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# DESIGN OF THE RURAL ELECTRIFICATION EVALUATION IN THE PHILIPPINES

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## Introduction

The rural electrification program began in the Philippines in 1965 with the fielding of a team from the National Rural Electric Cooperative Association (NRECA) to conduct a feasibility study of two pilot rural electric cooperatives. The success of these cooperatives led to the establishment in 1972 of a full program to electrify rural areas of the Philippines. [1] By the end of 1977, electrical connections exceeded 700,000 households in 62 cooperatives. Planning for evaluation of the institutional and socioeconomic aspects of the project began in late 1974 with the Census Bureau's involvement in evaluation planning beginning in September 1975.

A major problem in conducting evaluations in developing countries is institutionalization or development of evaluation capabilities in the host agency or the agency responsible for the project. Institutionalization, in this instance, means the establishment of an ongoing organization within the host agency which would have the capability for conducting sound evaluations. It is nearly impossible to find experienced statisticians with general survey and evaluation experience and to find management that fully appreciated the value of probability surveys in a host government agency. This is a continuing problem in the United States and no less a problem in the Philippines. Therefore, the first task of this project was to develop a capability for all phases of evaluation within the National Electrification Administration (NEA).

Evaluation can be conducted on various parts of a project. The group responsible for implementation of a project normally develops a management information system in conjunction with their accounting system for evaluating the implementation. The long-range impact of a project requires additional information gathered over a longer period of time in accordance with requirements of an impact evaluation plan. This plan usually specifies the type of

experimental design, the type and scope of surveys, the timing of data collection and other salient features of the impact evaluation study.

The purpose of an impact evaluation is to determine the effect of the experimental variable on project goals by careful appraisal and study of the change in value of key variables. The variables are selected because they constitute either a direct measurement of progress against a predetermined goal or they serve as an acceptable proxy for direct measurement. Project goals provide the stated reasons for conducting a project. In this it is presumed that the project outputs will initiate forces - social, economic and political forces - that will eventually produce the long-range effects envisioned by the project planners.

The importance of this type of evaluation can be appreciated more if one considers the limitation of resources that are available to developing countries and the hard choices which must be made in selecting development projects. Information on the impact of these projects provides obvectivity to the selection process with the ultimate goal of the evaluation being to enable developing countries to get the most for their development dollar.

However, a recent study of rural electrification projects in seven countries encompassing 20 AID projects concluded that the existing documentation on rural electrification projects is wholly inadequate for analyzing project effectiveness. [2] Probably the largest single factor contributing to this lack of information on the impact of rural electrification in developing countries is the absence of the institutional capability to conduct an evaluation. In those projects, this made it difficult for evaluation planning and implementation to be carried out properly. In recognition of that problem, the primary goal in the Philippines was to develop the institutional capability in

the NEA to conduct major impact evaluations. The NEA established the organization and provided staff for this purpose within the Directorate for Franchises and Regulation of Cooperatives. The U.S. AID Mission in Manila, through consultants from the U.S. Bureau of the Census, provided technical assistance and consultation.

This paper presents certain parts of the impact evaluation including the statistical design, the overall analytical plan, and sampling considerations which are being used for evaluation of introduction of rural electrification in the Philippines. The focus is on the revision to the overall evaluation plan and the design for the second nationwide survey.

In preparing the design for the second nationwide survey, NEA found it necessary to revise the original evaluation plan by changing some of its goals and their precedence. Primary emphasis in the first nationwide survey, in addition to identifying and describing the beneficiaries of rural electrification, was on evaluating the institutional capability of NEA in providing service to rural poor as compared to utilities who were not organized as cooperatives. This was accomplished by comparing cooperatives with privately franchised utilities. For the second survey, NEA wanted to place more emphasis on the impact of electrification on the rural poor and business establishments.

The NEA had planned a separate survey of business establishments. To thoroughly evaluate the impact of rural electrification, analytical requirements dictated that the evaluation of the effect of electrification on business establishments be combined with the nationwide household survey, although the fieldwork and data collection would be done separately from the household survey. Several problems exist though.

The experimental variable, in this case rural electrification, was not introduced randomly into municipalities. In addition, criteria used in selecting

municipalities for electrification vary from political consideration to the policy of private utilities being taken over by cooperatives. An added problem is that the selection criteria of these private firms would be difficult to reconstruct. Since the primary objective of this evaluation was to measure the socioeconomic benefits of rural electrification over time, one approach would be an experiment designed to measure these benefits by comparing electrified and nonelectrified towns that had similar socioeconomic characteristics prior to introduction of the experimental variable or by comparing the socioeconomic characteristics of households before and after electrification. A true experimental design for comparing electrified and nonelectrified towns could not be designed at the time because the experimental variable was not introduced randomly.

A quasi-experimental design could have been attempted, but it would have required matching the sample of nonelectrified towns with electrified towns prior to sampling; even then the sample would not have been representative of the nonelectrified subuniverse. In addition, assumptions would have to have been made that all variables had the same relationship to the other subuniverse as the matched variables.

Because of the problems associated with matching samples, a decision was made to look for an experimental design for the 1980 surveys which did not require matching variables and yet, was compatible with the original 1977 design. [3] The "before-after" design required waiting at least two years until the next survey in order to meet the goal of assessing the benefits of rural electrification. However, by enlarging the nonelectrified sample, some matching of the probability samples of the electrified and nonelectrified subuniverses will be possible after the fact. This matching will be based on available socioeconomic data or income and expenditure data for 1970. These

data will predate the introduction of the experimental variable in most provinces. A special cross tabulation will then be made of key socioeconomic variables for matched towns to assess the benefits accruing to the electrified towns. Since current plans call for the entire country being electrified by 1990, the 1980 survey will probably be the last opportunity to conduct a "before-after" design of the nonelectrified towns by collecting information from these towns every 3 years and comparing socioeconomic status of the ones that get electrified with their status prior to electrification.

The rural electrification program in the Philippines provides an unusual opportunity to measure the benefits of electricity over time by making the comparisons previously described. It also compares the socioeconomic status of households with different dates of electrification to determine if length of electrical service improves socioeconomic well-being.

Objectives of the Household Survey

The main purpose of the household survey is to determine the socioeconomic impact of rural electrification on the rural household and measuring the extent to which the experimental variable is extended to the target group or rural household. Other specific objectives are listed below.

- To provide a baseline of social and economic data for future research.
- To compare the cost of electrifity to the consumer in areas served by electric cooperatives with areas served by private utilities and with alternative energy sources.
- To compare the social and economic characteristics of households in cooperative areas with households in areas served by private utilities and areas that do not have electricity.

- To compare the outreach of electricity to the rural poor, farmers and food producers in areas served by electric cooperatives with areas served by private utilities.
- To determine the charge in the socioeconomic characteristics of households in electrified towns for both users and nonusers of electricity since the last nationwide survey.
- To compare the socioeconomic characteristics of newly electrified households with households that have been electrified for serveral years.
- To identify and quantify other sources of energy used in households, especially those in nonelectrified towns.
- To determine the outreach of cooperative electrification.

Objectives of the Business Establishment Survey

In general, the purpose of the nationwide survey of business establishments is to determine the impact of rural electrification on business growth. More specific objectives are outlined below.

- To compare the economic status of businesses which have been electrified for more than one year with those that are not electrified and to create a file of business growth by standard industrial classification.
- To identify productive uses of electricity in business establishments.
- To provide a baseline for measuring employment and income trends.
- To identify and quantify the alternative energy sources used by businesses
- To determine the extent that capital formation or availment of credit impedes business expansion of old businesses.

Specific Objectives of the Cost Study

A cost comparison study was also incorporated into the second nationwide household survey. Because the objectives of this study are closely related to the objectives of the household survey, its incorporation only requires a

minor addition to the survey. The specific objectives of the cost survey are not stated below because of duplication with objectives of the household survey.

The Universe for the Household Survey and Business Survey

The universe consists of all households and businesses in the Philippines except those in Metro Manila, Davao, Cebu, Iloilo, and Angeles since these five areas are being served by private utilities which will not be taken over by NEA. This universe consists of households and businesses which are electrified and households and busineses which do not have electricity. A place which is electrified receives its electricity from either a co-op or a private franchised utility. A place which is not electrified either chooses not to have electricity (for whatever reason) or the electricity is not available.

The universe can then be said to consist of households and businesses in electrified cooperative areas or electrified private utility areas or in nonelectrified unorganized areas. These subsets of the universe are dynamic and the changes occurs in many different ways. In the cooperative subset, changes occurs when a nonelectrified household gets electricity or when a previously nonenergized area receives cooperative electrification or when a previously privately franchised area is taken over by a co-op. Change in the private utility subsets occurs when unelectrified household receives electricity. Change occurs in the nonorganized areas when a cooperative begins operating in the previously nonenergized area. As project implementation proceeds, the cooperative subset expands. The private utility subset diminishes at a lesser rate and the unorganized areas are reduced at a rate approximating the difference. It is said that all of the Philippines will be electrified by 1990. Because of this, the 1980 household survey had to be designed to capture enough data on the unelectrified households if an adequate "before and after" comparison were to be done with any reasonable accuracy.

Cooperatives

The subsets consist of households with or without electrification in areas served by a cooperative. Cooperative electrification begins in selected areas and expands until all areas are serviced. Because of this, there are both electrified and nonelectrified towns within a cooperative area. In addition, a town is electrified in a similar flow until the entire town is serviced. As a result some smaller areas in the town (barangays or barrios) will have electricity and some barrios may not. A household or business may or may not have electricity as a result of this evolutionary process of the cooperative. In addition, the household or business may choose not to have electricity.

Private Utility Areas

This subset consists of households with or without electrification served by a private utility. The service area of a private utility usually is smaller than a cooperative and consists of one or two towns. Within the service area, barangays are electrified in a similar fashion to cooperative electrification. Households may or may not have electricity because they choose not to have it or it is not available.

Nonelectrified Areas

The nonelectrified subset consists of households in municipalities (towns) which are not served by an electric utility (cooperative or private). Some of these towns have organized a cooperative on paper but there is no distribution system nor any other electric service facilities being constructed. The rest of the towns have not been organized at all and should eventually be organized if the goal of complete electrification by 1990 is to be realized.

General Analytical Comparisons and Sample Design Overview

The following diagrams illustrate several of the comparisons which are of interest. In each diagram, a smaller case letter represents a comparison of

interest. In addition, overall profiles of the five areas are to be developed as well as comparisons of these profiles. These are represented by capital letters.

Diagram A. Comparisons of change from 1977 to 1980

1980

| | | Coop area (Town or Hhs) | Private Utility Area (Town or Hhs) | |
|---|---|---|---|---|
| 1977 | Coop area (Town or Hhs) | $a_1$ | $a_2$ | $A_3$ |
| | Private Utility Area (Town or Hhs) | $a_3$ | $a_4$ | $A_4$ |
| | | $A_1$ | $A_2$ | |

Diagram B. Analytical comparisons of interest for 1980 Hh Survey

| | | Electrified: Coop Area (Town or Hhs) | Electrified: Private Utility Area (Town or Hhs) | |
|---|---|---|---|---|
| Non-electrified | Coop Area (Town or Hhs) | $b_1$ | $b_2$ | $B_3$ |
| | Private Utility Area (Town or Hhs) | $b_3$ | $b_4$ | $B_4$ |
| | Unorganized Area (Town or Hhs) | $b_5$ | $b_6$ | $B_5$ |
| | | $B_1$ | $B_2$ | |

These comparisons represent a first step in the analyses and should not be construed as the only comparisons of interest. Selection of the variables of interest is covered in a subsequent section of this paper.

Sample Design Overview

In accordance with the objectives and the planned comparisons of the household survey, the household universe was partitioned into seven subuniverses. These subuniverses are defined as follows:

In Electrified Towns in Cooperative Areas

Subuniverse 1 ($U_1$) = Towns served by co-ops energized prior to the 1977 survey (old towns in old co-ops)

Subuniverse 2 ($U_2$) = Towns served by co-ops energized at the time of the 1977 survey (new towns in old co-ops)

Subuniverse 3 ($U_3$) = Towns served by co-ops energized after 1977 (new co-ops)

In Noncooperative Areas

Subuniverse 4 ($U_4$) = Towns served by a private or municipal electric utility

In Nonelectrified Areas

Subuniverse 5 ($U_5$) = Nonelectrified towns within the geographical domain of an energized co-op

Subuniverse 6 ($U_6$) = Nonelectrified towns within the geographical domain of a registered by nonenergized co-op

Subuniverse 7 ($U_7$) = Nonelectrified towns in unorganized areas.

These partitions conform to the planned comparisons of the survey results and the sample size was designed to be large enough for linkage between the first and second nationwide household surveys.

Within each subuniverse, a self-weighting sample of households (electrified, nonelectrified, or both) was selected using a multistage procedure. It was attempted to give all electrified households a 1 in 600 change of being selected and for nonelectrified households a 1 in 1200 chance The samples for

the seven subuniverses will be combined to provide nationwide estimates. Budgetart constraints limited the total sample size to 5000 households for the sample. For further details of the sample design see the appendix.

Universe for the Business Establishment Survey

The Universe for the business establishment survey consists of all business establishments in the Philippines except those in the municipalities of Metro Manila, Davao, Cebu, Iloilo, and Angeles which are excluded from the households survey. A business establishment is defined as an economic unit which engages in economic activity as a specific location and having permanent assets on its premises during its operations.

The sample for the business establishment survey will use the same selection or a subsample from the municipalities used in the 1980 household survey. Within municipalities, business establishments will be selected from a list which has been stratified by large (10 or more employees) and small businesses. Any business establishment which has been in operation for less than a year will be classified as a new business so that new businesses can be excluded from parts of the analyses. Business establishments will be classified according to five major classifications: a) agricultural, b) manufacturing, c) services, d) wholesale and retail, and e) other.

Selecting Variables for Measurement

Survey design usually starts with defining the objectives of the survey. Broad general objectives such as measuring the impact of rural electrification on the rural poor must be translated into the specific objectives outlined above. Decisions must then be made on how these objectives will be measured. Such questions as: "Is income a sufficient measurement of the socioeconomic status of rural poor?" must be answered.[4] To facilitate the selection of

variables a method used experimentally by the Bureau called "associative chains" was applied. This method starts by listing the inputs to the project. The physical outputs of the project are then itemized. The next step is to examine the effect of each of these outputs. This is followed by anticipating the long-term, behavioral impact of the project.

For example, the output of the project may be 1.5 million connections to households by the date of the second nationwide survey. The cost savings per household was estimated at ₱142 per household per year over deriving an equivalent amount of light (in lumens) from a kerosene lamp. Electric pump irrigation was estimated to save ₱0.3 per KWH over diesel powered pumps. An evaluation of the effects of these savings based on established economic theory [4][5] resulted in the identification of the economic variables impacted by rural electrification.

After all of the variables were identified, tables were developed and reviewed from the standpoint of providing adequate information for measuring the objectives of the project. After a complete set of tables had been developed, the questionnaire was drafted together with the plan for processing the data. Along with the development of the tables, an analytical plan was developed which is described below.

Analytical Plan

The analytical plan consists of a general plan and a detailed list of tables. The analyses will incorporate the data from the first (1977) nationwide survey in addition to the analyses of data from the second (1980) nationwide survey. These data will be combined and used in evaluating change over time resulting from rural electrification.

Cooperative versus Private or Municipal Systems

In keeping with the comparisons made in the first nationwide survey, the analysis will include comparisons of the socioeconomic variables in towns (municipalities) served by private utilities with those served by cooperatives. Comparisons will be made of income level, education attainment, quality of housing, and other socioeconomic characteristics.

In addition, factors bearing on the impact of electrification on the community such as the outreach of electrical service, the number of food producers, the number of poor households, the number of electrified schools and medical facilities will be compared as well as the attitudes of the comsumers and management of the utilities. A detailed description of this comparison can be found in the report: "Nationwide Survey on Socioeconomic Impact of Rural Electrification, February 1977," published by the National Electrification Administration, Quezon City, Philippines in June 1978.

Households in Electrified versus Nonelectrified Towns

In concert with the objectives of this survey, the analysis of the 1980 data will include a comparison of the socioeconomic characteristics of households from municipalities that have no electrification -- cooperative or private. Because the experimental variable, rural electrification was no introduced randomly and because of the uncertainty surrounding the selection of locations for electrification by both cooperative and private utilities, nonelectrified municipalities in the 1980 sample will be matched with electrified municipalities (both cooperative and private) in the 1980 sample on the basis of population data for 1970 and 1975 or other available socioeconomic data and the type of water system serving the town.

Change in population from 1970 to 1975 and population as of 1975 can be used for matching to towns that were electrified subsequent to 1975. Data on population change for matching purposes should precede electrification of the town since it is the change caused by electrification that is being measured by these surveys. It is assumed that a high degree of correlation exists between the indicators of socioeconomic change, population change and family income.

In addition to the comparison of socioeconomic variables from matched towns, a correlation analysis will be required to determine the relationship between income, which will be used as the dependent variable, and the independent variables which will consist of:

- Basic need expenditures
- Educational attainment
- House and lot ownership
- Type of home construction
- Number of household items
- Type of household water system
- Employment status
- Total cost of all energy consumed
- Electrification status (within and between areas)
- Subuniverse

With the geographic coding in the data file, the file can be sorted by municipality. Total income can be used as the dependent variable. The percentage of each independent characteristic can be used as independent variables. The principal comparisons which will be made to show the socioeconomic benefits of rural electrification will include:

- Cooperative electrified households with households from non-electrified municipalities (HN-EM)
- Cooperative nonelectrified households with HN-EM
- Total cooperative households with HN-EM
- Noncooperative (private franchise) electrified households with HN-EM
- Noncooperative, nonelectrified households with HN-EM
- Total noncooperative households with HN-EM
- Total electrified households with HN-EM
- Total households from electrified towns with HN-EM
- Cooperative households with private franchises and HN-EM

A test for a significant difference at a confidence level of .05 will be made for each of the socioeconomic variables listed above and other selected variables such as agricultural income, distance from poblacion, distance from main road, urban-rural, etc. The geographic location variables could also be used as control variables in cross-tabulations and not directly involved in tests of significance.

Comparison of the Beneficiaries Over Time

Using the part of the sample that contains the households which were previously in the sample ($U_1$ and $U_2$ and $U_4$), a comparison of the socioeconomic status of these households with their status in January 1977 will include:

- Cooperative electrified households in 1977 with the same class of households in 1980
- Cooperative, nonelectrified households in 1977 with the same class of households in 1980
- Total cooperative households in 1977 and same class of households in 1980

- The above three items for households from municipalities served by privately franchised electric utilities
- Total households from electrified municipalities in 1977 with households in 1980

Tests for significant difference at the 5% level will be made as before for all socioeconomic variables and control with geographic location.

Maturation Effect of Electrification

Utilizing the entire sample for electrified areas, the relationship between duration of service and socioeconomic status will be determined by cross-tabulating key socioeconomic variables against duration of electrical service, and controlling as before with geographic variables (1980 data). Evaluation of the impact of electrification on employment of household members will be cross-tabulated with duration of electrical service, also, while controlling for other development projects in the area such as rural roads. A factored variable that represents all socioeconomic variables will be attempted and cross-tabulated with the duration of electrical service.

Other Analytical Considerations for Households

The analysis of the household data will include consideration of

- factors related to energy consumption
- the outreach of rural electrification
- the rural households perception of the quality of management
- the attitude of users toward the cost of electricity

General Analytical Plan for the Business Establishment Survey

The introduction of electrification to rural business establishments is expected to affect the growth of these establishments in terms of employment, production and efficiency.

The first nationwide survey conducted by NEA, concentrated on the impact of electrification on households. To evaluate the wider impact of rural electrification, the present survey will coordinate an evaluation of the impact on business establishments with the household survey.

The analysis of these data will include comparisons of the economic characteristics of business establishments in electrified towns with those in nonelectrified towns. In addition, towns served by cooperative utilities will be compared with those served by private utility companies. Hopefully, these data will be available for three to five years for variables such as employment, production, and electrical consumption. Trend analyses can then be made and rate of growth subsequent to the introduction of the experimental variable, rural electrification, can be evaluated.

Electrified versus Nonelectrified Towns

Comparisons will be made of the following:

- Number of new businesses by industrial classification (see universe description of these five classifications) in electrified towns compared to nonelectrified towns.
- Total production, measured in pesos, for electrified towns compared to nonelectrified towns.
- Total employment for electrified towns versus nonelectrified towns.
- Percentage utilization of plant and equipment in electrified towns versus nonelectrified towns.
- Capital expansion within the last year measured in pesos for electrified towns versus nonelectrified towns.
- Average wage paid by business establishments in electrified towns versus nonelectrified towns.

- Proportion of energy cost to total operating cost for electrified versus nonelectrified towns.
- Total wages paid by business establishments in electrified towns versus nonelectrified towns.
- Total energy cost per peso of production in electrified towns versus nonelectrified towns.

Similar comparisons are planned for cooperative towns versus towns served by private utilities plus the following:

- Perception of the management of electric companies serving the area.
- Attitudes towards the cost of quality of electric source.

Nationwide Uses of Electricity

This part of the analysis will involve trend analysis as well as a comparison of cooperative towns with towns served by private utilities. Trend analyses will include the following:

- Electrical consumption since 1975 using regressing analysis to develop the equation for forecasting consumption through 1985 by industrial classification.
- Trends in alternative sources of energy since 1977.
- Number of employees working at night since 1975.
- Total number of hours working at night since 1975.
- Total number of employees since 1975.
- Total production in pesos since 1975.
- Total wages paid since 1975.
- Average wage paid since 1975.
- Capital expansion since 1975 in pesos or in the number of square feet of space added per year since 1975.

It is anticipated that the regression analysis described in the first item above will be used throughout this part of the analysis. Some control

variables such as length of electrical service, interruptions in electrical service, geographic location, type of industry, cost per KWH, and so forth will be used to develop a better understanding of these trends. Comparisons will be made for the variables specified below:

- Electrical consumption of business establishments by industrial classification for cooperative towns and noncooperative towns
- Alternative sources of energy used by business establishments in cooperative and noncooperative towns
- A comparison of the costs of electricity to the costs of other energy used in production and operation for cooperative and noncooperative towns

Factors Affecting Consumption

The possible reasons for changes in electrical consumption will be explored through evaluations of the following variables:

- Availability of capital
- Change in sales over time
- Present operating level as a percent of toral capacity
- Change in cost of electricity

Summary

It is anticipated by the authors that the analysis described in this paper will produce an understanding of the impact of rural electrification on the rural poor, on employment and on business. It should not only provide us with an understanding of the impact of rural electrification with respect to the project goals but with respect to social and economic changes. This evaluation of the impact of rural electrification was made possible by the institutional capabilities for evaluation developed within the NEA with support from USAID in Manila and the U.S. Bureau of the Census.

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## APPENDIX

### 1980 Sampling Methodology for Household Survey

1. The Universe and the General Sample Design

The universe for NEA's 1980 household survey consists of all households in the Philippines except those in Metro-Manila, Cebu, Iloilo, Davao and Angeles, where private franchise systems will not be taken over by NEA electric cooperatives. The households in the survey then will be part of a national probability sample of households in the Philippines excluding those in the five cities mentioned previously. There also was a separate follow-up sample of the noncooperative sample barrios that were in the 1977 survey. In addition, after the national probability sample had been selected, an experimental design-like matching of the nonelectrified barrios to the electrified cooperative barrios in the sample was proposed.

2. Partition of the Universe for Sample Selection

In accordance with the objectives and analytical plan of the survey, the universe was divided into the following sub-universes:

(1) Cooperative Areas

$U_1$ = towns served by co-ops energized at the time of the 1977 survey (Old towns, old co-ops)

$U_2$ = towns served by the old co-ops after the 1977 survey (new towns, old co-ops)

$U_3$ = towns served co-ops energized after 1977 (new co-ops)

(2) Private Utilities (noncooperative areas)

$U_4$ = towns served by a private or municipal electric utility

(3) Nonelectrified areas

$U_5$ = towns within the domain of an energized co-op but without electricity.

$U_6$ = towns within the domain of a registered, but nonenergized co-op

$U_7$ = towns in unorganized areas

3. Sampling Procedures

$U_1$ = old towns, old co-ops

The co-op universe for the 1977 survey consisted of the energized towns in the 54 established co-ops. These towns will be represented by their 1977 sample towns so that the change in energized towns over the last two years can be analyzed. Since the 1977 co-op sample was not a self-weighting one, the selection rates were adjusted to give self-weighting samples of electrified and nonelectrified households.

Sampling rates that would provide a self-weighting sample were calculated. The actual sample size varied depending on the number of households in the selected barrios in 1977. But if the sampling rates or sampling intervals are applied exactly, each electrified household in the sample will have a weight of 600 and each nonelectrified household a weight of 1200.

To illustrate the manner in which these sampling intervals were obtained, the sample design will be discussed. 1/ First the co-ops were divided into six non-self-representing strata and two self-representing strata of one co-op each. 2/

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1/ The 1980 sample design is almost the same as the sample design used in 1977. The selection of the households within the selected barrios is different.

2/ VRESCO in Negros Occidental and MORESCO in Misamis Oriental are the two self-representing strata.

(The sampling intervals for the self-representing co-ops are explained later in the appendix.) The co-ops were selected with probability proportional to the number of households in a co-op.

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So the chance of drawing La Union into the sample was 2 times the ratio of the 1970 number of households in La Union to the 1970 total number of households in Stratum I, i. e. 2 x (37218/282294) = .2637. Second, two towns were selected probability proportional to the estimated number of households in a town in 1970. The chance of drawing Aringay in La Union, then, was two times the ratio of the 1975 number of households in Aringay to the total for La Union, i.e 2 x (4166/37218) = .2239. Third, four barrios were selected probability proportional to the 1975 number of households in a barrio. The chance of drawing the barrio, poblacion within Aringay, was four times the ratio of its 1975 number of households to the 1975 number of households in Aringay, i.e. 4 x (425/4175) = .4072. For the overall probability of selection for each household to be .001667 or 1 out of 600 we must have:

$$\frac{1}{600} = \frac{1}{SI_{hijk}} \times \frac{2\,N_{hi70}}{N_{h70}} \times \frac{2\,N_{hij70}}{N_{hi70}} \times \frac{4N_{hijk75}}{N_{hij75}}$$

where $SI_{hijk}$ = the sampling interval for the kth barrio in the jth town, the ith co-op, the hth stratum;

$N_{h70}$ = the 1970 number of households in the hth stratum

$N_{hi70}$ = The 1970 number of households in the lth co-op, the hth stratum

$N_{hij70}$ = The 1970 number of households in the jth town, lth co-op, hth stratum;

$N_{hij75}$ = The 1975 number of households in the jth town, in the co-op, hth stratum;

$N_{hijk75}$ = The 1975 number of households in the kth barrio, jth town, ith co-op, hth stratum

The sampling interval then is:

$$SI_{hijk} = \frac{9600}{N_{h70}} \times \frac{N_{hij70}}{N_{hij75}} \times N_{hijk75}$$

For example in Poblacion in Aringay of La Union:

$$\frac{1}{600} = \frac{1}{SI} \times 2 \frac{37218}{282294} \times 2 \frac{4166}{37218} \times 4 \frac{425}{4175}$$

SI = 14.42

Exceptions:

1. In stratum IV, Camarines Norte was selected assuming a population of 74549, but in fact the electrified towns sum to 37549. The sampling interval calculated using the above formula must be multiplied by a factor of 37549/74549.

2. In Stratum IV, Poblacion in Maercedes of Camarines Norte was a double hit in the systematic sampling of barrios because its 1975 population of 1365 was greater than one-fourth of the total for Mercedes, 4084. The interval in table 1 is one half that given by the formula.

3. In Stratum V, Zamboanga City, a town, represents an entire co-op. Because the probability of selecting Zamboanga City was one, the correct sampling interval is one half of that given by the above formula.

For the self-representing co-ops, the number of towns and barrios selected was reduced to lower the sampling interval. In 1977, two towns were selected from each self-representing co-op. For the 1980 survey, one of these towns was selected with equal probabilities: Gitagum in MORESCO and Manapla in VRESCO. Two of the four barrios were also selected with equal probabilities. Cogan and Matangad in MORESCO, and Poblacion and Purisima in VRESCO. The sampling intervals for the self-representing barrios are

$$SI_{hijk} = 1200 \times \frac{N_{hij70}}{N_{hi70}} \times \frac{N_{hijk75}}{N_{hij75}}$$

(2) U2 = New towns, Old Co-ops

Using NEA's "Status of House Connections by towns served per co-op," the new towns were identified and their 1975 household population recorded. The co-ops with their new town's household population were grouped according to their 1977 stratification. The total number of households per strata was obtained and these co-ops were stratified into four (4) super-strata on the basis of geographical location and approximately equal size strata. Size is defined as the number of households.

The co-ops were sorted by the household population of their new towns and one co-op was selected per stratum. In selecting the U2 sample co-ops the overlap with the U1 sample was maximized using a Keyfitz technique. A sample co-op was treated as a cluster and two (2) towns were selected per co-op by PPS (probability proportional to size) method of sampling. Prior to selection, the towns were ranked by their percent electrification (i.e., no of electrified households ÷ total no. of households). Similarly, the barrios were ranked under each sample town by percent electrification (the unelectrified barrios were selected per town by PPS. At the barrio level, selection rates were computed to obtain self-weighting samples of electrified and nonelectrified households.

Sampling rates: 1 in 600 electrified

1 in 1200 nonelectrified

The sampling interval ($SI_{ijk}$) for electrified households can be calculated from the following formula:

$$SI_{ijk} = 600 \times Pi \times 2 \frac{Nij}{N_i} \times 4 \frac{N_{ijk}}{Nij}$$

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where Pi = probability of a co-op being selected using Key fitz technique

Ni = the 1975 number of households in the ith co-op,

Nij = The 1975 number of households in the ith co-op, jth town

Nijk = The 1975 number of households in the ith co-op, jth town and kth barrio.

(3) U3 = Towns served by New Co-ops

The same set of records were used to identify and the same basis for stratification was employed as in U2, the new co-ops were identified and stratified into four (4) strata. Then the co-ops were sorted by their 1975 household population and one co-op was selected per stratum by PPS. A sample co-op was treated as a cluster and two (2) towns were selected per co-op by PPS. Prior to selection the towns were ranked by their percent electrification. Within sample towns, the barrios were ranked by percent electrification with unelectrified barrios being ranked by their household population. Then four (4) barrios were selected per town by PPS. At the barrio level, selection rates were computed to get self-weighting samples of electrified and non-electrified households.

Sampling rates : 1 in 600 electrified

1 in 1200 non-electrified

The overall probability of selection for each electrified household is:

$$\frac{1}{600} = \frac{1}{SI_{hijk}} \times \frac{N_{hi}}{N_h} \times 2\,\frac{N_{hij}}{N_{hi}} \times 4\,\frac{N_{hijk}}{N_{hij}}$$

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where:

$SI_{hijk}$ = The sampling interval for the kth barrio in the jth town, the ith co-op, the hth stratum

$N_h$ = The 1975 number of households in the hth stratum

$N_{hi}$ = The 1975 number of households in the ith co-op, the hth stratum

$N_{hij}$ = The 1975 number of households in the jth town, ith co-op, hth stratum

$N_{hijk}$ = The 1975 number of households in the kth barrio, jth town, ith co-op, hth stratum

(4) U4 = Nonco-op Towns

NEA's Program Control Center's list of towns served by private or municipal systems was used to identify the nonco-op towns and these were sorted by province and region. These were then stratified geographically into four (4) approximately equal-size strata. Ten sample towns were selected and allocated proportionately per stratum on the basis of stratum size. Within stratum, the towns were ordered by their 1975 household population. Once the sample town was selected by PPS, the barrios within towns were sorted by their 1975 Census urban-rural classification and 1975 household population. Then four barrios were selected per town by PPS and selection rates were computed to get self-weighting samples of electrified and non-electrified households.

To obtain a 1 out of 600 over-all probability of selection for electrified households, then

$$\frac{1}{600} = \frac{1}{SI_{hij}} \times C \frac{N_{hi}}{N_h} \times 4 \frac{N_{hij}}{N_{hi}}$$

Where $SI_{hij}$ = the sampling interval for the jth barrio, in the ith town, the hth stratum

$C$ = the number of towns selected per stratum; $C = 2$ Or 3

$N_h$ = the 1975 number of households in the hth stratum

$N_{hi}$ = the 1975 number of households in the ith town, hth stratum

$N_{hij}$ = the 1975 number of households in the jth barrio, the ith town, the hth stratum

(5) U5 = Non-electrified towns in the Service Area Coverage of Energized Co-ops.

The list of towns under the service area coverage of each energized co-op was obtained from the Franchising Division in NEA and together with the list of energized towns per co-op, the U5 towns were identified. The towns were sorted by province, and the provinces sorted by region. Then the towns were stratified into four (4) approximately equal size strata.

Within stratum, the towns were ordered by their 1975 household population and two towns were selected per stratum by PPS.

Within towns, the barrios were ordered by their 1975 Census urban-rural classification and 1975 household population and four barrios were selected per town by PPS. Once the sample barrios were selected, the sampling intervals were computed to get a self-weighting sample of non-electrified households. For the overall probability of selection of each non-electrified household to be 1 out of 1200, we must have

$$\frac{1}{1200} = \frac{1}{SI_{hij}} \times \frac{2\,N_{hi}}{N_h} \times \frac{4N_{hij}}{N_{hi}}$$

Where $SI_{hij}$ = the sampling interval for the jth barrio, in the ith town, the hth stratum

$N_h$ = the 1975 number of households in the hth stratum

$N_{hi}$ = the 1975 number of households in the ith town, the hth stratum

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$N_{hij}$ = the 1975 number of households in the jth barrio, the ith towns, the hth stratum

(6) U6 = Nonelectrified towns in registered but nonenergized co-ops

A list of the registered but nonenergized co-ops and the towns under the service area of these coops was obtained from the Feasibility Division of NEA. These towns were sorted by province and region and stratified geographically into four (4) approximately equal size strata. Then the same procedure was followed in selecting the U5 sample towns and barrios. The selection rates were also computed to get a self-weighting sample of nonelectrified households using the formula given in section 3.5.

(7) U7 = Towns in unorganized areas

From the National Census and Statistical Office list of towns by province and region for the whole country, the towns that belong to sub-universes U1 through U6 were crossed out. Then the remaining towns were sorted by province and region, and stratified geographically into four (4) approximately equal size strata. The same procedure in selecting the U5 sample towns and barrios was followed and the same formula for computing the sampling intervals in U5 was used.

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