARIA	5.0	5. OTHER VIRAL DISEASES	2.9	5. OTHER DISEASES OF RESPIRATORY SYSTEM	3.2

	ACTIVITIES		STATISTICS (DRY ZONE)
BEFORE SAFE WATER SUPPLY	PILOT SURVEY	JAN	YEAR
	BASE LINE SURVEY	FEB	
		MAR	
	SUBMISSION TO MINISTRY FOR APPROVAL	APR	
		MAY	
		JUN	
	BASE LINE SURVEY REPORT (INTERM)	JUL	1983
		AUG	
	APPROVAL BY MINISTRY	SEP	
	BASE LINE SURVEY REPORT (FINAL)	OCT	
		NOV	
	PERIODIC SURVEY 1	DEC	
		JAN	
		FEB	
TUBEWELL INSTALLATION	PERIODIC SURVEY 2	MAR	
AFTER SAFE WATER SUPPLY		APR	
		MAY	1984
		JUN	
		JULY	
	" SURVEY 3	AUG	
		SEP	
		OCT	
		NOV	
	" SURVEY 4	DEC	
	" SURVEY 5	JAN	
		FEB	
		MAR	
		APR	
		MAY	
		JUN	
	" SURVEY 6	JUL	1985
		AUG	
		SEP	
		OCT	
	" SURVEY 7	NOV	
		DEC	
		JAN	
	" SURVEY 8	FEB	
		MAR	
		APR	
		MAY	
		JUN	
	" SURVEY 9	JUL	1986
		AUG	
		SEP	
		OCT	
	" SURVEY 10	NOV	
		DEC	
		JAN	
	" SURVEY 11	FEB	
		MAR	
	" SURVEY 12	AUG	



ANNEX 3.

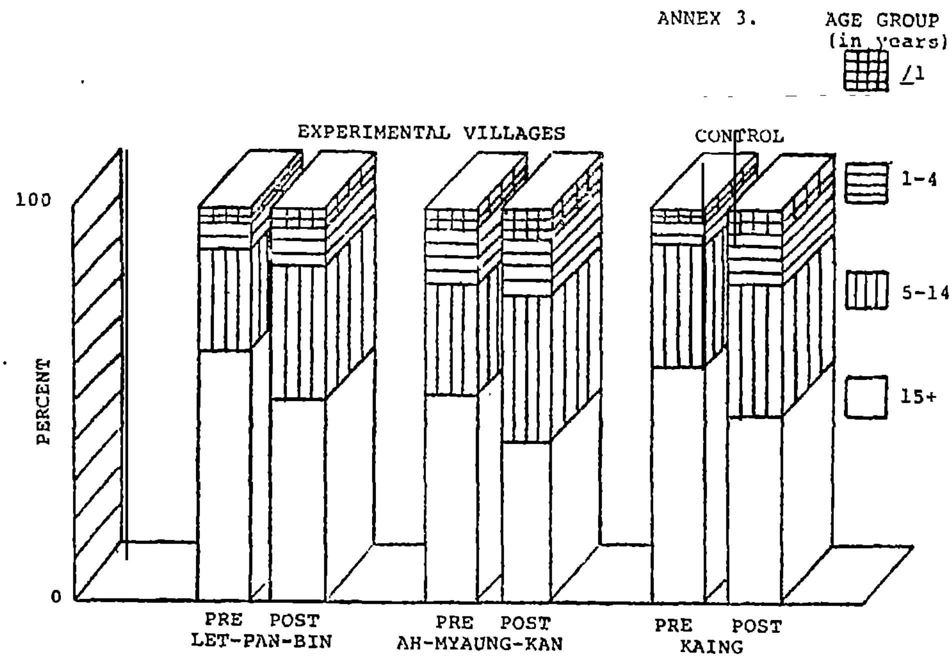


FIGURE 5. AGE COMPOSITION OF MALE POPULATION IN KYAUK-PA-DAUNG.

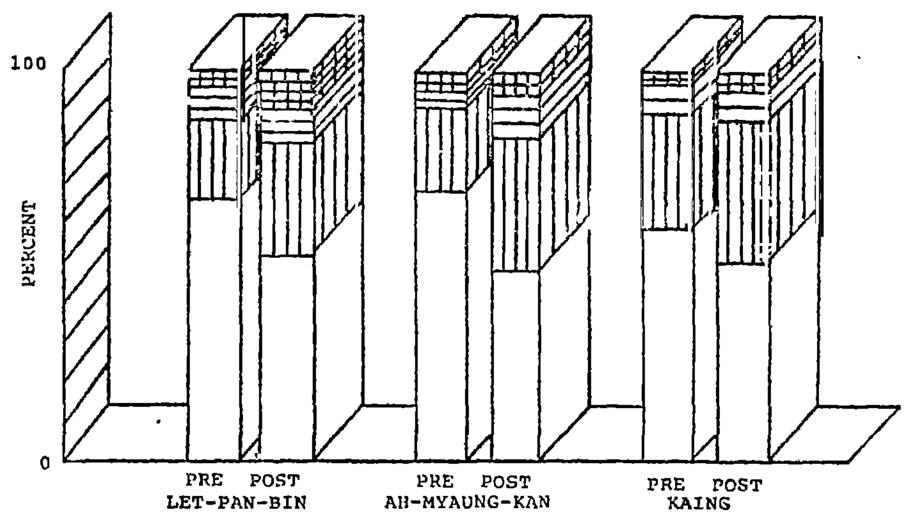


FIGURE 6. AGE COMPOSITION OF FEMALE POPULATION IN KYAUK-PA-DAUNG.

ANNEX 4.

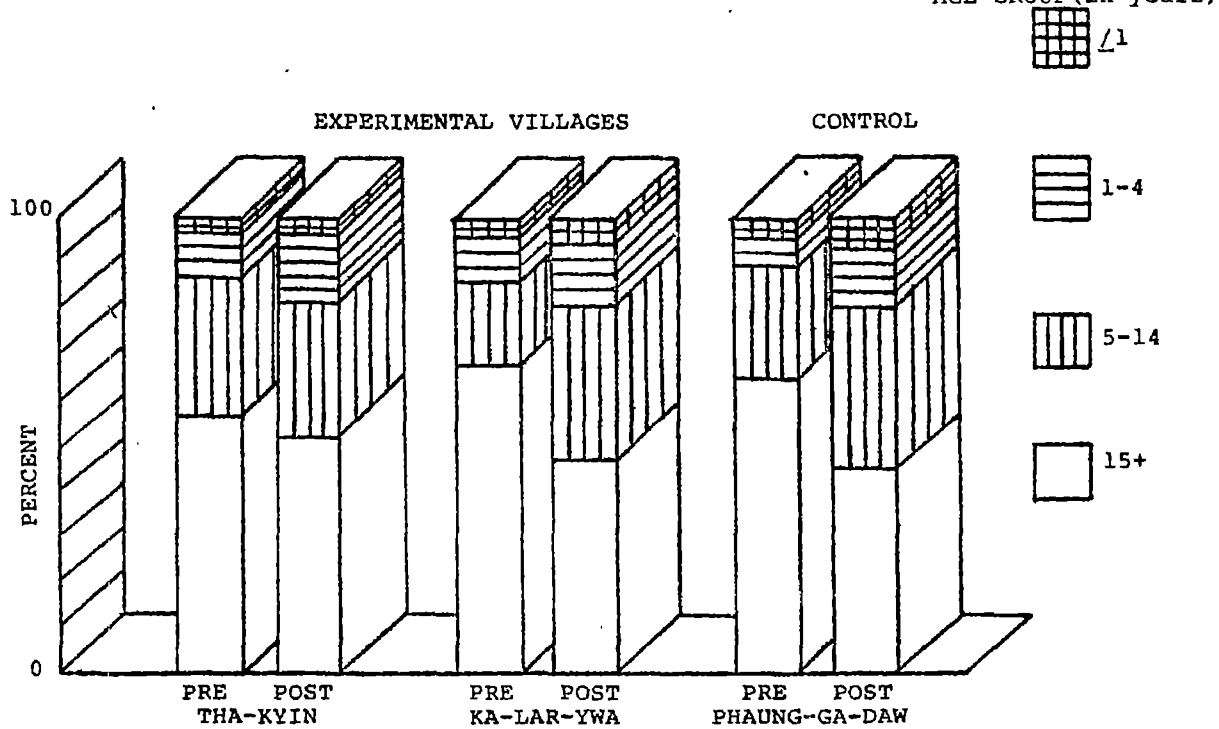


FIGURE 7. PERCENT OF MALE POPULATION BY AGE GROUPS IN NGA-ZUN.

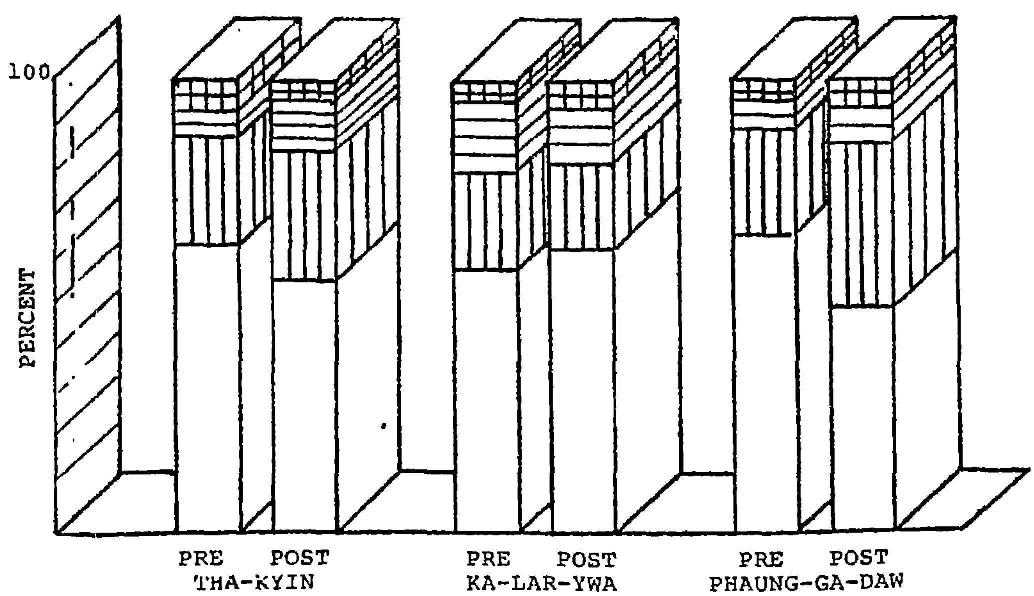


FIGURE 8. PERCENT OF FEMALE POPULATION BY AGE GROUPS IN NGA-ZUN.

ANNEX 5.

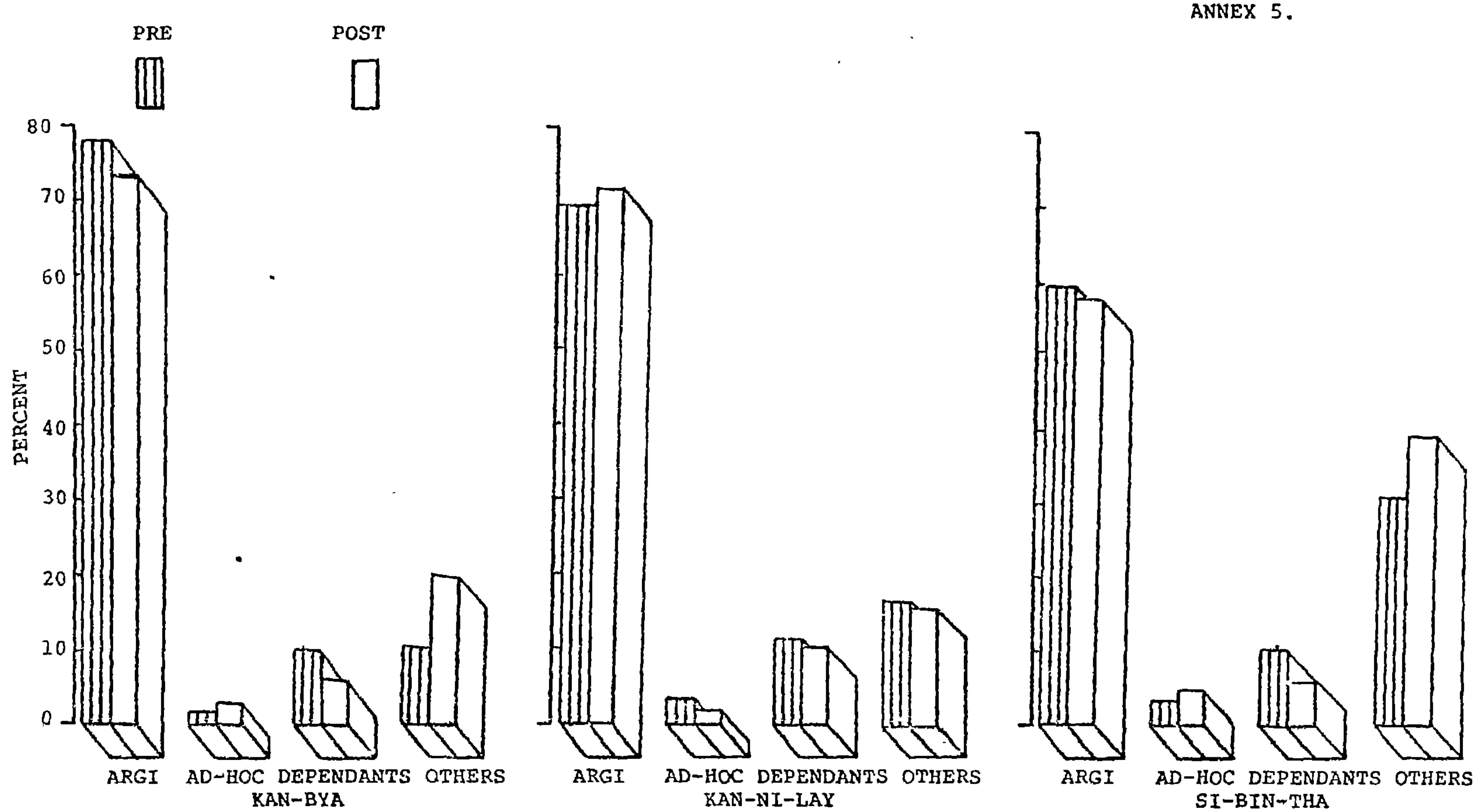


FIGURE 9. PERCENTAGE DISTRIBUTION OF THE MAIN OCCUPATION OF HEAD OF HOUSEHOLDS IN MAGWE.

ANNEX 6.

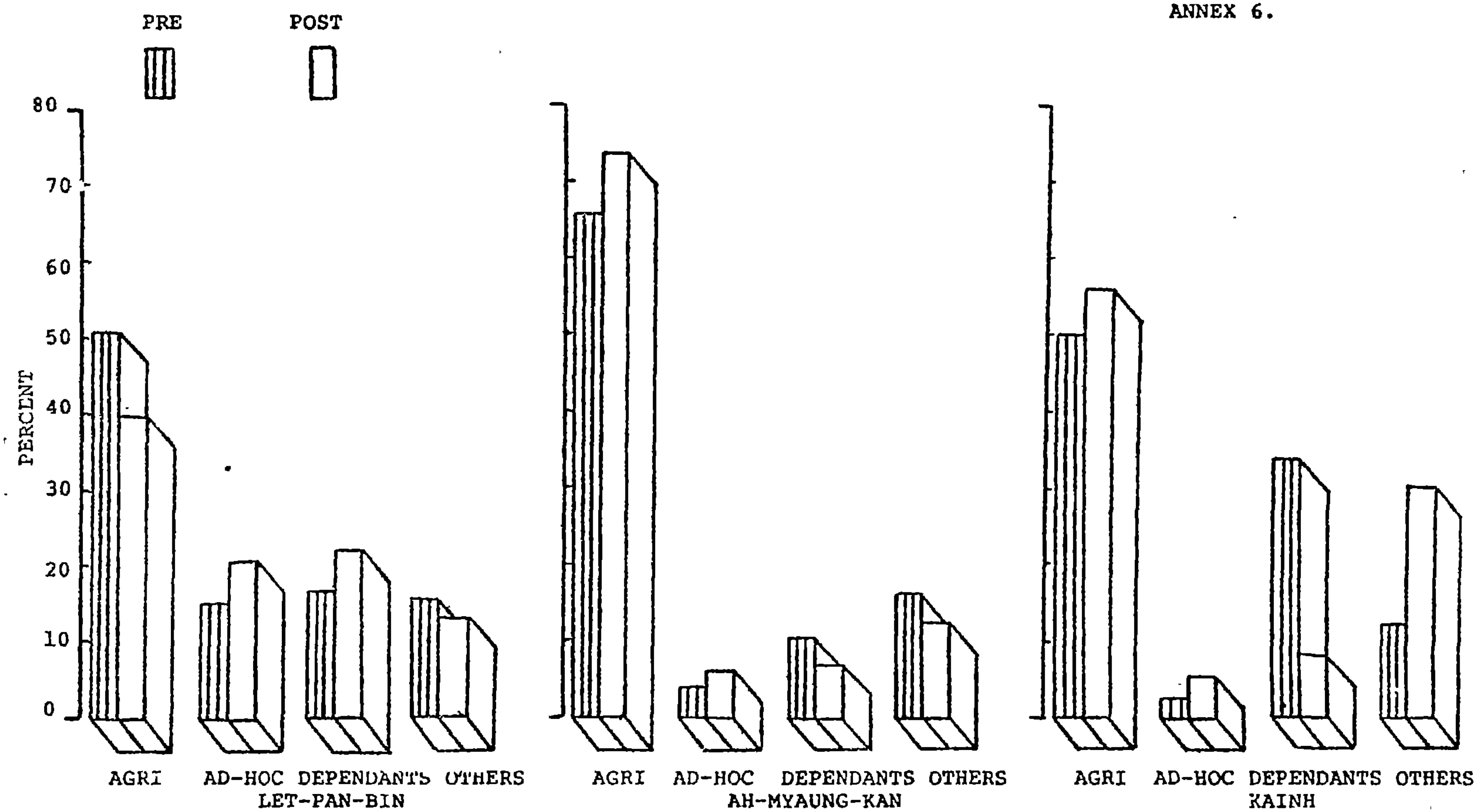


FIGURE 10. PERCENTAGE DISTRIBUTION OF THE MAIN OCCUPATION OF HEAD OF HOUSEHOLDS IN KYAUK-PA-DAUNG.

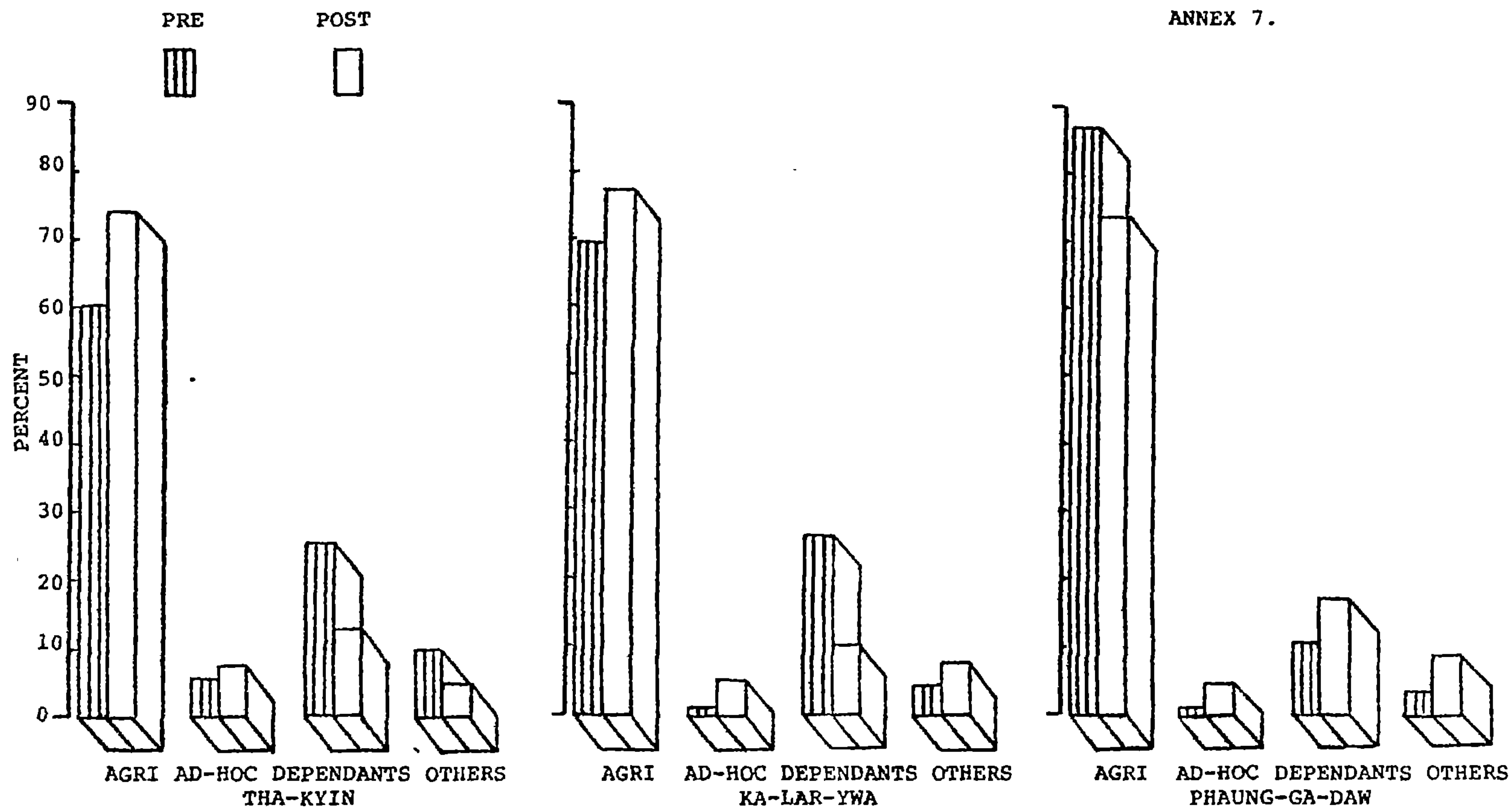


FIGURE 11. PERCENTAGE DISTRIBUTION OF THE MAIN OCCUPATION OF HEAD OF HOUSEHOLDS IN NGA-ZUN.

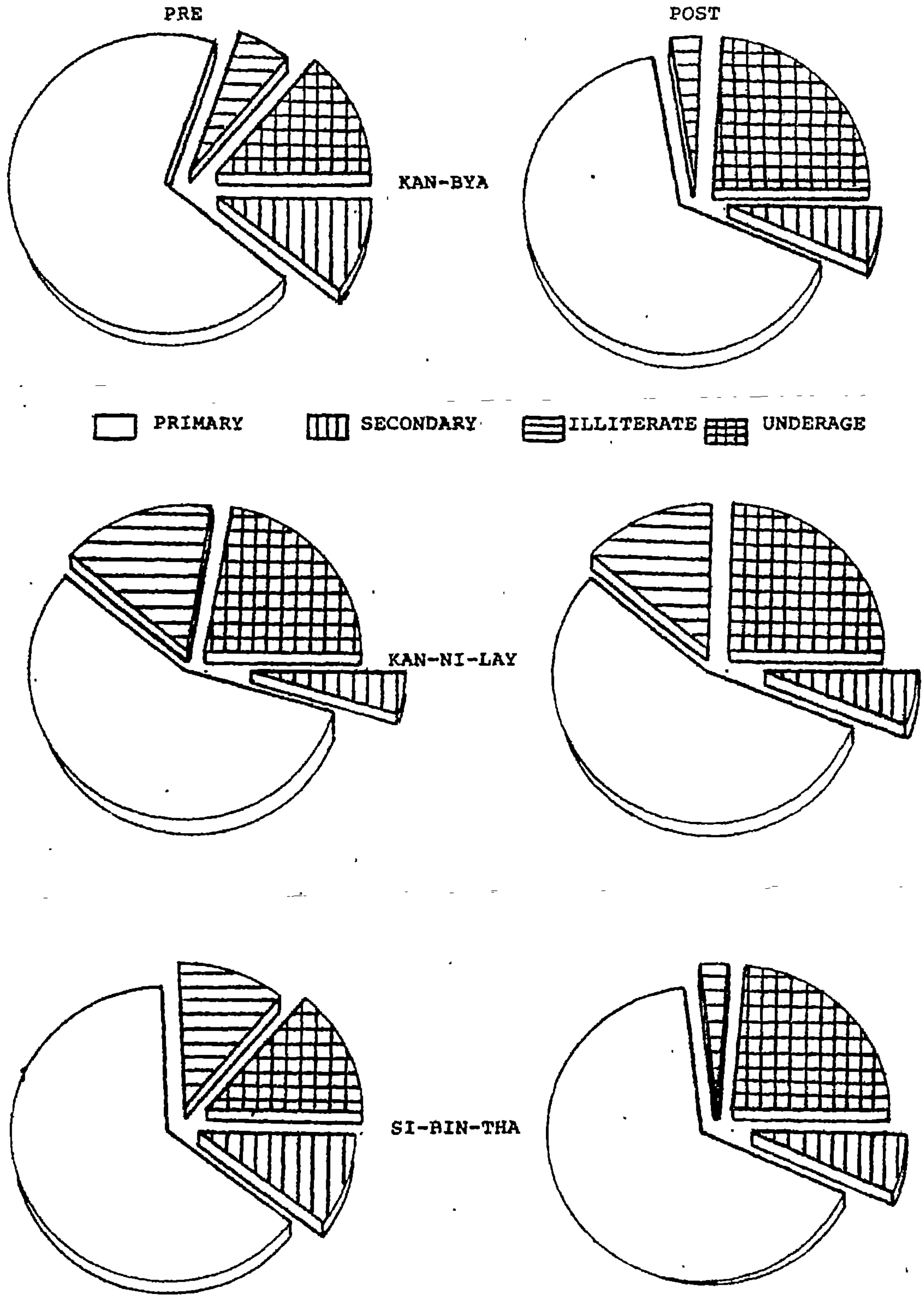


FIGURE 12. POPULATION BY LEVEL OF EDUCATION IN MAGWE.

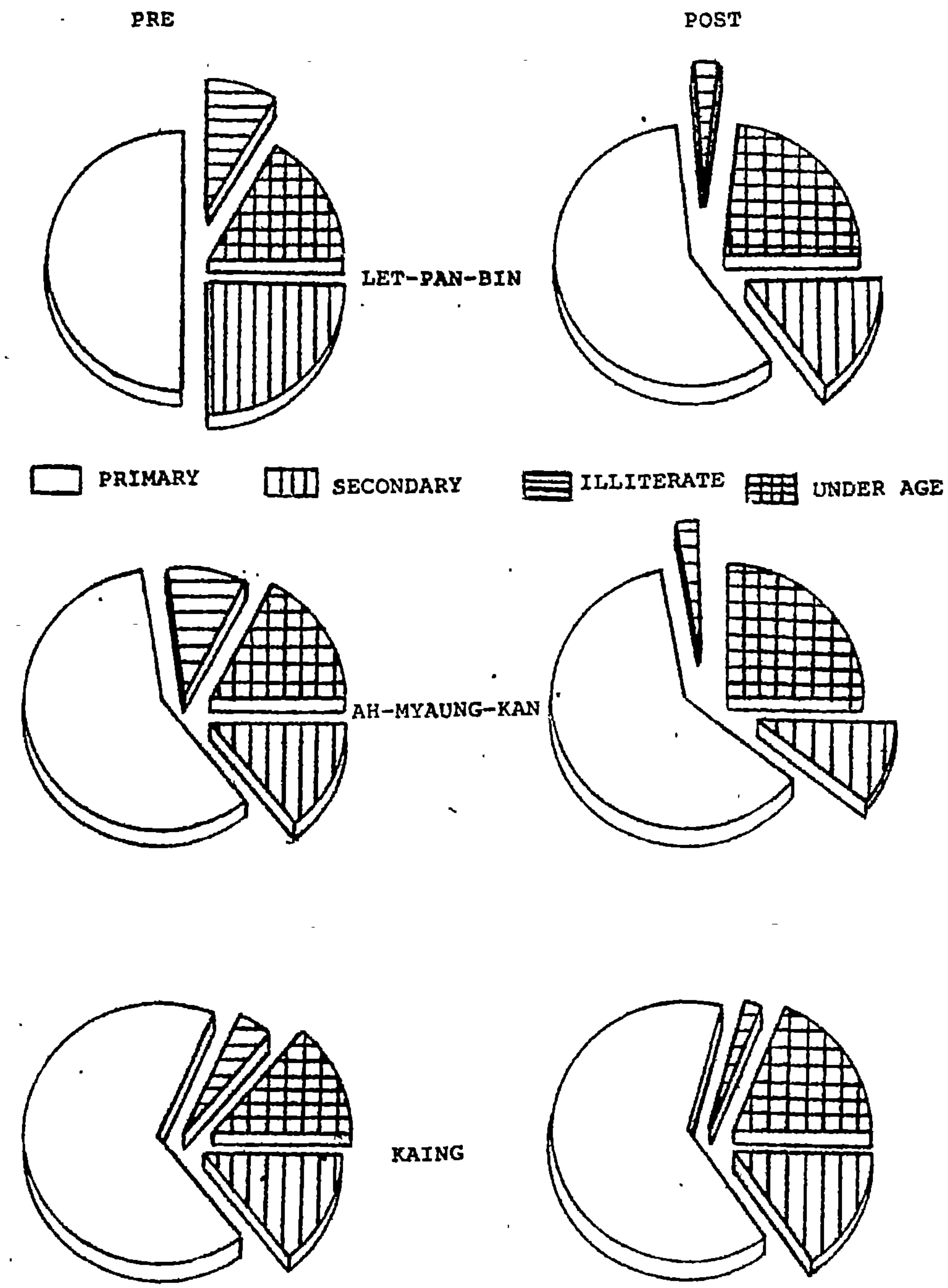


FIGURE 13. POPULATION BY LEVEL OF EDUCATION IN KYAUK-PA-DAUNG.

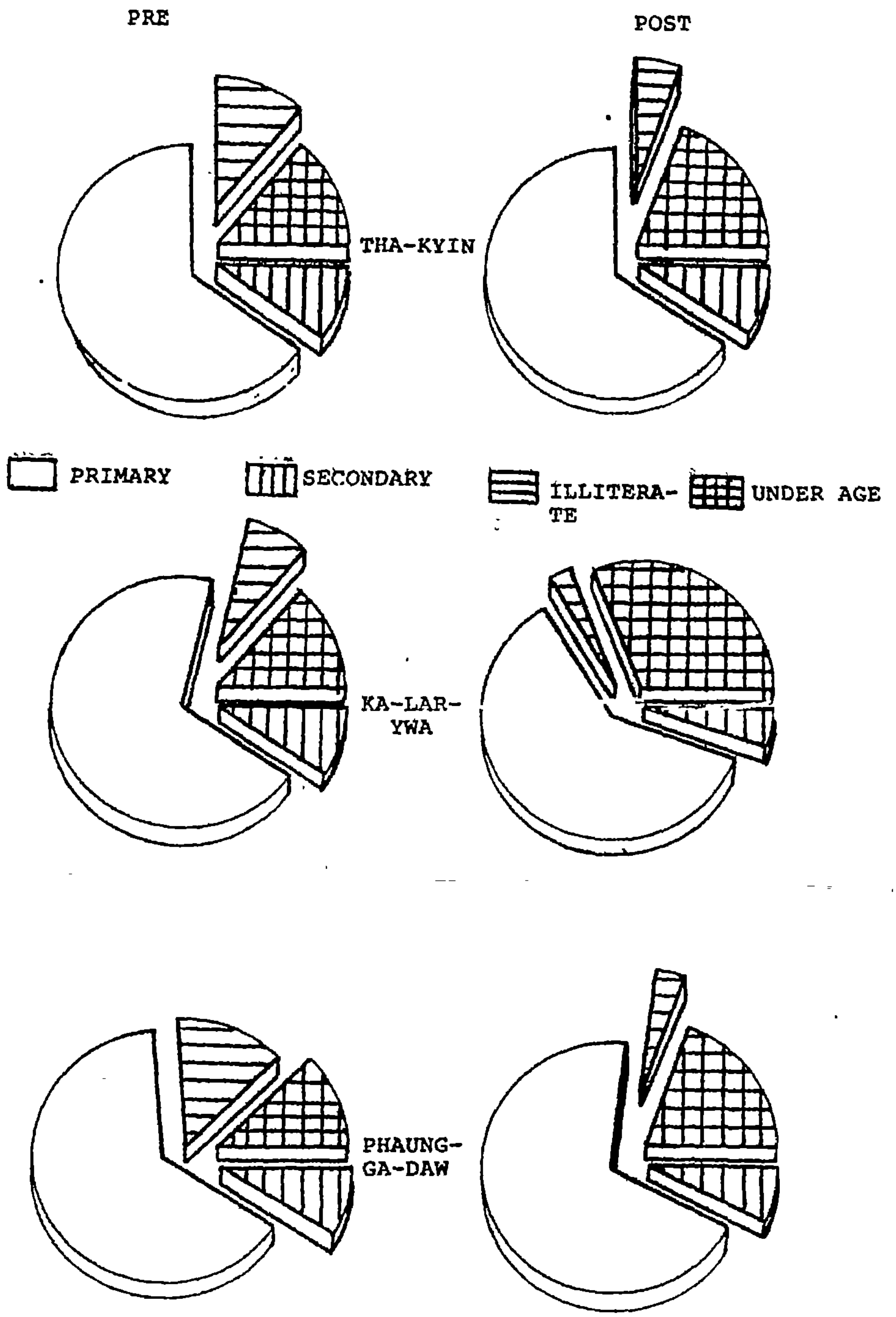


FIGURE 14. POPULATION BY LEVEL OF EDUCATION IN NGA-ZU.

FACTORIAL EXPERIMENT
THREE-FACTOR EXPERIMENT

Factorial experiment on factors such as weather, intervention and use of water facilities based on the prevalence of diarrhoea in children under 5 of sampled villages was carried out as follows:

Prevalence of diarrhoea in children under 5 by Weather, Intervention and Water Facility users.

No	M (Monsoon)				W (Winter)			
	*		**		*		**	
	T	C	T	C	T	C	T	C
1.	34.3	29.6	17.8	22.9	22.9	20.8	9.7	17.6
2.	31.9	25.7	25.3	13.9	19.7	15.7	20.2	9.7
3.	26.4		19.7		17.6		14.5	
4.	30.2		24.7		17.6		17.3	
TOTAL	122.8	55.3	87.5	40.2	78.0	36.5	61.7	27.3

* Before intervention ** After Intervention
T Test C Control

As shown in the table, it will be seen that the top rows of the table are factors and the data is presented in the body of the table and the total is shown in the last row.

Theoractically the mathematical model of the three factor analysis is

$$Y = U + a_i + b_j + c_k + (ab)_{ij} + (ac)_{ik} + (bc)_{jk} + (abc)_{ijk} + e;$$

where Y being the response variable, prevalence of diarrhoea in children under 5, U, the overall effect, a ; b ; and c, the main effects, (ab) ; (ac) ; (bc) and (abc) are two and three factors interactions and lastly e being a random element from a normally distributed population with mean zero and variance, sigma squares .

Careful examination of the table will reveal the uneven number of villages under each factor of Test and Control but it has a typical proportionality throughout the main effect. As an exercise, correction term C and three major sum of squares; TSS - total sum of squares, SST - sum of squares due to treatments and ESS - error sum of squares being obtained by substracting SST' from TSS. SST' is the compound sum of squares of main factors. Two and three interactions which could be calculated from three two-way tables are constructed as shown below: -

Decomposition of two factor from three factors of table 1.

	TABLE A		
	B	A	
T	200.8^{8}	149.2^{8}	350.0^{16}
C	91.8^{4}	67.5^{4}	159.3^{8}
	292.6^{12}	216.7^{12}	509.3^{24}

TABLE B			
	B	A	
M	178.1 (6)	127.7 (6)	305.8 (12)
W	114.5 (6)	89.0 (6)	203.5 (12)
	292.6 (12)	216.7 (12)	509.3 (24)

TABLE C			
	B	A	
T	210.5 (8)	95.5 (4)	305.8 (12)
C	139.7 (8)	63.8 (4)	203.5 (12)
	350.0 (16)	159.3 (8)	509.3 (24)

In each and every cells of two way tables, two numbers, namely decimal numbers and integers; left bottom and right top of the cells represent the total of rates and sample sizes. SSTA, SSTB and SSTC mean the sum of squares due to tables, SSB, SSM and SST mean sum of squares due to intervention, weather and water facilities. SS(BxT), SS(BxM), SS(MxT) and SS(BxMxT) are mean sum of squares of the two and three factors interactions. When sum of squares due to main factors, two and three factors interactions are available then the analysis of variance could be calculated as shown below: -

Analysis of variance of 3 factors

Source of Variation	Sum of Squares	Degree's of Freedom	Mean Sum of Squares	F-value	Critical Value 5%	1%
B	240.0338	1	240.0338	13.67**	4.99	8.53
M	436.0538	1	436.0538	24.83**	4.99	8.53
T	20.5409	1	20.5409	1.17	4.99	8.53
BxM	25.8337	1	25.8337	1.47	4.99	8.53
BxT	0.1874	1	0.1874	0.01	4.99	8.53
MxT	1.0799	1	1.0799	0.06	4.99	8.53
BxMxT	1.0821	1	1.0821	0.06	4.99	8.53
ESS	280.9300	16	17.5581			
TSS	1005.7396	23				

* Significant at 5 percent probability level
** Significant at 1 percent probability level

It will be seen in the analysis of variance table as shown above that sum of squares due to Intervention - B and Weather - M show statistically significant differences in the means at one percent probability level.

FACTORIAL EXPERIMENT
TWO-FACTOR EXPERIMENT

For two factor experiment, the following table was constructed using prevalence of diarrhoea rate in all ages by users and non-users of Water and Latrine facilities.

Prevalence of Diarrhoea in all ages by Water and Latrine facilities.

WATER			
USER		NON-USER	
LATRINE		LATRINE	
USER	NON-USER	USER	NON-USER
5.6	7.5	6.5	6.3
5.2	6.0	3.1	7.0
5.3	5.6	4.8	8.9
16.1	19.1	14.4	22.2
			71.8

The above table involves 3 replications - the villages under study, three having water facility and three without. Among water users, some have latrine facility and some do not have such facility.

The mathematical model given symbolically is -

$$Y = U + W_i + L_j + (WL)_{ij} + e_{ij}$$

Where Y being the response variable, Prevalence of Diarrhoea in all ages, u, the overall effect, W_i, L_j and $(WL)_{ij}$ being effect of Water, Latrine and their interaction and e_{ij} being a random element from a normally distributed population with mean zero and variance, $@^2$.

From table 1 above the following sum of squares could be calculated.

(1) C, Correction Term $= (5.6+5.2+----+7.0+8.9)^2/(2)x(2)$

$= 429.6033,$

(2) TSS, Total Sum of Squares $= (5.6^2+5.2^2+----+7.0^2+8.9^2)-C$

$= 23.2967,$

(3) SST, Sum of Squares due to Treatments

$= (16.1)^2/3+(19.1)^2/3+(14.4)^2/3+(22.2)^2/3-C$

$= 11.8034$ and

(4) ESS, Error Sum of Squares = TSS - SST' = 23.2967-11.8034

= 11.4933

In order to obtain sum of squares due to Main Effects and Interaction a second table is constructed as shown below.

Two-way Classification of Main Effects.

WATER	LATRINE		TOTAL
	USER	NON-USER	
USER	3 16.1	3 19.1	6 35.2
NON-USER	3 14.4	3 22.2	6 36.6
TOTAL	6 30.5	6 41.3	12 71.8

Decimal numbers at the left bottom of cells are the sum of Prevalences with reference to the marginal lables of Water and Latrine Facilities and integers at the right top of the cells are the replicates. Similarly totals and replicates of the main effects are shown at the margins. This table will provide sum of squares due to main effects and their interactions as shown below.

(5) SST2, Sum of Squares due to 2nd Table

$= (16.1)2/3+(14.4)2/3+(19.1)2/3+(22.2)2/3-C$

$= 11.8034$

(6) SSL, Sum of Squares due to Latrine

$= (30.5)^2/6+(41.3)^2/6-C$

$= 9.7200$

(7) SSW, Sum of Squares due to Water

$= (35.2)^2/6+(36.6)^2/6-C$

$= 1.92$ and

(8) SS(L*W), Sum of Squares due to Intraction of Latrine and Water

= SST2-SSL-SSW

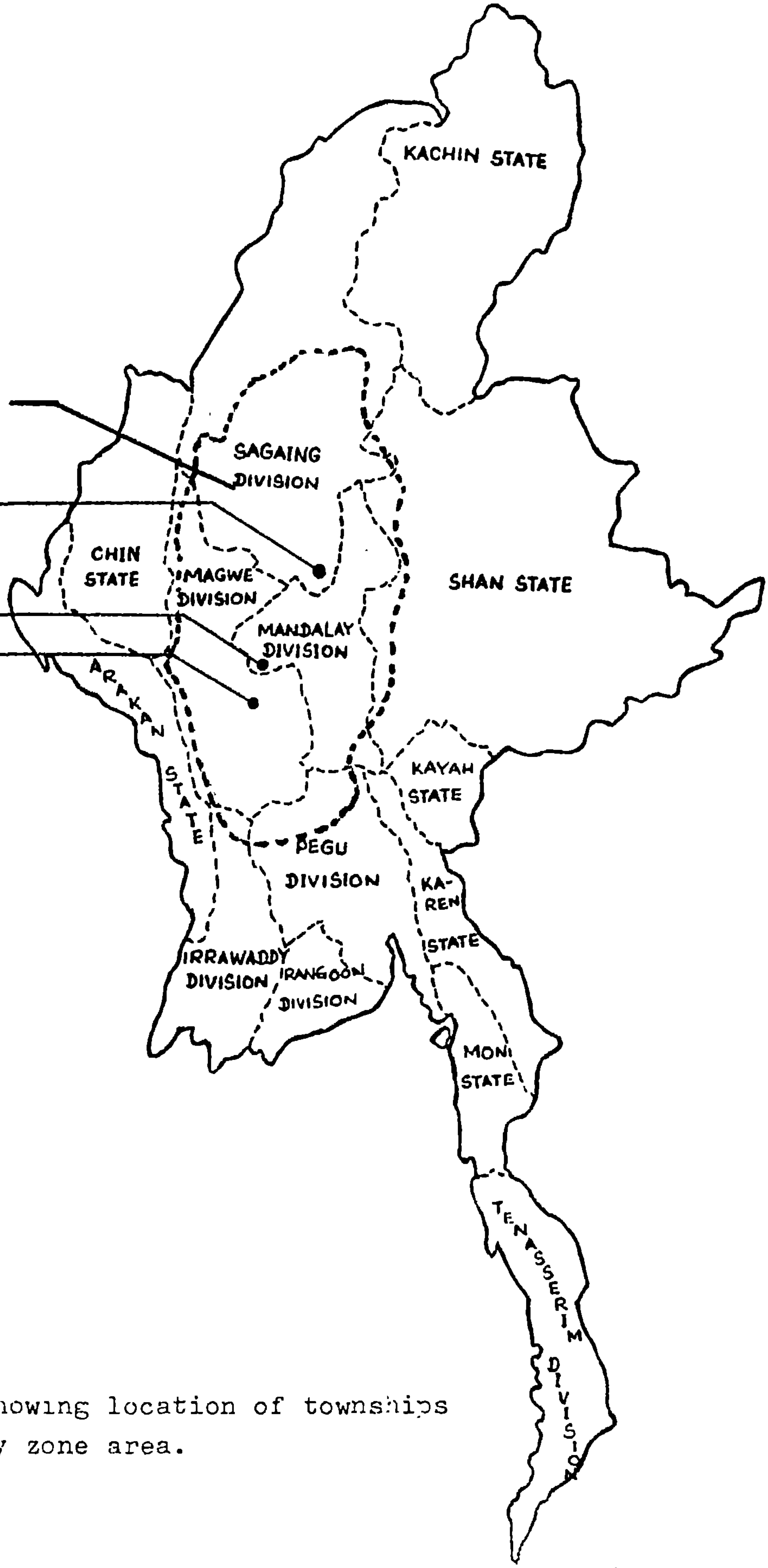
= 1.9200

From the above caculations Two-Factor Analysis of Variance table could be made as follow.

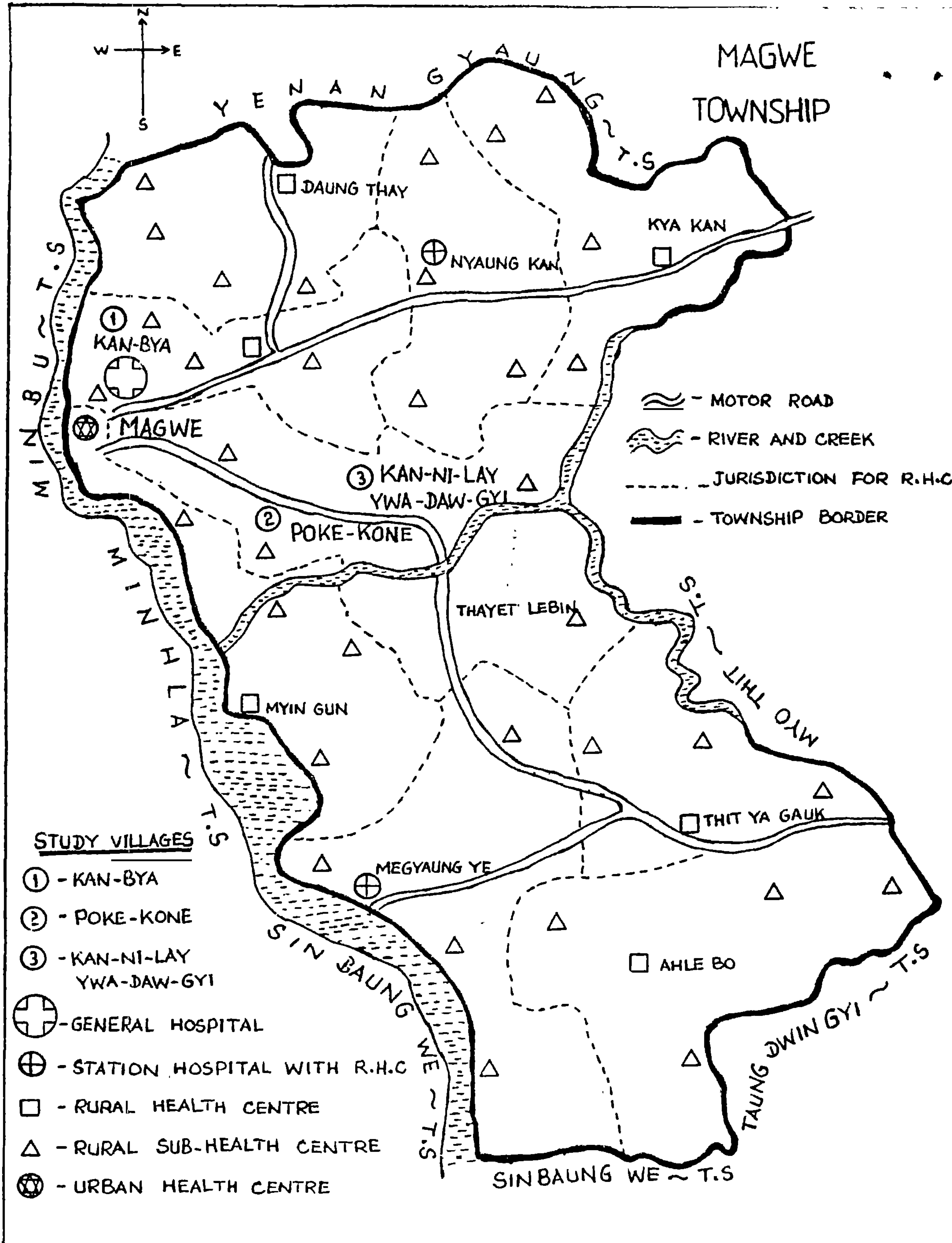
Two-Factor Analysis of Variance.

Source of Variation	Sum of Squares	Degree's of Freedoms	Mean Sum of Squares	F-value	Critical Value 5%	Critical Value 1%
Main Effect 1.SSL	9.7200	1	9.7200	6.77*	5.32	11.26
2.SSW	0.1634	1	0.1634	0.11	5.32	11.26
Intraction 3.SS(L*W)	1.9200	1	1.9200	1.34	5.32	11.26
Error 4.ESS	11.4933	8	1.4367			
TSS	23.2967	11				

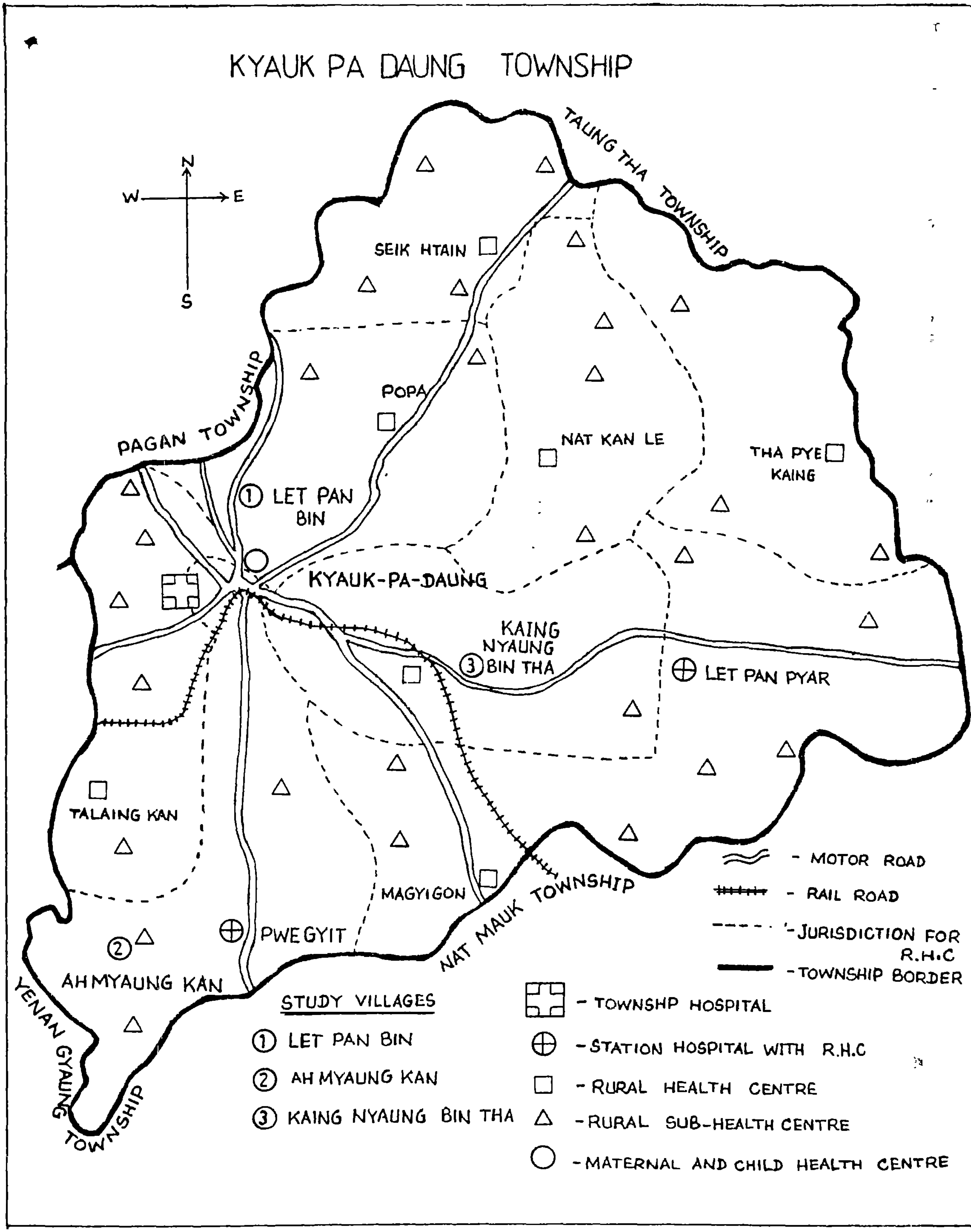
* Significant at 5% percent probability level.



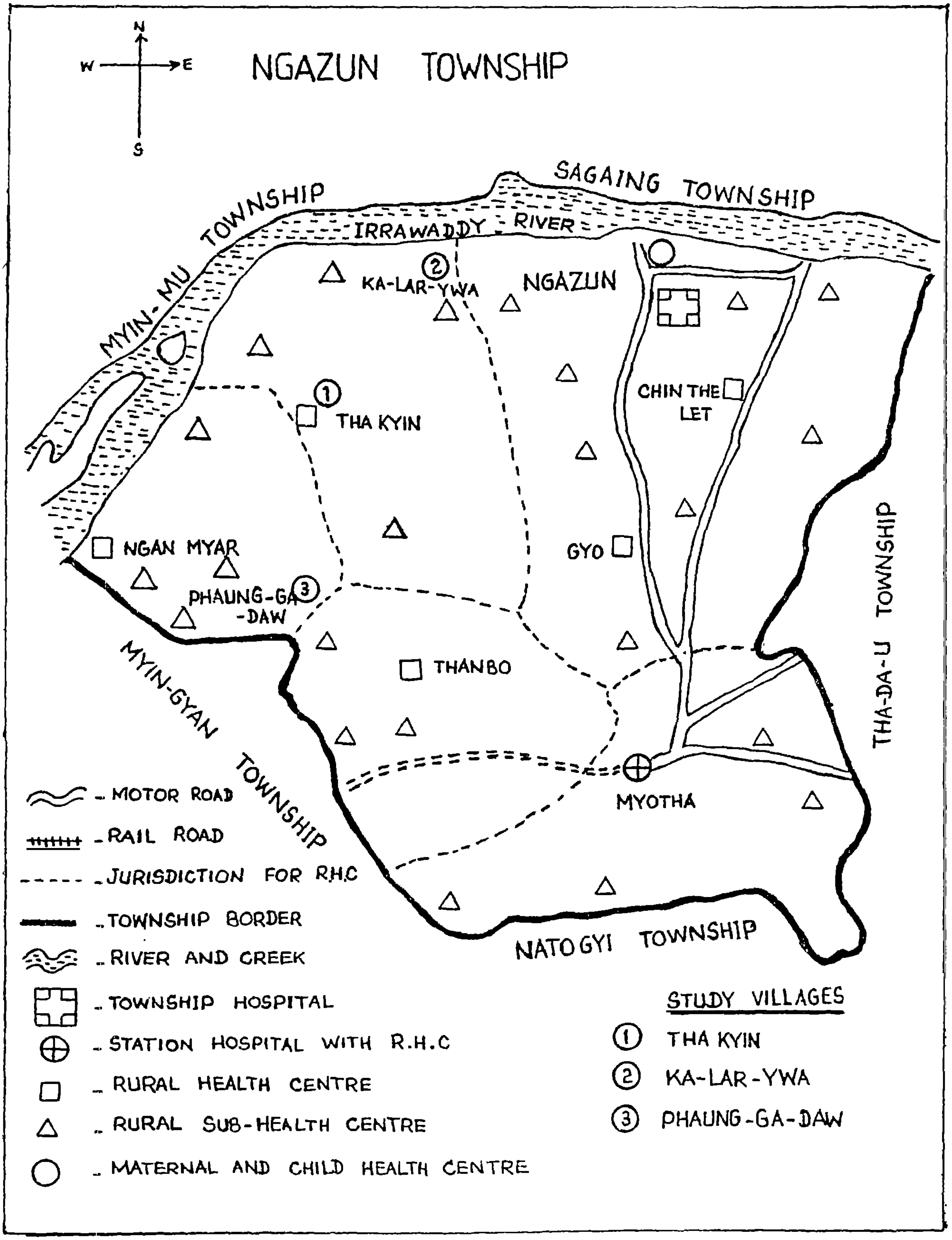
Map. 1. Map showing location of townships in dry zone area.



Map. 2. Map showing location of study villages in Magwe Township



Map. 3. Map showing location study villages in Kyauk-Pa-Daung Township



Map. 4. Map showing location of study villages in Nga-Zun Township