Discussion Paper D-730

PN-AAQ-626

ENERGY IN DEVELOPING COUNTRIES SERIES

IAN: 35885

SOCIOECONOMIC IMPACT OF RURAL ELECTRIFICATION IN INDIA

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RESOURCES FOR THE FUTURE/WASHINGTON, D.C.

January 1983

ACKNOWLEDGMENT

The research for this study was funded under Cooperative Agreement No. AID/DSAN-CA-0179 established between Resources for the Future and the U.S. Agency for International Development, Office of Energy (Director, Alan B. Jacobs). Pamela L. Baldwin is the AID Project Officer for this Cooperative Agreement. The research staff at RFF is headed by William Ramsay, Project Officer and Principal Investigator, and Joy Dunkerley, Co-Principal Investigator.

Douglas Barnes oversaw draft revisions and with Bill Ramsay, Joy Dunkerley and Joel Darmstadter provided valuable comments on report findings. Manuscript preparation was coordinated by Linda Walker, who also contributed editorial assistance. Shelley Matsuba and Michael Coda of the Center for Energy Policy Research verified the report contents. Angela Blake and Peter Anestos typed the original draft.

The views expressed in this paper are those of the authors and should not be interpreted as representing the views of either AID or Resources for the Future.

Contents

INTRODUCTORY NOTE

Rural electrification has been the cornerstone of rural energy strategies in developing countries. It is also a source of controversy among development analysts. Advocates of rural electrification claim that it has major impacts on agricultural and industrial productivity, reduces rural-urban migration, creates more jobs and significantly raises the overall quality of life in rural areas. Critics claim that rural electrification may not have the hoped for impacts on social and economic life and in its unequal incidence could contribute to social tension.

This study, "Socioeconomic Impact of Rural Electrification in India," presents a systematic assessment of these issues. It addresses the following sorts of questions: Does rural electrification increase productivity, income, and employment and bring structural change in rural areas? Does rural electrification reduce excessive migration to urban areas? How does rural electrification fit into the broad strategy of rural development? What complementary conditions make for success in rural electrification schemes? How does rural electrification affect the roles of women and children?

The analysis is based on primary date collected by the Operations Research Group (ORG) in 132 villages in four states--Andhra Pradesh, Maharashtra, Punjab, and West Bengal. Data were collected at both the village and household levels, and from State Electricity Board and research and manufacturing enterprises in the sample villages. For 108 of the 132 villages, these data were supplemented by a baseline 1966 survey of agricultural innovation.

The ORG study finds that rural electrification has made a major contribution to rural development. It is found to be positively associated with the two most critical inputs--irrigation and innovation--in the agricultural sector. It is also found to have positive effects on development of rural industry and services. In the social sectors, the effects were less pronounced though still consequential.

This study was funded by the U.S. Agency for International Development under the ARDEN (AID-RFF-Development and ENergy) Cooperative Agreement #AID/DSAN-CA-0179. Other works on rural electrification supported at RFF include studies in Colombia and Indonesia which complement the India findings. The results from all these reports and the data on which they are based at present are being subjected to further analysis. A comprehensive study of rural electrification that will synthesize this material is planned. Thus this paper should be considered as work in progress. It is released with the multiple purposes of informing the energy policy community of the state of knowledge, of stimulating research elsewhere, and of eliciting comments on our own efforts.

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Chapter 1

RURAL ELECTRIFICATION AND SOCIOECONOMIC DEVELOPMENT: THE CONCEPTUAL FRAMEWORK

Introduction

Among the basic infrastructural services geared to developmental needs, electricity is a critical input. The use of electricity serves economic as well as social needs. While in the context of much of the developed world, and possibly, in the urban areas of the developing world, the above statement may sound somewhat trite, the availability and use of basic services in rural areas of the developing world presents a completely different and more complex set of issues. There is, indeed, even a conflict in policy perceptions: are these inputs a basic need or a want? If the former, can the recipient respond effectively to the provision of the service; should service be subsidized; and finally, are the economic and social benefits that the electrification is meant to provide commensurate with developmental expectations. These issues have been the basis for a considerable amount of developmental debate. However, what is clear is that development policies will continue to stress investment in infrastructure. Given this fact, an understanding of the consequences that result from and the determinants that shape the use of any such basic input is imperative for the design of more effective future policies as well as for the analysis of those of the past.

Rural electrification is one such infrastructural input. It has been estimated that, across the world, in the areas of operation of the International Bank for Reconstruction and Development alone, close to $10,000 million have been invested in rural electrification as of 1971 (representing 10 percent of the total investment in electric power) and that, in the succeeding 10 years, another $10,000-$15,000 million would probably have been invested.[1] This would still make rural electrification accessible only to an estimated one-fourth of the rural population (as opposed to three-fourths in urban areas). A large portion of the rural population yet remains to be covered, indicating the magnitude of investment that remains.

The situation in India has been quite similar. Until the late 1960s, the growth of rural electrification in India was rather slow. This is evidenced by the fact that during the period 1966-1969 alone, more pumpsets were electrified than during the previous six decades. With the recognition, made evident by severe droughts in 1965 and 1966, that the caprice of weather on agriculture can be overcome only through a conscious attempt to tap the country's groundwater potential, the Government of India proceeded to make a substantial commitment to rural electrification. Based on the recommendations of the All India Rural Credit Review Committee (1966-1969), the Rural Electrification Corporation (REC) was established and investments into rural electrification, through the REC as well as through the other ongoing plan programs of the government (for example, the Minimum Needs Programme), were stepped up considerably during the 1970s. By June 1981 the REC alone had, since its inception in 1969, sanctioned loans of approximately Rs. 15 billion (about $1.850 billion) on rural electrification in India.[2]

The growth during the 1970s in India is clearly illustrated in the graph of the number of electric pumpsets per one lakh (100,000) hectares of Gross Cropped Area (see figure 1-1). From a mere 20 in 1951, it grew to 267 by 1966, and by 1977 there were nearly 3,500 electric pumpsets per lakh hectares.

The growth in percentage of villages electrified also shows a dramatic growth: barely 4 percent of the villages in India were electrified during the early 1960s, compared to nearly 43 percent by 1980 (see table 1-1). Approximately 57 percent are yet to be electrified.

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1. International Bank for Reconstruction and Development (1975).

2. Statement made by Minister of State for Energy in the Lok Sabha, reported in Eastern Economist, September 11, 1981.

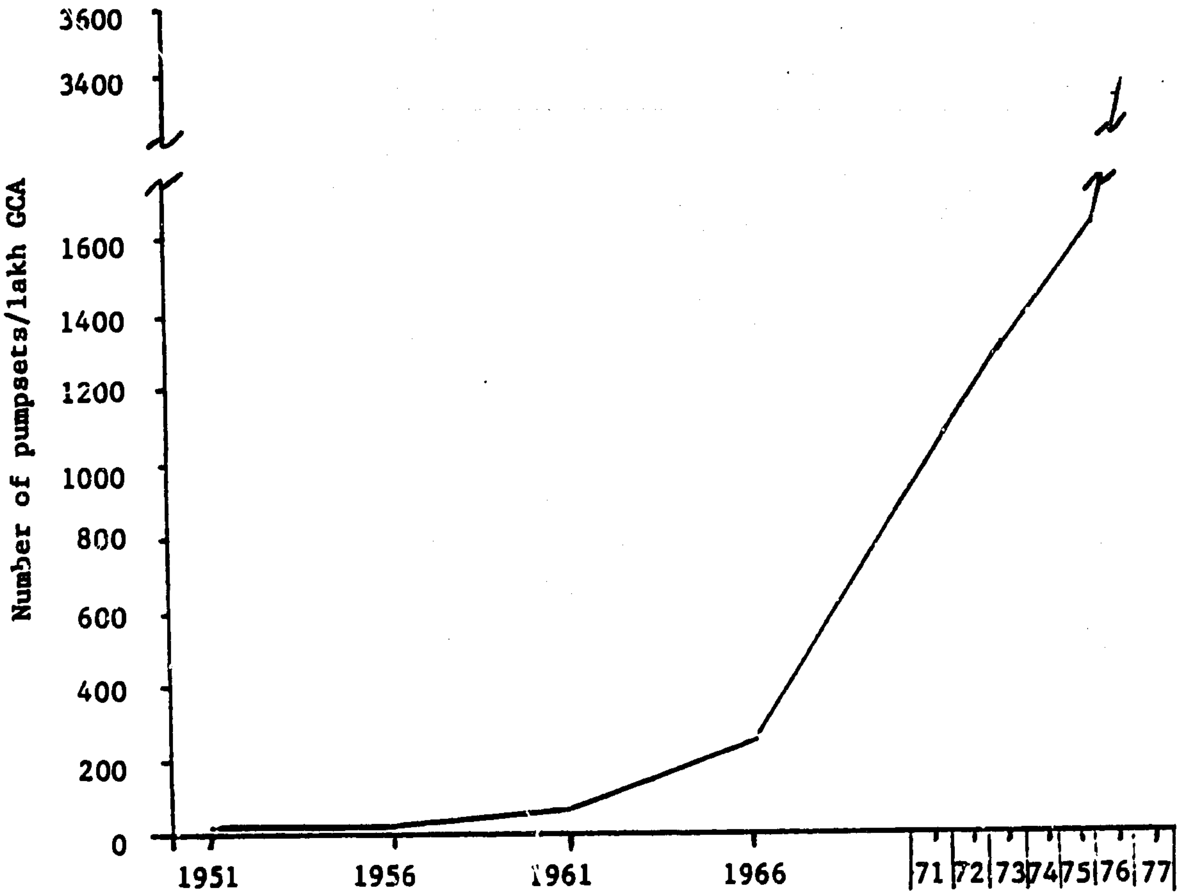

Figure 1-1. Growth of rural electrification in India--electric pumpsets per lakh* hectares--gross cropped area.

*Lakh = 100,000 hectares

Source: "Basic Statistics on Indian Economy," Commerce Research Bureau, Bombay, January 1980.

The target of rural electrification set by India's policy makers aims to cover approximately 280,000 villages (or 49 percent) by the year 1985, and 60 percent in each state by the year 1990.[3] It is clear that the next

3. "Sixth Five Year Plan 1980-85," Planning Commission, Government of India, New Delhi, 1980.

Table 1-1. Progress of Rural Electrification

Year	Number of villages electrified	Percent of villages electrified
1950/51	3,061	0.53
1960/61	21,750	3.78
1968/69	73,732	12.81
1973/74	156,729	27.22
1979/80	250,112	43.44

Source: Planning Commission, Government of India, "Sixth Five Year Plan 1980-85," (New Delhi, 1980).

decade-and-a-half will witness a huge investment in rural electrification in India. This magnitude of past and proposed investment has resulted in considerable debate, leading to both justifications and criticisms of rural electrification. The issues assume further significance in an environment characterized by an increasing squeeze on developmental resources, both internally and internationally. It is in the context of this debate that this study was conceived.

Justifications and Criticisms of Rural Electrification

Rural electrification has been the source of both praise and criticism by development analysts in terms of both its costs and benefits. Critics claim that it is too expensive, does not benefit all social classes equitably, and has no direct impact on agricultural development. Advocates of rural electrification claim it increases agricultural and industrial productivity, reduces rural-urban migration, creates more jobs (leading to employment intensity), increases the overall quality of life in rural areas through the use of rural electrification for household appliances, better/safer/cleaner lighting, street lighting.

The methods of responding to issues have ranged from eulogizing anticipated benefits of rural electrification,[4] to scathing quantitative

4. Valunjkar (1968), quoted in L. Gordon and D. Barnes, "A Draft Research Proposal on Rural Electrification and Socio-economic Development," (Mimeo), Resources for the Future, Inc., Washington, D.C., January 1980.

indictments of its economic viability if certain prerequisites are not satisfied.[5] In the Indian context these subjects have been well researched, and yet conclusive evidence to provide firm answers is lacking because of the contradictory results often produced. The contradictory nature of evidence is the result of the complexity of the issues involved, as much as that of situation-specificity and problem-specificity of past research designs. Further, there has been no clear demarcation of the effects of rural electrification at the community levels; most evidence relates to household/firm/farm/establishment levels. The effects at the two levels are qualitatively different in that a perceived effect at the household level (which may be evident in comparisons of, say, electrified versus non-electrified farms), may not be translated into a conclusion that could hold between farms in electrified versus non-electrified villages.

The justifications and criticisms have involved both costs and benefits of rural electrification. Our concern in this study is primarily with the benefit considerations of rural electrification achieved through a comprehensive research design. We seek to answer questions relating to a broad canvas of issues related to consequences or impacts of rural electrification at the household, village and regional levels, across various sectors (both economic and social), as well as to identify determinants that contribute to improved rural electrification connection growth rates.[6]

In the present study we propose to (a) answer certain questions relating to the justifications and criticisms of benefits of rural electrification and (b) to place rural electrification into the overall context of rural development. We will attempt to derive certain guidelines that future rural electrification policy in India should consider, from the point of view of expected benefits.

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5. For example, N.I.B.M. (1976).

6. The objectives of the study are clearly spelled out in the next chapter.

Rural Electrification and Development--A Conceptual Framework

The conceptual framework under which we have conceived this study is shown in figure 1-2. Rural electrification is essentially a village level input into social and economic development, utilized by households, farms and establishments (I ⟶ III, I ⟶ IV). The use of rural electrification may lead to certain changes or social/economic development at the village level as well as at the household level (I ⟶ III, I ⟶ IV). At both levels, these changes might involve employment, incomes, productivity and others. For example, in the agricultural sector, rural electrification might lead to changes in irrigated area, causing changes in cropping intensity and cropping pattern, which in turn leads to changes in use of factors of production (for example, employment, agricultural innovations), all ultimately affecting productivity and income. Such change processes might occur in different ways across all sectors.

The changes at the household and community levels may interact with and reinforce each other (III ⟶ IV), and may become self-sustaining processes. The interaction and changes at both levels produce certain outputs which may ultimately enhance the "rural quality of life" (III & IV ⟶ V).

Rural electrification itself, and the extent to which it is successful in village conditions, might be determined by a set of complementary conditions (II ⟶ I). For example, adoption of rural electrification on farms may depend upon the availability of groundwater, while among households it may depend upon household incomes or level of village poverty.

The enhancement of income, productivity and employment, and hence, quality of life, may in turn lead to higher growth rates of rural electrification, and rural electrification may similarly influence the complementary conditions as well.

As is well known, it is difficult to precisely delineate causal issues in cross-sectional socioeconomic research. Hence, one has to draw certain arbitrary lines in the analysis of the process described above. However, in the present study, we have attempted to tackle some of these causality

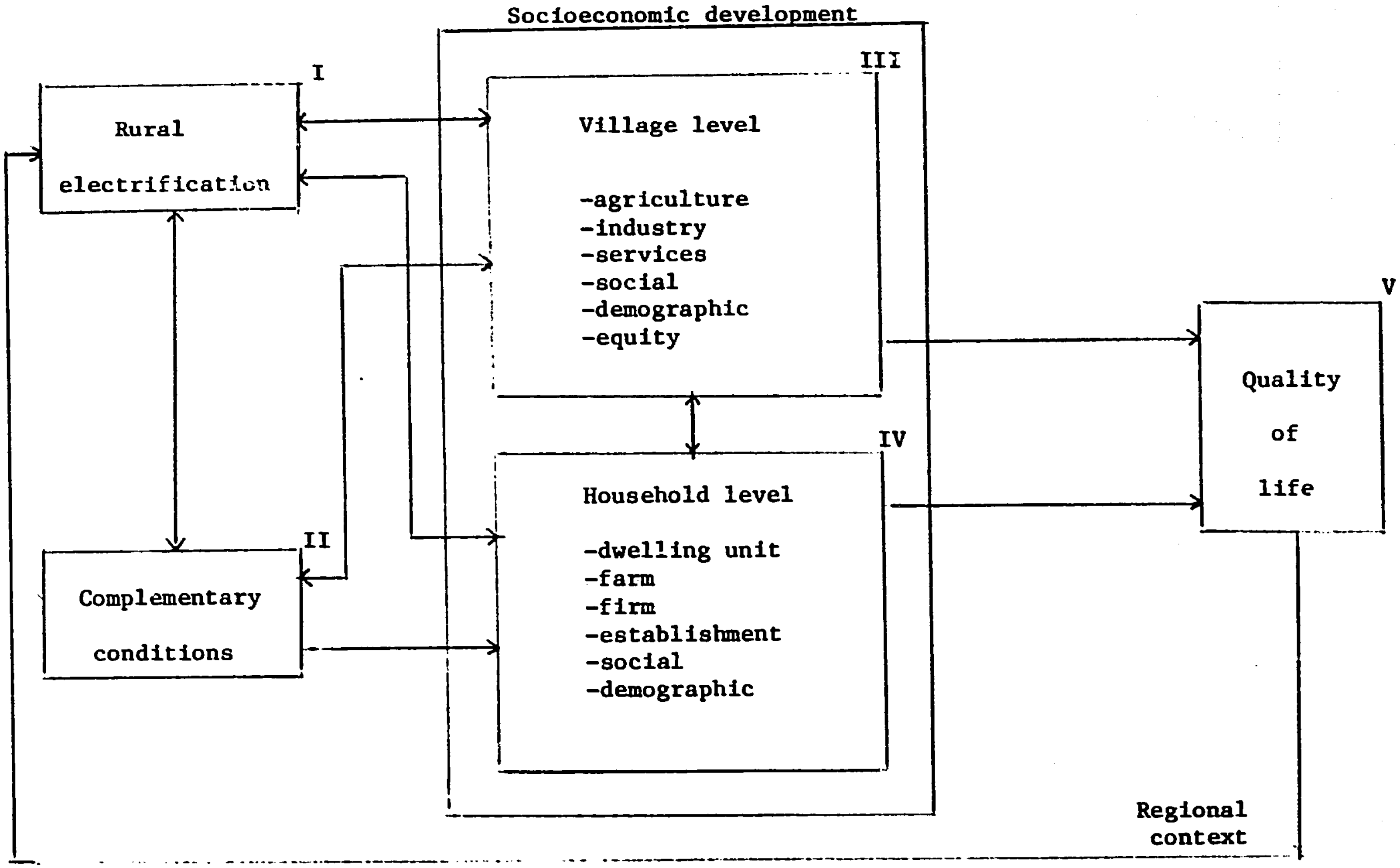

Figure 1-2. Conceptual framework.

<u>Source</u>: Present study

issues through the research design that we have adopted.[7] A large proportion of villages in our study were covered in an earlier study (1966) on agricultural innovations in Indian villages[8] for which we had data. Nevertheless, the conceptual framework described above translates into a concrete research design as shown below:

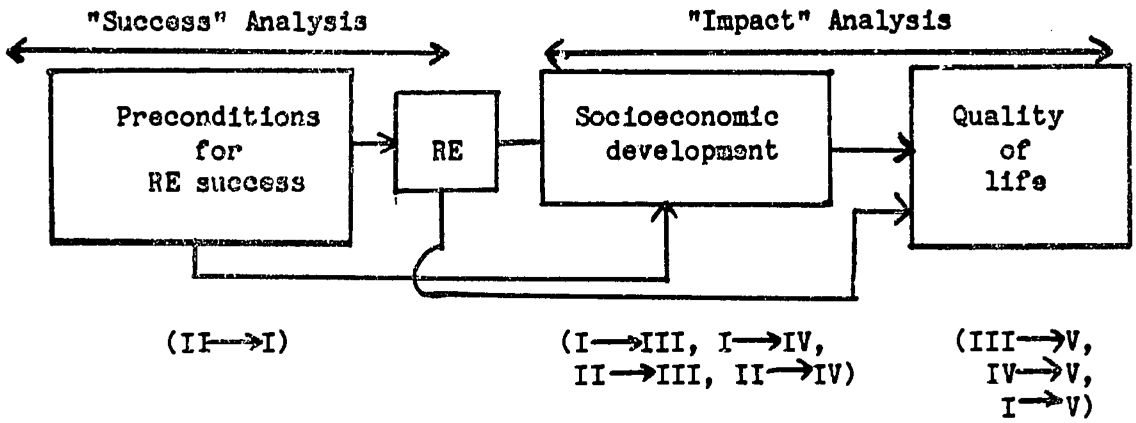

Figure 1-3. Research Design

The processes above in specific sectors (agriculture, industry, services, social/demographic) and levels (household, village, region) are discussed in succeeding chapters, where the linkages are more specific.

Role of the ORG/RFF Study

Broadly stated, the Operations Research Group/Resources for the Future study seeks to define the impacts of rural electrification in India across various sectors and at various levels. The study also looks at preconditions for adequate growth of rural electrification connections and touches upon some of the equity questions that often arise in the rural electrification debate. Cross-sectional and longitudinal quantitative

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7. The research design and other background material relating to the present report is contained in volume 2 of this report. Inquiries on the availability of volume 2 should be addressed to the Center for Energy Policy Research, Resources for the Future, 1755 Mass. Ave., N.W., Washington, D.C. 20036. See volume 2, appendix 3, "Analytical Framework."

8. See volume 2, appendix 2, "1966 Study".

analyses are conducted of the primary data collected by ORG, supplemented by data from the 1966 study made available to ORG by RFF. The ORG/RFF study, as it relates to existing evidence from the previous study in India, is expected to be complementary while at the same time seeking to revalidate or question some of the past findings. The ultimate objective is to examine issues important to policy makers, planners, rural electrification agencies and funding authorities to guide future rural electrification policy in India.

Chapter 2

OBJECTIVES, SCOPE AND METHODOLOGY

Objectives of the Study

This chapter examines the justifications and criticisms of rural electrification in India. The conceptual framework described in chapter 1, broadly stated, illustrates that (1) rural electrification is one among many inputs that contribute positively to socioeconomic development, and, (2) economic development has important consequences for rural communities and rural quality of life.

The study therefore attempts to look specifically at the socioeconomic impacts of rural electrification at both the village and household levels and across agriculture, industry, service, and demographic social sectors. The impact of rural electrification by itself, and in conjunction with or in the context of other inputs into the development process, are studied. The extent to which rural electrification is both a cause as well as an effect of development is examined. We also investigate the factors that make favorable rural electrification connection growth rates possible. Finally, the equity and regional balance aspects of rural electrification are analyzed.

Specifically stated, the objectives of the study are to answer the following questions:

a. Does rural electrification increase productivity, income, employment, and structural change in rural areas?

b. Does rural electrification contribute to regional demographic balance and reduce excessive migration to urban areas?

c. How does rural electrification fit into the broader strategy of rural development?

d. What complementary conditions make for success or failure of rural electrification schemes? Can one rank the complementary conditions and inputs in their order of importance to rural electrification itself?

e. What are the effects of rural electrification on equity in development (for example, providing benefits to different income classes or widening opportunities for small farmers, landless agricultural workers, and artisans)?

f. How does rural electrification affect the roles of women and children?

For analytical and presentational convenience, these questions are translated into the following issues: (1) rural electrification and rural development (c); (2) impact of rural electrification (a, b, part of f); (3) preconditions for successful rural electrification (d); (4) rural electrification and equity (e, f); and (5) rural electrification and regional balance (b).

Data Base and Sampling[1]

The study was based on primary data collected by ORG in 132 villages in 12 districts in Andhra Pradesh, Maharashtra, Punjab, and West Bengal during the period March to June 1981. Data was collected at both the village and household levels, as well as from State Electricity Board records and non-household manufacturing units in the sample villages. This was supplemented by data on 108 of the 132 sample villages from a 1966 study on agricultural innovations, made available to ORG by RFF.[2] The villages sampled represent a wide cross-section of cropping zones, geo-climatic conditions, population sizes, geographical isolation and electricity intensity. Details and summary statistics on the sample villages and states vis-a-vis their socioeconomic characteristics and rural electrification indicators are presented in chapter 4.

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1. See volume 2, appendix 1, "Sample Methodology."

2. See volume 2, appendix 2, "1966 Study."

Five types of questionnaires and one State Electricity Board proforma were used in collecting data for the study.[3] They were:

a. Village Level Schedule (VIS): This was primarily based on data from village records, census data, panchayat functionaries, and Village Level Worker. The VIS generated the "hard" data for village-level analysis.

b. Village Leader Schedule (VLS): This questionnaire was administered to four village leaders in each village to record their opinions on various aspects of rural life--agricultural inputs, rural electrification, program success, extension services, urban contact, secularism, and perceived quality of life. The data from VLS complemented VIS data in village level analysis.

c. Household Schedule, Part I (HH I): This schedule dealt with household level lifestyle and economic characteristics, and the use of rural electrification in households and in farms/establishments. The social groups covered were large farmers, medium farmers, small farmers, agricultural laborers, artisans and shopkeepers.

d. Household Schedule, Part 2 (HH II): Part 2 dealt with the use of conventional (electricity, kerosine, coal, diesel, petrol) and non-conventional (firewood, charcoal, animal dung, agricultural waste) energy sources in the household and in economic activities across the various social groups mentioned above.

e. Industry Schedule: The industry schedule was administered to all non-household manufacturing units in the sample villages. It dealt with all aspects of the industry's operations, with particular emphasis on use of electricity and other energy sources.

f. Section Office Proforma: This schedule was used to collect data on rural electrification consumers in each category of connection starting from the year of village electrification. The data collected related to connected load, type of connection, and date of obtaining connection.

3. See volume 2, appendix 4, "Questionnaires."

While questionnaires a, b, f and part of d were used in the village and regional level analyses, questionnaires b, c and part of d were used in the household level analyses.

Analytical Framework[4]

Analyzing the data required a clear analytical framework involving the following elements: (1) levels of analysis; (2) sectors of analysis; (3) nature of analysis; (4) sources of data; (5) methods of analysis; and (6) independent/dependent variables for analysis.

Level of analysis refers to whether questions are being answered at the regional, village, and household levels. The village is the primary focus of analysis. The household (including farm/firm/establishment) level analysis seeks to answer questions relating to certain inter-social group characteristics as well as certain questions (for example, income) which could not be answered at the village level.

Economic and social sectors are analyzed with regard to the impact of rural electrification (that is, on agriculture, industry, commerce, lifestyle, demography, perceptions, and quality of life). Similar aspects are covered in the household and village level analyses. Regional level analysis is restricted to the agricultural sector.

The analysis is cross-sectional as well as longitudinal. Longitudinal analysis was made possible through the availability of data[5] for 1966 on 108 of the 132 villages in our sample. Sources of data for the study included primary (collected by ORG), secondary (for example, district statistical abstracts and census), and tertiary (evidence from past studies). We relied predominantly on primary data, but where our data was inadequate or inconsistent, we have looked to tertiary data.[6] Statistical techniques include bivariate as well as multivariate comparisons of

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4. For details, see volume 2, appendix 3, "Analytical Framework."

5. Collected through similar instruments and methods of research.

6. These appear from time to time in the text. For a comprehensive summary of major characteristics of past studies on rural electrification in India, see appendices 5 and 6 of volume 2.

relationships. Simple tabular comparisons and presentations are used, as are those based on statistical tests of significance. While the village level analysis is somewhat more complex, household and regional level analyses have been kept relatively simple.

Dependent and independent variables for analysis of each question were clearly delineated and defined. For each question, diverse types of independent and dependent variables had to be constructed for the village, household and regional levels. These are shown in volume 2, appendix 3-1 and their definitions are shown in volume 2, appendix 3-3. For the question on impact, rural electrification was a primary independent variable. In the analysis of "preconditions for successful rural electrification," rural electrification was the dependent variable. The method of defining "successful rural electrification" and the independent variables for this analysis are shown in volume 2, appendix 2-2 and 2-3, respectively. In the regional balance and equity analyses, rural electrification was again the independent variable.

In analyzing agricultural sector impacts, agricultural connections were the independent variables. Likewise, for social/demographic indicators, residential and industrial connections were the respective explanatory variables.

In conducting cross-sectional analysis, issues of causality are difficult to resolve. The resolution in many cases is fairly clear on intuitive grounds, but when possible, a longitudinal analysis was conducted in order to complement the cross-sectional findings.

In closing, we would like to caution that certain limitations arise in any exercise in quantitative socioeconomic research. For example, some of the seemingly "hard" data derived from the village level schedule could be subject to measurement errors imposed by the very means of data collection (for example, use of research schedules), despite the fact that they are interval or ratio scale measures. We would, however, like to respond to this caveat by falling back upon two arguments: first, given the existing time and resource constraints, the trade-off was between intensiveness and extensiveness of the issues being examined; second, the patterns of association between variables should not be greatly affected by the presence of random errors.

Organization of the Paper

The report has been divided into two volumes which allows readers to absorb the major findings and conclusions without getting into methodological details. This paper, volume 1, contains the findings of the study and can be read independently of volume 2 which contains details relating to the background and methodology of the study. Chapter 3 is a summary of the status of rural electrification in India in terms of policies, strategies and achievements. The authors focus on the role played by policies adopted by Indian policy makers and planners and on the sequence of the same over the pre-independence (before 1947), preplan (1947-1951), and plan periods (first through six five-year plans).

Chapter 4 contains summary statistics on socioeconomic characteristics of the sample villages and states. The village level characteristics are presented in perspective with data from the state level as well as for India as a whole utilizing secondary data sources. Some of the broad rural electrification-related characteristics of sample villages across various sectors are also discussed.

Chapters 5, 6, 7, 8 and 9 contain the major findings of the study. Chapter 5 presents findings on rural electrification and agricultural development. Past evidence in the Indian context is discussed, followed by a description of temporal rural electrification response patterns in the agricultural sector. The preconditions for successful agricultural rural electrification are then investigated, and impacts of rural electrification on certain critical indicators are analyzed. Impacts of rural electrification are analyzed separately at the village, household and regional levels.

Chapter 6 deals with rural electrification and industrial development, chapter 7 with rural electrification and the services sector, and chapter 8 with rural electrification and the social/demographic sectors. The chapters are organized in the same way as chapter 5, except that a regional level analysis is not conducted (or where conducted, is somewhat sketchy).

Chapter 9 looks at the relationship between rural electrification and equity. Chapter 10 summarizes the findings of the study and derives certain conclusions on the directions that future rural electrification policy in India could take. This chapter also looks at rural electrification response in various sectors conjunctively.

Volume 2 contains methodological details relating to the study. It contains six appendices relating to each. Appendix 1 describes the sampling methodology, details of fieldwork, targetted and achieved calls, names of villages/blocks/districts and names of field personnel involved in the study. Appendix 2 briefly describes the 1966 study in terms of its background, sampling methodology, methods of analysis and major findings. Appendix 3 contains the analytical framework that guided the study. Levels, sectors, nature, indicators and methods of analysis, as well as sources of data are discussed. Dependent and independent variables are identified and defined, as are methods of deriving rural electrification "success" indicators. Names of personnel involved in analysis and computerization are also given. Appendix 4 contains the questionnaires used in the study. Appendix 5 is a summary of the scope, coverage and characteristics of past studies on rural electrification in India, while appendix 6 contains the bibliography.

Chapter 3

RURAL ELECTRIFICATION IN INDIA: A POLICY SUMMARY

Introduction

The rural electrification program in India has a checkered history. Over the last thirty years, rural electrification policy in India has undergone a series of changes, manifested in a shift in the role assigned to electrification in the process of rural development in India. Although electricity was considered an input for rural development even before the five year plans were developed, its importance is recognized now more than ever. This chapter describes and analyzes the rural electrification program in India in order to clarify the role that rural electrification has played over the last fifty years. For the sake of convenience, the developments are reviewed for the pre-five year plan days and for each plan separately, and the future role that rural electrification is likely to play is also discussed.

Pre-Five Year Plan Period

Literature covering rural electrification policies adopted in India prior to the development of five year plans is very limited, particularly in the context of rural development. However, a review of events in the sphere of energy development in general and rural electrification in particular in the pre-five year plan period establishes a link between rural electrification and rural development.

Although the first step toward energy development in India was initiated at the turn of the present century with the commissioning of the Hydro-electric Power Station at Shivasamudram in Karnataka, use of electricity in rural areas was virtually nonexistent until 1933, when electric power development became part of the first tubewell scheme in India for irrigation in Uttar Pradesh. With the advent of the "Grow More Food Campaign," electricity was considered essential for lifting water from rivers or wells for agricultrual purposes. Another step forward was taken in Madras and Karnataka when electricity was introduced for pumping water, mostly from open wells or tanks, before 1950. Available data indicate that in 1949 there were about 12,500 consumers of electricity for agricultural purposes in Madras State alone. An actual shortage of plant capacity developed, leaving about 20,000 applicants awaiting power. In Travancore, Cochin, electricity was also used to drain marsh land to make it fit for agriculture. No data are available on electricity consumption for agriculture prior to 1939, but between 1939 and 1949 the consumption of electricity for irrigation and draining marsh land increased from 64 million kWh to 150 million kWh. This consumption level was considered very insignificant compared with demand.

The major problem of electricity supply to the rural areas during the period was that electricity supply was managed by private utilities (licensed under the Indian Electricity Act, 1910), whose major consideration was maintaining profitability, which meant supplying urban areas and a few villages in close proximity to cities. Table 3-1 indicates the availability of electricity in 1950 to various towns and villages in India.

Table 3-1. Number of Towns and Villages Electrified, 1950

Population range (1941 census)	Total number of towns or villages	Number of towns or villages with public electricity supply	Percent of towns or villages with public electricity supply to total
Over 100,000	49	49	100.00
100,000 to 50,000	88	88	100.00
50,000 to 20,000	277	240	86.64
20,000 to 10,000	607	260	42.83
10,000 to 5,000	2,367	258	10.86
Less than 5,000	559,062	2,792	0.50
TOTAL	562,450	3,687	0.64

Source: Planning Commission, First Five Year Plan (Government of India).

While all the towns above 50,000 population and most of the towns between 20,000 and 50,000 population had the benefit of electricity, settlements below 5,000 were largely devoid of electrical service; a clear indication of the bias of suppliers toward larger towns is evident. Only one out of every 200 villages in India was served with electricity, confined mainly to Mysore, Madras, and Uttar Pradesh and provided primarily by hydroelectric stations.

In 1948, the Electricity Supply Act was passed, which provided for the creation of state level statutory bodies for generating, transmitting, and distributing electricity. This proved a significant step as the new state electricity boards took over the power supply from the private utilities. This shift in responsibility of power supply from private to public sector was expected to have a positive influence on developing a policy to extend electricity to rural areas to bring about economic as well as social benefits. Augmenting the power supply became a major national objective at this point, and the constitution of the Central Water and Power Commission was an important step in this regard.

First Five Year Plan (1951-1956)

Given the emphasis in the First Five Year Plan on agriculture and irrigation, power development in general and rural electrification in particular could not be overlooked. The importance of rural electrification is clearly expressed in the plan document:

> Extensive use of electricity can bring about the much needed change in rural life in India. It can not only improve the methods of production in agriculture and encourage cottage and small scale industry but can also make life in rural areas much more attractive and thus help in arresting the influx of rural population into cities.[1]

It was recognized that electric power would become popular for agricultural operations once the necessary facilities were in place. Some of the salient features of the First Five Year Plan can be stated as follows:

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1. Planning Commission, First Five Year Plan (Government of India, 1953).

1. The plan provided for an outlay of 270 million rupees for rural electrification as against 1.3 billion rupees for power projects.

2. In order to promote use of electricity in rural areas, the plan suggested government assistance in the form of loans to enable people to take advantage of the power supply for productive purposes. The proposed scheme was similar to that of the U.S. Rural Electrification Administration for providing long-term loans to village cooperatives for rural electrification.

3. As regards power generation, the plan envisioned making 1.3 million kWh available in addition to the 2.3 million kWh available at the beginning of the plan period.

4. Decentralizing the benefit accruing from electricity was an important element of the plan strategy. The planners were aware that 3 percent of the country's population in 6 large towns were virtually monopolizing the power supply, accounting for 56 percent of the total public utility installation. Shortage of power and lack of funds to augment power supply were considered to be the bottlenecks to electrifying remote rural areas.

5. It was expected that availability of electricity in rural areas would assist cottage industry, particularly in the handloom sector. Conversion of handlooms (numbering more than 200 times that of powerlooms) to powerlooms was considered to represent a significant step toward improving rural industrialization as well as rural economic conditions.

6. The plan anticipated that *per capita* electricity consumption would rise from 14 units in 1950/51 to 25 units by 1955/56. About 95 percent of the towns with a population of 20,000 or more and 40 percent of the towns with a population between 10,000 and 20,000 were to be assured of electricity supply.

Although the plan realized the importance of rural electrification for overall rural development, it was directed more toward industrial development than to agricultural development. Even toward the end of the First Five Year Plan (1954/55), when a scheme for the expansion of power facilities to provide employment opportunities was introduced, the emphasis remained on developing power in small and medium-sized towns and suburbs of large towns already electrified. However, the plan was more specific on the development of local skills/resources for industrial development in newly created community project areas. Exploiting irrigation potential by using power received a low priority in the plan.

One of the major reasons why rural electrification could not penetrate into rural areas on a large scale was the heavy investment required. Under such circumstances, it was natural that larger settlements near a power line had the first priority in the electrification program. As can be seen in table 3-2, the percentage of settlements electrified fell as the size of the settlements decreased. By the end of the First Five Year Plan (1955/56) all the towns above 50,000 population were electrified, but less than 1 percent of the villages with less than 5,000 population had the benefit of electricity. In all, 7,400 towns/villages were provided with electricity by the end of this five year plan.

Table 3-2. Number of Towns and Villages Electrified, 1951-1955/56

Population	Total number according to 1951 census	Number of electrified as of March 1956	
		Number	Percent
Over 100,000	73	73	100.00
50,000 - 100,000	111	111	100.00
20,000 - 50,000	401	366	91.20
10,000 - 20,000	856	350	40.00
5,000 - 10,000	3,101	1,200	38.70
Less than 5,000	556,565	5,300	0.90
TOTAL	561,107	7,400	

Source: Planning Commission, Second Five Year Plan (Government of India, YEAR).

One of the striking features of the progress made during the First Five Year Plan was that a relatively larger number of settlements in the population group 5,000 to 10,000 received electrical service. Compared with 1950, the percentage of villages electrified in this population range had increased from 11 percent in 1950 to nearly 39 percent in 1955/56.

The additional energy generated during the First Five Year Plan was more than 4 billion kWh (from 6.575 billion kWh in 1950/51 to 11 billion kWh in 1955/56). That target of raising the *per capita* consumption of twenty-five units was fully achieved. The plan witnessed the completion of eleven power projects, and the expenditure on power development (2.6 billion rupees) far exceeded the target. This did not include 320 million rupees spent by company-owned utilities and 100 million rupees spent by industrial establishments for their own generation. With regard to rural electrification, 8.9 percent of total outlay onpower was devoted to rural electrification.

Second Five Year Plan, 1956-1961

The Second Five Year Plan promised to electrify all towns with a population of 10,000 or more and 85 percent of those towns with 5,000-10,000 population. In addition, 8,600 villages with population less than 5,000 were to be provided with electricity. Although the plan realized the importance of extending services to rural areas, the magnitude of investment restricted such expansion. It was estimated that the investment per village to be electrified would have been a minimum of 60,000-70,000 rupees, meaning that if all the villages were electrified, the total investment would be on the order of 30 billion rupees. According to the plan, provision of electricity supply to villages and small towns with a population of less than 5,000 entailed heavy expenditure and hence had to be phased in over a longer period. The financial planning integrated urban and rural schemes so that the surplus from the revenues realized from urban and industrial consumers would act to reduce rates charged to rural consumers. The plan stated that it might not always be possible to apply the usual yardstick of financial return to rural electrification schemes. The plan expected that with the increased tempo of rural electrification, there would be a substantial increase in the number of electrified wells for pumping water for irrigation, and thus no separate strategy was devised to directly intervene in the process of agricultural development through rural electrification. It was only presumed that wherever electrification had been provided, it would facilitate irrigation.

The second plan emphasized industrial development and hence it could be expected that the target of consumption would focus on industrial consumers. Industrial consumption was targeted to constitute 72 percent of total consumption by the end of the second plan, which was much larger when compared to the situation at the beginning of the First Five Year Plan (less than 63 percent). In contrast, consumption for irrigation was about 4 percent. The plan budgeted 750 million rupees for rural electrification; the outlay for the power sector was 4.27 billion rupees. The goal for energy generation was 22 billion kWh as against 11 billion kWh at the end of the first plan. The installed capacity was to go up from 3.4 million kW to 6.9 million kW, and it was anticipated that the per capita consumption of electricity would double during the second plan.

The achievements of the Second Five Year Plan were commendable. The number of towns and villages electrified by the end of the plan exceeded the target (21,750 versus 18,000). Both installed capacity and power generation capacity were very close to the targets. Expenditures also overshot the target. The total number of pumpsets electrified by the end of the plan was about 200,000. However, the plan had focused on industrial development centered in towns and around their periphery, and a strategy of directly integrating electrification as a part of rural development was still lacking.

Third Five Year Plan, 1961-1966

Like the earlier plans, the Third Five Year Plan was concerned with village electrification rather than with sectoral development to be achieved through electrification. Nevertheless, the plan did recognize the importance of rural electrification in the development of the rural economy. According to the plan document, "...in relation to the development of the rural economy rural electrification has growing importance and indeed its value can not be assessed only in terms of the immmediate economic benefits." The plan appears to have a bias (like the earlier ones) toward developing small scale industries. "[A]n important objective of the Third Plan is to develop efficient small scale industries in small towns and rural areas so as to increase employment opportunities, raise income and living standards and bring about a more balanced and diversified rural economy." With regard to agriculture, the plan noted that "in several states electricity is being increasingly used for irrigation pumping, and the scope for this is likely to increase rapidly," but it did not assign much importance to electrification in agricultural development. On the contrary, it once again gave priority to power for industry: "power being the basis for the development of industries, both large and small, a high priority has been given to production of power in the Third Plan."

The plan aimed at providing electrical service to an additional 21,000 villages (making a total of 43,000 by 1965/66) with the objective of making power available to all towns and villages above 5,000 population. In addition, it targeted half of the villages with populations of 2,000 to 5,000 for electrification. The outlay for rural electrification was budgeted at 1.05 billion rupees (excluding the cost of generation), the total outlay on power being 10.89 billion rupees. The generating capacity was to increase to 13 million kW; power generation was to reach 45 billion kWh. However, the power consumption for irrigation was to remain at only 4 percent.

In terms of number of villages electrified, the plan exceeded the target. While the total projected number of villages to be electrified by the end of 1965/66 was 43,000, the actual achievement was 45,144. The number of pumpsets electrified went up from 200,000 at the beginning of the plan to 513,000. While the plan fell short of the goal for generating capacity by about 2 million kW, it surpassed its financial target by more than 1.5 billion rupees. This increase was reportedly due to large carryovers of some projects from the previous plans and inclusion of certain additional generation and transmission schemes. Also, larger amounts were spent on rural electrification for extending power supply for the agricultural sector. The third plan spent 12.5 billion rupees on the power sector, of which 1.5 billion went for rural electrification.

The Three Annual Plans, 1966-1969

The three years following the Third Five Year Plan were very significant for rural electrification policy. As mentioned earlier, the emphasis in the early years was placed more on village electrification and to some extent on village industrialization. Of course, it was implied that rural electrification would lead to extensive use of electricity domestically. A major shift in the policy came toward the end of the third plan when the country experienced the first of a series of serious droughts which severely affected agricultural production. The situation was so serious that it forced the government to postpone the Fourth Five Year Plan for several years and to substitute annual plans for three consecutive years until 1969. There was an urgent need to have small scale irrigation to stabilize agricultural production and the National Development Council, the highest decision making body in the country on development, decided to shift the emphasis of rural electrification to pumpset electrification to promote the Minor Irrigation Programme. This shift had several implications. First, a source of irrigation located in the farmer's own field and under his own control was established. Second, a positive impact on crop productivity was immediately felt. Thus for the first time a deliberate strategy was conceived to electrify pumpsets.

A second important development during this period was the appointment of the Rural Credit Review Committee by the Reserve Bank of India to review the entire scope of rural credit, with special reference to agriculture. The committee emphasized the potential of small scale irrigation from ground and surface water in agricultural development and made a strong case for mechanical lifting of water, primarily with the help of electricity. It proposed the creation of an autonomous credit agency for rural electrification at the national level, with a view to undertaking a massive program of rural electrification to supply power for small scale irrigation. The Rural Electrification Corporation, Ltd. (REC) was set up by the Government of India in July 1969 in pursuance of the recommendations made by the committee.

The formation of REC was very significant in the history of rural electrification in India. The main objectives of the REC were: (1) to finance rural electrification schemes throughout the country, (2) to subscribe to special rural electrification bonds that may be issued by the State Electricity Boards on conditions to be stipulated periodically, (3) to promote and finance rural electric cooperatives in the country, and (4) to administer the funds received from the Government of India and other sources as grants or otherwise for the purpose of financing rural electrification in the country in general.

REC organized its lending to the State Electricity Boards on the basis of rural electrification schemes. The criteria employed for selecting projects for REC financing varied with the degree of general area development as assessed by REC and with the type of schemes. The major breakthrough which occurred in the field of rural electrification was the REC area approach in selecting rural electrification schemes; such areas were classified on the basis of the level of development to be achieved. REC also dealt with electrification programs in functional areas like Special Project Agriculture (SPA) and Special Project Industries (SPI). REC has financed more than 20 categories of such schemes, most of which are area based.

During the three annual plans, the number of villages electrified went up from 45,144 to 73,732--an addition of 28,588 villages. The number of pumpsets electrified jumped from 513,000 to 1,089,000, an addition of 576,000. The total expenditure on power was 10.4 billion rupees of which 2.3 billion were for rural electrification. This is a clear indication of the favorable impact of the change in policy since the Third Five Year Plan. Then, the number of villages electrified constituted less than 13 percent of the total.

Fourth Five Year Plan, 1969-1974

The Fourth Five Year Plan aimed at establishing a better balance between generation, transmission, and distribution and integrated agricultural development with power development. In reviewing the achievement during the Third Five Year Plan, the plan document noted:

> Although lapses occurred in agriculture itself, part of the failure was due to inability of the industry to supply the targeted output of fertilizers. Partly also it was absence of an agricultural-oriented policy on the part of the authorities in charge of the distribution of power.

The National Commission on Agriculture, appointed during this period, was more emphatic about the role of electricity in rural development. The commission devoted a separate section on this subject:

> Electricity plays an important role in the agricultural production and the development of rural economy. Electricity is required for pumping for irrigation and domestic water supply, processing agricultural produce, cottage, small and medium scale industries and for providing amenities like lighting, heating and

radio/television for entertainment and as essential medium of instruction and education. Above all electricity modernizes the entire outlook of rural population and makes them progressive.

The commission strongly recommended that the rate of rural electrification be stepped up so as to make electricity available for pumpsets and rural industries in practically all the villages by 1990. It favored an integrated approach to rural electrification to assure its impact when it suggested: "Keeping in view the target of almost complete rural electrification by 1990, we recommend that the State Electricity boards should prepare a well considered and coordinated programme of rural electrification in consultation with other development departments at the state, district and block levels." The commission had many suggestions for the integrated development of agricultural, industrial, and domestic loads, including reduction of regional imbalance in the sphere of rural electrification and provision of electricity to certain backward communities at a concessional rate. Many of the recommendations of the commission found their way into the strategy subsequently adopted by the government.

The Fourth Five Year Plan emphasized that in power, REC programs would give precedence to electrifying tubewells and pumps for irrigation. It was expected that area plans for small scale irrigation would be prepared to reach the optimum level and these plans would be closely linked with rural electrification programs designed to provide electricity to clusters of wells or tubewells.

The plan outlay for rural electrification was fixed at 2.5 billon rupees as against an outlay for power of 20.3 billion rupees. It was planned that the number of villages with electricity would increase 110,000 by the end of 1968/69. An additional 700,000 pumpsets were to be electrified, making the total nearly 180,000. The generating capacity was to increase to 20 million kW.

The plan greatly exceeded the target fixed for village pumpset electrification. As against the target of 110,000 villages to be electrified, the plan ended with 157,000 electrified villages which constituted more than 27 percent of existing villages. Similarly, the number of pumpsets electrified was 2,426,000 as against the target of 1,800,000. The amount spend on rural electrification (including that of

REC) was 8.43 billion rupees and this constituted more than one-third of the plan expenditure on power.

Fifth Five Year Plan, 1974-1978

A major breakthrough that occurred in the Fifth Five Year Plan in the field of rural electrification was the integration of rural electrification with the newly introduced Minimum Needs Programme (MNP) which aimed at achieving economic growth with social justice. The MNP was essentially an investment in human resources development. The provision of free or subsidized services through public agencies was expected to improve the consumption level of those living below the poverty line and thereby improve the productive efficiency of both rural and urban workers. This integration of social consumption programs with economic development programs was considered necessary to accelerate growth, reduce regional imbalances, and ensure the achievement of plan objectives. Under MNP the target was to provide electricity for 40 percent of the rural population. This preceded the normal program which had other targets. For the first time the plan contained a specific target of electrifying about 1,300,000 pumpsets. About 81,000 additional villages were targeted to be electrified, taking the total number of electrified villages to 238,000.

The plan was originally to coincide with the period 1974-1979, but ended in four years, that is by 1977/78. This adjusted the targets of villages to be electrified to 58,000 and the number of pumpsets to be electrified to 917,000. Against these targets, the achievements were quite significant. In terms of number of villages to be electrified, the plan exceeded the target by 2,000, making the total number of villages electrified by the end of the modified Fifth Five Year Plan 217,000. Similarly, 858,000 additional pumpsets were electrified compared with the target of 917,000 (93.5 percent achievement). This brought the total number of pumpsets electrified by 1977/78 up to 3,300,000. The investment on rural electrification during this period was 6.853 billion rupees (including 990 million rupees from institutional financing) compared with Rs. 72.94 billion rupees in the power sector. Rural electrification as an instrument of rural development assumed considerable importance during this period.

The Fifth Five Year Plan was followed by two annual plan, 1978/79 and 1979/80.

The Committee on Power

The Ministry of Energy (Department of Power) appointed a Committee on Power in 1978 to examine all the functions of State Electricity Boards and Central Organizations engaged in electricity generation, transmission and distribution including organization structure, management practices, planning systems, efficiency of operation, financial performance, tariff structure, and legislative framework for the purpose of preparing recommendations for improving operations. As part of this process the committee reviewed the functions of the Rural Electrification Programme.

According to the committee, rural electrification covers a broader field than just power for agriculture. It includes, for instance, domestic and street lighting and power for rural-based industries, but by far the largest share of the power consumed in the rural areas goes to agricultural pumpsets.

For planning purposes the committee suggested that there be no net addition to diesel sets in the country after 1990 although replacement could be required for some time. It presumed that by 2000 all diesel sets would have been replaced either by electric pumps or by pumps using renewable fuels. It was indicated that it would be possible for the state electricity boards to achieve 100 percent electrification of all villages by 1994/95. The committee felt strongly that village electrification should be accompanied by improvement of the load in villages already connected and to be electrified so that the broader socioeconomic objectives of the REC are achieved. The committee was optimistic that 100 percent electrification of households was possible by 2000.

It was further suggested that the State Electricity Boards should prepare on a block-by-block basis the prospective program for rural electrification in consultation with the small scale irrigation development agencies and ensure that it was integrated with the overall distribution plan. In order to improve the viability of such block projects, the extent to which they can be built into the Integrated Rural Development (IRD) program should be explored; for example, the scope for developing non-agricultural demand through the establishment of village, cottage and small scale industries. The committee felt that planning should be carried out in consultation with the concerned District Industries Centre and other central and state agencies. The recommendations of this committee are under active consideration by the Government of India.

Sixth Five Year Plan

The Sixth Five Year Plan which began in April 1980 has carried over the concept of MNP and links it with the rural electrification program, but emphasizing village overpopulation. In the Fifth Five Year Plan the target was to cover 40 percent of the rural population; the Sixth Five Year Plan targets are consistent with covering 60 percent of the villages in each state and union territory by 1990. During the plan period it is anticipated that 100,000 additional villages will be electrified, of which about 46,000 would be under MNP. The Minimum Needs Programme of the Fifth Five Year Plan has been given a new name in the Sixth Five Year Plan and is now referred to as the Revised Minimum Needs Programme (RMNP). The states in which more intensive MNP effort is required are Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Bihar, Orissa, Rajasthan, West Bengal, Sikkim and North Eastern States. The outlay on rural electrification for the Sixth Plan has been placed at 15.76 billion rupees as against 192.65 billion rupees outlay for the power sector.

The Plan has heavily emphasized rural electrification as an important component to develop small scale irrigation for achieving an accelerated growth of agricultural production. According to the plan document,

> rural electrification coupled with assured supply of power is a vital input for accelerating minor irrigation programmes. There will be closer synchronisation between rural electrification programme and the development of lift irrigation to achieve quick progress. Imposition of power restriction in irrigated agriculture will be avoided, as far as possible.

It has been estimated that on the basis of the ground water potential available nationwide there is potential for installing 12,000,000 pumpsets. The country had nearly 4,000,000 pumpsets at the commencement of the sixth plan. The plan proposes to electrify 2,500,000 additional pumpsets during 1980-1985 so as to have 7,500,000 pumpsets electrified by 1984/85. Special attention is to be paid to pumpset electrification in the state of Uttar Pradesh, Bihar, West Bengal, Orissa and Madhya Pradesh which still have a large untapped ground water potential.

An Overview

The previous sections reveal that although rural electrification was viewed as an important instrument in the rural development process in the minds of planners from the beginning of the planning era in India, translating this idea into an appropriate strategy and working out concrete programs has been a rather gradual process. This process can be divided into five phases.

During the initial years of planning in India, rural electrification was confined to only a few states and the attention was more on electrifying larger towns. The sheer magnitude of investment forced planners to give rural electrification a very low priority in power development. In the second phase of development, although the program was extended to all states, the emphasis was on fixing a target for village electrification rather than making any deliberate planning to electrify pumpsets or supporting rural industries with electric power. Between agriculture and industry, the latter was preferred. It was only during the late 1960s that the need for agricultural development through electrification of pumps received attention. Thus planners were forced to accept electrification of pumpsets as a separate program while planning for electrifying villages.

Since that period, the rural electrification program has been quite specific about schemes for agricultural development. With the establishment of the Rural Electrification Corporation in 1969, the area approach to development was introduced; the strategy was to adopt a contiguous area showing a certain amount of homogeneity either in terms of level of development or potential for development in various sectors and link up the rural electrification program with this area. This was a boost to the rural electrification program in India and the response from the State Electricity Boards to this new approach was phenomenal.

Current events in the field of rural electrification can be considered as the fifth stage in which the area approach has been further extended to bring about a reduction in the regional imbalances relating to availability of power to the rural area in different states and provide a certain minimum facility to the people as a gesture of social justice from a welfare state. The four-pronged approach which the present strategy on rural electrification has evolved includes:

1. speeding up the process of rural electrification on a larger scale,

2. reducing the regional imbalance while extending the program to different states,

3. providing electricity to a minimum percentage of villages (MNP) under the concept of economic growth with social justice, and,

4. hastening the electrification program to exploit the untapped groundwater potential as soon as possible.

It is expected that availability of electricity for agriculture would also help development of agricultural-based industries in the rural areas. In fact the various studies undertaken so far in the country on rural electrification versus rural industrialization indicate that there is a very distinct impact of rural electrification on promotion of industries using electricity. It is therefore no wonder that the current plan does not have any specific target for rural industrialization in the areas covered under the rural electrification program.

Table 3-3 presents the progress of rural electrification in India from the pre-plan days to date. The sixth plan target is to electrify 40 percent of the villages (under RMNP) by 1985 with a goal of extending the same to 60 percent by 1990. This contrasts with less than 1 percent of villages electrified on the eve of the First Five Year Plan. In terms of expenditures, the sixth plan has a target for 15.76 billion rupees for rural electrification which is nearly 60 times more than the expenditure incurred during the first plan. The achievements with regard to pumpset electrification is quite spectacular--from a mere 21,000 in 1951 to 3,309,000 by 1977/78. This figure is likely to reach 7.5 million by 1984/85.

Table 3-3. Progress of Rural Electrification in India

Plan periods	Financial outlay (million Rs.) Total power sector	Rural electrification REC	Rural electrification Total	Percent of rural electrification to total outlay on power	Villages electrified (cumulative)	Percent of villages electrified	Total pumpsets electrified (cumulative)
Pre-plan (1950)	--	--	--	--	3,687	0.64	21,000
First plan (1951-1956)	3,020	--	270	8.9	7,400	1.30	56,056
Second plan (1956-1961)	5,250	--	750	14.3	21,750	3.77	198,904
Third plan (1961-1966)	12,523	--	1,530	12.2	45,144	7.83	512,756
Three annual plans (1966-1969)	10,407	--	2,370	22.7	73,732	12.80	1,088,804
Fourth plan (1969-1974)	24,476	1,710	8,430	34.4	156,729	27.20	2,426,133
Fifth plan (1974-1978)[a]	72,940	5,201	6,853	9.4	216,898	37.65	3,309,246
Sixth plan (1980-1985)	192,650	n.a.	15,760	8.2	316,898	55.01	7,500,000

Source: Planning Commission documents.

[a]Outlay given for fifth plan refers to the five year period 1974-1979.

Table 3-4. Statewide Progress in Rural Electrification

	States/Union territories	Total no. of villages (1971 census)	As of Dec. 31, 1951 No. of villages electrified	As of Dec. 31, 1951 Percent of villages electrified	As of Dec. 31, 1979 No. of villages electrified	As of Dec. 31, 1979 Percent of villages electrified
1.	Andhra Pradesh	27,221	119	0.4	15,899	58.4
2.	Assam	21,995	--	--	3,440	15.6
3.	Bihar	67,566	4	Neg.*	19,490	28.8
4.	Gujarat	18,275	37	0.2	10,283	56.3
5.	Haryana	6,731	--	--	6,731	100.0
6.	Himachal Pradesh	16,916	9	Neg.	8,697	51.4
7.	Jammu & Kashmir	6,503	--	--	4,428	68.1
8.	Karnataka	26,826	551	2.1	16,037	59.8
9.	Kerala	1,268	159	12.5	1,268	100.0
10.	Madhya Pradesh	70,883	9	Neg.	21,175	29.9
11.	Maharashtra	35,778	33	0.1	24,470	68.4
12.	Manipur	1,949	9	0.5	309	15.9
13.	Meghalaya	4,583	--	--	489	10.7
14.	Nagaland	960	--	--	303	31.6
15.	Orissa	46,992	--	--	15,660	33.3
16.	Punjab	12,188	42	0.3	12,126	99.5
17.	Rajasthan	33,305	2	Neg.	13,083	39.3
18.	Sikkim	215	--	--	53	24.7
19.	Tamil Nadu	15,735	1495	9.5	15,531	98.7
20.	Tripura	4,727	--	--	667	14.1
21.	Uttar Pradesh	112,561	110	0.1	36,688	32.6
22.	West Bengal	38,074	386	1.0	12,602	33.1
	Total (States)	571,251	2,965	0.5	239,429	41.9
	Total (Union territories)	4,685	96	2.1	1,365	29.1
	Total (All India)	575,936	3,061	0.5	240,794	41.8

Source: Central Electricity Authority.

*Neg. indicates negligible, less than .1 percent villages electrified.

While overall progress under rural electrification seems quite satisfactory, an analysis of the statewide progress indicates the uneven distribution of electricity in different states of India (see table 3-4). It is expected that the Minimum Needs Programme lessen this disparity to a significant extent.

Outlook for the Future

The Working Group on Energy Policy appointed by the Government of India has devised a scenario for the long-term utilization of ground water and has arrived at the figures shown in table 3-5. As can be seen, the Working Group has assumed that by 2000 India will utilize the ultimate groundwater potential through dugwells, private tubewells, and public tubewells. It has been assumed that the number of diesel pumpsets, despite the increase in the price of petroleum products, will continue to grow initially at the current rate of about 150,000 per year for the five years and will taper off to about 50,000 per year for the rest of the period. On the other hand, electric pumpsets are likely to continue to increase at a rate of about 400,000 additional pumpsets per year for a decade and taper off slowly thereafter.

While the National Commission on Agriculture had suggested 100 percent electrification of villages by 1990, the present strategy is to reach 60 percent of the villages by that year. Currently, of the 22 states in

Table 3-5. Future Trends in the Utilization of Ground Water Potential in India (in thousands)

Item	Ultimate potential	1977/78	1982/83	1987/88	1992-1996	2000/01
Dugwells	12,000	7,700	8,700	9,700	10,700	12,000
Private tubewells	4,000	1,740	2,300	2,800	3,300	4,000
Public tubewells	60	30	45	60	60	60
Total wells	16,060	9,470	11,045	12,560	14,060	16,060
Electric pumps		3,300	5,400	7,400	9,000	11,000
Diesel pumps		2,500	3,250	3,750	4,000	4,400
Animal-powered lifting devices		3,670	2,395	1,410	660	660

Source: Working Group on Energy Policy, 1979.

India, three states have already achieved 100 percent electrification (in terms of number of villages electrified). These are Punjab, Haryana and Kerala. Tamil Nadu is close to total electrification and a few states like Maharashtra, Karnataka, Jammu and Kashmir, Gujarat and Andhra Pradesh are well past the half way mark. According to the Committee on Power, all State Electricity Boards have accepted the goal of electrifying all villages by 1994/95 subject to availability of funds.

One of the criticisms of the rural electrification program has been that a village is considered to have been electrified once the distribution network is extended to it and the first connection in the village is made. The subsequent utilization of electricity and the number of connections made for village industries, households and street lighting or for any other purpose is not reflected in the statistics on village electrification. This indicates that only increasing the number of villages electrified is not an answer to rural development through electrification. What is more important is to intensify electrification in the areas with service already available to significantly improve electricity consumption. This is the reason why the Committee on Power has emphasized that load development in an electrified village must receive the same priority as electrifying new villages.

Chapter 4

PROFILES OF SAMPLE STATES AND VILLAGES

Socioeconomic Characteristics of Sample States

The study was conducted in 132 villages in 12 districts in the following states:

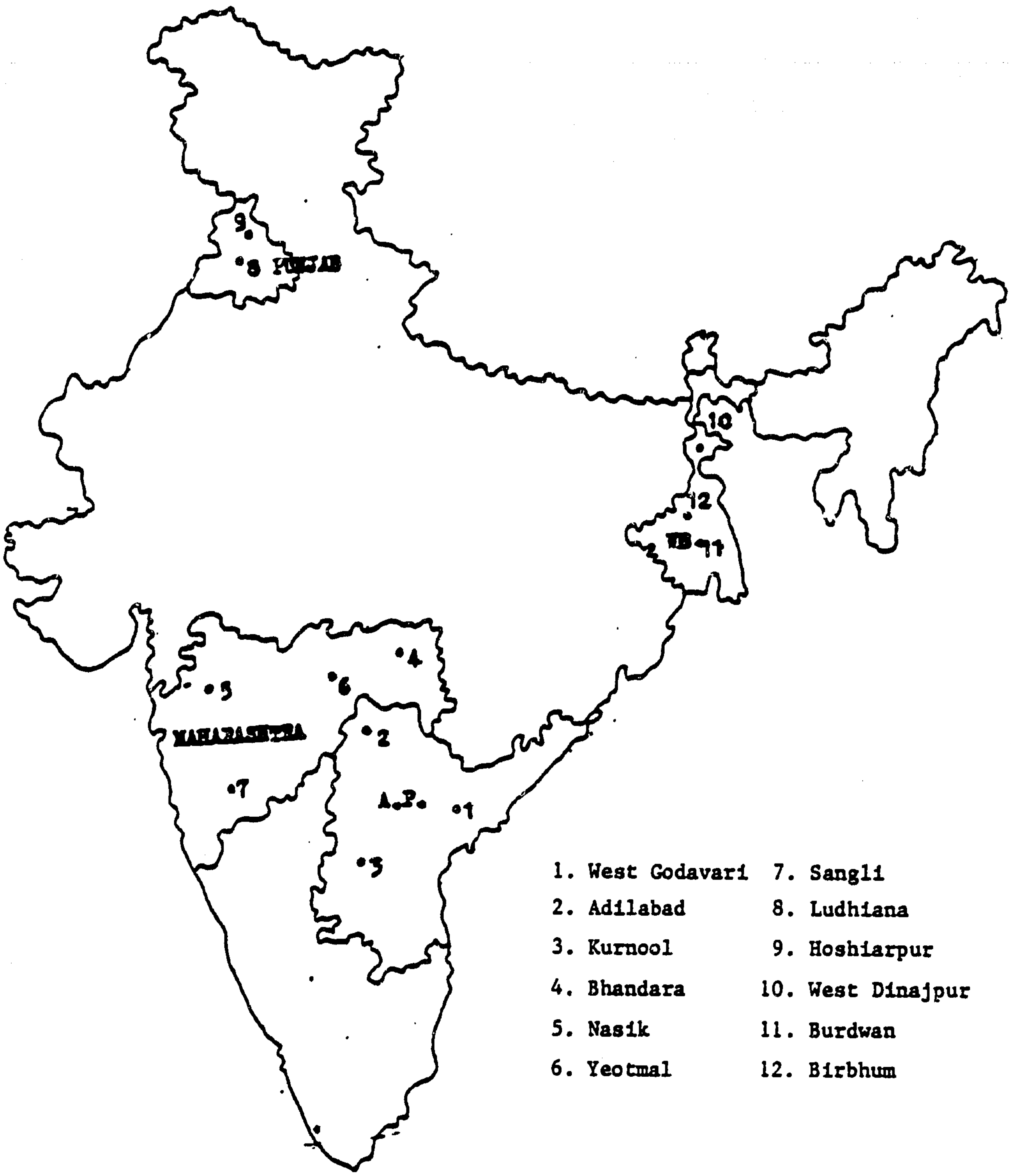
Andhra Pradesh	-	36 villages in 3 districts
Maharashtra	-	36 villages in 4 districts
Punjab	-	24 villages in 2 districts
West Bengal	-	36 villages in 3 districts.

The location of districts and states is shown in map 4-1.

The four states chosen for the study broadly represent the diversity that India possesses in terms of its sociocultural, geoclimatic and economic characteristics. Together, these four states account for 27.5 percent of India's population and 22 percent of India's geographical area (see table 4-1 for comparison of state indicators). The four states represent a wide variety of characteristics, distributed evenly above and below the national average. They also represent diverse levels of achievement in rural electrification.

Andhra Pradesh, a state in the south of India with an annual average rainfall of 90 centimeters (cm), is characterized by deltaic alluvial and medium and deep black soil types. The ratio of kharif to rabi[1] cropping area for food grains is approximately 2.53 to 1. It is thus predominantly a kharif state. The major food crops grown in Andhra Pradesh are rice,

1. "Kharif" is the monsoon crop, while "rabi" is the winter crop.



Map 4-1. Location of states and districts of India.

Table 4-1. Selected Socio-economic Indicators--Sample States and India[1]

State	Area ('000 sq.km)	Population 1980 (mn)	Percentage rural population 1971	Average rain-fall (cm)	Percent of agri-culture to ndp 1977-78	Ratio of kharif to rabi area[2]	Agricultural income per ha (rupees) 1976-77	Agricultural income per capita (rupees) 1977-78	Percent workers in agri-culture 1971	Gross irrigated area to gross cropped 1975-76
Andhra Pradesh	277	50.9	81	90	47.1	2.53:1	1465	490.31	73.4	34.9
Maharashtra	308	60.1	69	106	28.0	1.65:1	1205	419.72	66.4	11.0
Punjab	50	15.9	76	64	57.0	0.47:1	2468	1155.39	63.6	73.8
West Bengal	88	55.2	75	174	39.1	3.87:1	2757	501.65	61.4	24.7
All-India	3288	663.6	80	119	39.6	1.91:1	1674	464.51	72.0	25.1

[1] Drawn from diverse sources; see Appendix 1 to Volume 1.

[2] Foodgrain area only, averaged for the period 1967/68 to 1978/79.

maize, ragi, bajra, jowar (all types of millets), and "small" millets. The major cash crops are sugarcane, groundnut, cotton, tobacco, chillies, castor, and sesamum. Approximately 81 percent of the Andhra Pradesh population lives in rural areas, and agriculture[2] constitutes 47.1 percent of Andhra Pradesh net domestic product (NDP). The per capita agricultural income of the state, as of 1977/78, was Rs. 490 (in current prices).

Maharashtra, a state in the west of India, with an annual average rainfall of 106 cm, is characterized by medium and deep black soil types. The ratio of kharif to rabi food grains area, at 1.65 to 1, is lower than the national average. The major food crops grown in Maharashtra are rice, wheat, bajra, jowar and ragi (types of millets), while the major cash crops are sugarcane, groundnut, cotton, chillies, banana, and sesamum. Approximately 69 percent of the population lives in rural areas, and agriculture constitutes only 28 percent of the state NDP, as opposed to the national average of 39.6 percent. The per capita agricultural income, as of 1977/78, was Rs. 419 (at current prices).

Punjab, in the north, is agriculturally the most advanced state in India. It has an average annual rainfall of only 64 cm, and the soil type is largely alluvial. The ratio of kharif to rabi food grains area is 0.47 to 1, and thus it is predominantly a rabi state--which is natural, given the low rainfall. The major food crops of Punjab are wheat, rice, maize, gram and bajra, while the major cash crops are sugarcane, groundnut, cotton, mustard and potato. Approximately 76 percent of the population of Punjab is rural, and agriculture constitutes 57 percent of the state NDP. Per capita agricultural income, at Rs. 1,155 (1977/78) is the highest in India.

West Bengal, in the east, is a high rainfall state (174 cm), characterized, again, largely by alluvial soil. Reflecting the rainfall level, it is a kharif state, with a ratio of kharif to rabi area under food grains of 3.87 to 1. The major food crops are rice, wheat, gram and maize, while the major cash crops are potato, tea and jute. Seventy-five percent of the West Bengal population is rural, and agriculture constitutes 39 percent of the state NDP (close to the national average). Per capita agricultural income, as of 1977/78, was Rs. 502.

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2. Including animal husbandry.

Rural Electrification Characteristics of Sample States

The four states chosen for study also represent different levels of achievement of rural electrification. Punjab, as of 1978, had all its villages electrified. The figures for Andhra Pradesh, Maharashtra and West Bengal are 55.4 percent, 62.9 percent and 31.4 percent respectively (in comparison to the national average of 39 percent).

In terms of absolute number, Maharashtra has the largest number of pumpsets (as of 1975/76)--412,000 followed by Andhra Pradesh (296,000), Punjab (146,000) and West Bengal (only 10,000). Number of pumpsets per 1,000 acres net sown area were as follows--14.4 in Punjab, followed by Andhra Pradesh (10.69), and Maharashtra (9.14), with West Bengal having only 0.05 per 1,000 acres net sown area. Data on rural electrification characteristics of the four states are shown in table 4-2.

Table 4-2. Rural Electrification Characteristics: Sample States and All-India*

State	Percent villages electrified (1966)	Percent villages electrified (1978)	Number of pumpsets/ electrified tubewells (1975/76)	Number of pumpsets/ energized per (100,000) ha gca (1975/76)	Number of pumpsets/ per 1000 acres net sown area (1975/76)**
Andhra Pradesh	15.1	55.4	296,000	2276	10.69
Maharashtra	11.9	62.9	412,000	2091	9.14
Punjab	30.3	100.0	146,000	2354	14.40
West Bengal	4.2	31.4	10,000	125	0.05
All-India	7.8	39.0	2,787,000	1628	7.91

*Drawn from diverse sources; see volume 2, appendix 1.

**Arrived at on the assumption that 1 hectare = 2.47 acres, and Gross Cropped Area/Net Sown Area (1975/76) for

Andhra Pradesh	=	1.16
Maharashtra	=	1.08
Punjab	=	1.51
West Bengal	=	1.29

Thus, in Punjab, rural electrification is both extensive and intensive, while it is less so in Andhra Pradesh and Maharashtra. In West Bengal, rural electrification is relatively neither extensive nor intensive.

Socioeconomic Profile of Sample Villages

A socioeconomic profile of 132 villages in the sample is compared against similar indicators in the national profile in table 4-3. State-level sample village profiles are shown in table 4-4. We restrict the discussion largely to the national profile, since ultimately the results derived from the study are meant to be generalized at a national level.

Starting with rural electrification indicators, the sample has approximately 80 percent of its villages electrified, as opposed to the national average of 43 percent. This should, however, not concern us unduly, because

1. The numbered villages with no connecting in either the agricultural, residential or industrial sectors are much higher for the sample.
2. At the village and regional levels, concern is with the intensity of rural electrification and length of rural electrification as independent variables, rather than with more narrow comparisons between electrified and non-electrified villages. For analysis of the village-level impact of rural electrification, the more important requirement is that of a good distribution of villages by various intensity and year-since-electrification classes.

The sample villages, with a higher percentage of villages electrified, also have nearly twice the national average number of agricultural connections per 1,000 acres of net sown area. This rural electrification effect is possibly carried through to agricultural indicators, because cropping intensity, gross irrigated area, and percentage net sown area are higher among sample villages.

As for the demographic and employment indicators, the sample villages are generally close to national averages except in average population size.

Table 4-3. Socioeconomic Profile--Sample Villages vs. All-India (Rural)[1]

Indicator	Sample villages (pooled)	All-India
1. Agricultural		
a. Cropping intensity	136.96	120.32 (1975/76)
b. Gross irrigation area as percent of gross cropped area	26.46	25.10 (1975/76)
c. Net sown area as percent of total reporting rural area	71.04	49.03[2] (1975/76)
2. Demographic (1971)		
a. Male/female ratio	1.07	1.08
b. Distribution of villages by population size:		
<1000	34.8%	78.5%
1000 - 1999	43.9%	14.2%
2000 - 4999	18.9%	6.3%
>5000	2.4%	1.1%
c. Literacy (rural)	29.32%	23.26%
3. Employment (1971)		
a. Percent female workers to total	24.74	18.82
b. Percent agricultural employment to rural population	37.33	38.12
4. Electrification		
a. Percent electrified villages	79.55	43.00 (1980)
b. Agriculture connections/1000 acres new sown area	14.65	7.95[3] (1976)

[1]For sources of all-India data, see volume 2, appendix 1.

[2]Excludes urban geographical data.

[3]Arrived at on the assumption of 1 hectare = 2.47 acres, and GCA/NSA for India 1.20.

Table 4-4. Socio-economic Profiles of Sample Villages[1] and States[2]

Indicator	Andhra Pradesh		Maharashtra		Punjab		West Bengal	
	Sample	State	Sample	State	Sample	State	Sample	State
Cropping intensity	132.19	120.0	100.27	105.0	170.51	151.0	148.02	129.0
Percent GIA/GCA	14.50	34.9	6.82	11.0	78.06	73.6	23.65	19.4
Average yield index	132.01	-	72.29	-	139.02	-	94.12	-
Literacy	22.90	19.20	25.08	30.60	40.53	27.80	32.30	25.70
Percent employment	42.04	50.82	45.81	52.99	28.70	37.87	30.38	31.96
Percent female workers	30.18	28.80[3]	33.20	26.00[3]	1.74	1.80[3]	8.19	7.40[3]
Percent electrified villages	97.20	55.40[4]	88.90	62.90[4]	100.0	100.0[4]	38.90	39.40[4]
Male : female ratio	1.01	1.01	0.99	1.01	1.19	1.16	1.16	1.07

[1]Source: Present study.

[2]Source: Drawn from diverse sources; see Appendix 1 to Volume 1.

[3]Includes urban + rural.

[4]As of 1978.

GIA = Gross Irrigated Area

GCA = Gross Cropped Area

Villages in the sample are on the average larger than an average Indian village.

Putting the sample villages into a national perspective, they are somewhat more developed and larger than average villages in the country. However, it has to be kept in mind that (a) our findings are primarily intended to make generalizations regarding electrified villages in India, and (b) according to the national average, 57 percent of villages have yet to be electrified. If comparisons were possible between similar groups of electrified villages at the national level and at the level of sample villages, it is our contention that the sample would be quite representative. This disaggregation for comparison purposes was not possible due to data availability constraints.

The socioeconomic characteristics of villages aggregated by states are presented in table 4-4. In general, all four villages are quite representative. However, the village samples for Maharashtra and Andhra Pradesh contain a larger proportion of villages with electricity.

Rural Electrification Characteristics of Sample Villages

In the sample, 97 percent of villages in Andhra Pradesh, 89 percent in Maharashtra, 100 percent in Punjab and 39 percent in West Bengal are electrified (see table 4-5). On an average, electrified villages in all states have been electrified for more than 10 years. The sample has a very good distribution of villages by years since electrification, from those electrified for more than 25 years to those electrified in 1980 (see table 4-6). The presence of various types of connections in electrified villages varies by type of connection as well as by states. Residential connections are present in 92 percent of electrified villages, while agricultural, industrial, and commercial connections are present in approximately only 65 percent of the villages.

Residential connections predominate. An average electrified village in the sample has 53.4 residential connections, as opposed to 12.2 agricultural connections, or a ratio of approximately 4.4 to 1. Punjab villages have an average of about 105 residential connections, Andhra Pradesh 69, Maharashtra 38.7, and West Bengal 18.4. In terms of agricultural connections, Punjab has the highest with 29.3 per electrified

Table 4-5. Rural Electrification Characteristics of Sample Villages

Indicator	Andhra Pradesh	Maharashtra	Punjab	West Bengal	Pooled
Percent villages electrified	97.2	88.9	100.0	38.9	79.5
Percent electrified villages having AC	71.4	84.4	100.0	28.6	68.5
Percent electrified villages having RC	97.1	87.5	100.0	85.7	91.9
Percent electrified villages having IC	74.3	78.1	58.3	57.1	67.7
Percent electrified villages having CC	65.7	65.6	79.2	50.0	63.8
Average years since village electrification	14.3	12.0	14.3	10.5	12.6
AC/1000 acres NSA[a]	7.3	9.9	49.1	3.8	14.7
Percent HH electrified[a]	11.7	14.3	47.5	4.7	17.0
AC/electrified village	10.1	13.3	29.3	1.8	12.2
RC/electrified village	68.9	38.7	104.9	18.4	53.4
IC/1000 persons[a]	0.7	0.9	0.6	1.2	0.9
CC/1000 persons[a]	2.6	1.6	2.2	2.6	2.3

Source: Present study.

AC = Agricultural Connections
RC = Residential Connections
IC = Industrial Connections
CC = Commercial Connections
NSA = Net Sown Area
HH = Households

[a] For electrified villages only.

Table 4-6. Distribution of Sample Villages by Length of Rural Electrification

Length of rural electrification	Andhra Pradesh	Maharashtra	Punjab	West Bengal	Pooled
More than 20 years	10	1	3	3	17
16 - 20 years	8	12	6	-	26
11 - 15 years	5	5	10	1	21
6 - 10 years	6	8	4	5	23
0 - 5 years	6	6	1	5	18
Not electrified	1	4	-	22	27
Total	36	36	24	36	132

Source: Present study.

village, followed by Maharashtra (13.3), Andhra Pradesh (10.1) and West Bengal (1.8).

An average electrified village in the sample has 2.3 commercial and 0.9[3] industrial connections per 1,000 persons. For intra-village residential coverage, only 17 percent of households in the electrified sample villages have residential connections; the figures statewide are 47.5 percent in Punjab, 14.7 percent in Maharashtra, 11.7 percent in Andhra Pradesh, and 4.7 percent in West Bengal. Agricultural connections in electrified villages per 1,000 acres of net sown area are highest in Punjab (49.1), followed by Maharashtra (9.9), Andhra Pradesh (7.3) and West Bengal (3.8), the pooled average being 14.7.

Thus, the villages represent great diversity in rural electrification achievements in terms of intensity of service as well as years since electrification. They also reflect the broad macro-level rural electrification patterns for the individual states. To summarize, villages in Punjab are most intensively and extensively electrified, followed by Andhra Pradesh and Maharashtra, where the extensiveness of rural electrification is far higher than the intensiveness, and finally by West Bengal, where the relative rural electrification achievement is neither intensive nor extensive.

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3. The figure for industrial connections may be an underestimate; see chapter 6.

Chapter 5

RURAL ELECTRIFICATION AND AGRICULTURAL DEVELOPMENT

In India, electrification of pumpsets for irrigation is the primary example of the direct way in which rural electrification brings about agricultural change. But rural electrification may have more indirect than direct impacts on agriculture. Thus the availability of rural electrification may lead to changes in the sources and modes available for irrigation, which in turn affects the irrigated area of farms. Changes in irrigated area could lead to changes in cropping intensity and cropping pattern. These changes in turn might result in alterations in production factor proportions--that is, use of labor (human and animal) and adoption of other agricultural innovations. The combined effect of all these changes would be measured in higher productivity and incomes, in turn leading to improvements in rural quality of life. On the other hand, the adoption of rural electrification itself can be affected by certain complementary conditions such as groundwater availability, absence of canal irrigation, and other factors. This sequence of causes and effects is depicted in figure 5-1. This is the conceptual frame under which we propose to examine rural electrification and agricultural development.

We will first look at previous evidence on rural electrification and agricultural development in India. The evidence is organized in the same way as the presentation of our own findings--that is, we first discuss temporal response to rural electrification availability, then preconditions for successful rural electrification, and finally the impacts at the household, village and regional levels.

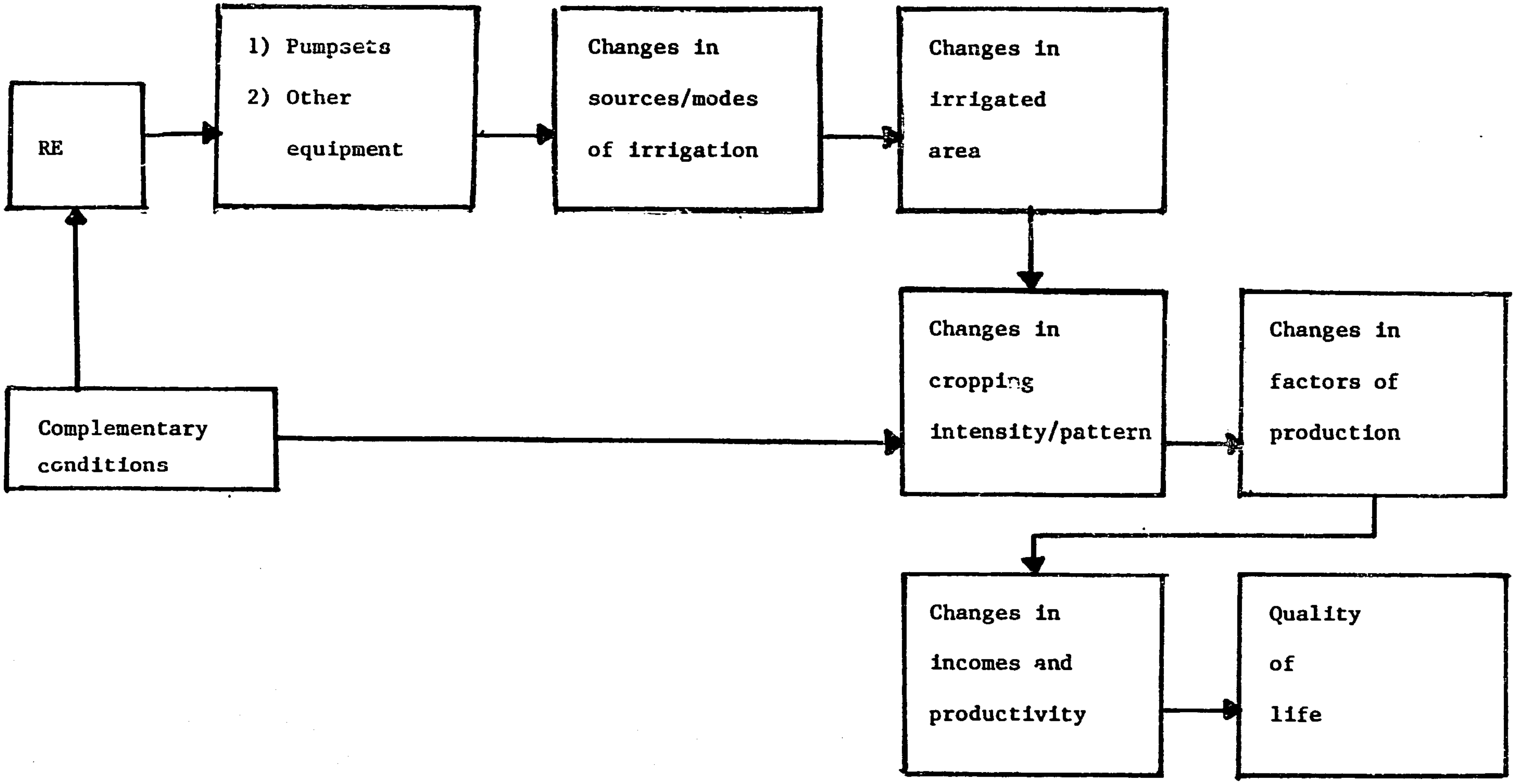

Figure 5-1. Rural electrification and agricultural development.

Source: Present study.

Previous Studies of Indian Rural Electrification

The growth rate of rural electrification connections has been rather inadequately researched in the Indian context.[1] The two studies that address the problem in some depth were prepared by the Planning Commission (1965) and the Administrative Staff College of India (1980). The studies do seem to concur that growth rates have generally been far below targets set by supply agencies, regardless of the measure of growth rates.

The Planning Commission, Government of India (PEO, 1965), examined growth rates of both connected load and consumption levels. It was found that the connected load for all sectors in the villages was highly correlated with the logarithm of the year of electrification--that is, additional load per year was proportional to the reciprocal of the year. Regarding consumption levels, in the agricultural sector rates reached significant levels only after (approximately five years). Thereafter, the rate steadily increased even beyond ten years. However, consumption per unit of connected load levelled off after about five years in the agricultural sector. Regarding the growth in number of connections, the study does not come to any definitive conclusion.

The Administrative Staff College of India (ASCI, 1980) investigated the problem by attempting to derive an explanatory equation for number of connections. "Time since electrification" and eleven other independent variables were utilized to explain the number of connections in a region. Although the overall explanatory power of the equation was low, "time since electrification" was a significant variable, implying that there was a linear association between time and growth in number of connections. Most other studies have made a reference to response only through cross-sectional comparisons of achievements between villages, districts and states.

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1. For greater details, see Operations Research Group, "Studies Relating to Rural Electrification in India--Summary of Past Evidence," (Working Paper, Washington, D.C., May 1981).

Several studies have examined the preconditions or reasons for adequate or inadequate rural electrification growth rates.[2] However, findings and analyses have been mostly qualitative and based on opinion surveys. According to available evidence, the important preconditions for adequate agricultural growth rate are:

- Adequate groundwater -- (ASCI, 1980; MSU, 1977; NIBM, 1976; PEO, 1965)
- Adequate credit -- (ORG, 1977, 1979; ASCI, 1980)
- Adequate land-holding size -- (ORG, 1979; ASCI, 1980)
- Supply regularity -- (ORG, 1977, 1979)
- Absence of canal irrigation -- (NIBM, 1976; ASCI, 1980)
- Water requirements of existing cropping patterns -- (PEO, 1965)

Since these findings are based on opinion survey, a broader treatment of village preconditions for favorable rural electrification growth rates has not been possible. Many other characteristics are possible, structural and otherwise, that might aid or inhibit rural electrification response. We propose to investigate some of these additional factors in the present study.

The impact of rural electrification generally has been found to result from electrification of pumpsets for irrigation. The use of other electrical farm equipment has been rather limited in India, and hence has not been discussed in many studies. The methodology of most studies generally is some kind of a before/after electrification comparison, relying on recall information. Other studies have used cross-sectional comparisons between electrified/nonelectrified farms.

The major findings are summarized below, in relation to the conceptual scheme in figure 5-1:

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2. These studies include: SIET, 1979; ASCI, 1980; PEO, 1965; ORG, 1977; MSU, 1977; NCAER, 1967; ORG, 1979; NIBM, 1976, NICD; 1976.

1. Sources of Irrigation

- Rural electrification is associated with a decline in the use of tanks and rivers, and an increase in the use of dugwells/ tubewells (ORG, 1979, 1980).

2. Modes of Irrigation

- The effects of rural electrification have been predominantly in the extent of well irrigation. Rural electrification leads to electrification of previously non-electrified wells (MSU, 1977; SIET, 1979).
- There is an overall slight increase in the total number of irrigation modes (ORG, 1979, 1980; SIET, 1979).

- There is a sharp decline in the use of traditional irrigation modes, a moderate decline in the use of diesel pumpsets, and a significant increase in the use of electrical pumpsets (ORG, 1979, 1980).

3. Irrigated Area

- Moderate-to-significant increases are found in irrigated area. Estimates of increases in net irrigated area range from 29 percent to 203 percent, while those for gross irrigated area vary from 25 percent to 84 percent (PEO, 1965; NCAER, 1967, 1970; ORG, 1979, 1980; SIET, 1979; MSU, 1977).

- One study reported no change in irrigated area (ASCI, 1980).

4. Cropping Intensity

Increases in cropping intensity would be a natural corollary to increases in irrigated area:

- There are increases in cropping intensity in electrified forms (ORG, 1979, 1980).

- Increase in cropping intensity is high in kharif (monsoon) areas, low in rabi (winter) areas and minimal in two-season crop areas (ORG, 1980).

5. Cropping Pattern

- There are significant changes in cropping patterns in electrified regions (PEO, 1965; NCAER, 1967; NICD, 1976; ORG, 1979, 1980; SIET, 1979).

- ORG (1980) presents a good summary of findings regarding cropping patterns. In electrified areas there is a marked shift towards cultivation of wet and highly remunerative crops; inferior cereals are replaced by superior cereals and high yield varieties of wheat and paddy are increasingly planted.

6. Production and Income

   - Rural electrification has a positive effect on both crop production and income from agriculture (NCAER, 1967; NICD, 1976; SIET, 1979).

   - Increases in income are higher in smaller villages than in larger ones (NCAER, 1967).

7. Employment

   - There is initially a release of human labor due to rural electrification (PEO, 1965).

   - There is an overall increase in employment intensity, arising from significant increases in irrigation resulting from rural electrification (ORG, 1979, 1980).

   - One study reports a change in overall demand for labor when other irrigation modes are changed to electric pumpsets (ASCI, 1980).

8. Bullock/Animal Labor

   - There is a release of animal labor. However, the animal labor is used for other purposes, since a negligible percentage of respondents sold their animals (PEO, 1965; NCAER, 1967).

9. Use of Innovations

   - Rural electrification is associated with the use of other agricultural innovations (NICD, 1966).

   - Rural electrification is associated with increases in the use of high yielding varieties of wheat and paddy (ORG, 1980).

In summary, the previous evidence in the Indian context indicates that (1) the impact on Indian agriculture has been primarily through electrification of pumpsets, and (2) the impact of rural electrification on agricultural development is positive, except possibly in the case of employment. Although there are significant increases in employment intensity, there may be a decline or no change in number of people employed.

Most of the above evidence is predominantly at the farm level. In most cases, village and regional level evidence on impact of rural electrification on agricultural development was lacking. We now proceed to present the findings and results of the present study on temporal response, preconditions for successful rural electrification and impact of rural electrification at the village/farm/regional levels.

Temporal Response to Rural Electrification in the Agricultural Sector: Evidence from this Study

Understanding the temporal response or electrification connection growth rate is important from three viewpoints:

1. in providing an empirical basis for forecasting exercises (that is, for deriving projections for determining expected cash flows) and in providing an understanding of take-off periods, rates of growth over the years, etc. This is particularly important since targets set by rural electrification supply agencies have often been overly optimistic;

2. in providing a clue on whether to pursue an intensive or extensive strategy of rural electrification, from the point of view of provision of connected loads; and

3. in assisting in the process of producing "successfully" electrified villages.

Longitudinal data were available from SEBs on yearly connections in 90 of the 108 electrified villages of our sample. Using this longitudinal data, we have attempted to derive a pattern of temporal response to rural electrification in the agricultural sector.[3] Data for only Andhra Pradesh, Maharashtra and Punjab were used in deriving patterns, since the West Bengal data were of uneven quality and hence not used.

The agricultural temporal response indicator is average additional agricultural connections per village per year since electrification. The length of time over which analysis has been conducted covers the two decades since electrification. The basic data is presented in table 5-1. Average agricultural connections per village per year for the pooled[4] sample was found to be 1.21. They were highest in Punjab (1.53), next highest in Maharashtra (1.29) and lowest in Andhra Pradesh (0.74).

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3. See also, volume 2, appendix 3-2.

4. "Pooled" refers to Andhra Pradesh, Punjab, and Maharashtra.

Table 5-1. Agricultural Response--Key Statistics

	Andhra Pradesh	Maharashtra	Punjab	Pooled
Average connections/ village/year in the first 20 years since electrification	0.744	1.293	1.528	1.205
Standard deviation of 1	0.406	0.475	0.642	0.322
Coefficient of variation	0.546	0.367	0.420	0.276
Average connections/ village/year				
First five years	0.908	0.995	1.313	1.158
Second five years	0.484	1.157	1.309	1.002
Third five years	0.741	1.615	1.902	1.408
Fourth five years	0.867	1.432	1.603	1.265
First decade	0.696	1.076	1.311	1.080
Second decade	0.804	1.523	1.753	1.344

Source: Present study.

Year-to-year relative variations are quite high when the states are taken individually, however, it is much lower for the pooled sample. A graphical presentation of annual average and cumulative connections over the first twenty years since electrification (YSE) for an average sample electrified village is shown in table 5-2.

Looking at five yearly averages, the average annual connection rate is 1.16 connections in the first five years, decreasing to 1.00 connection in the second five years, increasing to 1.41 in the third five years, and again decreasing to 1.27 in the last five years. The average for the second decade is higher than that of the first across all states.

Before temporal response patterns could be derived, the presence of two possible factors affecting the growth rate patterns had to be examined. These factors include a "year of electrification" and "village population size" effects. The "year" effect relates to particularly good or bad periods in rural electrification years which could influence the year-since-electrification sample data. If all village rates grew faster in 1975-1980 than in 1965-1970, then this might bias the results for

Table 5-2. t-Test for Year Effect
(agricultural sector--pooled)

	Period	Year effect
Average connections	1960/1969	1.18
Average connections	1970/1979	1.10
Standard deviation	1960/1969	0.66
Standard deviation	1970/1979	0.38
Computed "t"		0.31

Source: Present study.

villages electrified during each one of those periods. The "size" effect relates to the possible problem of larger villages getting electrified first.

A test for presence of a "year effect" indicates that response rates for agricultural connections were not significantly different for the two decades. A "t" test for comparison of mean connections of 1960-1969 versus that of 1970-1979 was not significant.[5] The population (or size) effect also did not seem to be a problem, since the correlation between average village population and YSE was found to be 0.177, which was not significant. The data is shown in table 5-3.

Table 5-3. Relationship Between Population
and YSE (Year Since Electrification)

Population class	< 1000	1000-2499	2500-4000	> 4000
Average YSE	13.52	11.89	11.50	17.00

Source: Present study.

"Patterns" of response over the two decades since electrification were derived from the data. Simple linear annual response patterns were not

5. The computed "t" statistic was 0.31, against a tabulated value, at 90 percent (19 df), of 1.328 (see table 5-2).

found to be significant,[6] but a decadal average increase was discernible across all three states. We therefore hypothesized that there is a stepwise-change in average annual additional response in the second decade, in comparison with the first. The stepwise change hypothesis is that average annual additional connections during year 0 to 9 will equal average annual additional connections during years 10 to 19. For the pooled sample, the hypothesis of equality was rejected at the 90 percent level. Though the hypothesis was accepted in the case of Andhra Pradesh, it was rejected in the case of Punjab (at 85 percent) and Maharashtra (at 95 percent). The results are summarized in table 5-4. It is therefore concluded, with some qualification, that in the agricultural sector there is indeed a stepwise change in response levels during the second decade since electrification. The second decade sees an increase in annual response in comparison with the first.

Table 5-4. Results of "Step-change" Test

State	Computed "t"	Comments
Andhra Pradesh	0.53	Not significant
Maharashtra	2.16	Significant, 95 percent
Punjab	1.48	Significant, 85 percent
Pooled	1.74	Significant, 90 percent

Source: Present study.

Unlike the case of residential connections, where the results of use of rural electrification are likely to be quick and perceptible, in the agricultural sector the effect is mediated by an indirect process and occurs over a longer term. The utility of a form input in relation to anticipated benefits in the agricultural sector is probably derived over a longer time frame. Therefore, a farmer may first wait to see the impact of the capital investment made by other farmers before adopting it himself (that is, a possible demonstration effect). The second reason could be that the installation of an electric pumpset may mean switching from an

6. A linear curve-fit of annual average connections was attempted against YSE. Results were not significant.

already used mode of irrigation (and in some cases, even creating new sources of irrigation). Hence, if an electric pumpset is to be used, this could mean dismantling, selling, or simply not utilizing the old irrigation mode. The farmer may be unwilling to abandon his current irrigation practices unless his existing modes deteriorate in the physical sense or become highly uneconomical.

Using the findings above, one could make a broad and fairly non-rigorous statement regarding expected number of connections in an average electrified sample village, as appears in table 5-5.

Table 5-5. Expected Number of Agricultural Connections Per Village

End of year	Expected agricultural connections
1	1.08
5	5.40
10	12.14
15	18.84
20	25.54

Source: Present study.

Preconditions for Rural Electrification Success in the Agricultural Sector

In the provision of rural electrification as an input to socioeconomic development, it is important to know the factors which aid or inhibit connection growth rates. This is important from the supply as well as benefit point of view. Rural electrification connection growth rates determine financial returns to supply agencies (if defined in terms of connections or consumption levels) as well as having greater impact on community benefits. Of course, this assumes rural electrification is a positive input into socioeconomic development.

In the present analysis, rural electrification success is defined at the village level in terms of number of connections. In the agricultural sector, it is defined on the basis of agricultural connections, deflated for the 'time' dimension, since the number of connections at the village level is related to the length of time for which rural electrification has been available. In considering time, the connection growth rates derived in the previous section have been used to determine if an individual village is above or below the predicted growth rate.

Similarly, the number of connections would also be dependent upon the number of farms that a village possesses. The larger the number of farms, the larger the likely number of agricultural connections. Therefore the indicator of success has to be appropriately deflated on a "per-farm" basis. As a surrogate indicator for number of farms in a village, the net sown area of the village (in acres) has been used. Thus, the measure of agricultural rural electrification success (ASINSA) is very simply an index of number of agricultural connections per acre net sown area deflated for the length of time for which the village has had access to rural electrification.[7]

The interpretation of this index, from the rural electrification supply agency point of view, is that it represents the rate at which connections are generated at the village level, on a *per capita* and per farm basis. The indices of success for an average village in the four states in our sample are shown in table 5-6 and percentage distribution of

Table 5-6. Indices of Average Agricultural Rural Electrification Success

State	Success index
Andhra Pradesh	3.42
Maharashtra	5.89
Punjab	19.39
West Bengal	2.84

Source: Present study.

7. The appropriate empirically derived temporal response pattern has been used to determine the degree to which a village is above or below the average growth rate. The details of how the index has been constructed are shown in volume 2, appendix 3-2.

villages by various levels of success is shown in table 5-7. Punjab is most successful, followed by Andhra Pradesh and Maharashtra, with very low growth rates in West Bengal.

The analysis is predominantly longitudinal, except in the case of two variables, for which unfortunately data were not available from the 1966 survey or from the 1971 census.

Table 5-7. Percentage Distribution of Villages Above and Below Average Success Levels (agricultural sector)

State	Percent villages with			
	Low RE success	Below avg. RE success	Above avg. RE success	High RE success
Andhra Pradesh	66.67	19.44	13.89	0.00
Maharashtra	47.22	33.33	13.88	5.56
Punjab	4.17	8.33	25.00	62.50
West Bengal	88.89	2.78	0.00	8.33

Source: Present study.

The following are the variables considered as explanators of agricultural rural electrification growth rates (all variables except POP71 (1971 population measure) and INSTNS (institution measure) were converted into indices):

CREDIT - Percent farmers who asked for loans getting loans (as an indicator of credit availability), 1966

MLRAT - Man-land ratio (as an indicator of population pressure on cultivable land), 1966

CRINT - Cropping intensity, 1966

RICEAC - Percent acreage under rice (as an indicator of kharif (monsoon) intensity of village activity), 1966

AGRSF - A summary scale of agricultural "success/failure" of the village (as an indicator of village yield), 1966

INSTNS - Number of institutions per 1,000 capita (as an indicator of institutional development of the village), 1966

AGADP - Agricultural innovation adoption index (as an indicator of use of innovations), 1966

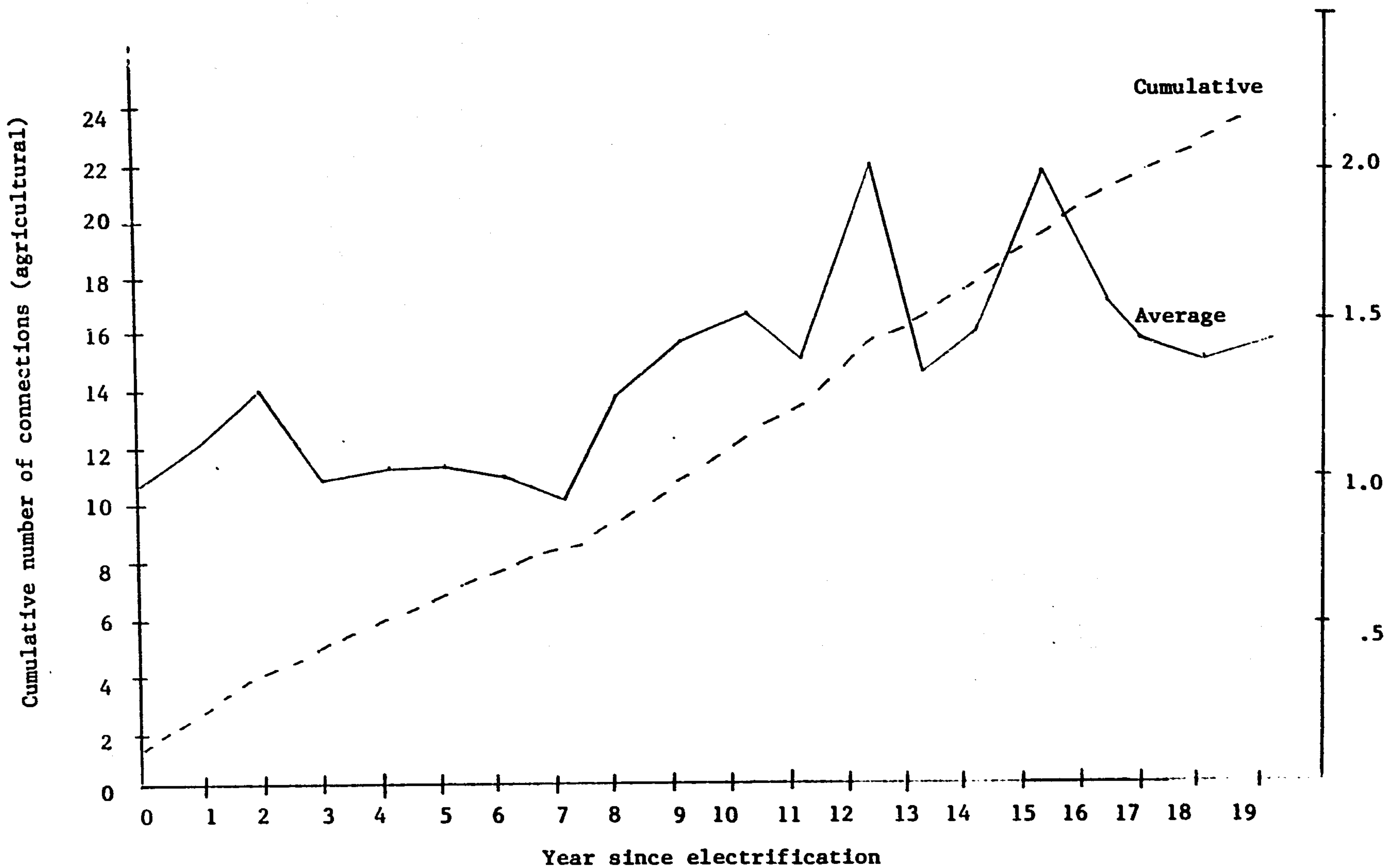

Figure 5-2. Average and cumulative annual response in the first two decades since electrification (agricultural sector--pooled).

Source: Present study.

EXCON - External contact of village leaders, 1966

POP71 - Population of village as an indicator of village size, 1971

LIT71 - Percent population literate, 1971

REGSU - Regularity of electricity supply in the agricultural sector (Yes/No variable), 1981

POVER - Percent households in the village in poverty, 1981

Given the number of independent variables, the analysis was conducted in two stages: first, bivariate associations between each of the independent variables and ASINSA (agricultural connections per acre, time deflated) were examined. If there was significant or near significant association, the variable was considered for multivariate analysis. The multivariate analysis consisted of a multiple regression of ASINSA against those independent variables which were identified as being significant or near significant. The correlations of ASINSA against the independent variables are shown in table 5-8.

Table 5-8. Correlations Between ASINSA (Agricultural Connections per Acre Time-Deflated) and Preconditions to Successful Rural Electrification[a]

Preconditions[b]	R
CREDIT (percent farmers getting loans)	0.166
MLRAT (man-land ratio)	0.266
CRINT (cropping intensity)	0.065
RICEAC (acreage under rice)	-0.201
AGRSF (agricultural success/failure)	-0.032
INSTNS (institutional measure)	0.132
AGADP (agricultural innovation)	-0.020
EXCON (external contact)	0.012
POP71 (1971 population)	-0.031
LIT71 (percent literacy)	-0.089
POVER (percent poverty)	-0.025

Note: Number of cases: 47.

Source: Present study.

[a]For REGSU, see table 5-9.

[b]See preceding text for volume 2 for precise definitions.

In the case of REGSU, since it was a nominal level measure (that is, a Yes/No variable), we conducted a X^2 test. The results are presented in table 5-9.

Table 5-9. Breakdown of Agricultural Connection Growth Rate by Regularity of Supply

REGSU (regularity of supply)	ASINSA (Agricultural Rural Electrification Success)				
	0-5	6-22	23-40	>40	No. of villages
Regular supply	22	12	9	5	48
Irregular supply	17	6	4	6	33
Number of villages	39	18	13	11	81

Note: The computed X^2 (1.95) was not significant. The table value at 95 percent for 3 df was 7.81.

Source: Present study.

The variables that came out as having significant or near significant associations with ASINSA (agricultural rural electrification growth rates) are presented in table 5-10. It is important to note that use of innovations, literacy, external contact, size of village, poverty in the village and regularity of supply are not determinants of agricultural rural electrification success.

Table 5-10. Correlation between agricultural connection growth and selected variable

Variable[a]	2	Comment
CREDIT (percent farmers getting loans)	0.166	Significant at 80 percent
MLRAT (man-land ratio)	0.266	Significant at 90 percent
RICEAC (acreage under rice)	-0.201	Significant at 85 percent
INSTNS (institutions measure)	0.132	-

Source: Present study.

[a]See preceding text for more precise definitions.

Using ASINSA (agricultural rural electrification success) as the dependent variable, a multiple regression against CREDIT, MLRAT (man-land ratio), RICEAC (acreage under rice), and INSTNS produced the following result:

$$ASINSA = 19.98 + (0.356)\ MLRAT - (0.076)\ CREDIT - (0.179)\ RICEAC + (0.008)\ INSTNS$$

$$n = 47$$
$$R = 0.418$$
$$F_{5,42} = 2.2$$

The summary statistics are presented in table 5-11.

Table 5-11. Explanators of ASINSA (agricultural rural electrification success)

Variable	b	Beta	sb	t
CREDIT	-0.076	-0.132	0.084	-0.904
MLRAT	0.356	0.371	0.156	2.282[a]
RICEAC	-0.179	-0.293	0.089	-2.011[a]
INSTNS	0.008	0.093	0.013	0.657

<u>Note</u>: MLRAT and RICEAC are significant explanators of agricultural rural electrification success. MLRAT is a positive determinant while RICEAC is a negative determinant.

<u>Source</u>: Present study.

The correlation matrix (table 5-12) of independent variables in the regression shows interesting results--CREDIT and MLRAT, as well as RICEAC and MLRAT are positively associated. However, ASINSA, while being significantly positively associated with MLRAT, is negatively associated with RICEAC.

There would appear to be an apparent contradiction in the results. It is natural to expect that the man-land ratio of a village might be positively associated with acreage under rice, since rice is a labor-intensive crop. However, agricultural rural electrification growth rates are positively associated with the man-land ratio and negatively associated with acreage under rice. The absence of relationships between ASINSA and

Table 5-12. Correlation Matrix of Independent Variables in ASINSA (agricultural rural electrification success) Regression

	CREDIT	MLRAT	RICEAC	INSTNS
CREDIT	-	0.286[a]	0.011	0.065
MLRAT	-	-	0.268[a]	0.1[illegible]8
RICEAC	-	-	-	-0.068
INSTNS	-	-	-	-

Source: Present study.

[a]Significant at 90 percent.

certain independent variables present equally important information. It is important to note that ASINSA is not significantly influenced by literacy levels, credit, institutional development, regularity of supply, poverty in the village, agricultural innovation use, village size, agricultural success/failure of the village, or external contact.

The interpretation of negative association between percentage acreage under rice and ASINSA is fairly straightforward. Increasing rice acreage is normally reflective of increasing "kharif" (monsoon) crop in Andhra Pradesh, Maharashtra and West Bengal.[8] Since kharif (monsoon) areas are rain-dependent areas it is natural to expect that adoption of pumpsets would be at lower levels. This finding therefore leads to the conclusion that the chances of agricultural rural electrification response are low in kharif areas.

The explanatory power of man/land ratio is less obvious, but nevertheless interpretable. Increasing man/land ratio is normally associated with large number of farms per village for the same geographical area. The measure of ASINSA is defined using the number of connections, and it is therefore natural to expect that increasing numbers of farms should positively affect agricultural rural electrification adoption. That farms may be smaller in size may not be of much consequence, since past evidence shows that adoption levels among different categories of farmers in electrified villages is large, regardless of size of holding. For

8. In the longitudinal analysis, these are the only three states considered, because of availability of 1966 data.

example, the percentage of farmers in three categories owning pumpsets in electrified villages are presented in table 5-13.

Considering that small and medium holdings form a large portion of all farms,[9] the actual number of connections in electrified villages in these categories must be very high (regardless of the percentage of owners being lower). Coupled with the fact that high man/land ratio is normally associated with a larger number of farms per village, the relationship between ASINSA (agricultural rural electrification success) and MLRAT (man/land ratio) becomes obvious.

Table 5-13. Percentage Agricultural Consumers by Type of Farmer

Type of farmer	No. of farmers	No. having agricultural connections	Percent farmers having connections
Small/marginal farmer	133	54	40.6
Medium farmer	109	52	47.7
Large farmer	138	97	70.2
Total	380	203	53.4

Source: Operations Research Group, India, (1979), pp. 138, 139.

We wish to point out that in past studies several other variables have been found to be strongly associated with successful rural electrification. These variables include groundwater availability and the absence of canal irrigation. We did not have data on groundwater availability, but on the canal irrigation we had limited data for Andhra Pradesh. Four of the thirty-six villages in Andhra Pradesh had extensive canal irrigation, and all four had no agricultural connections, despite being electrified.

The results therefore, can be summarized as follows. (1) Agricultural rural electrification is likely to be successful in villages with high man/land ratio and low percentage kharif (monsoon-oriented) cropping area. (2) From past evidence, it would appear that groundwater availability is also positively associated with rural electrification for agriculture. (3)

9. These two categories accounted for approximately 85 percent of all holdings according to the All-India Agricultural Census, 1970-71.

There is limited evidence in our sample, and strong evidence from past studies, that canal irrigation is negatively associated with agricultural rural electrification success. (4) Agricultural rural electrification growth apparently is not associated with levels of use of innovations, literacy, village size, external contact, credit, institutional development, poverty in village, and regularity of supply.

The most important conclusion from our analysis is that higher rural electrification growth rates are associated with population or geographic village characteristics. All four variables--man-land ratio (determined by village population and bounds of geographical area), kharif area (determined by rainfall levels), groundwater availability, and canal irrigation--represent a specific village geographic and historical profile. The evidence suggests that socioeconomic characteristics such as levels of economic and social development may not play much of a role in the growth of agricultural connections as had been anticipated.

Apart from the significance of this finding from the point of view of what is positively associated with rural electrification growth, the findings are suggestive with regard to crucial issues on causality between rural electrification and socioeconomic development, especially in the context of our 1981 cross-sectional analysis. In the case of the agricultural sector, rural electrification seems to be a cause[10] of socioeconomic development, rather than an effect, lending credence to our cross-sectional analysis of 1981 data for analysis of "impact."

We would, however, like to suggest a possible limitation in the longitudinal analysis. The comparisons, for the most part, are being made between two data streams separated by a fifteen year time gap. Various interventions--policy determined and others--may have taken place with unequal intensities over this period. However, our finding may be considered as a significant step forward in answering certain crucial causality issues.

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10. Whether a positive or negative determinant we probe later in the "impact" question.

Impact of Rural Electrification on Agriculture - Village Level: Present Study

Impact of rural electrification at the village level is primarily dependent upon the extent to which rural electrification has penetrated into farming operations, which in turn is determined by the length of time rural electrification has been available in the village. Another factor would be the extent of agricultural connections.[11]

This suggests that there are at least two rural electrification variables of interest in the analysis of the village-level impact of rural electrification: length of electrification and intensity of electrification. Length of electrification is simply the number of years the village has had access to rural electrification (referred to as YSE in this text) while intensity of electrification is measured by the number of agricultural connections per thousand acres net sown area in the village (referred to as ACNSA in the text below).

There is a third measure too that is of interest: a combination of length and intensity of rural electrification--that is, the rate of response to rural electrification (referred to as ACYSE in text). It is defined as the number of agricultural connections per thousand acres net sown area (ACNSA) divided by length of rural electrification (YSE). This measure is conceptually close to the measure of "rate of rural electrification growth" (or ASINSA) discussed in the preceding section.

In the first section of this text and in figure 5-2, the process by which rural electrification affects agricultural development has been already discussed. In keeping with the sequence of linkages in this conceptual frame, we now look at the impact of rural electrification on the following indicators:

1. gross irrigated area to gross cropped area (GIGCA), 1981;

11. It is possible that there is an indirect effect from connections in other sectors too; for example, industrial connections leading to industrialization at the village level, in turn giving a stimulus to agriculture (and hence agricultural connections). But we are not concerned with this effect, since it appears to be of a very long-term nature, if at all.

2. cropping intensity (CRINT), 1981;

3. cropping pattern (various: see subsection (c) below), 1981;

4. agricultural employment (AGEMP), 1971;

5. number of workers per 10,000 rupees agricultural production (WPROD), 1971/81;

6. female employment (FLFPR), 1971;

7. use of innovations (INNOV), 1981;

8. productivity of land/village yield (YIELD), 1981;

9. value of production (in Rs) per agricultural worker, as a measure of productivity of labor (YLABR), 1981; and

10. value of agricultural production per capita (in Rs.) as a measure of agricultural income (VPROD), 1981.

The three types of analyses which are conducted are all predominantly cross-sectional, and they include tabular, bivariate and multivariate analyses. In the tabular analysis we look at indicators against various class intervals of YSE (years since electrification), ACNSA (agricultural connections), and ACYSE (rate of connections) as independent or control variables. In the bivariate and multivariate analysis, ACNSA and ACYSE are used as independent variables along with other complementary conditions in the multivariate analysis.

Since the major control variables in the multivariate analysis are ACNSA and ACYSE, villages with zero agricultural connections are treated conceptually for the agricultural sector as being equivalent to non-electrified villages (referred to as the "0+NE" category in the text below). In the multivariate analysis, we have only considered those villages in the electrified, non-zero category, since our interest is with the impact of rural electrification intensity (ACNSA and ACYSE) rather than the presence or absence of rural electrification.

Of the 132 villages in the sample, 27 are non-electrified while 23 are electrified with zero agricultural connections.[12] The distribution of zero-connection villages is 10 in Andhra Pradesh, 7 in Maharashtra, 0 in Punjab and 6 in West Bengal.

The description of each variable, and the rationale for considering it is discussed in the following subsection.[13]

Rural Electrification and Irrigated Area

The most critical impact of rural electrification on agriculture is expected to be that of raising the irrigated area of the village through the use of pumpsets. It is primarily through the increase in irrigated area that (as we saw in the first section of this text) all the other impacts of rural electrification on agriculture are expected to follow. Gross irrigated area as a percentage of gross cropped area (GIGCA) has been chosen as an indicator of the extent of irrigation in the village. Tabular presentations of analysis of GIGCA against YSE, ACNSA and ACYSE are shown in tables 5-14, 5-15, and 5-16, respectively.

Table 5-14. Gross Cropped Area (GIGCA) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	15.60 (27)	14.32 (36)	37.87 (65)
Andhra Pradesh	1.70 (1)	4.77 (12)	20.14 (23)
Maharashtra	3.40 (4)	4.78 (13)	8.93 (19)
Punjab	--	49.10 (5)	85.68 (19)
West Bengal	18.45 (22)	25.13 (6)	50.22 (4)

Source: Present study.

12. There is a minor difference between 0+NE categories of ACNSA and ACYSE tables, because in ACNSA, the first electrified village class excludes those with less than 1 ACNSA, while these are included in ACYSE.

13. The variables are also listed volume 2, appendix 1-3 and defined in appendix 3-3.

Table 5-15. Gross Cropped Area (GIGCA) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	13.77 (54)	7.79 (36)	37.23 (10)	70.00 (6)	74.77 (21)
Andhra Pradesh	6.13 (16)	10.90 (15)	24.55 (2)	55.80 (2)	100.00 (1)
Maharashtra	1.84 (10)	5.93 (17)	11.56 (5)	8.40 (1)	24.60 (2)
Punjab	--	0.53 (3)	88.47 (3)	100.00 (3)	87.06 (15)
West Bengal	22.41 (28)	14.74 (1)	--	--	38.36 (3)

Source: Present study.

There is clearly a positive association of GIGCA (Gross Cropped Area) with all three independent variables--YSE, ACNSA and ACYSE. Compared to nonelectrified villages with a GIGCA of 15.6 percent, villages electrified for more than ten years have 37.87 percent of gross cropped area under irrigation. The direction of the relationship also is positive when each state is examined individually. Similarly, the figure for O+NE (zero connections and non-electrified) villages is 13.77 percent as opposed to intensively electrified villages (ACNSA >40) having 74.77 percent and villages with high rate of rural electrification growth (ACYSE >2) having 65.54 percent of gross cropped area under irrigation. The tabular

Table 5-16. Gross Cropped Area (GIGCA) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	14.49 (49)	7.23 (36)	42.33 (14)	65.54 (28)
Andhra Pradesh	5.85 (11)	9.09 (19)	54.76 (5)	11.60 (1)
Maharashtra	1.84 (10)	5.44 (13)	8.90 (6)	17.15 (6)
Punjab	--	0.67 (3)	88.47 (3)	89.22 (18)
West Bengal	22.41 (28)	14.74 (1)	--	38.36 (3)

Note: Figures in brackets indicate sample size.

Source: Present study.

presentation thus clearly indicates a strong positive relationship between rural electrification and irrigated area.

The correlations between GIGCA and ACNSA and between GIGCA and ACYSE for the effectively electrified villages (that is, non-O+NE) was found to be 0.75 and 0.74 respectively. Because both are highly significant, separate multiple regressions with ACNSA and ACYSE were conducted. Along with ACNSA and ACYSE, the other independent variables considered as possible explanators of GIGCA were use of innovations (INNOV), literacy, 1971 (LIT71), and access to mass media (MEDAC).[14]

The regression equation for the ACNSA analysis was

$$\begin{aligned} \text{GIGCA} &= -25.26 + (42.84)\ \text{INNOV} + (0.162)\ \text{LIT71} \\ &\quad + (0.929)\ \text{ACNSA} + (0.835)\ \text{MEDAC} \\ n &= 82 \\ R &= 0.798 \\ F_{5,77} &= 33.80 \end{aligned}$$

The summary statistics of the regression equation can be found in table 5-17. The finding is that ACNSA, INNOV and MEDAC are significantly associated with gross irrigated area.

The regression equation of the ACYSE (rate of agricultural connections) analysis was as follows:

$$\begin{aligned} \text{GIGCA} &= -29.39 + (12.22)\ \text{ACYSE} + (46.29)\ \text{INNOV} \\ &\quad + (\ 0.22)\ \text{LIT71} + (\ 1.05)\ \text{MEDAC} \\ n &= 82 \\ R &= 0.807 \\ F_{5,77} &= 36.12 \end{aligned}$$

14. It was initially felt that the size of the village (POP81) and geographical isolation (GEOIS) should also be controlled for; however, it was decided not to, because correlations between GIGCA and POP81 (R = 0.10) and between GIGCA and GEOIS (R = -.19) were not very strong.

Table 5-17. Explanators of GIGCA (Gross Cultivated Area) [Using Agricultural Connections (ACNSA) as the RE variable]

Variable	b	Beta	S_b	t	Simple R
INNOV	42.840	0.219	18.265	2.35[a]	0.64
LIT71	0.162	0.070	0.174	0.93	0.35
ACNSA	0.929	0.556	0.150	6.19[b]	0.75
MEDAC	0.835	0.135	0.456	1.83[c]	0.39

Source: Present study.

[a]Significant at 99 percent.

[b]Significant at 99.95 percent.

[c]Significant at 95 percent.

The summary statistics of the ACYSE regression are presented in table 5-18. The analysis above confirms that ACYSE and ACNSA are very strongly associated with irrigated area, whether compared individually or in controlling for some other complementary conditions. Additional variables associated with GIGCA are use of innovations (INNOV) and access of the village to mass media (MEDAC). When controlling for the other variables, the literacy connotation becomes insignificant.

Table 5-18. Explanators of GIGCA (Gross Cultivated Area) [Using Rate of Agricultural Connections (ACYSE) as the RE variable]

Variable	b	Beta	S_b	t	Simple R
ACYSE	12.22	0.544	1.85	6.61[a]	0.74
INNOV	46.29	0.237	17.37	2.66[b]	0.64
LIT71	0.22	0.096	0.17	1.29	0.35
MEDAC	1.05	0.170	0.44	2.39[b]	0.39

Source: Present study.

[a]Significant at 99.95 percent.

[b]Significant at 99 percent.

The interpretation of the impact of use of innovations on GIGCA seems fairly clear: increasing use of certain innovations such as high yielding varieties, fertilizers and pesticides presupposes adequate controlled irrigation, barring which their effect on agricultural productivity would be negligible (or even negative). Thus, irrigation can almost be viewed as a necessary condition for innovation. The relationship between media access and GIGCA may be partly explained by the fact that greater awareness of and access to information might possibly lead to better cropping practices.

However, the most significant relationship is that between rural electrification and irrigation. The strength of relationships between length, intensity and rate of growth of rural electrification with gross irrigated area of the village--whether considered individually or controlling for complementary conditions--would lead one to believe that electrification programs with a focus on agriculture definitely lead to more extensive irrigation.

Rural Electrification and Cropping Intensity

The relationship between rural electrification and cropping intensity (CRINT) is not expected to be a direct one. Increases in CRINT are primarily expected to come via increases in irrigated area. Apart from irrigation, other factors might also affect CRINT directly or indirectly. These include use of innovations (since innovations again presuppose irrigation), literacy and media access (as contributors to better awareness and information, leading to better cropping practices), and geographical isolation (since the level of use of innovations, literacy, media access and overall level of village development may be dependent on the isolation of the village). Further, cropping intensity may also be determined by whether a particular area is dominated by monsoon or winter cropping patterns.[15] Tabular presentations of analysis of CRINT against YSE, ACNSA and ACYSE are shown in tables 5-19, 5-20, and 5-21.

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15. See section below, "Rural Electrification and Regional Balance," also see ORG (1980, pp. 68-69).

Table 5-19. Cropping Intensity (CRINT) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	137.99 (27)	126.27 (36)	141.79 (65)
Andhra Pradesh	156.38 (1)	120.44 (12)	137.27 (23)
Maharashtra	105.77 (4)	104.00 (13)	111.72 (19)
Punjab	-	160.66 (5)	173.23 (19)
West Bengal	143.01 (22)	157.54 (6)	161.31 (4)

Note: Figures in parentheses indicate sample size.

Source: Present study.

The relationship between CRINT and YSE does not appear to be very strong, except that in the case of villages electrified for more than ten years, CRINT is higher (at 141.79) than those electrified for less than or equal to ten years (126.27). ACNSA or intensity of rural electrification amongst effectively electrified (that is, non-0+NE) villages, appears to be positively associated with CRINT. It increases from 117.49 (ACNSA 1-15) to nearly 164 (ACNSA above 40). For rate of growth of rural electrification (ACYSE) the direction of relationship is similar between effectively electrified villages and cropping intensity CRINT increases from 120.07 (ACYSE <1) to 157.7 (ACYSE >2).

Table 5-20. Cropping Intensity (CRINT) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	137.29 (54)	117.49 (36)	134.37 (10)	158.21 (6)	163.99 (21)
Andhra Pradesh	140.36 (16)	122.47 (15)	148.00 (2)	134.50 (2)	111.65 (1)
Maharashtra	106.29 (10)	105.48 (17)	106.00 (5)	141.82 (1)	132.19 (2)
Punjab	-	148.03 (3)	172.90 (3)	179.47 (3)	172.77 (15)
West Bengal	146.61 (28)	155.40 (1)	-	-	158.73 (3)

Note: Figures in brackets indicate sample size.

Source: Present study.

Table 5-21. Cropping Intensity (CRINT) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	138.51 (49)	120.07 (36)	132.87 (14)	157.70 (28)
Andhra Pradesh	150.37 (11)	122.00 (19)	136.87 (5)	102.3 (1)
Maharashtra	102.78 (10)	108.08 (13)	109.50 (6)	117.52 (6)
Punjab	-	148.03 (3)	172.93 (3)	174.00 (18)
West Bengal	146.61 (28)	155.40 (1)	-	158.73 (3)

Note: Figures in parenthese indicate sample size.

Source: Present study.

Statewide patterns corroborate these relationships, except in the case of Andhra Pradesh. In Andhra Pradesh, four electrified villages with intensive canal irrigation and zero agricultural connections have very high cropping intensities (in the range of 180). Thus, the effect of these four villages probably has significantly influenced the patterns in Andhra Pradesh.

Increasing intensity of electrification among electrified villages seems to be positively associated with cropping intensity. The difference is not quite so strong for the 0+NE and effectively electrified villages. However, the 0+NE villages in the sample appear to be characterized by a much higher than average cropping intensity in comparison with the national average.

The correlations between CRINT and ACNSA and between CRINT and ACYSE for effectively electrified (that is, the non-0+NE) villages were found to be 0.34 and 0.38 respectively, and both are significant. Separate multiple regressions were conducted, on ACNSA and ACYSE. The variables that were additionally included in the equation were irrigated area (GIGCA), use of innovations (INNOV), literacy, 1971 (LIT71), access to media (MEDAC), and geographical isolation (GEOIS). The regression equation for the ACNSA analysis was:

$$CRINT = 108.36 + (0.26)\ GIGCA + (40.38)\ INNOV + (0.19)\ LIT71 - (0.06)\ ACNSA + (0.65)\ MEDAC - (0.43)\ GEOIS$$

$$n = 82$$
$$R = 0.617$$
$$F_{6,75} = 7.68$$

The summary statistics of the regression are presented in table 5-22.

As expected, irrigation is strongly associated with cropping intensity. The coefficient for geographical isolation is negative and significant, while the coefficient for use of innovations is positive and significant. Intensity of rural electrification, along with literacy and media access, appears to play no direct role in raising cropping intensity

Table 5-22. Explanators of Cropping Intensity (CRINT) with Agricultural Connections (ACNSA) as the RE Variable

Variable	b	Beta	S_b	t	R
GIGCA (gross area irrigated)	0.26	0.264	0.15	1.73[a]	0.49
INNOV (innovations)	40.38	0.208	25.17	1.60[b]	0.48
LIT71 (literacy)	0.19	0.082	0.23	0.82	0.33
ACNSA (agricultural connections)	-0.06	-0.033	0.24	-0.25	0.34
MEDAC (success to media)	0.65	0.105	0.62	1.05	0.33
GEOIS (geographical isolation)	-0.43	-0.256	0.16	-2.69[a]	-0.39

Source: Present study.

[a]Significant at 95 percent.

[b]Significant at 90 percent.

when controlling for the other variables. However, given the strong association between rural electrification and irrigation, and in turn, irrigation and cropping intensity, it is possible that the conjunctive effect of rural electrification on CRINT is suppressed, despite a significant simple correlation.

The regression equation for the ACYSE (rate of agricultural connections) analysis was:

$$\begin{aligned} CRINT &= 108.47 + (0.28)\,GIGCA - (1.11)\,ACYSE \\ &\quad + (40.7)\,INNOV + (0.18)\,LIT71 + (0.62)\,MEDAC - (0.43)\,GEOIS \\ n &= 82 \\ R &= 0.617 \\ F_{6,75} &= 7.70 \end{aligned}$$

The summary statistics are presented in table 5-23.

Table 5-23. Explanators of Cropping Intensity (CRINT) [With Rate of Agricultural Connections (ACYSE) as the RE Variable]

Variable	b	Beta	S_b	t	R
GIGCA	0.28	0.277	0.15	1.87[a]	0.49
ACYSE	-1.11	-0.050	3.13	-0.35	0.38
INNOV	40.70	0.209	24.63	1.65[b]	0.48
LIT71	0.18	0.079	0.23	0.78	0.33
MEDAC	0.62	0.101	0.62	1.00	0.33
GEOIS	-0.43	-0.255	0.16	-2.69[a]	-0.39

Source: Present study.

[a]Significant at 99 percent.

[b]Significant at 95 percent.

Here again the results are very similar to that from table 5-22, the ACNSA analysis.

The evidence suggests the hypothesis that the major impact of rural electrification in raising cropping intensity occurs through its impact on irrigation. The other variables associated with cropping intensity are use of innovations and geographical isolation. For other variables, use of innovations is positively related to cropping intensity while the coefficient extent of geographical isolation is negative.

Rural Electrification and Cropping Pattern

Irrigation availability normally leads to changes in cropping pattern because wet crops can be grown and cropping in different seasons becomes possible. Some of the common changes found are: inferior cereals are replaced by superior cereals, use of high yielding strains increases, and in the dry season, wheat tends to be grown instead of grams and other pulses. Below, we look at the impact of rural electrification on five different cropping pattern indicators.

The gross cropped area of a village can be split up into food and nonfood crop area--the latter being a surrogate for cash crops. Food crop area can in turn be split up into superior cereal (that is, rice and wheat) area and inferior cereal area. Finally, superior cereal area can be divided into rice and wheat area. Using these concepts, we examine the following cropping pattern indicators: (1) percent nonfood crop and superior cereal area to gross cropped area (NFSCA); (2) percent nonfood crop area to gross cropped area (NFACA); (3) percent superior cereal area to gross cropped area (SCACA); (4) percent rice area to gross cropped area (RCACA); and (5) percent superior cereal area to total food crop area (SCFCA). Since the number of indicators involved are large, we are not presenting state-by-state details on each of the five indicators in the YSE, ACNSA and ACYSE tables.[16] Also, we do not conduct multivariate analyses.

The data on the five cropping pattern indicators against YSE, ACNSA and ACYSE are shown in tables 5-24, 5-25, and 5-26 respectively. Length of electrification does not appear to have a very significant bearing on cropping pattern, except that the percentage of nonfood crop area among

16. Where relevant the results for a particular state are referred to.

Table 5-24. Cropping Pattern and Year Since Electrification (YSE) (Pooled)

Indicator[a]	Not electrified	Electrified <10 years	Electrified >10 years
NFSCA (non food and superior cereal vs. gross area)	83.14	64.55	64.52
NFACA (non-food vs. gross area	13.98	27.99	19.43
SCACA (superior cereal vs. gross area)	69.16	36.56	45.09
RCACA (rice vs. gross area)	62.46	28.32	28.60
SCFCA (superior cereal vs. food)	80.40	50.77	55.96

Source: Present study.

[a]See preceding text for more precise definition.

villages electrified for more than ten years is lower at 19.43 percent than that for villages electrified for less than ten years (27.99 percent). In the case of area under superior cereals, the reverse is true--it goes up from 36.56 percent (YSE ≤10 years) to 45.09 percent (YSE >10 years). Non-electrified villages in the sample show somewhat contrary trends, and hence the description is restricted to effectively electrified villages.[17]

Intensity of agricultural connections (ACNSA) seems to be a relatively strong discriminant of cropping pattern. The total area under nonfood crops and superior cereals goes up from approximately 59 percent (ACNSA = 1-15 connections) to about 67 percent (ACNSA >40).

This increase is accompanied by a steady decline in area under nonfood crops (24.68 percent to 11.94 percent) and a dramatic increase in area under superior cereals (34.64 percent to 55.10 percent). Superior cereal area to food crop area also increases from 46 percent to about 63 percent. Within superior cereals, rice area decreases from about 30 percent of gross cropped area to 22 percent, suggesting that there is a perceptible shift to wheat.

17. It may be recalled that the NE+0 villages in the sample have quite high levels of irrigation and cropping intensity, especially in comparison with villages with lower intensity of rural electrification. This qualification should be kept in mind while reading the following paragraphs.

Table 5-25. Cropping Pattern and Agricultural Connections (ACNSA) (Pooled)

Indicator[a]	Zero connections & nonelectrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
NFSCA (non-food and superior cereal vs. gross area)	71.37	59.32	67.38	64.42	67.04
NFACA (non-food vs. gross area)	21.63	24.68	22.41	16.82	11.94
SCACA (superior cereal vs. gross area)	49.74	34.64	44.97	47.60	55.10
RCACA (rice vs. gross area)	49.25	30.04	27.15	16.51	22.16
SCFCA (superior cereal vs. food)	63.46	45.99	57.96	56.50	62.57

Source: Present study.

[a]See preceding text for more precise definition.

A graphical description of these shifts, presented in figure 5-3, explicitly portrays the changes in cropping pattern, visually simplifying the findings described above. The findings relating to impact of rate of growth of rural electrification (that is, ACYSE) are almost exactly similar

Table 5-26. Cropping Pattern and Rate of Agricultural Connections (ACYSE) (Pooled)

Indicator[a]	Zero connections & nonelectrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
NFSCA (Non-food and superior cereal vs. gross area)	79.21	61.99	62.05	65.03
NFACA (Non-food vs. gross area)	20.81	26.08	24.95	10.37
SCACA (Superior cereal vs. gross area)	58.40	35.91	37.10	54.66
RCACA (rice vs. gross area)	52.56	31.51	23.91	20.36
SCFCA (superior cereal vs. food)	73.74	48.57	49.43	60.93

Source: Present study.

[a]For full descriptions of indicators, see text.

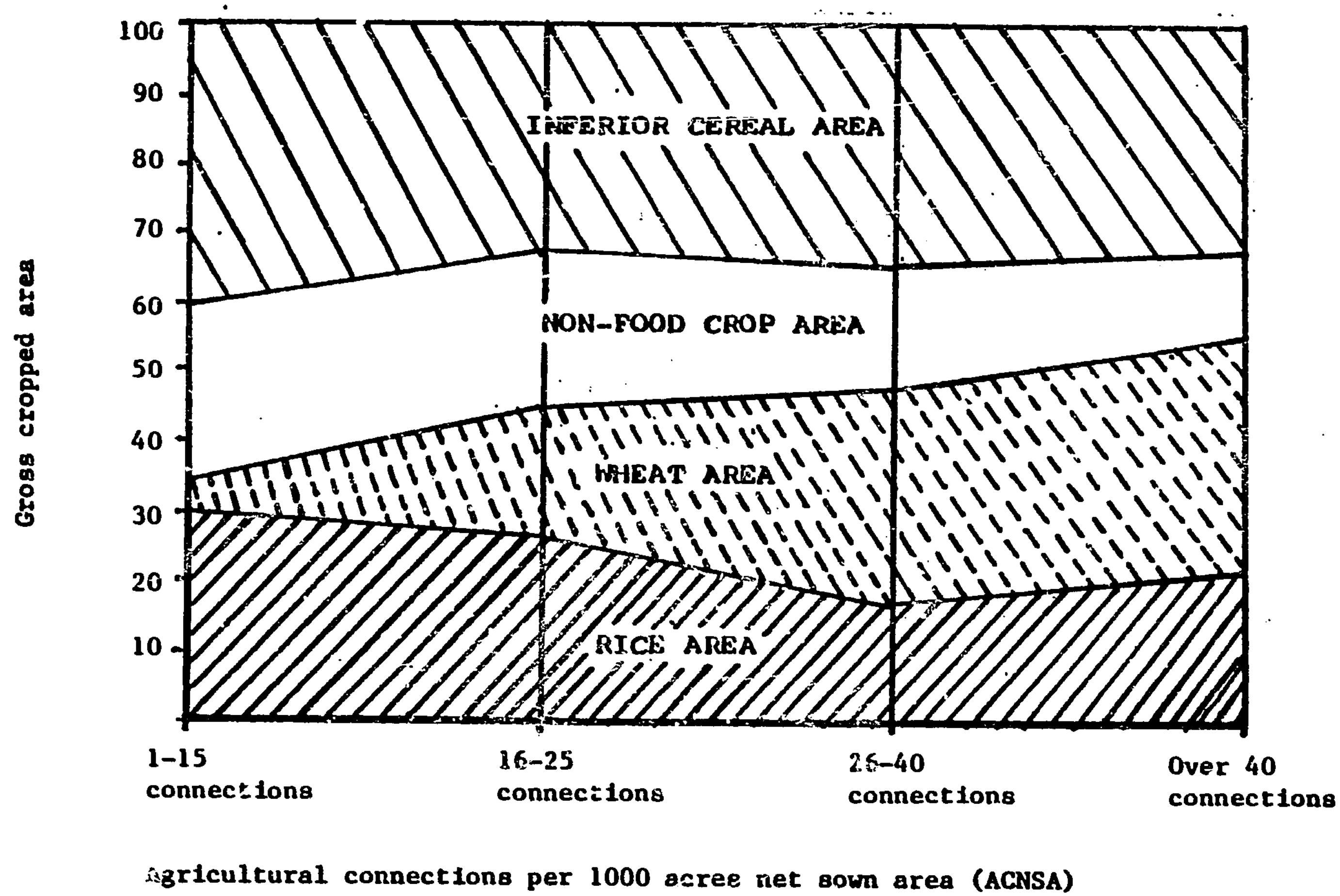

Figure 5-3. Intensity of rural electrification (ACNSA) and cropping pattern.

Source: Present study.

to that for ACNSA--the directions of shifts remain the same. The graphical description of shifts is presented in figure 5-4.

To summarize, both intensity and rate of growth of rural electrification are related to different cropping patterns among electrified villages. Area under nonfood crops decreases, and area under superior cereals (that is, rice and wheat) increases. Inferior cereal area also is lower in the most intensely electrified regions. Among superior cereals, area under rice decreases and area under wheat increases.

The major technological breakthroughs in high yielding varieties in India has been for superior cereals, that is, wheat and rice. Development of new strains has not taken place to the same extent among cash crops (except for cotton), and has been almost negligible in the case of inferior cereals (except to some extent for jowar). Further, superior cereal crop prices in the recent past have been rising faster than that of cash crops.[18] Both these factors, coupled with the availability of irrigation resulting from rural electrification (since high-yield varieties presuppose irrigation) may be major contributors to the increasing share of superior cereal area in relation to that of nonfood crops and inferior cereals.

The shift from rice to wheat makes intuitive sense. First, three out of the four states in the sample are kharif (monsoon-crop) states, and rural electrification availability leading to irrigation tends to increase cropping intensity by affecting mainly rabi (dry-season) cropping. Rice is rarely grown as a rabi crop, even in a rabi state like Punjab,[19] because it is an extremely water intensive crop, requiring waterlogging. The shift to wheat normally takes place at the expense of grams and other pulses, which is the normal rabi crop grown in kharif areas characterized by unirrigated conditions.

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18. For example, the wholesale price index of "food articles" among primary commodities grew from 136.6 in 1973/74 to 172.4 in 1978/79; the same for nonfood primary commodities was 146.6 and 170.4 respectively ("Basic Statistics Relating to Indian Economy," Central Statistical Organisation, Government of India, New Delhi, 1980).

19. Our sample data shows that even in Punjab rice is grown almost exclusively as a kharif (monsoon) crop.

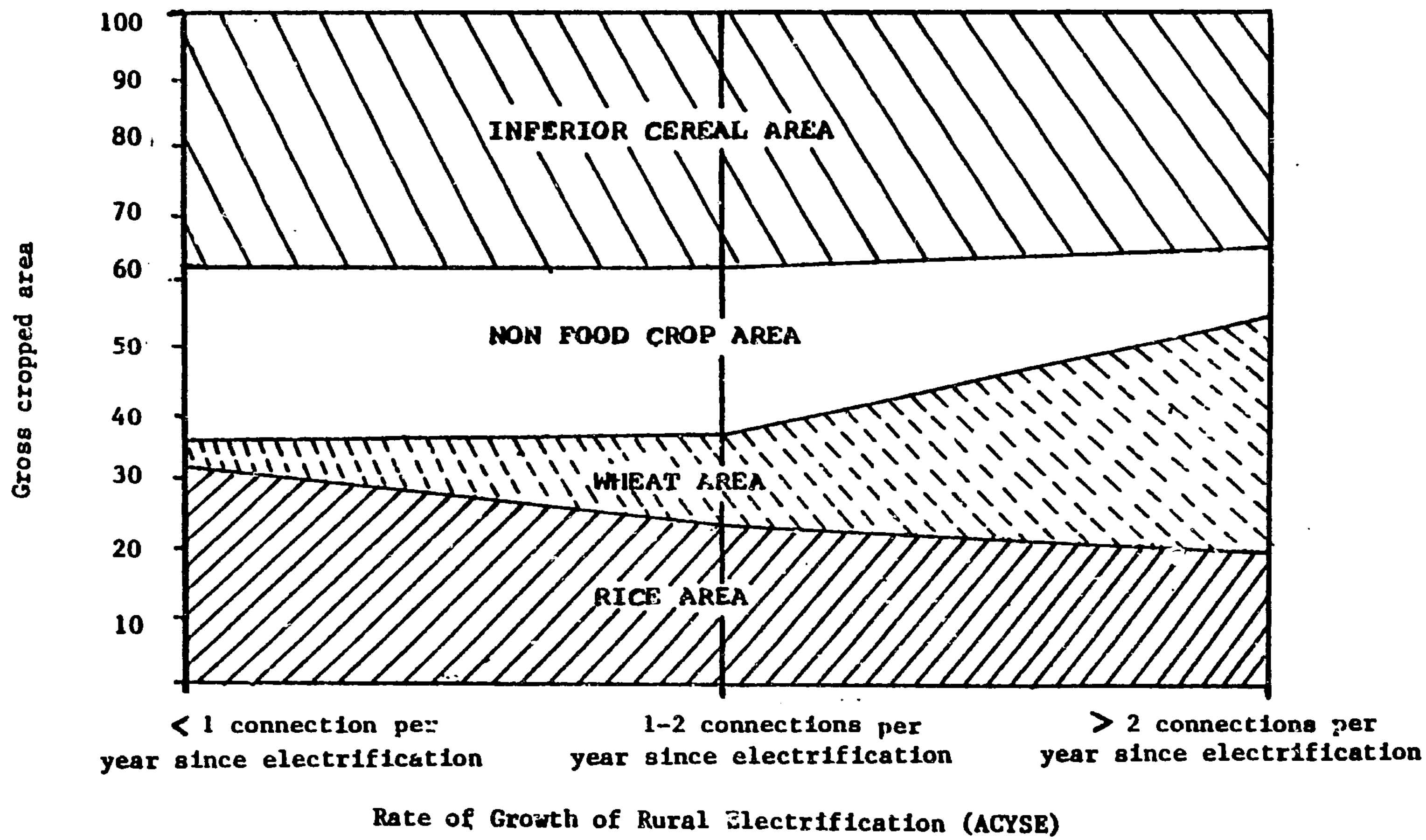

Figure 5-4. Rate of growth of rural electrification (ACYSE) and cropping pattern.

Source: Present study.

Rural Electrification and Agricultural Employment

The availability of rural electrification and consequent changes in irrigated area, cropping intensity and cropping pattern might lead to changes in production factors, notably employment and use of innovations. In the analysis of rural electrification and employment below, we consider three types of employment variables: (1) number of agricultural workers per 10,000 rupees agricultural output[20] (WPROD); (2) percent employed (relative to total population) in the agricultural sector (AGEMP); and (3) percent females employed to total (FLFPR).

Since the dependent variable is for an earlier time period (1971), we have conducted the analysis by treating 1971 as the cut-off point for year of electrification. As may be recalled, data had been collected on agricultural connections by year, since the year of village electrification, based on State Electricity Board records. However, since this data could not be collected for a few villages, the analysis does not cover all 132 villages in our sample.

The definition of "workers" in the 1971 census has been the source of a considerable amount of discussion and views regarding its quality vary widely. Secondly, the definition of workers is not indicative of employment intensity, but only number employed. In the Indian rural context, measurement of employment using merely number of workers can be a somewhat misleading indicator of the extent of labor input into the production process. Thus, we would like to qualify our findings by saying that the analysis that follows is only indicative of the percent of persons engaged in agriculture, with no conclusions being drawn in relation to intensity of employment.

Data relating to number of agricultural workers per 10,000 rupees of agricultural production (WPRODN) is displayed in tables 5-27, 5-28, and 5-29, against YSE, ACNSA and ACYSE, respectively. Length of rural electrification (YSE) does not appear to be a discriminant of agricultural employment--the data, pooled or statewide, does not show any pattern. However, if only electrified villages are considered, the ACNSA and ACYSE

20. This is derived as a combination of 1971 census and 1981 sample data, see volume 2, appendix 3-3.

Table 5-27. Unit of Workers per Unit of Output (WPROD) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	3.13 (25)	3.25 (34)	4.14 (56)
Andhra Pradesh	4.50 (1)	1.37 (10)	6.54 (18)
Maharashtra	9.14 (4)	4.61 (14)	5.15 (17)
Punjab	-	5.04 (5)	1.28 (18)
West Bengal	2.36 (20)	1.40 (5)	2.56 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

tables indicate that with increasing rural electrification intensity (ACNSA) among electrified villages, the number of workers per 10,000 rupees output decreases from 5.39 to 2.49, or to approximately half, for the pooled sample. With increasing rate of rural electrification growth (ACYSE), it decreases from 5.81 to 2.89 or again, to approximately half, for the pooled sample. This would suggest that among electrified villages, as intensity of rural electrification and rate of growth of rural electrification increase, labor intensity (measured by number of workers) in farm production (measured in rupee value of output) decreases. However,

Table 5-28. Workers per Unit of Output (WPROD) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	2.97 (39)	5.39 (43)	348 (10)	2.02 (6)	2.49(17)
Andhra Pradesh	2.14 (4)	5.57 (21)	1.92 (2)	3.36 (2)	--
Maharashtra	5.85 (9)	5.17 (19)	5.41 (5)	2.67 (1)	7.95 (1)
Punjab	--	6.54 (2)	1.29 (3)	0.90 (3)	2.02(15)
West Bengal	2.10 (26)	3.40 (1)	--	--	4.04 (1)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-29. Workers per Unit of Output (WPROD) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	3.42 (48)	5.81 (29)	2.42 (14)	2.89 (24)
Andhra Pradesh	1.61 (7)	6.62 (17)	1.68 (4)	5.64 (1)
Maharashtra	6.21 (16)	4.37 (9)	3.33 (7)	8.67 (3)
Punjab	-	6.54 (2)	1.29 (3)	1.83 (18)
West Bengal	2.15 (25)	3.40 (1)	-	2.44 (2)

Note: Figures in parentheses indicate sample size.

Source: Present study.

this may be partly reflective of increases in the denominator too (that is, value of agricultural output), which in turn could be a result of cropping pattern changes to more remunerative crops. But the extent of decrease certainly suggests a rural electrification effect.

We now examine the number of agricultural workers as a percentage of village population. Data on percentage of agricultural workers against YSE, ACNSA and ACYSE are presented in tables 5-30, 5-31, and 5-32, respectively. When percent of agricultural employment is broken down by YSE, there does not appear to be much of a rural electrification effect:

Table 5-30. Percentage of Employment in Agriculture (AGEMP) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	31.64 (67)	29.19 (44)	29.29 (21)
Andhra Pradesh	34.46 (13)	35.68 (11)	33.96 (12)
Maharashtra	40.17 (17)	31.44 (17)	54.6 (2)
Punjab	22.54 (5)	21.94 (15)	17.7 (4)
West Bengal	27.28 (32)	28.4 (1)	9.17 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-31. Percentage of Employment in Agriculture (AGEMP) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	29.94 (83)	37.32 (9)	32.91 (8)	28.59 (10)	24.45 (11)
Andhra Pradesh	34.42 (14)	34.96 (5)	38.2 (2)	29.6 (1)	34.9 (3)
Maharashtra	37.5 (23)	40.26 (4)	32.12 (5)	35.63 (4)	-
Punjab	20.83 (10)	-	26.3 (1)	22.76 (5)	20.53 (8)
West Bengal	25.89 (36)	-	-	-	-

Note: Figures in parentheses indicate sample size.

Source: Present study.

percentage agricultural employment remains more-or-less steady. However, ACNSA appears to have a strong negative association with employment in agriculture. Percentage employment in agriculture drops steadily from 37.32 percent in villages with 1-15 agricultural connections to 24.45 percent (villages with ACNSA above 40). But the low percent employed in agriculture in the Punjab accounts for a significant part of the pooled average above 40 connections per thousand. The finding with regard to ACYSE is mixed--it goes up from 31.59 (ACYSE less than 1) to 36.71 for the middle category, but declines quite significantly to 27.85 (ACYSE greater

Table 5-32. Percentage of Employment in Agriculture (AGEMP) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	30.61 (76)	31.59 (12)	36.71 (10)	27.85 (34)
Andhra Pradesh	33.86 (17)	34.9 (9)	35.33 (3)	36.07 (7)
Maharashtra	39.39 (18)	21.67 (3)	37.3 (7)	36.43 (8)
Punjab	23.03 (6)	-	-	20.8 (18)
West Bengal	25.82 (35)	-	-	28.4 (1)

Note: Figures in parentheses indicate sample size.

Source: Present study.

than 2). Therefore, with some qualifications, very high rural electrification intensity and growth rate levels may contribute negatively to number of workers in agriculture. This means that a higher percentage of workers are engaged in activities outside of agriculture.

Data relating to percentage females employed to total persons employed (FLFPR, all sectors) is presented in tables 5-33, 5-34 and 5-35. Several different trends emerge here. Increasing YSE demonstrate increasing female employment. However, in electrified villages increasing ACNSA shows a steadily decreasing female employment. Percent females in the workforce goes down from 35.37 (1-15 connections) to 8.80 (villages with ACNSA more than 40). ACYSE shows a trend similar to that of agricultural employment: an initial increase and then a steep decline with greater electrification intensity.

Table 5-33. Percent Employment Female (FLFPR) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	17.30 (67)	21.83 (44)	33.69 (21)
Andhra Pradesh	26.84 (13)	34.43 (11)	29.91 (12)
Maharashtra	33.31 (17)	31.52 (17)	46.5 (2)
Punjab	1.1 (5)	1.29 (15)	9.33 (4)
West Bengal	7.46 (32)	26.7 (1)	4.38 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

When examining intensity and rate of growth of rural electrification, some portion of the reduction in agricultural employment is accounted for by decrease in female employment. But factors other than rural electrification also may contribute to this decline. Hence these findings have to be interpreted with much caution. Secondly, the census data relates to number of workers and not productivity of employment. In fact, if employment productivity could be interpreted as the inverse of WPROD (workers employed per unit output) (see subsection below), the evidence

Table 5-34. Percent Employment Female (FLFPR) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	18.24 (83)	35.37 (9)	26.65 (7)	20.36 (10)	8.80 (11)
Andhra Pradesh	32.00 (14)	32.46 (5)	37.25 (2)	21.2 (1)	27.5 (3)
Maharashtra	33.18 (23)	39.00 (4)	22.42 (5)	41.00 (4)	-
Punjab	0.96 (10)	-	-	3.68 (5)	1.79 (8)
West Bengal	8.15 (36)	-	-	-	-

Note: Figures in parentheses indicate sample size.

Source: Present study.

suggests that rural electrification leads to greater employment productivity. Finally, subsequent to rural electrification, certain structural changes in economic activity may occur within the secondary and tertiary sectors (see chapters 6 and 7). Thus the employment decrease may be the result of labor demand in other sectors rather than labor released from the agricultural sectors.

The finding emerging from quantitative analysis is corroborated to some extent by the perceptions of village leaders. In response to the question, do farms using electricity employ more labor or less labor?, the percentages of leaders who said "more" and "less" was:

More labor - 44.2 percent

Less labor - 51.5 percent

Though the opinion is divided, rural electrification may not necessarily be positively associated with rural employment.

Table 5-35. Percent Employment Female (FLFPR) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	17.22 (76)	31.84 (12)	34.66 (10)	17.06 (34)
Andhra Pradesh	27.63 (17)	37.79 (9)	31.9 (3)	32.29 (7)
Maharashtra	31.46 (18)	29.00 (3)	35.84 (7)	36.36 (8)
Punjab	1.00 (6)	-	-	2.02 (18)
West Bengal	7.62 (35)	-	-	26.7 (1)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Rural Electrification and Use of Agricultural Innovations (INNOV)

The effect of rural electrification on use of agricultural innovations such as pesticides, high yielding varieties, fertilizers, and farm mechanization will occur through a process similar to the one described in the employment section. Irrigation acts as an impetus to use of these inputs since high yielding varieties normally presuppose controlled irrigation.

We had earlier seen, subject to the limitation of our longitudinal analysis, that rural electrification did not experience higher than average growth rates of agricultural connections in villages with higher levels of agricultural adoption of innovations.[21] However, the reverse may not necessarily be true, and we propose to examine this issue with tabular data relating to INNOV against YSE, ACNSA and ACYSE (see tables 5-36 through 5-38).

21. See "Preconditions for Agricultural Rural Electrification Success" of this report.

Table 5-36. Agricultural Innovation (INNOV) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	36 (27)	54 (40)	66 (65)
Andhra Pradesh	53 (1)	60 (12)	65 (23)
Maharashtra	34 (4)	50 (13)	52 (19)
Punjab	-	67 (5)	85 (19)
West Bengal	35 (22)	47 (10	46 (4)

Note: Figures in parentheses indicate sample size.

Source: Present study.

The data exhibit a clear covariation between rural electrification and the index of innovation. The innovation index increases from 36 for non-electrified villages to 66 for villages electrified for more than ten years. With regard to intensity of rural electrification (ACNSA), the innovation index rises from 51 for the villages with no agricultural connections, to 74 for villages with more than 40 agricultural connections per 1,000 acres net sown area. The relationship holds for the rate of growth of rural electrification (ACYSE); the innovation index increases from 48 in villages with no connections to 75 (ACYSE >2). The correlations

Table 5-37. Agricultural Innovation (INNOV) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	51 (58)	64 (37)	73 (10)	72 (6)	74 (21)
Andhra Pradesh	59 (16)	65 (15)	67 (2)	68 (2)	72 (1)
Maharashtra	41 (10)	60 (18)	64 (5)	50 (1)	63 (2)
Punjab	-	83 (3)	93 (3)	82 (3)	79 (15)
West Bengal	50 (32)	56 (1)	-	-	55 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-38. Agricultural Innovation (INNOV) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	48 (54)	64 (36)	70 (14)	75 (28)
Andhra Pradesh	59 (11)	64 (19)	67 (5)	67 (1)
Maharashtra	44 (11)	62 (13)	59 (6)	56 (6)
Punjab	-	81 (3)	96 (3)	85 (18)
West Bengal	46 (32)	56 (1)	-	54 (3)

Note: Figures in parentheses indicate sample size.

Source: Present Study.

between INNOV and ACNSA and INNOV and ACYSE for villages with access to electricity are 0.64 and 0.58 respectively, and both are significant (n = 82, both correlations significant at 99 percent).

Given the significance of association between rural electrification and use of innovations within electrified villages, we proceed to conduct separate multiple regressions for ACNSA and ACYSE for the same sample, controlling for literacy (LIT71), village size (POP81), access to credit (CRTAC), and geographical isolation (GEOIS).

Literacy would be expected to be a strong positive determinant of INNOV, since better access to information would be expected to be a contributor to improvement of cropping practices. Credit access is also expected to be positively related to literacy, since the purchase of agricultural inputs generally requires that the farmer obtain credit. Village size (or population) is expected to have a positive association since larger villages are normally better developed villages and innovation is expected to be highly correlated with development. Geographical isolation would be expected to have a strong negative effect because of poor access to inputs and information.

The ACNSA regression equation for the electrified village sample is as follows:

$$\text{INNOV} = 0.481 + (0.00001)\ \text{POP81} + (0.00195)\ \text{LIT71} + (0.00484)\ \text{ACNSA} + (0.00057)\ \text{CRTAC} - (0.00073)\ \text{GEOIS}$$

$$n = 82$$

$$R = 0.70$$

$$F_{6,76} = 14.58$$

The summary statistics of the multiple regression are presented in table 5-39.

Table 5-39. Explanators of Agricultural Innovation (INNOV) with Agricultural Connections (ACNSA) as the RE Variable

Variable	b	Beta	t	Simple R
POP81 (population)	0.00001	0.08272	1.00	0.15
LIT71 (literacy)	0.00195	0.16397	1.86[a]	0.38
ACNSA (agricultural connections)	0.00484	0.56590	6.63[b]	0.64
CRTAC (credit access)	0.00057	0.13608	1.58[c]	0.26
GEOIS (geographical isolation)	-0.00073	-0.08400	-0.94	-0.24

Source: Present study.

[a]Significant at 90 percent.

[b]Significant at 99.9 percent.

[c]Significant at 85 percent.

The finding is that intensity of agricultural connections (ACNSA) is strongly related to innovation use, even after controlling for other complementary conditions. The other positive coefficients are literacy and credit access. Population and geographical isolation are not significantly related to use of innovations.

The same equation was run for the subsample of electrified villages, but ACYSE was substituted for ACNSA. The results appear in table 5-40. For the subsample of electrified villages, rural electrification, by itself and controlling for other inputs, remains a strong explanator of use of

Table 5-40. Explanators of Agricultural Innovation (INNOV) with Rate of Agricultural Connection (ACYSE) as the RE Variable

Variable	b	Beta	S_b	t	Simple R
ACYSE	0.06037	0.52516	0.01012	5.97[a]	0.58
POP81	0.00001	0.13102	0.00001	1.00	0.15
LIT71	0.00247	0.20803	0.00107	2.31[b]	0.38
CRTAC	0.00055	0.13158	0.00038	1.45[c]	0.26
GEOIS	-0.00065	-0.07473	0.00081	-0.80	-0.24

Source: Present study.

[a]Significant at 99.9 percent.

[b]Significant at 95 percent.

[c]Significant at 85 percent.

agricultural innovations--a finding that is corroborated by the 1966 study (see volume 2, appendix 2).

This finding is quite suggestive with regard to the causality issue, especially when viewed in conjunction with previous findings subject to the built-in limitations of the longitudinal analysis. Rural electrification is strongly associated with the use of agricultural innovations in the cross-sectional analysis, while agricultural innovations apparently do not affect the rate of growth of agricultural connections.

Rural Electrification and Productivity (YIELD & YLABR)

Rural electrification is not expected to directly influence yield--yield is normally influenced more directly by irrigation and use of innovations. But as we saw in the earlier subsections, rural electrification is a major contributor to both innovation and irrigation.

We look at rural electrification and two measures of yield or productivity--land productivity (YIELD) and labor productivity (YLABR). The precise definitions of YIELD and YLABR are shown in the appendix. Data relating to YIELD against YSE, ACNSA and ACYSE are shown in tables 5-41, 5-42, and 5-43. YSE seems to be positively associated with yield--the index of yield goes up from 80.83 for non-electrified villages, to 110.52

Table 5-41. YIELD and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	80.83 (27)	110.52 (36)	114.22 (64)
Andhra Pradesh	154.36 (1)	149.50 (12)	121.92 (23)
Maharashtra	39.75 (4)	67.78 (13)	82.78 (18)
Punjab	-	125.45 (5)	137.34 (19)
West Bengal	84.96 (22)	112.75 (6)	101.56 (4)

Note: Figures in parentheses indicate sample size.

Source: Present study.

for villages electrified for less than ten years and to 114.22 for villages electrified for more than ten years. The effect of intensity of rural electrification (ACNSA) is less pronounced, as is the rate of growth of rural electrification (ACYSE). YIELD goes up from 101 for the 0+NE villages to about 119 for villages with ACNSA above 40. However, after an ACNSA of about 16, the YIELD levels remain more or less constant. Similarly, for villages with ACYSE less than 1, YIELD is about 109, as opposed to villages with ACYSE greater than 2 having a YIELD index of only about 111. The YIELD levels rise to about 118 for the middle category.

The correlation between YIELD and ACNSA, and YIELD and ACYSE for the subsample of electrified villages is 0.074 and 0.049 respectively (n = 82, both correlations insignificant). Given that the direct association

Table 5-42. YIELD and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	101.01 (58)	98.47 (37)	116.27 (10)	117.09 (6)	118.87 (21)
Andhra Pradesh	140.52 (16)	119.37 (15)	100.26 (2)	89.68 (2)	127.45 (1)
Maharashtra	59.23 (10)	77.79 (18)	79.64 (5)	75.28 (1)	62.88 (2)
Punjab	-	126.10 (3)	188.00 (3)	149.37 (3)	129.75 (15)
West Bengal	94.32 (32)	74.20 (1)	-	-	98.93 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-43. YIELD and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	98.19 (50)	108.77 (36)	117.84 (14)	110.58 (27)
Andhra Pradesh	142.09 (11)	132.04 (19)	104.06 (5)	54.13 (1)
Maharashtra	64.13 (11)	73.42 (13)	94.25 (6)	48.06 (5)
Punjab	-	126.10 (3)	188.00 (3)	133.02 (18)
West Bengal	94.32 (28)	74.20 (1)	-	98.93 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

between land productivity and rural electrification is insignificant, we proceed to conduct a multiple regression for YIELD by looking at the following control variables: percent gross irrigated area (GIGCA), use of innovations (INNOV), village size (POP81), access to credit (CRTAC), and access to media (MEDAC).

Having established the strong relationship between rural electrification and both GIGCA and INNOV, we would expect that these two variables would in turn be strong explanators of yield, if rural electrification is a contributor to improvements in agricultural productivity. It was necessary to examine the other possible variables that might relate positively to yield. These include size of village, access to credit and access to media.

The regression equation for the electrified villages in the sample is as follows:

$$\begin{aligned} YIELD &= -9.14 - (0.20)\ GIGCA + (124.73)\ INNOV + (0.005)\ POP81 \\ &\quad + (0.31)\ CRTAC + (1.45)\ MEDAC \\ n &= 82 \\ R &= 0.55 \\ F_{6,76} &= 6.59 \end{aligned}$$

The results of the regression are presented in table 5-44.

Table 5-44. Explanators of Yield

Variable	b	Beta	t	Simple R
GIGCA	-0.1986	-0.1106	-0.842	0.222
INNOV	124.7325	0.3553	2.762[a]	0.410
POP81	0.0054	0.1893	1.500[b]	0.346
CRTAC	0.3066	0.2101	2.104[c]	0.330
MEDAC	1.4485	0.1306	0.954	0.356

Source: Present study.

[a]Significant at 99 percent.

[b]Significant at 85 percent.

[c]Significant at 95 percent.

The results indicate that agricultural innovation is the strongest explanator of yield (beta = 0.3553), followed by access to credit (beta = 0.2101) and village size (beta = 0.1893). Irrigation and media access are not significant explanators of yield. It may be speculated that the significant positive correlation that irrigation has with yield (0.22) may be suppressed by the somewhat strong correlation with variables in the analysis.

However, the results point to the fact that use of agricultural innovations and credit (which in turn is a strong explanator of innovation use) are most strongly related to yield. The finding suggest that the effect rural electrification might possibly occur indirectly through the impetus given to innovation. However, at this point these findings are only suggestive and should not be interpreted as definitive evidence.

Data relating to labor productivity in rupees output per unit labor (YLABR) against YSE, ACNSA, and ACYSE are shown in tables 5-45 to 5-47. In these tables there appears to be a strong positive rural electrification effect. The output per worker is only Rs. 2889 in non-electrified villages, as opposed to Rs. 6,682 in villages electrified for less than ten years, and Rs. 7,451 for villages electrified for more than ten years. Similarly, as far as intensity of rural electrification is concerned, the output per worker is as high as Rs. 9,245 in villages with ACNSA above 40, as opposed to Rs. 4,587 for the 0+NE villages. Villages with a high rate

Table 5-45. Labor Productivity (YLABR) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	2888.57 (25)	6682.17 (34)	7450.66 (56)
Andhra Pradesh	2410.65 (1)	11094.34 (10)	5678.52 (18)
Maharashtra	1569.18 (4)	3086.22 (14)	4932.12 (17)
Punjab	-	3866.87 (5)	12074.91 (18)
West Bengal	3176.34 (20)	10742.42 (5)	4609.74 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

of rural electrification growth (ACYSE >2) have an output of Rs. 9,110 per worker, as opposed to those with lower growth rate (ACYSE <1) showing only Rs. 5,579. In sum, rural electrification apparently is positively associated with labor productivity. Here again, this increase may be due to lower number of workers as well as due to cropping pattern shifts to cash crops.

Table 5-46. Labor Productivity (YLABR) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	4586.75(39)	5522.57(43)	8240.40(10)	8142.80(6)	9245.07(17)
Andhra Pradesh	6032.05(4)	8048.23(21)	5709.17(2)	5503.98(2)	-
Maharashtra	3234.83(9)	3214.03(19)	7458.40(5)	3748.37(1)	1257.31(1)
Punjab	-	2224.03(2)	11231.22(3)	15036.15(3)	10228.84(15)
West Bengal	4832.65(26)	2942.99(1)	-	-	2476.35(1)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Rural Electrification and Agricultural Income (VPROD)

Ultimately, the availability and use of rural electrification are supposed to lead to enhancement in the rural quality of life. The singular variable through which this enhancement can be brought about is agricultural income per capita, since agriculture is the mainstay of India's rural economy.

In this section, we look at rural electrification in relation to per capita rupee value output of agricultural income (VPROD). Tabular data on VPROD against YSE, ACNSA and ACYSE are shown in tables 5-48, 5-49, and 5-50. Length of electrification (YSE) seems to have some degree of association with per capita agricultural income. It goes up from Rs. 1,066 for nonelectrified villages to Rs. 1,543 for villages electrified for more than ten years.

The relationship of VPROD with intensity of electrification (ACNSA) is, however, erratic. It rises steadily from ACNSA = 1-15 (Rs. 1,394) to ACNSA = 26-40 (Rs. 2,073). However, for the intensively electrified villages, it drops. The finding is similar in relation to ACYSE--value of agricultural income goes up steadily from Rs. 1,252 (0+NE villages) to Rs. 1,622 (ACYSE > 1-2), but then decreases to Rs. 1,338. In sum, the association between rural electrification and agricultural income per

Table 5-47. Labor Productivity (YLABR) and Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	4706.17 (48)	5579.48 (29)	7817.62 (14)	9110.34 (24)
Andhra Pradesh	10220.21 (7)	6825.12 (17)	6556.25 (4)	1773.89 (1)
Maharashtra	2545.85 (16)	4265.20 (9)	7075.43 (7)	1276.44 (3)
Punjab	-	2224.03 (2)	11231.22 (3)	11030.06 (18)
West Bengal	4544.85 (25)	2942.99 (1)	-	7251.99 (2)

Note: Figures in parentheses indicate sample size.

Source: Present Study.

Table 5-48. Per Capita Agricultural Income (VPROD) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	1066.13 (25)	1474.67 (34)	1543.32 (56)
Andhra Pradesh	968.30 (1)	2350.88 (10)	1848.56 (18)
Maharashtra	560.11 (4)	644.93 (14)	1127.76 (17)
Punjab	-	675.15 (5)	1813.20 (18)
West Bengal	1172.22 (20)	2285.03 (5)	447.49 (3)

Note: Figures in parentheses indicate sample size.

Source: Present study.

capita is not clear and the results are somewhat inconclusive. A plausible explanation for the drop in higher intensity categories may be that the rural economy has diversified into secondary and tertiary sectors subsequent to rural electrification--a conclusion which is supported in later chapters.

Table 5-49. Per Capita Agricultural Income (VPROD) and Agricultural Connections (ACNSA)

State	Zero connections & non-electrified	1-15 connections	16-25 connections	26-40 connections	Above 40 connections
Pooled	1620.98(39)	1394.45(43)	1900.76(10)	2073.47(6)	1268.06(17)
Andhra Pradesh	1576.42(4)	2123.37(21)	2031.73(2)	1395.56(2)	-
Maharashtra	979.70(9)	715.01(19)	1719.65(5)	1734.26(1)	506.38(1)
Punjab	-	486.18(2)	2115.28(3)	2638.47(3)	1385.31(15)
West Bengal	1351.05(26)	813.15(1)	-	-	270.92(1)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-50. Per Capita Agricultural Income (VPROD) Rate of Agricultural Connections (ACYSE)

State	Zero connections & non-electrified	<1 connection per YSE	1-2 connections per YSE	>2 connections per YSE
Pooled	1252.31 (48)	1571.37 (29)	1621.74 (14)	1337.68 (24)
Andhra Pradesh	2048.81 (7)	2130.62 (17)	1661.48 (4)	543.03 (1)
Maharashtra	755.63 (16)	891.42 (9)	1387.52 (7)	382.38 (3)
Punjab	-	486.18 (2)	2115.28 (3)	1594.17 (18)
West Bengal	1347.17 (25)	813.15 (1)	-	859.50 (2)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Impact of Rural Electrification on Agriculture - Household (Farm) Level

Past research on impact of rural electrification is mainly at the household/farm level. Our attempt therefore is not so much to complement past evidence as to revalidate or question some of the past findings. The analysis of farm-level impact has been conducted at the tabular level, by controlling for presence/absence of electricity across three farmer categories--large, medium and small farmers. The agriculture sector indicators considered are: size of operational holding, number of fragments, actual and percent gross irrigated area, use of other agricultural innovations, and income from cultivated land.

The first two variables--size of operational holdings and number of fragments--are not really "impact" variables, as they might possibly be determinants of use of rural electrification. Additionally, we could have considered variables such as cropping intensity, yields by various crops, area under high yielding varieties, and use of human/animal labor. However, given the volume of previous evidence on these indicators, they were not examined in our analysis.

The data base for household level analysis was Part 1 of the Household Questionnaire.[22] All analysis is at the "pooled" level (that is, Andhra Pradesh, Maharashtra, Punjab, and West Bengal).

Size of Operational Holdings

The basic data are presented in table 5-51. Across all three categories, electrified farms are larger in size than non-electrified farms. The difference is approximately 28 percent for larger farmers and 46 percent for small farmers; for medium farmers, the difference is much less, at 15 percent. In the case of large and medium farmers, though the average farm size is larger, the difference is not statistically significant. The t statistics reveal a significant difference only in the case of small farmers.

Table 5-51. Size of Operational Holdings by Farmer Category

Farmer category	Size of holding (in acres)	
	Electrified farm (E)	Non-electrified farm (NE)
Large farmer (LF)	22.45 (29)	17.61 (41)
Medium farmer (MF)	8.08 (12)	7.05 (64)
Small farmer (SF)	4.05 (20)	2.79 (48)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Statistics : $t_{LF} = 1.37$
$t_{MF} = 1.26$
$t_{SF} = 3.36$*

*Significant at 95 percent.

22. Sampling details are described in volume 2, appendix 1 and the analytical framework in volume 2, appendix 2. The questionnaire is shown in volume 2, appendix 4.

Number of Fragments

The extent of fragmentation of landholdings in India is very high and attempts to consolidate holdings here have not been very successful. As farm size increases, the number of fragments also generally tends to increase. Some previous studies have indicated that the greater fragmentation inhibits the growth rate of agricultural connections. A farmer may not consider a pumpset viable if his land holdings are scattered.

The data in table 5-52 reveal that there is a significant decrease in the number of fragments from large farmer to small farmer for non-electrified farms. Meanwhile, electrified farms generally are less fragmented. The difference is statistically significant (at 95 percent) for large and medium farmers, but not significant in the case of small farmers. Thus the land-holding fragmentation seems to be much lower in the case of electrified farms.

Table 5-52. Number of Fragments by Farmer Category

Farmer category	Number of fragments	
	Electrified farm (E)	Non-electrified farm (NE)
Large farmer (LF)	3.06 (18)	8.00 (31)
Medium farmer (MF)	1.70 (10)	6.70 (43)
Small farmer (SF)	2.60 (15)	3.21 (34)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Statistics: $t_{LF} = 2.36$*

$t_{MF} = 4.13$*

$t_{SF} = 1.23$

*Significant at 95 percent.

Irrigated Area

The data on gross irrigated area (in acres) are shown in table 5-53. It is evident--and this evidence supports the village level findings--that rural electrification has an extremely significant impact on gross irrigated area. The difference is as much as 106 percent and 135 percent in the case of large and small farmers, respectively, and 63 percent in the case of medium farmers. Statistical tests of significance indicate that in all three categories, electrified farms have significantly more gross irrigated area.

Table 5-53. Gross Irrigated Area (in acres) by Farmer Category

Farmer category	Gross irrigated area (in acres)	
	Electrified farm (E)	Non-electrified farm (NE)
Large farmer (LF)	13.17 (29)	6.38 (40)
Medium farmer (MF)	5.64 (11)	3.46 (63)
Small farmer (SF)	3.10 (20)	1.32 (47)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Statistics: $t_{LF} = 3.10^{*}$

$t_{MF} = 2.26^{*}$

$t_{SF} = 4.85^{*}$

The percentage of farm land under irrigation is presented in table 5-54. For electrified farms, percent irrigated farmland is much higher for all farmer categories. A large farmer with electricity has about 59 percent of his land under irrigation while a small farmer with electricity has 77 percent of his land under irrigation. Among non-electrified farms, not only is the percentage of irrigated area much lower, but the differences among the three farmer categories do not follow the same pattern as in the case of electrified farms. Irrigation by means of rural

Table 5-54. Percent Irrigated Area by Farmer Category

Farmer category	Percent area irrigated of total farm area Electrified farm (E)	Non-electrified farm (NE)
Large farmer	58.67	36.11
Medium farmer	69.80	49.08
Small farmer	76.54	47.31

Source: Present study.

electrification apparently benefits all categories of farmers, and it appears to benefit the small farmer even more than large farmers in terms of percentage of landholding brought under controlled irrigation.

Use of Innovations

Past evidence has shown that irrigation normally accompanies increased levels of use of other agricultural innovations. In the village-level analysis in the previous section, the relationship between rural electrification and use of innovations was one of the strongest associations found in the multivariate analysis, confirming that rural electrification has indeed significantly contributed to the use of innovations. But note that the reverse was not necessarily found to be true (see section entitled "Preconditions for Rural Electrification Success in the Agricultural Sector").

Data relating to use of four agricultural inputs--high yielding varieties (HYVs), fertilizers, pesticides and tractors--is presented in table 5-55. In the case of large and medium farmers, a larger percentage of electrified farms use HYVs, fertilizers and pesticides, while among small farmers, there is not much of a difference. However, our sample of farms comes from electrified villages only (and mostly villages electrified for more than five years), and the finding that rural electrification may lead to higher innovation use at the village level might explain the high percentage of use among non-electrified farms. The presence of a possible demonstration effect cannot be ruled out.

Table 5-55. Percentage Farmers Using Other Innovations, by Farmer Category

Farmer category	Percent farmers using							
	HYV		Fertilizer		Pesticide		Tractor	
	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified
Large farmer	92.86 (28)	77.78 (36)	96.43 (28)	83.33 (36)	85.71 (28)	77.78 (36)	21.43 (28)	25.00 (35)
Medium farmer	85.71 (14)	68.25 (63)	100.00 (14)	92.06 (63)	92.86 (14)	77.78 (63)	21.43 (14)	26.98 (63)
Small farmer	78.95 (19)	82.61 (46)	94.74 (19)	93.48 (46)	84.21 (19)	84.44 (46)	11.11 (18)	23.91 (46)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Farmers also were asked to rank, from one to five, the importance of various inputs in improving agricultural productivity. The results are shown in table 5-56. There is a high degree of similarity of responses between all three farmer categories and between farmers with and without electricity. The inputs, ranked in terms of their descending order of reported importance are: (1) irrigation, (2) high yielding varieties, (3) fertilizers, (4) pesticides, and (5) tractors. Though an expected finding, this reaffirms the importance of rural electrification in agriculture. The use of rural electrification for irrigation and the importance attached to irrigation by farmers indirectly confirms the importance of rural electrification.

Income from Cultivated Land

Lastly, we look at the relationship between rural electrification and farm income. The data is shown in table 5-57. Of the three farmer categories, electrified farms have higher incomes. The difference is as much as 52 percent in the case of large farmers, while it is 15 percent in the case of small farmers and only 0.4 percent in the case of medium farmers. However, a test for statistical significance does not indicate a difference in the case of medium and small farmers at any reasonable level of significance. In the case of large farmers the difference is statistically significant at 90 percent. Because one of the goals of the sampling design was to control for occupation and income level, this result is to be expected. From such a cross-sectional sample it is impossible to infer that rural electrification leads to higher incomes, or vice versa.

Table 5-56. Ranks of Innovations by Farmer Category

Farmer category	RANK OF									
	Irrigation		HYV		Fertilizer		Pesticide		Tractor	
	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified	Elec-trified	Nonelec-trified
Large farmer	1.89 (27)	1.89 (34)	2.33 (27)	2.46 (35)	2.63 (27)	2.40 (35)	3.89 (27)	4.00 (35)	4.26 (27)	4.21 (34)
Medium farmer	1.64 (14)	1.97 (62)	2.93 (14)	2.38 (63)	2.29 (14)	2.24 (63)	3.86 (14)	3.69 (62)	4.23 (14)	4.54 (61)
Small farmer	1.89 (19)	2.05 (44)	2.26 (19)	2.28 (46)	2.37 (19)	2.29 (46)	3.68 (19)	3.59 (46)	4.79 (19)	4.77 (44)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-57. Annual Net Income from Cultivated Land by Farmer Category

Farmer category	Annual income (rupees)	
	Electrified farm (E)	Non-electrified farm (NE)
Large farmer	17725 (29)	11674 (41)
Medium farmer	7042 (12)	7012 (63)
Small farmer	4032 (19)	3511 (47)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Statistics: $t_{LF} = 1.75$

$t_{MF} = 0.03$

$t_{SF} = 0.75$

Farmer Preferences for Mode of Irrigation

Farmers in all three categories were asked their preferences for energy source for pumping water. The farmer responses, by category, for electricity and diesel are as shown in table 5-58. Nearly 89 percent of all farmers prefer electricity, while only about 8 percent prefer diesel. It is interesting to note that the preference for electricity increases with decreasing land-holding size; for example, 81 percent of large farmers prefer electricity, while 95 percent of small farmers do. Coupled with the finding in table 5-56, where irrigation was given the highest rank, this underlines the importance of rural electrification in the farmers' minds.

Table 5-58. Preference of Energy Source for Pumping Water

Type of farmer	Percent preferring			Sample base
	Electricity	Diesel	Neither	
Large farmer	80.65	16.13	3.22	62 (100%)
Medium farmer	90.48	7.14	2.38	84 (100%)
Small farmer	95.24	1.59	3.17	63 (100%)
All farmers	88.99	8.13	2.88	209 (100%)

Source: Present study.

Rural Electrification and Regional Balance

The availability and use of rural electrification is expected to lead to creation of greater regional balance. In the context of this study, a "region" is not so much a bounded or given geographical area as it is a set of areas or aggregation of villages characterized by a structural or socioeconomic characteristic. Rural electrification could be expected to create balance through its impacts, regardless of the structural variable characterizing a particular region.

There are two types of possible effects that may result from rural electrification:

1. Regardless of the regional characteristic, the effects of rural electrification in electrified villages can be more similar for certain indicators than occurs in non-electrified villages, even when the regional characteristic is controlled for (similarity analysis).

2. Regardless of the regional characteristic, rural electrification should lead to greater stability of certain indicators for electrified villages when compared with non-electrified villages; that is, the relative variations on these indicators should be lower in electrified villages when the regional characteristic is controlled for (stability analysis).

The methodology that we have used for the similarity analysis (1) is to compare the means on certain indicators in electrified villages against those for non-electrified, controlling high/low levels of the regional characteristic. For the stability analysis (2), the coefficients of variation are compared, controlling for high/low levels of the regional characteristic between electrified and non-electrified village.

In the present analysis, as in the village level analysis, "non-electrified" villages include those that have zero agricultural connections. Five types of regions are considered:

1. High isolation versus low isolation regions (GEOIS)
2. Large villages versus small villages (POP81)
3. High literacy versus low literacy regions (LIT71)
4. High inequality versus low inequality regions (TOP10)
5. Kharif (monsoon) versus non-kharif regions (KHARIF)

Each of the variables are described below in the respective subsections. A general rule for defining "high" and "low" has been to consider "above average" and "below average" villages respectively for each concerned indicator.

The three indicators on which we test the regional effects are:

1. Yield index of the village (YIELD)
2. Gross irrigated area as percent of gross cropped area (GIGCA)
3. Cropping intensity (CRINT)

The variables have been defined in volume 2, appendix 3-3. The present analysis should be viewed as tentative and as a first step forward in quantitatively grappling with an issue that has until now not been examined in any detail. There are certain environmental characteristics like soil type and topography that we would have liked to have controlled for, but data were not available on these indicators. In the present analysis we are not so much concerned with making statements relating to the absolute values of indicators as we are with comparing the similarity and stability of indicators.

Rural Electrification and Geographical Isolation (GEOIS)

Geographical isolation of a village has been defined on the basis of scores for the distance of the village from all-weather road, bus stop, railway station and nearest city or town. Data relating to YIELD, GOGCA (irrigated area) and CRINT (cropping intensity) for analysis of "similarity" as well as "variability" are presented in tables 5-59 and 5-60. A glance at the "similarity" analysis table reveals that geographical isolation is strongly associated with yields, gross irrigated area, and cropping intensity; increasing geographical isolation results in across-the-board reductions in all three, regardless of whether the village is electrified or not. The presence of rural electrification seems to improve the indicators, regardless of whether the isolation is high or not, but tests of significance have not been performed. However, the results show that rural electrification may assist in overcoming the effect of isolation for yield, but not for the other variables. The ratio of the means of the high isolation and low isolation villages are higher for electrified villages for both gross irrigated area and cropping intensity.

The findings from the "variability" tables are ambiguous. In general, variation in yield, gross irrigated area, and cropping intensity are lower in the low isolation villages. However, the coefficients of variation for electrified villages are generally higher, showing no contribution from

Table 5-59. Similarity Analysis (GEOIS, Geographical Isolation)

	Mean YIELD			Mean GIGCA (Irrigated Area)			Mean CRINT (Cropping Intensity)		
	High GEOIS	Low GEOIS	High/ low mean	High GEOIS	Low GEOIS	High/ low mean	High GEOIS	Low GEOIS	High/ low mean
Electrified villages	103.71 (31)	119.2 (47)	1.149	15.10 (31)	44.73 (48)	2.963	115.06 (31)	148.20 (48)	1.288
Nonelectrified and zero connection villages	81.85 (27)	113.11 (18)	1.382	12.10 (27)	23.56 (18)	1.947	133.64 (27)	140.26 (18)	1.050

Source: Present study.

rural electrification to agricultural stability irrespective of isolation of a village. This variability analysis therefore is equivocal. The evidence provides little support for the hypothesis that rural electrification assists in creating regional balance where the regions are defined on the basis of the extent of their geographical isolation.

Table 5-60. Variability Analysis (GEOIS, Geographical Isolation)

	Mean YIELD		Mean GIGCA (Irrigated Area)		Mean CRINT (Cropping Intensity)	
	High GEOIS	Low GEOIS	High GEOIS	Low GEOIS	High GEOIS	Low GEOIS
Electrified villages	0.494	0.454	1.563	0.955	0.207	0.245
Nonelectrified and zero connection villages	0.460	0.389	1.165	1.194	0.267	0.199

Source: Present study.

Rural Electrification and Village Size (POP81)

The size of the village is defined on the basis of its 1981 population. Data for this is shown in tables 5-61 and 5-62. The first finding is that yields, gross irrigated area, and cropping intensity are higher in larger villages than in the smaller ones. The ratio of means, except for cropping intensity (where it is very similar), is lower for electrified villages, indicating that rural electrification may help improve the yield and irrigated area of smaller villages. In fact the effect of rural electrification on smaller villages appears to be much more than in larger villages.[23] YIELD increases from 87.67 to 106.42, GIGCA from 15.77 to 32.80, and CRINT from 135.9 to 136.15. Thus, rural electrification appears to help smaller village size by raising yield and irrigated area, if not necessarily by increasing cropping intensity. Regarding stability (the

23. NCAER (1967) also came to a similar conclusion.

	Mean YIELD			Mean GIGCA (Irrigated Area)			Mean CRINT (Cropping Intensity)		
	Large vill-ages	Small vill-ages	High/low mean	Large vill-ages	Small vill-ages	High/low mean	Large vill-ages	Small vill-ages	High/low mean
Electrified villages	139.64 (14)	106.42 (64)	1.312	34.33 (15)	32.80 (64)	1.047	131.04 (15)	136.15 (64)	1.040
Nonelectrified and zero connection villages	137.83 (6)	87.67 (39)	1.572	22.78 (6)	15.77 (39)	1.445	138.77 (6)	135.90 (39)	1.021

Note: Figures in parentheses indicate sample size.

Source: Present study.

variability analysis), smaller villages appear to have somewhat greater stability in yields and irrigated area, while larger villages have somewhat greater stability in cropping intensity.

The overall effect of rural electrification here is not as pronounced as in raising the levels of yield, irrigated area, and cropping intensity. Rural electrification may be an effective policy for helping to increase irrigation in smaller villages, but there is no effect for yield or cropping intensity. Summing up, rural electrification appears to have a favorable balancing effect over village size where levels of certain indicators are concerned.

Table 5-62. Variability Analysis (POP81)

	Mean YIELD		Mean GIGCA (Irrigated Area)		Mean CRINT (Cropping Intensity)	
	High GEOIS	Low GEOIS	High GEOIS	Low GEOIS	High GEOIS	Low GEOIS
Electrified villages	0.479	0.463	1.224	1.180	0.224	0.273
Nonelectrified and zero connection villages	0.467	0.399	1.275	1.282	0.227	0.245

Note: Figures in parentheses indicate sample size.

Source: Present study.

Rural Electrification and Literacy (LIT71)

Data on rural electrification and levels of literacy are shown in tables 5-63 and 5-64. Literacy is associated with yield, gross irrigated area, and cropping intensity, regardless of whether a village is electrified or not. All three variables are higher in the high literacy villages. The evidence gives only moderate support to the hypothesis that rural electrification creates regional balance, once literacy levels of a region are controlled for.

Table 5-63. Similarity Analysis: Literacy (LIT71)

	Mean yield			Mean GIGCA (Irrigated Area)			Mean CRINT (Cropping Intensity)		
	High literacy	Low literacy	High/low mean	High literacy	Low literacy	High/low mean	High literacy	Low literacy	High/low mean
Electrified villages	116.47 (53)	105.72 (25)	1.101	41.98 (54)	13.88 (25)	2.020	142.46 (54)	119.44 (25)	1.193
Nonelectrified and zero connection villages	96.01 (23)	92.55 (22)	1.037	23.65 (23)	9.40 (22)	2.516	152.75 (23)	118.98 (22)	1.284

Note: Figures in parentheses indicate sample size.

Source: Present study.

Table 5-64. Variability Analysis (LIT71)

	Mean YIELD		Mean GIGCA (Irrigated Area)		Mean CRINT (Cropping Intensity)	
	High literacy	Low literacy	High literacy	Low literacy	High literacy	Low literacy
Electrified villages	0.43	0.57	1.03	1.26	0.25	0.23
Nonelectrified and zero connection villages	0.38	0.53	1.05	1.47	0.21	0.20

Source: Present study.

Rural Electrification and Inequality (TOP10)

"Inequality" is defined here as land held by the top 10 land owners as a percentage of net sown area of the village. High inequality villages are those where more than 25 percent of land is held by the top ten land owners. The relevant data is presented in tables 5-65 and 5-66.

Table 5-65. Similarity Analysis: Inequality (TOP10)

	Mean YIELD			Mean GIGCA (Irrigated Area)			Mean CRINT (Cropping Intensity)		
	High inequality regions	Low inequality regions	High low mean	High inequality regions	Low inequality regions	High low mean	High inequality regions	Low inequality regions	High low mean
Electrified villlages	107.16 (31)	110.97 (32)	1.035	38.08 (31)	33.56 (33)	1.135	146.71	130.61	1.123
Nonelectrified and zero connection villages	79.27 (15)	93.93 (27)	1.185	23.34 (15)	11.82 (27)	1.975	143.58 (15)	132.40 (27)	1.084

Note: Figures in parentheses indicate sample sizes.

Source: Present study.

Yield levels are at least slightly negatively associated with land inequality in the village regardless of electrification--electrified high inequality villages have a yield of 107.16, as opposed to low inequality villages having nearly 111. The differences for non-electrified and zero villages are much larger at levels of 79.27 and approximately 94, respectively. However, both cropping intensity and gross irrigated are higher in the high inequality villages.

Rural electrification appears to mitigate the effect of land inequality as far as the levels of indicators are concerned; for example, in the high inequality villages, yield increases from 79.27 to 107.16. Gross irrigated area goes up from 11.82 to 33.56 in the low inequality

Table 5-66. Variability Analysis: Inequality (TOP 10)

	Mean YIELD		Mean GIGCA (Irrigated Area)		Mean CRINT (Cropping Intensity)	
	High inequality regions	Low inequality regions	High inequality regions	Low inequality regions	High inequality regions	Low inequality regions
Electrified villages	0.46	0.42	1.05	1.28	0.27	0.22
Nonelectrified and zero connection villages	0.41	0.51	1.08	1.18	0.23	0.25

Source: Present study.

villages, while cropping intensity remains more or less the same. The balancing effect regarding stability appears to be mixed, and the findings are somewhat inconclusive.

Rural Electrification and Kharif (Monsoon)/Non-Kharif Regions (KHARIF)

A kharif (monsoon) region has been defined as one in which more than 50 percent of the gross cropped area is under kharif rice and jowar (millet). The non-kharif regions in our sample could be equated with rabi (dry season) regions. The data relating to levels and variability of indicators are presented in tables 5-67 through 5-68.

Table 5-67. Similarity Analysis: Monsoon Cropping (KHARIF)

	Mean YIELD			Mean GIGCA (Irrigated Area)			Mean CRINT (Cropping Intensity)		
	Kharif regions	Rabi regions	High low mean	Kharif regions	Rabi regions	High low mean	Kharif regions	Rabi regions	High low mean
Electrified villages	108.45 (40)	121.52 (58)	1.12	19.4 (41)	36.9 (58)	1.90	144.33 (41)	131.80 (58)	1.10
Nonelectrified and zero connection villages	94.5 (12)	67.94 (17)	1.39	16.0 (12)	15.7 (17)	1.02	147.99 (12)	125.77 (17)	1.18

Note: Figures in parentheses indicate sample size.

Source: Present study.

There is a clear difference between electrified and non-electrified and zero connections villages when kharif domination is controlled. This suggests a strong rural electrification effect. Yields are far higher in non-electrified and zero connections kharif villages when compared to non-electrified and zero rabi villages while for electrified villages yields are higher in the rabi villages. The direction of relationships is the same for gross irrigated area.

Rural electrification apparently leads to very significant impacts on rabi villages as opposed to kharif villages. Yield goes up from 67.94 to 121.52, gross irrigated area from 15.7 percent to 36.9 percent, and cropping intensity from 125.77 to 131.80, in the case of rabi villages. In kharif villages, yield increases from 94.5 to only 108.5, gross irrigated area from 16.0 percent to only 19.4 percent, and cropping intensity actually declines slightly.

Thus rural electrification appears to have a very important balancing effect as far as kharif/rabi domination is concerned. In rabi villages all three indicators are higher in electrified compared to non-electrified villages. This in a sense supports the finding on preconditions for agricultural rural electrification success that rural electrification was less successful in the kharif villages. Given the relationship between rural electrification and GIGCA, and that between GIGCA and YIELD, the effect of higher rural electrification growth rates may explain its impact

Table 5-68. Variability Analysis: Monsoon Cropping (KHARIF)

	Mean YIELD		Mean GIGCA (Irrigated Area)		Mean CRINT (Cropping Intensity)	
	Kharif regions	Rabi regions	Kharif regions	Rabi regions	Kharif regions	Rabi regions
Electrified villages	0.45	0.43	1.49	1.11	0.24	0.27
Nonelectrified and zero connection villages	0.36	0.42	1.00	0.64	0.21	0.22

Source: Present study.

on rabi regions. Variability of indicators is also generally lower in rabi electrified villages, while it is similar or worse to kharif villages for rabi non-electrified and zero connections villages. In summary, rural electrification appears to have a favorable effect on balancing rabi (dry sea on) regions vis-a-vis kharif (monsoon) regions.

In summary, regional characteristics such as geographical isolation, village size, literacy, structural inequality, and kharif/rabi domination play an important part in affecting the levels and stability of certain agricultural indicators such as yield, gross irrigated area, and cropping intensity. Rural electrification is expected to act as a balancing force by both equalizing and stabilizing such differences in these quite different regions. Our evidence suggests that rural electrification could play such a role, though the extent of significance in quantitative terms has not been fully gauged. However, rural electrification in particular, seems to assist in improving the levels of certain indicators in smaller villages and in rabi dominated villages. Further, there is certainly no evidence to suggest that rural electrification exacerbates regional imbalances.

Summary of Findings

Our findings in relation to rural electrification and agricultural development are summarized below.

1. In India, past evidence collected predominantly at the farm level has shown that rural electrification is a positive input into agricultural development in terms of changes brought about in irrigated area, cropping intensity, cropping pattern, use of innovations, land yield, and agricultural income. Findings relating to employment have been mixed.

2. From our analysis of temporal response to rural electrification availability in the agricultural sector, a very critical finding is that the rate of response does not slacken over a period of two decades; in fact, in the second decade, response levels are significantly higher than during the first decade.

3. Another critical finding is that certain structural characteristics such as groundwater, high man-land ratio, low kharif (monsoon) area and absence of canal irrigation seem to be stronger determinants of rural electrification agriculture connection growth rates than factors that reflect socioeconomic development (such as levels of innovation use, literacy, credit, yield, cropping intensity, poverty, and regularity of electricity supply).

4. At the village level, rural electrification is very positively associated with increased area under irrigation, increased use of innovations, changes in cropping pattern, and increased cropping intensity. The impact of rural electrification on labor productivity is also positive and significant. However, rural electrification has no significant direct impact on per capita agricultural income or land yield, although the indirect effect through use of innovation is large. The overall impact of rural electrification on number of workers appears to be steady-to-negative--employment input per rupee output decreases, as does female employment; however, male agricultural employment seems to remain steady. It may be pertinent to mention at this juncture, anticipating the findings in chapters 6 and 7 that this decline is accompanied by a very significant employment shift to secondary and tertiary sectors. Thus, while the impact of rural electrification on agricultural employment alone may be negative, this has to be viewed in conjunction with the fact that absorption in the other sectors may increase subsequent to rural electrification.

5. A graphical summary of findings from the village level analysis is shown in figure 5-5. A very suggestive pattern that emerges--though we cannot statistically justify it--is that there appears to be a threshold effect across indicators at the level of 16-25 connections per 1,000 acres net sown area, after which the rate of growth of positive impacts decelerate and that of negative impacts accelerate. If this is indeed true--and it is merely a question of interpretation of data presented in the study--it would have significant implications for the pursuit of an intensive versus extensive strategy of electrification. The threshold pattern would suggest that an extensive strategy may be most beneficial. In any case, after a level of 25-40 connections per 1,000 acres net sown area has been reached, the incremental positive impacts seem to become marginal.

6. At the <u>farm level</u>, evidence suggests that farm having rural electrification tend to have a significantly lower number of fragments. Land holding sizes of farms with electricity, though slightly larger, are not significant. Increase in irrigation and use of innovations are found to be significant. Income increases are found to be significant only in the case of large (that is, more than ten acres of land) farms. Farmers rank irrigation as the most important input in improving agriculture, underscoring the importance of rural electrification. Finally, rural electrification is preferred as the energy source for pumping water by nearly 90 percent of the farmers.

7. At the <u>regional level</u>, evidence from the limited analysis that we have conducted suggests that rural electrification has a somewhat favorable impact on creating regional balance--particularly for rabi (dry season) villages and villages with low populations.

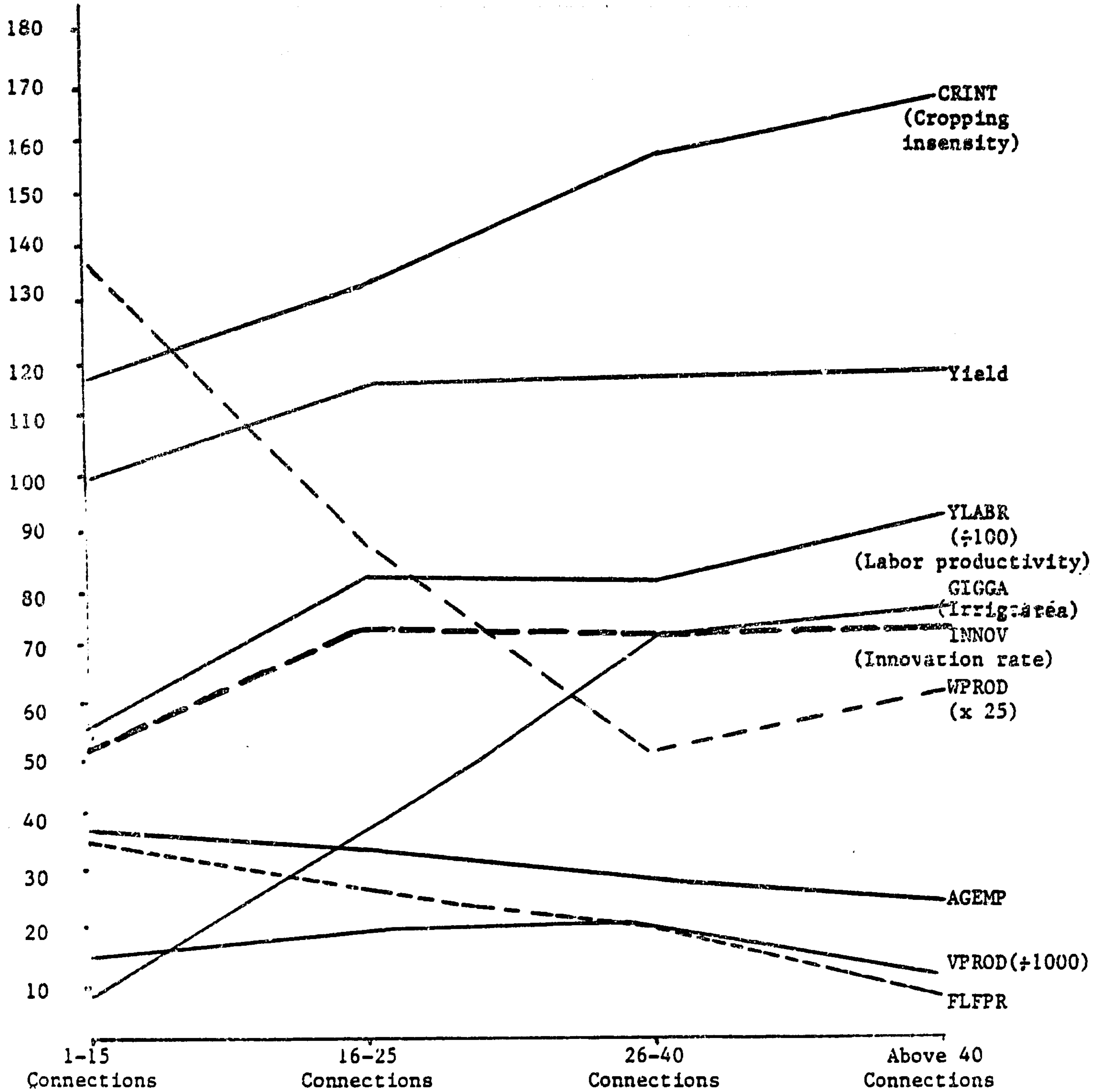

Figure 5-5. Intensity of rural electrification and agricultural indicators.

Source: Present study.

Chapter 6

RURAL ELECTRIFICATION AND INDUSTRIAL DEVELOPMENT

Across much of the Third World, the major impact of rural electrification has been felt in the industrial rather than the agricultural sector in rural areas. In the case of India, however, it is generally accepted that the major economic impact of rural electrification has been on the agricultural sector, with impact on the industrial sector arising from the creation of agricultural surplus and enhancement of rural incomes.

Nevertheless, rural electrification may also have direct impacts on industrialization. The presence of rural electrification may stimulate the growth of new industries through structural alterations in the share of primary and secondary production sectors at the village level. It may lead to greater cost economies, higher capacity utilization, greater labor and capital productivity, employment, and enhanced returns at the firm level. At the intra-firm level, that is, among various firms characterized by different degrees of electricity intensity, rural electrification may lead to overall operational efficiency and greater returns. The effects may also be similar in the case of household manufacture. Thus, there are a variety of effects that are possible in relation to rural electrification and rural industry. We probe these in depth in the various sections below.

There are two types of industries in rural areas--"service" units and "manufacturing" units. In India, service industries are those firms which process against demand, where the raw materials are supplied by the person who demands the service. For example, a rice miller sets up an establishment to grind rice for those who come with the raw material. The manufacturing firm is one that buys and processes raw materials and then finds a market to sell the finished product. It is commonly accepted that the latter type of industrialization involves entrepreneurship, entailing as it does greater capital risk.

Below is a summary of previous studies relating to rural electrification and rural industry in India in terms of temporal response, preconditions for successful response, and impact of rural electrification. Next, we discuss the temporal response of industrial rural electrification based on our own data. We then discuss in detail the impact of rural electrification on rural industry at three levels:[1]

1. Village level nonhousehold manufacture
2. Firm-level nonhousehold manufacture
3. Firm-level household manufacture

Summary of Previous Studies

With regard to temporal response to rural electrification in the industrial sector, the Report on Evaluation of the Rural Electrification Programme (PEO, 1965) studied the growth in connected loads and consumption levels. They found that consumption levels in industry reached significant levels only after five years, and steadily grew for another five years, after which they tended to level off. Consumption per unit of connected load tended to rise for the first ten years and drop thereafter, suggesting possibly that more additional load was created than was warranted. The overall level of utilization of connected load in the industrial sector was found to be comparable to that in the agricultural sector, but was lower than that for street lighting and higher than that for the residential sector.

With respect to preconditions for industrial rural electrification success, the evidence is predominantly from Jain (1975) and SIET (1979). Jain (1975) identified the following impediments to successful industrial response:

1. Absence of local entrepreneurship

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1. There was a fourth level of analysis also initially proposed at the intra-firm level among electrified industries, controlling for the electricity intensity of the firm. However, this was abandoned since no promising results emerged.

2. State bans on industrial connections (to conserve electricity for other purposes)

3. Delays in sanctioning connections

4. Lack of coordination between State Electricity Boards and other agencies

5. Irregular or insufficient electricity supply

SIET (1979) found that adequate industrial development took place only in "central places." The hierarchy or order of central places was found to be a major determinant of relative degrees of industrial development.

The findings on impact of rural electrification on rural industry have generally been positive. Some of the major findings are:

1. The impact on commencement of new industries has been significant. PEO (1965) found that 77 percent of existing industrial units were electrified when operations first began; NCAER (1967) found that 68 percent of sampled industrial units would not have started up had rural electrification not been available; SIET (1976) found that the number of industrial units in selected villages went up from 33 to 127 (that is, up 284 percent); ORG (1980) found that 85 percent of units in sample villages started up after rural electrification; others who have come to similar conclusions are NCAER (1970), MSU (1977), and SIET (1979).

2. Production diversity apparently increases with rural electrification (ORG, 1980).

3. Electrified firms have been found to have comparatively lower operating costs than diesel-operated firms (PEO, 1965; NCAER, 1967 and 1970).

4. There has been an overall increase in profitability (PEO, 1965).

5. The percent of industrial employment is significantly higher in electrified villages (SIET, 1976), suggesting a structural change in the village economy.

6. The overall social cost of electric motors in rural industry was found to be significantly lower than for diesel motors (Jain, 1975).

7. There is evidence of a shift from household to nonhousehold manufacturing consequent to rural electrification (ORG, 1980), suggesting again a possible structural alteration.

8. One study (Jain, 1975) reported, however, that rural electrification did not lead to any significant improvements in capacity utilization, earnings or employment.

Summing up, it would appear that the overall impact of rural electrification on rural industry has been positive; however, in past studies, there has been no clear demarcation of impacts at the village and firm levels.

Temporal Response to Rural Electrification in the Industrial Sector

The data base for analysis of temporal response is longitudinal data collected from State Electricity Boards on yearly connections realized in 90 of the 108 electrified villages in our sample, dated from their respective years since village electrification. The analysis of response has been done at the pooled level,[2] and the first twenty years are presented in figure 6-1. The analysis of data for temporal response by pooling villages electrified over various time periods by equalizing their years of electrification may have been hindered by the presence of a "year" effect or "size" effect;[3] hence such effects, if any, had to be controlled for. However, as was argued earlier, there was no perceptible size effect present in our sample, and the test for year effect did not indicate any (see table 6-2).

The average number of industrial connections per village per year since electrification was found to be 0.15, or on an average, one electrified industry per village nearly every seven years (table 6-1). A glance at the five-yearly trend data reveals that during the first five years, a higher than average response of 0.170 connections was realized, which dropped to 0.084 in the second five years, and remained steady (0.104) during the third five years. In the fourth five years, there was a sharp increase to 0.242 connections per village per year.

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2. That is, not statewide. Statewide analysis was not done since the number of industries for yearly analysis across 20 years was insufficient.

3. This is discussed in greater detail in section 5, and in volume 2, appendix 2-3.

Table 6-1. Temporal Industrial Response to Rural Electrification

Variable	Pooled
Average connections/village/year in the first 20 years	0.15
Standard deviation	0.07
Coefficient of variation	0.47
Average connections/village/year during	
First five years	0.170
Second five years	0.084
third five years	0.104
Last five years	0.242
First decade	0.127
Second decade	0.173

Source: Present study.

Thus, there is a distinctly flattened, U-shaped pattern in industrial response to rural electrification--an initial steady rate of growth followed by a decline at which level the response remains steady for a decade and then increases significantly over the next five years.

This pattern of response may indicate that with the availability of rural electrification, there is an immediate impetus for industrialization that possibly even results in some overcapitalization.[4]

4. This is actually found to be true, as is described under "Village-level Impact."

Table 6-2. Test for Year Effect

Hypothesis: Average industrial connections during the period 1960-1969 = average industrial connections during the period 1970-1979.

Average connections	-	1960-1969	=	0.16
Average connections	-	1970-1979	=	0.15
Standard deviation	-	1960-1969	=	0.07
Standard deviation	-	1970-1979	=	0.06
Computed "t"			=	0.65
Table "t", 90 percent, 19 d.f			=	1.328

Result: Hypothesis is accepted that no "year" effect exists, and that one year of electrification is equivalent to any other.

Source: Present study.

Thereafter, the industries already set up cater only to existing village demand and therefore the growth rate slows down. However, rural electrification during this period may have had impacts on other sectors as well, as in increasing yields and hence incomes from agriculture, leading to overall village development. This, coupled with the growth in population possibly explains the increased rate of industrialization during the latter half of the second decade.

As in the case of the analysis of temporal response to agriculture, we can make a judgment relating to expected numbers of electrified industries in an average sample village. Table 6-3 summarizes these conclusions.

Table 6-3. Expected Number of Industrial Connections

End of year 0	-	0.14
End of year 6	-	Approximately 1
End of year 15	-	2.0
End of year 19	-	3.0

Source: Present study.

As an explanator of industrialization, the only factor that we have considered as a possible precondition is the presence of commercial banks; a more detailed analysis of preconditions for industrial rural electrification success has not been conducted. As can be seen below, villages with commercial banks have a significantly larger number of industries. Of course, this could be partly explained by the population size of the village, since commercial bank branches are present only in the larger villages in the country (see table 6-4).

Table 6-4. Average Number of Industries in Villages With and Without Commercial Banks

Village with	Average number of industries
Commercial bank	8.375 (8)
No bank	1.132 (122)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Industrial Base in Sample States--A Broad Description

Our survey has covered approximately 60 percent of the units[5] in sample villages in relation to our estimate[6] of the actual number of industries. Reasons for lack of response among the other 40 percent included: (a) no responsible person available; (b) industry closed due to seasonal nature of operations; (c) refusal to cooperate. It is possible (as described later) that our sample may have a bias towards industries more recently set up, given the high "mortality rate" of rural industries.

Using the information collected through the village level questionnaire and also that collected from State Electricity Board records, we have

5. The discussion in this section relates explicitly to nonhousehold manufacture.

6. See volume 2, appendix 3-3, for method of estimation.

estimated the average number of industries per sample village for all four states (and pooled):

Table 6-5. Average Number of Industries per Sample Village By Sample State

State	Average number of industries per village
Andhra Pradesh	2.22
Maharashtra	2.14
Punjab	1.17
West Bengal	1.47
Pooled	1.80

Source: Present study.

Punjab has the lowest level of rural industrial development, followed by West Bengal; Andhra Pradesh and Maharashtra have nearly the same level of development, almost twice that of Punjab and one-and-a-half times that of West Bengal.

The lower rural industrial base of Punjab is somewhat surprising and is contrary to expectations, considering the level of penetration of electrification in rural areas there. This may be due to the fact that in Punjab the extent of industrialization in the lower-order towns is far greater than in the other states--the small town industrialization levels in Punjab may be acting as "pulls" weaning industries away from rural areas.

While the data above is indicative of "intra-village" intensity of industrial development in rural areas, table 6-6 shows the extensiveness of rural industrialization.

Table 6-6. Village Industrialization by State

State	Percent villages having industries
Andhra Pradesh	75.0%
Maharashtra	75.0%
Punjab	87.5%
West Bengal	33.3%
Pooled	65.9%

Source: Present study.

It can be seen that in Andhra Pradesh and Maharashtra rural industrial development is relatively intensive and extensive, while in Punjab it is extensive but not intensive. In West Bengal it is neither very intensive nor very extensive. Among the villages contacted, the proportion of electrified industries to total are shown in table 6-7.

West Bengal has the lowest percentage of industries electrified, followed by Punjab. In Andhra Pradesh and Maharashtra more than 90 percent of sample industries are electrified.[7]

Table 6-7. Percent of Industries Electrified by State

State	Percent of total industries electrified
Andhra Pradesh	91.11%
Maharashtra	94.12%
Punjab	79.17%
West Bengal	60.87%
Pooled	85.31%

Source: Present study.

It is interesting to analyze the temporal pattern of commencement of industries in the four states, since the early 1950s (see table 6-8 and figure 6-2). There has been a steady growth in the rate of industrialization over the last thirty years in all states. Of all the existing industries, 40 percent were set up during the period 1976-1980, 23 percent were set up during 1971-1975, 19 percent during 1966-1970, 13 percent during 1961-1965, and only 5 percent during the 1950s.

7. These figures are indicative of only our sample villages, and are not necessarily true for the state as a whole, since Andhra Pradesh and Maharashtra had a large percentage of electrified sample villages as opposed to West Bengal.

Table 6-8. Five-Year Pattern of Commencement of Village Industries to 1980 (percent)

Year	Andhra Pradesh	Maharashtra	Punjab	West Bengal	Pooled
Before 1955	0.00%	5.88%	4.35%	4.55%	3.55%
1956-1960	2.22%	1.96%	0.00%	4.55%	2.13%
1961-1965	17.78%	11.76%	8.70%	9.09%	12.77%
1966-1970	24.44%	9.80%	34.78%	13.64%	19.15%
1971-1975	17.78%	25.49%	26.09%	22.73%	22.70%
1976-1980	37.78%	45.11%	26.08%	45.44%	39.70%
	100.00%	100.00%	100.00%	100.00%	100.00%
Sample base	45	51	23	22	141

Source: Present study.

Andhra Pradesh has the largest number of manufacturing units--approximately 11 percent of total industrial connections--followed by Punjab and West Bengal, which have a little more than 4 percent each. In Maharashtra, virtually all industrial connections are for service units.

The preponderance of service units could be interpreted as meaning that the level of rural industrial development in these states is still at a very preliminary stage in terms of entrepreneurship and levels of venture capital risk. Most of the units in rural areas are cereal processing units. The distribution of industries by various types of products processed or manufactured is shown in table 6-9.

Table 6-9. Distribution of Firms by Type of Product Processed/Manufactured (percent)

Type of firm	Percent firms processing/manufacturing
Processing of superior cereals	87.4
Processing of inferior cereals	46.2
Oilseed crushing	9.8
Cotton ginning	9.8
Pulse processing	9.1
Food processing (including bakeries)	4.9
Sawmills	3.5
Others	4.9
Sample base	143

Source: Present study.

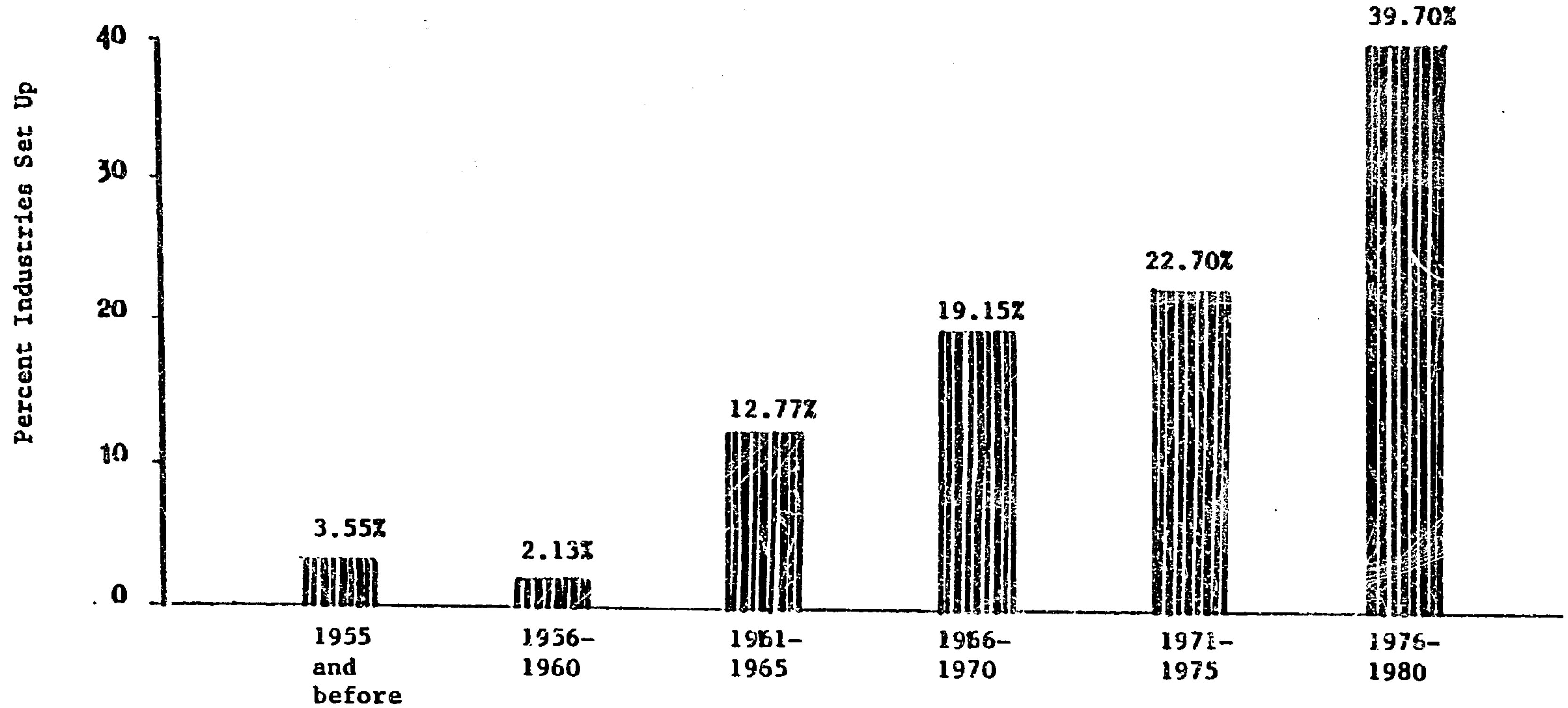

Figure 6-2. Five yearly pattern of commencement of village industries (percent) up to 1980 (pooled).

Source: Present study

Sample base: 141 industries

Some of the key statistics relating to industries in the sample are shown in table 6-10.

Impact of Rural Electrification on Industry - Village Level

In this section the impact of rural electrification on village level non-household manufacture is examined, while in the next section, we analyze firm-level impacts.

Table 6-10. Rural Industries: General Statistics

Indicator	Andhra Pradesh	Maharashtra	Punjab	West Bengal
Number of villages	36	36	24	36
Percent villages with industries	75.0	75.0	87.5	33.3
Percent villages electrified	97.2	88.9	100.0	38.9
Average number of industries/villages (estimated)*	2.22	2.14	1.17	1.47
Percent industries electrified	91.1	94.1	79.2	60.9
Average fixed capital (Rs.)	51,000	12,500	20,750	32,831
Average sales (Rs.)	57,005	5,542	8,321	24,978
Average net revenue (Rs.)	30,026	2,125	2,260	13,159
Average electricity consumption (kWh)	8,931	3,700	2,200	No adequate response
Percent fuel cost to total cost	45.5	63.8	69.6	40.89
Average capacity utilization (%)	49.1	15.4	22.0	41.0
Sample base (number of industries)	45	51	24	22

Source: Present study.

*See volume 2, appendix 3-3.

At the village level, answers are sought for the following questions:

1. Has rural electrification contributed significantly to the process of setting up rural industries?

2. Is the performance of rural industries based on the following indicators[8] better in electrified villages?

   - Number of industries
   - Size of capital
   - Full-time and part-time employment
   - Percent industrial employment to total employment
   - Capital productivity
   - Labor productivity
   - Capacity utilization
   - Fuel economies
   - Net return on gross fixed assets
   - Diversity

The relationship between rate of growth of industries before and after rural electrification is first examined. It may be recalled that we had suspected a possible near-dependent bias in the representation of industries in the sample. To account for this, we first disaggregate the sample into various classes of villages controlled for their years of electrification. Against these various classes, the commencement of industries by five-yearly categories are compared. A strong rural electrification effect on industrialization should indicate a greater average number of industries set up post-electrification, per year, regardless of year of village electrification.

The basic data is presented in table 6-11. There is clear evidence that there is a perceptible rural electrification effect regardless of the specific year in which a village was electrified. For example, it can be seen that villages electrified earlier (that is, before 1961) show a higher rate of response between 1961-1965, 1966-1970 and subsequently. Similarly, villages electrified later (during 1976-1980) show very low rates of commencement of industries during the periods before electrification (that is, 1961-1965, 1966-1970 and 1971-1975). The data is broken down by year of electrification, given the fact that there appears to be an impact on industrial growth in the village regardless of year of village electrification.

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8. The indicators are defined in volume 2, appendix 3-3.

Table 6-11. Year of Village Electrification versus Year of Commencement on Industries
(number of industries set up)

Year of village electrification	Year of commencement					
	Before 1961	1961-1965	1966-1970	1971-1975	1976-1980	All years
Before 1961	3	4	4	6	12	29
1961-1965	3	9	12	5	18	47
1966-1970	3	1	5	11	8	28
1971-1975	1	0	3	3	9	16
1976-1980	-	1	1	3	9	14
All years	10	15	25	28	56	134

Source: Present study.

The rates of growth of industries before and after electrification are compared for the electrified villages of our sample. The "time since electrification" considered are:

a. More than 10 years before rural electrification
b. 6-10 years before rural electrification
c. 1-5 years before rural electrification
d. Year of electrification
e. 1-5 years after rural electrification
f. 6-10 years after rural electrification
g. 11-15 years after rural electrification
h. 16-20 years after rural electrification

The number of industries set up during each of these periods, statewide and pooled, is shown in table 6-12 and graphically in figure 6-3.

There is clear evidence that electrification has significantly aided the process of rural industrialization. The salient features seen are:

- Approximately 85 percent of all industries in electrified villages were started after village electrification.

- The ratio of industries set up annually during the ten years before electrification to ten years after electrification is 1:4.92, or nearly one-to-five.

- 38 percent of all industries were set up within the first five years after (including year of) electrification.

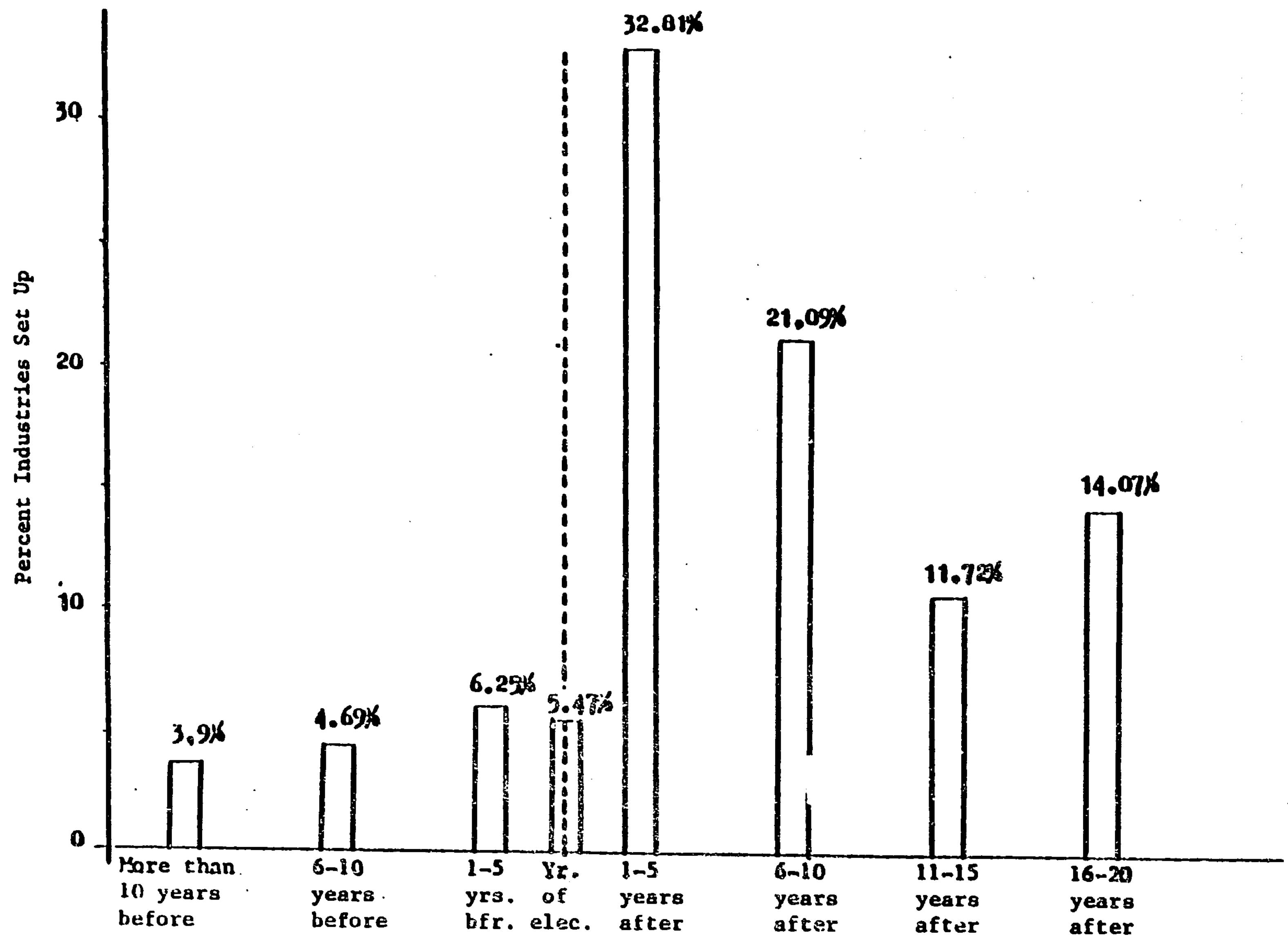

Figure 6-3. Commencement of existing industries (percent) in relation to year of village electrification (pooled).

Source: Present study.

Sample base: 128 industries.

Table 6-12. Industrial Growth in Relation to Year of Village Electrification (electrified villages only) (percent)

Time since electrification	Andhra Pradesh	Maharashtra	Punjab	West Bengal	Pooled
10 years	-	4.17%	4.17%	12.50%	3.90%
6-10 years before	2.50%	4.17%	4.17%	12.50%	4.69%
Year of electrification	5.00%	4.17%	8.33%	6.25%	5.47%
1-5 years after	32.50%	35.42%	25.00%	37.50%	32.81%
6-10 years after	20.00%	25.00%	25.00%	6.25%	21.09%
11-15 years after	15.00%	14.58%	4.17%	6.25%	11.72%
16-20 years after	17.50%	10.41%	16.66%	12.50%	14.07%
Total	100.00%	100.00%	100.00%	100.00%	100.00%
Sample base	40	48	24	16	128

Source: Present study.

Similar patterns corroborate in all four states. It is interesting to note that the pattern of commencement of industries after village electrification as derived from our sample of industries is very similar to the pattern derived from State Electrification Board records on temporal industrial response to rural electrification.This finding is also supported by the perception of village leaders. In response to the question: "What has been the impact of rural electrification on industrial growth in your village?", leaders provided the answers shown in table 6-13.

Table 6-13. Impact of Rural Electrification on Industrial Growth (percent of leaders responding)

State	Industrial growth has been			
	Significant	Negligible	Nil	Don't know
Andhra Pradesh	73.17	19.51	2.44	4.88
Maharashtra	50.98	26.47	21.57	0.98
Punjab	83.33	3.33	6.67	6.67
West Bengal	79.55	18.88	2.27	0.00
Pooled	68.40	18.40	10.07	3.13

Source: Present study.

Nearly 70 percent of the leaders responded by saying that the impact of rural electrification on industrial growth has been significant.

The performance of rural industries at the village level between electrified and non-electrified villages on indicators of interest is shown in table 6-14. The definitions of indicators used in the analysis are shown in volume 2, appendix 3/3, and detailed statewide tables are shown in table 6-15.

We would have preferred to conduct the analysis below by disaggregating for the type of product processed or manufactured so that a greater insight into industries in rural areas could be obtained. However, this was not feasible since most of the industries in the sample were multiproduct firms. Moreover, the dominance of cereal processing units (nearly

Table 6-14. Village Level Industrial Indicators--Electrified versus Nonelectrified Villages (Pooled)

Indicator*	Electrified villages	Nonelectrified villages
Average number of industries**	2.13	0.56
Size of industrial capital Rs.**	82,150	10,576
Number of full-time employees**	5.73	1.14
Number of part-time employees	0.36	0.26
Industrial employees to total, 1971 (%)	14.42	7.44
Capital productivity	0.80	0.91
Labor productivity (Rs.)	11,330	7,640
Capacity utilization (%)	32	33
Fuel cost to total (%)	54	72
Net return on gross fixed assets (%)	44	25
Coefficient of diversity	2.37	1.67
Number of sample industries***	134	9
Number of villages	105	27

Source: Present study.

*The definitions of indicators are shown in volume 2, appendix 3-3 and detailed statewise tables are shown in table 6-16.

**These figures are derived on the basis of village totals estimated as described in volume 2, appendix 3-3.

***The sample base for each indicator differs slightly; see statewide data in table 6-16.

Table 6-15. Village Level Industrial Indicators - Electrified versus Nonelectrified Villages (statewide and pooled)

Indicator	Andhra Pradesh		Maharashtra		Punjab		West Bengal		Pooled	
	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages
Total no. of villages	35	1	32	4	24	--	14	22	105	27
Total no. of industries	44	1	48	3	24	--	18	5	134	9
Estimated no. of industries per village	2.223	1.776	2.265	1.133	1.170	--	2.957	0.523	2.13	0.56
Net return on investment	0.75[1]	0.27	0.20[6]	0.03	0.22[7]	--	0.62[8]	0.40[12]	0.44[16]	0.25[14]
Size of industrial capital (s)	108,016	18,648	28,015	10,174	78,782	—	136,185	13,644	82,150	10,576
Fuel cost to total cost (%)	44.39[2]	92.04	63.29[4]	71.64	68.20[7]	--	35.01[9]	66.35[12]	54.18[17]	71.55[14]
No. of employees										
- Full time	7.655	1.776	2.552	0.378	2.586	--	15.778	1.679	5.73	1.14
- Part time	0.515	--	0.091	0.755	0.094	--	1.311	0.207	0.31	0.26
Labor productivity (Rs)	15273	17955	6364	2291	17357	--	7215	8214	11330	7640
Capital productivity	1.12[1]	1.71	0.59[6]	0.17[3]	0.58[7]	--	0.87[10]	1.08[12]	0.80[18]	0.91[15]
Capacity utilization	0.48[1]	0.33	0.16[5]	0.06	0.23[11]	--	0.41[11]	0.51[13]	0.32[19]	0.33[15]

[1]Only 41 Industries
[2]Only 42 Industries
[3]Only 2 Industries
[4]Only 47 Industries
[5]Only 46 Industries
[6]Only 45 Industries
[7]Only 22 Industries
[8]Only 15 Industries
[9]Only 17 Industries
[10]Only 15 Industries
[11]Only 10 Industries
[12]Only 4 Industries
[13]Only 3 Industries
[14]Only 8 Industries
[15]Only 8 Industries
[16]Only 124 Industries
[17]Only 128 Industries
[18]Only 123 Industries
[19]Only 121 Industries

Source: Present study.

Table 6-16. Disaggregation of Industrial Employment Electrified versus Nonelectrified Villages*

% Employment to total in:	Andhra Pradesh		Maharashtra		Punjab		West Bengal		Pooled	
	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages
Mining etc.	3.66	2.01	2.17	3.93	0.54	0.41	2.19	1.07	2.29	2.06
Household manufacture	4.01	1.36	12.47	4.45	4.82	14.62	3.32	1.46	6.15	3.36
Nonhousehold manufacture	2.70	0.93	3.37	1.00	6.18	1.12	15.95	1.84	4.89	1.39
Construction	0.80	1.10	1.07	0.89	1.40	1.38	0.25	0.18	1.09	0.63
Total	11.17	5.40	19.08	10.27	12.92	17.53	21.71	4.55	14.42	7.44
No. of villages	26	10	15	21	19	5	5	31	65	67

*1971 is the cut-off point for electrification.

Source: Present study.

88 percent of all industries) did not leave an adequate sample base for derivation of various indicators in the non-cereal processing category.

Number of Industries

Electrified villages in our sample have an estimated total of 2.13 industries per village, as opposed to nonelectrified villages which have only 0.56--approximately four times more industries in electrified villages. This finding is supported by our earlier finding on the impact of rural electrification on rural industrialization--it was found that nearly 85 percent of all existing industries started operations after electrification. The longitudinal evidence thus supports the cross-sectional evidence. We would caution that this dramatic difference may be affected by the level of development of the electrified villages.

Industrial Capital

The estimated size of industrial capital in value terms in electrified villages is approximately Rs. 82,150. This is nearly eight times greater than the value of industrial capital in nonelectrified villages. When viewed in conjunction with data on number of industries, this indicates that the per firm value of industrial capital is higher among electrified industries (since 91 percent of all industries in electrified villages in our sample are electrified).

Industrial Employment

Electrified villages have 5.73 full-time industrial employees engaged in nonhousehold manufacture, while nonelectrified villages have only 1.14--that is, a ratio of five-to-one. The number of seasonal employees, as a percentage of permanent employees, is 6 percent in electrified villages, while it is 23 percent in nonelectrified villages. This would indicate that seasonality in operations is lower in electrified villages.

Total industrial employment as a percentage of total employment (as of 1971) was 14.42 percent, or almost twice that of nonelectrified villages (7.44 percent). Total industrial employment has been defined as consisting of the sum of employment in mining and quarrying, etc.,[9] household manufacture and nonhousehold manufacture, and construction sectors.

The disaggregation data, statewide and pooled, is shown in table 6-16. There is clear evidence of a structural change in terms of percentage employment. Further, increases in the share of employment of each of the sectors is noticed--mining/quarrying employment goes up from 2.06 percent to 2.29 percent, household industrial employment from 3.36 percent to 6.15 percent, nonhousehold industrial employment from 1.39 percent to 4.89 percent and construction employment from 0.63 percent to 1.09 percent. The most significant finding is that the relative share of nonhousehold industrial employment in relation to household industrial employment tilts significantly in favor of the former. However, it would not appear to be at the cost of household industry since its percentage share of total (industrial and nonindustrial) employment also goes up.

Assuming that employment structure can be roughly equated with the overall economic structure of the village, one could conclude that rural electrification is associated with diversification of the village economic structure, in favor of the secondary production sectors of the village economy. Within the secondary sector, the strongest relationship is between rural electrification and the nonhousehold manufacturing sector.

Capital and Labor Productivity

Capital productivity in electrified villages is lower, in comparison with non-electrified villages, although labor productivity is far higher in electrified villages.

Lower capital productivity could be reflective of (a) lower utilization of capital, or (b) the achievement of lower unit prices (since capital productivity is defined on the basis of gross sales, in value). But lower capital utilization is definitely not the reason, since the capacity utilization in electrified villages (32 percent) is almost exactly the same as that in nonelectrified villages (33 percent). The reason, therefore, would appear to be achievement of lower unit prices in electrified

9. Though this could be considered as part of the primary sector, our instructions to field teams on definition of "nonhousehold" manufacture included mining and quarrying.

villages, which in turn could be the result of lower prices charged by units in electrified villages. The reason for lower prices may be twofold: (1) cost economies may result, or, (2) because of overcapitalization against relatively static consumer demand, the firm may be forced to price its goods and services lower. Both reasons appear to be equally plausable, given that cost economies are greater among industries in electrified villages (see section below), and competition (as shown by the number of industries), is also greater.

Output per unit of labor is higher in electrified villages; this is again reflective of the relatively more capital-intensive nature of industrial operations. As we noted earlier, the capital in electrified villages is nearly eight times higher, while labor is only five times higher, in comparison with non-electrified villages. The labor input per rupee capital invested is thus higher in non-electrified villages.

Cost Economies

In comparing cost economies, we took percent fuel cost to total cost as the sole indicator, since most firms were service units, and fuel formed the most important cost item. Fuel cost, as a percentage of total cost is only 54 percent in electrified villages, while it is 75 percent in non-electrified villages. Cost economies are, therefore, greater in electrified villages. All units in our sample in non-electrified villages are diesel-operated. Thus, this conclusion could be construed as being valid for industries in electrified villages as opposed to diesel-operated industries.

Return on Gross Fixed Assets

Net return on gross fixed assets is 44 percent in electrified villages, as opposed to 25 percent in non-electrified villages. In absolute terms, therefore, the net return on fixed assets is nearly fourteen times higher in electrified villages. Given that fuel costs form the single most important cost item--the reasons for higher return on fixed assets may not be far to seek--the lower fuel costs incurred by industries in electrified villages may contribute significantly to the higher returns despite lower unit price realization.

Product Diversity

Product diversity in electrified villages, as shown by the average number of different products processed or manufactured per unit in electrified villages, is 2.37, as opposed to 1.67 in non-electrified villages. The percentage of units engaged in various types of processing/manufacturing for the pooled sample is shown below.

Table 6-17. Distribution of Industries in Electrified/Nonelectrified Villages by Type of Product Processed/Manufactured

Type of unit	Percent of industries processing/mfrg.*	
	Electrified villages	Nonelectrified villages
Processing cereals (inferior)	48.5	12.5
Oilseed crushing	10.4	-
Cotton ginning	10.4	-
Processing pulses	9.0	-
Food processing	5.2	12.5
Sawmills	3.7	-
Others	5.2	-
Sample base (no. of industries)	134	8

Source: Present study.

*Multiple reporting gives total percentage greater than 100.

Cereal processing is still the predominant industrial activity in rural areas. Electrified villages have nearly 90 percent of units processing superior cereals (that is, rice and wheat), while in nonelectrified villages, 75 percent are engaged in this activity. This could be reflective of the cropping pattern of electrified villages.[10]

The year of commencement of industries is analyzed against year of electrification among 115 electrified industries in our sample. The data are presented in table 6-18 and graphically in figure 6-4. The results are extremely revealing. Ninety percent of all currently existing electrified industries commenced their operations with electricity. Only 10 percent

10. See section 5, on village level agricultural impact of rural electrification.

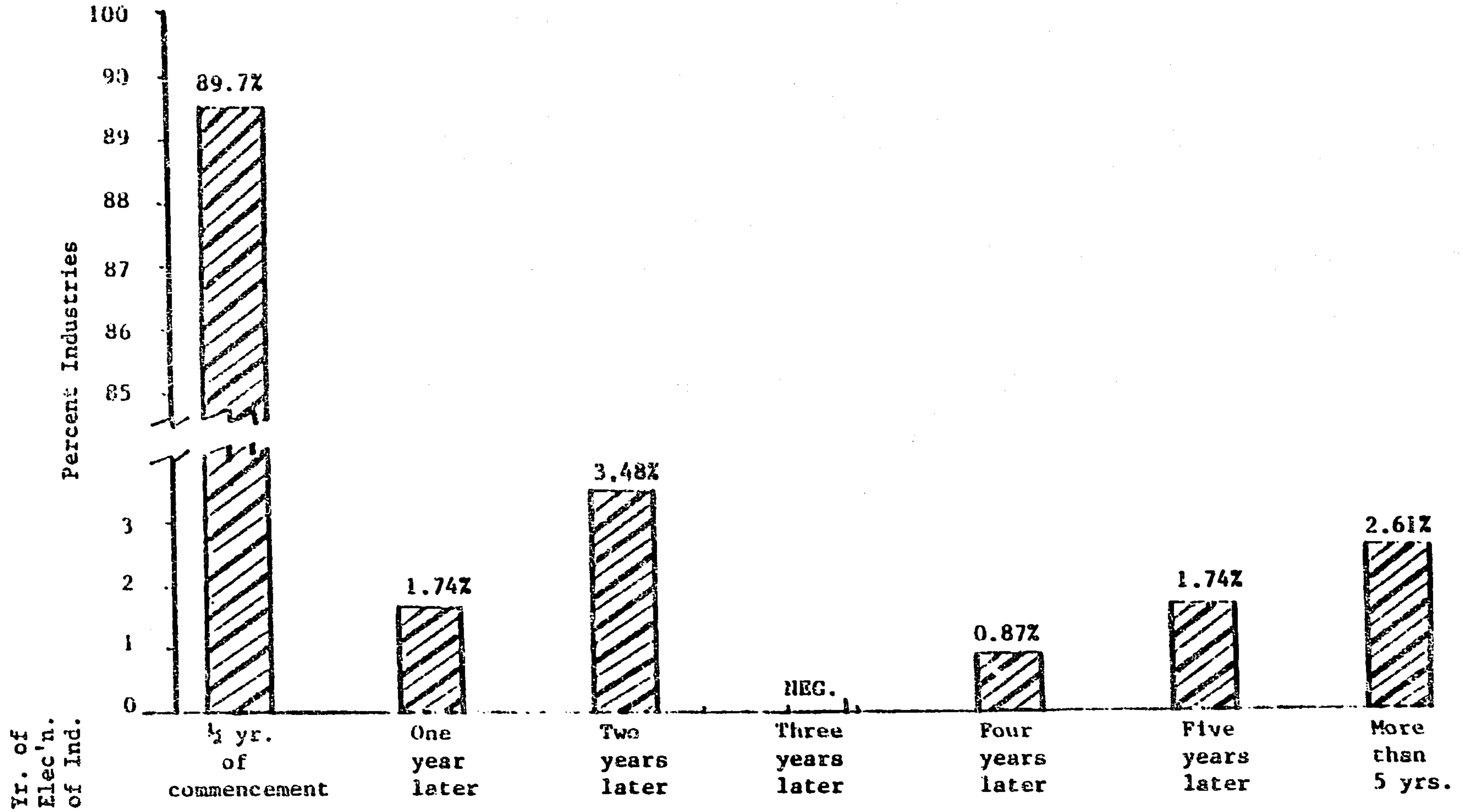

Figure 6-4. Commencement of existing industries (percent) in relation to year of village electrification (pooled).

Source: Present study.

Sample base: 128 industries.

Table 6-18. Percent Industries by Year of Electrification of Industry versus Year of Commencement (electrified villages only, pooled)

YOE / YOC	Same year	One year later	Two years later	Three years later	Four years later	Five years later	More than five years
1961-1965	70.59%	11.76%	--	--	5.88%	--	11.77%
1966-1970	86.96%	--	8.70%	--	--	--	4.34%
1971-1975	92.00%	--	--	--	--	8.00%	--
1976-1980	96.00%	--	4.00%	--	--	--	--
All years	89.57%	1.74%	3.48%	--	0.87%	1.74%	2.60%
Sample base	103	2	4	--	1	2	3

Source: Present study.

converted from other pre-existing sources of energy to electricity. Further, of the 10 percent, 50 percent converted to electricity within the first two years of commencement.

It is also interesting to note that over the years, a steadily increasing percentage of industries in electrified villages commenced their operations with electricity. During the period 1961-1965, only 71 percent of electrified industries commenced their operations with electricity, while during 1976-1980, 96 percent of electrified industries commenced their operations with electricity. The statistics were for the period 1966-1970 were 87 percent, and 92 percent for the period 1971-1975. It can therefore be inferred that the probability of new industry commencing with electricity in an electrified village is extremely high, and over time this probability steadily grows.

Impact of Rural Electrification on Industry-
Firm Level (Nonhousehold)

We have observed at the village level that rural electrification has generally led to positive consequences in terms of various industrial indicators. Below, we look at the firm-level impacts, in terms of electrified and nonelectrified industries, since electrified villages also have non-electrified industries.

Recalling the data presented earlier, 85 percent of the industries in villages in our sample are electrified, the highest being in Andhra Pradesh and Maharashtra, followed by Punjab and West Bengal. The findings regarding similar indicators to those discussed in village-level analysis are described below. The summary data at the pooled level are shown in table 6-19, while detailed statewide data are shown in table 6-20.

The results, and the possible interpretations, are fairly similar to those deriving from the village-level analysis, across all indicators. They may be summarized as follows:

- Size of electrified industries is greater, by a little more than twice.

- Employment in electrified industries is higher; however, employment per unit capital is lower.

Table 6-19. Firm-Level Industrial Indicators--Electrified versus Nonelectrified Industries (pooled)

Indicator*	Electrified industry	Nonelectrified industry
Size of industrial capital (Rs.)	39,586	18,142
Number of full time employees	2.68	2.14
Number of part time employees	0.20	0.10
Capital productivity	0.77	1.01
Labor productivity (Rs.)	10,964	8,367
Capacity utilization (%)	31	33
Fuel cost to total (%)	53	69
Net return on gross fixed assets	44	32
Coefficient of diversity	2.46	1.57
Number of industries**	122	21

Source: Present study.

*The definitions of variables are shown in volume 2, appendix 3/3 and detailed statewide tables are shown in table 6-20.

**The sample base for each indicator differs slightly, see statewise table 6-20.

- Capital productivity is lower, while labor productivity is higher.

- There is no significant difference in capacity utilization between electrified and nonelectrified industries. (In fact, utilization is somewhat low, at a little more than 30 percent of one-shift capacity.)

- Fuel costs are lower in electrified industries. Given the predominance of diesel operated units among nonelectrified firms, this conclusion could be translated into an "electricity versus diesel" comparison.

- Returns on gross fixed assets are higher in electrified industries.

- Diversity is greater in electrified industries. The pattern of products processed/manufactured is shown in table 6-21.

Table 6-20. Firm-Level Industrial Indicators--Electrified versus Nonelectrified Industries (statewide and pooled)

Indicator	Andhra Pradesh		Maharashtra		Punjab		West Bengal		Pooled	
	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages	Electrified villages	Nonelectrified villages
Total no. of industries	41	4	48	3	19	5	14	9	122	21
Net return on investment	0.78[2]	0.36	0.18[5]	0.36	0.21[8]	0.10[7]	0.54	0.41[10]	0.44[18]	0.32[15]
Size of industrial capital (Rs)	51393	8025	13219[4]	4200	90716	16490	35531[12]	31079[9]	39586[16]	18142[14]
Fuel cost to total cost (%)	44.65[1]	53.78	62.16[3]	89.48	65.31[8]	81.21[7]	30.29	62.08[9]	53.07[17]	69.05[8]
No. of employees										
- Full time	3.61	1.00	1.08	1.00	2.42	1.40	5.79	3.44	2.68	2.14
- Part time	0.24	0.00	0.08	0.00	0.11	0.00	0.57	0.22	0.20	0.10
Labor productivity (Rs)	15983[2]	7303	5901	6762	19528[8]	5772[7]	4792	9805[9]	10964[17]	8367[8]
Capital productivity	1.16[2]	0.91	0.50[6]	1.61	0.60[8]	0.49[7]	0.82[12]	1.12[10]	0.77[19]	1.01[15]
Capacity utilization (1979/80)	0.49[2]	0.33	0.16[4]	0.16	0.23	0.20	0.44[13]	0.55[11]	0.31[20]	0.33[15]

[1]Only 39 Industries
[2]Only 38 Industries
[3]Only 47 Industries
[4]Only 46 Industries
[5]Only 45 Industries
[6]Only 44 Industries
[7]Only 4 Industries
[8]Only 18 Industries
[9]Only 7 Industries
[10]Only 6 Industries
[11]Only 5 Industries
[12]Only 13 Industries
[13]Only 8 Industries
[14]Only 19 Industries
[15]Only 17 Industries
[16]Only 119 Industries
[17]Only 118 Industries
[18]Only 115 Industries
[19]Only 113 Industries
[20]Only 107 Industries

Source: Present study.

Table 6-21. Percent Distribution of Units by Type of Product Processed

Type of unit	Percent units manufacturing/processing*	
	Electrified firm	Nonelectrified firm
Cereal processing (superior)	90.2	71.4
Cereal processing (inferior)	50.0	23.8
Oilseeds crushing	11.5	-
Cotton ginning	10.7	4.8
Pulses processing	9.8	-
Food processing	4.9	9.6
Saw mills	2.5	9.6
Others	4.9	4.8
Sample base	122	21

Source: Present study.

*Multiple reporting gives a percentage total greater than 100.

Impact of Rural Electrification on Industry--- Firm Level (Household Manufacture)

The major impact of rural electrification on household manufacture is expected to come via use of power and better lighting which makes possible longer working hours and extended daylight hours. The use of electricity for power in household industry is extremely limited in India, and this is revealed in our sample. The major source of impact is through the availability of better lighting.

Below, we compare the operations of electrified and nonelectrified household industries on the following indicators:

- Number of different items processed
- Number of family members engaged in activity
- Seasonality of work
- Total number of working hours per day
- Total number of working hours during evening/night
- Total income
- Income per family employee.

The basic data are presented in table 6-22. The following conclusions emerge from this table:

- Electrified units manufacture or process a larger number of items (1.88 per firm) than those without electricity (1.11 per firm).
- Electrified units have a larger number of family members engaged in household manufacturing, approximately 31 per cent more than nonelectrified firms.
- Both types of units report a relatively high level of year-round activity. However, 87.5 percent of electrified units report year-round activity as opposed to 74 percent of nonelectrified units.

Table 6-22. Electrified versus Nonelectrified Household Industry--Critical Indicators

Indicators	Electrified firm	Nonelectrified firm
Number of different items processed	1.88 (16)	1.11 (27)
Number of family members engaged in activity	1.94 (16)	1.48 (27)
Percent reporting "round-the-year" activity	87.5 (16)	74.0 (27)
Total number of working hours during whole day	8.93 (14)	7.04 (24)
Total number of working hours during evening/night	2.93 (14)	2.21 (24)
Total annual net income (Rs.)	3791 (28)	2678 (31)
Income (Rs.) per family employee	1954	1809

Note: Figures in parentheses indicate sample sizes.

Source: Present study.

- Electrified firms work for approximately 2 hours more during daylight; however, during the night, they work for approximately three quarters of an hour more. Stated differently, electrified units work approximately 27 percent longer during daylight and 33 percent longer during evening/nights.

- Per firm net incomes of electrified units is higher at Rs. 3,791 per year as opposed to Rs. 2,678 for nonelectrified units (a difference of approximately 42 percent).

- The net income per family member engaged in the activity (Rs. 1,954) is marginally higher for electrified units compared to nonelectrified (Rs. 1,809). This would imply that the productivity of family labor is marginally higher. In sum, the impact of rural electrification appears small but very positive for units engaged in household manufacture.

Summary of Findings

The results show conclusively that rural electrification has been a significant and positive input into industrialization and industrial operations at the village and firm levels for both household and non-household manufacturing sectors. Some of the critical findings are summarized below:

1. Temporal industrial response to rural electrification shows a flattened U-shaped response pattern--a higher than average response during the first five years, followed by a lower rate of response that remains steady over the next ten years, and which again increases significantly during the next five years. However, it should be kept in mind that the average number of connections generated per village per year is only 0.15, or approximately one electrified industry per village every seven years.

2. The presence of commercial banks appears to aid industrial response.

3. The industrial base in rural areas centers predominantly around cereal processing. Moreover, a majority of units are service firms rather than manufacturing firms; the steady but slow growth of industries during the 1970s has been very significant.

4. Industrialization in rural areas in Andhra Pradesh and Maharashtra in terms of industries and village is intensive and extensive regarding diversity of village industries. In Punjab, the rural industries are extensive but not intensive, while in West Bengal, rural industrialization is relatively neither intensive nor extensive.

5. Keeping in mind the qualification that industries that went out of business could not be included in the study, at the village-level the post-electrification industrial growth is nearly five times the pre-electrification growth. Further, there are four times more industries in electrified villages as opposed to nonelectrified villages. The increased rate of growth after rural electrification availability holds regardless of the year of village electrification.

6. Nonhousehold industrial operations in electrified villages are characterized by somewhat a larger size, more full-time industrial labor, relatively less part-time labor, larger percentage of persons employed in the secondary sector, higher labor productivity, higher returns on gross fixed assets and higher diversity, but lower capital productivity. Capacity utilization is not significantly different compared to nonelectrified villages.

7. In electrified villages, almost all industries commence operations with electricity as the energy input.

8. At the nonhousehold manufacturing firm level, between electrified and nonelectrified firms, the findings relating to similar indicators are similar to those at the village level (see number 6 above). Since a predominant portion of nonelectrified industries in our sample are diesel operated, this conclusion may be held roughly as being valid for "electricity versus diesel-operated" firms.

9. Among household industries, rural electrification is associated with a larger number of items being manufactured, greater family employment, longer working hours during the whole day as well as specifically during evenings and nights, (some) reduction in the seasonal nature of operations, significant increases in total income, and marginal increases in family labor productivity.

10. Rural electrification is associated with significant structural differences in the economic structure of the village (as proxied by employment). The percentage employment in the secondary sector rises from

7.44 percent to 14.42 percent and within the secondary employment the share of all sectors increases. The greatest shift is to that of nonhousehold manufacture, in which employment rises from 1.39 percent to 4.89 percent of total work force. However, this increase probably is not at the cost of household manufacture, since aggregate employment in this sector also is much higher, in fact, nearly twice that of nonelectrified villages.

Chapter 7

RURAL ELECTRIFICATION AND THE SERVICES SECTOR

The direct impact of rural electrification on the commercial sector is expected to come via the use of lighting, which makes longer working hours possible, as well as through the use of certain electrical appliances (for example, cold storage and refrigerator). Rural electrification also can have an indirect impact on the commercial sector, since the tertiary sector essentially responds to the primary and secondary production sectors.

Our analysis of rural electrification and the services sector is somewhat sketchy in comparison to the depth in other sectors and is restricted to comparisons based on very few indicators at the village and household levels. Furthermore, analysis of temporal response and preconditions for successful response have not been conducted. The lack of depth of analysis in this sector stems from the fact that the main focus of the study was to examine rural electrification in relation to the sectors where it contributes directly and perceptibly to the production process (that is, the primary and secondary sectors), as well as the contribution of rural electrification to the overall social and demographic aspects of the quality of village life.

At the village level, comparisons are drawn only between electrified and nonelectrified villages, as reflected in the following indicators:

1. Shops per 1,000 persons
2. Percent tertiary sector employment
3. Number of village level institutions per 1,000 persons.

At the household or establishment level, comparisons are made between shops with and without electricity, based on the following indicators:

4. Number of items sold (as an indicator of size)
5. Number of working hours during the whole day
6. Number of working hours during evening/night
7. Number of paid/hired shop assistants
8. Total income
9. Income per hired employee.

Impact of Rural Electrification on Services--Village Level

The data relating to shops per 1,000 persons, institutions per 1,000 persons, and percentage tertiary sector employment are shown in tables 7-1, 7-2 and 7-3, respectively, for each of the states and pooled.

Electrified villages have on an average 4.28 shops per 1,000 persons as opposed to nonelectrified villages having only 3.43, a difference of approximately 25 percent. The higher average number of shops per 1,000 persons are also found in electrified villages statewide.

Regarding institutional development proxied by number of village level institutions per 1,000 persons, the results are mixed. In Andhra Pradesh and Maharashtra, electrified villages have a much higher degree of institutional development than nonelectrified villages. However, in West Bengal, the reverse is true. Reflecting the contribution of a larger proportion of nonelectrified villages in West Bengal, the pooled average

Table 7-1. Number of Shops per 1,000 Persons: Electrified versus Nonelectrified Villages

State	Number of shops/1,000 persons	
	Electrified villages	Nonelectrified villages
Andhra Pradesh	4.47 (35)	0.60 (1)
Maharashtra	3.35 (32)	3.19 (4)
Punjab	3.03 (24)	-
West Bengal	8.11 (14)	3.60 (22)
Pooled	4.28 (105)	3.43 (27)

Source: Present study.

Table 7-2. Number of Village Level Institutions per 1,000 Persons Electrified versus Nonelectrified Villages

State	Number of institutions/1,000 persons	
	Electrified villages	Nonelectrified villages
Andhra Pradesh	3.11 (35)	2.20 (1)
Maharashtra	7.02 (32)	6.44 (4)
Punjab	3.02 (24)	-
West Bengal	5.57 (14)	6.59 (22)
Pooled	4.61 (105)	6.41 (27)

Source: Present study.

number of institutions per 1,000 persons is higher among nonelectrified villages. Thus, the results would seem inconclusive.

Percentage employment (based on 1971 census data) in the tertiary sector in electrified villages is 10.21 percent of the work force as opposed to 6.05 percent in nonelectrified villages, a difference of nearly 69 percent. Assuming that employment can be used as a proxy for the economic structure of the village, this finding suggests that economic activity has shifted to a certain extent toward the tertiary sector in electrified villages.

Table 7-3. Percentage Tertiary Employment to Total Employment: Electrified versus Nonelectrified Villages

State	Percent employment to total	
	Electrified villages	Nonelectrified villages
Pooled	10.21 (63)	6.05 (61)

Note: Figures in parentheses indicate sample size.

Source: Present study.

*Based on 1972 Census data; 1972 is the cut-off point for electrification.

Impact of Rural Electrification on Services--Household (Establishment Level)

The basic data are shown in table 7-4. The findings are summarized below.

1. The number of items sold in shops with electricity is marginally higher, at 14.58, than in shops without electricity (12.66).

2. There is a marginal difference in the number of working hours. Electrified shops work, on an average, for 12.08 hours, while nonelectrified shops work 11.63 hours.

3. During evening and nights, electrified shops work approximately three-quarters of an hour longer. It would appear therefore that the difference in working hours for the whole day comes from the additional time shops are kept open during the evening.

4. There is no difference in the number of hired assistants.

5. Annual income of shops with electricity is far higher than for those without electricity. There is a difference of approximately 38 percent between the annual incomes of electrified and nonelectrified shops.

6. Reflecting the lack of difference in employment and the wide difference in incomes, the net income per employee is far higher in electrified shops. It should be cautioned that some of the differences between electrified and non-electrified shops may be because wealthier shops can afford electrical connections.

The findings relating to income are similar to those of NCAER (1967, 1970); NCAER (1967) found that 95 percent of shopkeepers with electricity reported an increase in income after electrification; the difference in incomes was found to be to the extent of Rs. 532 per year. NCAER (1970) found that, though the cost of power is relatively high compared to the cost of oil (in an establishment not using electricity), the business turnover in a commercial establishment using electricity is higher.

Table 7-4. Indicators Relating to Commercial Establishments Electrified vs. Nonelectrified (pooled)

Indicator	Electrified comm. est.	Nonelectrified comm. est.
Number of items sold	14.58 (40)	12.66 (32)
Working hours during whole day	12.08 (40)	11.63 (32)
Working hours during evening/night	5.40 (40)	4.66 (32)
Number of assistants	2.00 (9)	2.00 (1)
Annual income (Rs.)	4248 (33)	3084 (19)
Income per employee (Rs.)	2124	1542

Note: Figures in parentheses indicate sample size.

Source: Present study.

Summary of Findings

Rural electrification appears to have a positive, though relatively less prominent, effect on the services sector. At the village level, electrified villages have a larger number of shops per 1,000 persons and a larger percentage of employment in the tertiary sector. The finding relating to institutional development is, however, mixed. Village economic activity is far more diversified into the tertiary sector in electrified villages. At the establishment level, rural electrification might lead to marginal increases in size, marginal increase in working hours during the day, a perceptible increase in working hours during evening/night and no increase in number of hired assistants per shop. However, significantly greater per establishment and per employee incomes are found in electrified shops, which may be caused by improvements in a business with electricity, or by wealthier and better run establishments adopting electricity.

Chapter 8

RURAL ELECTRIFICATION AND SOCIAL DEVELOPMENT

Social development is a broad term that encompasses both demographic and social indicators. The consequence of rural electrification may be direct or indirect over the short and long term. For example, changes brought about by rural electrification in the agricultural sector by raising cropping intensity may in turn lead to employment intensity, which could lead to a reduction in seasonal migration. Alternatively, the availability of rural electrification may lead to tapping of groundwater potential for drinking water, which in turn may lead to reduction of incidence of water borne diseases. In the longer run, the availability of rural electrification may lead to changes in working schedules (for example, shops being open longer, children studying longer, household industries running longer, and radio listening) and in turn, changes in lifestyle patterns. On the other hand, social indicators could be affected by rural electrification directly and indirectly, as well as in the short/long runs. For example, the availability of streetlights may contribute to a perception of greater security or increased community interactions after sunset, in the short run.

All these changes, along with those occurring in the economic sectors, will ultimately contribute to changes in rural quality of life. Below, we attempt to look at a wide set of indicators on which rural electrification might possibly have an impact, across both demographic and social sectors and both at the village and household levels. We use the rural electrification variable, residential connections, as the major discriminant of rural electrification-related sociodemographic changes.[1]

---

1. It might have been more appropriate to look at "total connections" (all connections in all sectors) for the village level analysis. However, the data relating to commercial connections were often not of very good quality.

In the succeeding subsections, we first examine past evidence relating to rural electrification and social/demographic sectors. Following this, we discuss temporal response to rural electrification in the residential sector and preconditions for successful residential rural electrification. Finally, we present the evidence relating to impact of rural electrification at the village and household levels. The details relating to indicators being studied are described in the respective subsections.

Summary of Past Evidence

Where it takes up to five years for rural electrification consumption to reach significant levels in agricultural and industrial sectors, it takes only two years in the residential sector according to PEO (PEO, 1965). While consumption levels tend to stabilize after 10 years, consumption per unit connected load levels off after 5 years, suggesting that connected loads increase at a slightly faster rate than consumption levels.

The Administrative Staff College of India (ASCI, 1980) conducted a multiple regression to explain growth in residential connections, using time since electrification along with 11 other variables. "Time" was not significant in explaining growth in connections.

Regarding preconditions for successful residential rural electrification, (that is, connections) past evidence identifies: (1) adequate credit (ORG, 1979, 1980); (2) literacy (ASCI, 1980); and (3) household income (ASCI, 1980). Findings relating to impact encompass both household and village levels. At the household level, most of the findings relate to changes in lifestyle patterns consequent to rural electrification, and to perceptions of rural electrification-related improvements in quality of life. The major source of impact is lighting. Benefits arising from use of other electrical appliances do not appear to have emerged in a significant way, except for the use of radios.

The major findings on the impact of rural electrification at the household level include increase in working hours (PEO, 1965; NCAER, 1967), greater security (ORG, 1977, 1979; PEO, 1965), and improved ability for children to study (ORG, 1979).

Impact of rural electrification on demographic indicators has been studied to a far lesser extent. Studies have not, for the most part, gone beyond non-quantified observations based on opinion surveys. Further, the only variable that has been analyzed is migration.[2] Rural electrification has had some impact on outmigration as well as return migration, according to previous evidence.

PEO (1965) found positive effects in stemming permanent outmigration and in facilitating return migration, especially among professionals. NCAER (1967) also found some reduction (in 23 percent of electrified villages) in permanent outmigration, and limited evidence of return migration. ORG (1979) found that 45 percent of the villages report a reduction in permanent outmigration or increase in return migration after rural electrification. But there is no evidence on seasonal migration and other demographic indicators. In the social sectors, there is no evidence on media habits, asset ownership, quality of life perceptions, and assessment of effectiveness of village level institutions.

Temporal Response to Rural Electrification in the Residential Sector

Based on longitudinal data collected from state electrification boards (SEBs) on yearly connections generated in 90 out of 108 electrified villages in our sample from their respective years of electrification, an attempt is made below to derive patterns of residential rural electrification response over the first two decades since electrification. The indicator used, as in the case of the agricultural and industrial sectors, is average additional connections per village per year since electrification.

The basic data are presented in table 8-1, and figure 8-1 gives a graphic presentation of annual average and cumulative connections over the first two decades. Average additional residential connections per village per year for the pooled sample is found to be 4.37. It is highest in Punjab (5.86), followed by Andhra Pradesh (5.14), Maharashtra (3.39) and

2. For evidence relating to fertility in the Philippines context, see Herrin (1979).

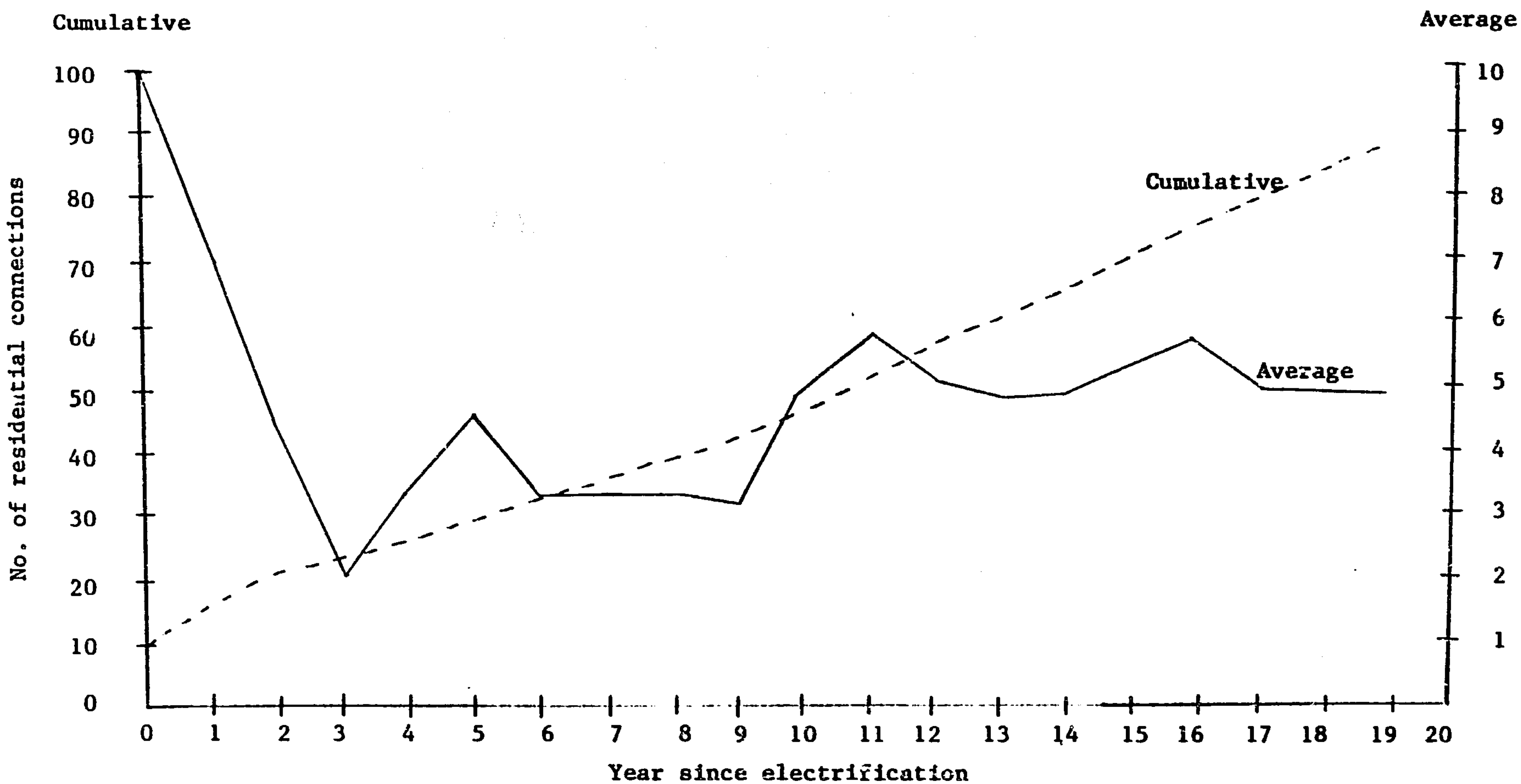

Figure 8-1. Average and cumulative annual response per village in the first two decades since electrification--residential sector (pooled)

Source: Present study.

Table 8-1. Residential Response: Key Statistics

Variable	Andhra Pradesh	Maharashtra	Punjab	West Bengal	Pooled
Average connection/ village/year in the first 20 years	5.143	3.385	6.864	1.858	4.37
Standard deviation	3.452	1.770	3.557	1.516	1.75
Coefficient variation	0.671	0.523	0.607	0.816	0.40
Average connection-					
year 0	16.043	2.215	17.455	1.80	9.64
year 1	10.870	3.467	11.364	2.40	7.39
years 3-7	6.000	3.267	7.636	0.70	4.92
years 8-12	5.976	3.067	3.535	1.92	4.03
years 13-19	3.510	4.832	5.752	2.67	4.42

Source: Present study.

West Bengal (1.86). The pooled coefficient of variation of mean connections is much lower for the pooled sample than for the states taken individually.

Unlike the agricultural sector, there is a marked initial response during the first three years, indicated in the pooled sample by 9.64 connections in year 0, 7.39 connections in year 1, and 4.92 connections in year 2 (Punjab, Andhra Pradesh and West Bengal exhibit remarkable similarity here, but Maharashtra does not). Over the next 17 years, there appears to be a gradual increase, from a base of approximately 2.5 connections.

A t-test for differences in rates of connection growth during the 1960s and 1970s did not indicate any effect (see table 8-2). Therefore, we could analyze yearly patterns of rate growth for villages electrified at different points in time.

Excluding the data for the first three years, where there is clear evidence of marked initial response, we test for a simple linear fit against "time." The equation derived was as follows:

$$C_t = 2.78 + (0.139)\ t$$

$R = 0.71$

$S_b = 0.037$

$t = 3.75$[3] where

C_t = average additional residential connections per village in year t

t = 3,4,...........19, years since electrification

In the pattern of residential response, there is a marked initial response, possibly reflecting pent up domestic demand, in years 0, 1 and 2 since electrification. Response then drops, after which there is a linear increase in the response rate over the next 17 years from a minimum of 2.78 with 9 slope of 1.139.

Table 8-2. t-Test for Year Effect

The Hypothesis: Average connections during 1960-1969 = average connections during 1970-1979

		1960-1969	1970-1979
Average connections	-	4.84	4.44
Standard deviation	-	2.13	2.25
Computed t			0.38

Therefore, the hypothesis that average connections growth during 1960-1969 is similar to rates during 1970-1979 is accepted at the 95 percent level.

Source: Present study.

3. Significant at 99 percent.

As in the case of the agricultui al and industrial sectors, we can make an approximation of the expected number of connections as of a siren year, for an average village in the sample (see table 8-3).

Table 8-3. Expected Number of Residential Connections Per Village as of Various Years

Connections as of year 5	=	31	(approx)
Connections as of year 10	=	48	(approx)
Connections as of year 15	=	69	(approx)
Connections as of year 19	=	86	(approx)

Source: Present study.

Preconditions for Rural Electrification Success in the Residential Sector

The index of village level rural electrification success in the residential sector (RSIHH) is derived in a manner similar to that of the agricultural sector. The index may be interpreted very simply as the number of residential connections per village household, deflated for the length of time for which the village has had access to rural electrification:[4] it could be construed as representing the relative rateat which villages have been responding to rural electrification availability.

The analysis below is predominantly longitudinal, except in the case of two variables where data was not available for 1966 or 1971. The following variables are considered as possible explanators of residential rural electrification success (RSIHH):

CREDIT	-	Percent of farmers who asked for loans getting loans, 1966
MLRAT	-	Man land ratio (as an indicator of population pressure), 1966
INSTNS	-	Number of village level institutions per 1,000 persons (as an indicator of institutional development of the village), 1966
EXCON	-	External contact of village leaders, 1966
POP71	-	Population of the village, 1971

4. The temporal response pattern derived in a later section of this chapter is used. The details of how the index has been derived are described in volume 2, appendix 2-3.

LIT71	-	Percent population literate, 1971
REGSU	-	Regularity of electricity supply in the residential sector (Yes/No variable), 1981
POVER	-	Percent household in the village in poverty, 1981

Since the number of independent variables was not as large as that for the agricultural sector analysis, we proceeded to conduct a multiple regression on the eight variables, without any intervening analysis.

The regression equation for residential sector success of rural electrification derived is as follows:

$$
\begin{aligned}
\text{RSIHH} = \; & 12.48 + (8.21)\ \text{REGSU} - (0.0032)\ \text{POP71} \\
& + (0.2907)\ \text{MLRAT} - (0.0793)\ \text{CREDIT} \\
& - (0.0191)\ \text{INSTNS} + (0.1583)\ \text{EXCON} \\
& + (0.2015)\ \text{LIT71} - (0.0147)\ \text{POVER}
\end{aligned}
$$

$$
\begin{aligned}
n &= 47 \\
R &= 0.57 \\
F_{9,38} &= 2.2
\end{aligned}
$$

and the summary statistics are presented in table 8-4.

Table 8-4. Preconditions for RSIHH

Variable	b	Beta	t	Simple R
REGSU	8.214	0.2646	1.66*	0.28
POP71	-0.0032	-0.4010	-2.46**	-0.12
MLRAT	0.2907	0.3802	2.59**	0.24
CREDIT	-0.0793	-0.1826	-1.21	-0.08
INSTNS	-1.0191	-0.1788	-1.35*	-0.05
EXCON	0.1583	0.2617	1.50***	0.24
LIT71	0.2015	0.1945	1.03	0.09
POVER	-0.0147	-0.0170	0.11	-0.12

Source: Present study.

*Significant at 90 percent

**Significant at 98 percent

***Significant at 85 percent

The variables which appear to have a significant bearing on successful residential response are village size (beta = -0.4010), man/land ratio (beta = 0.3802), regularity of electricity supply (beta = 0.2646), and external contact of village leaders (beta = 0.2617). While supply regularity, higher man/land ratio and increased external contact are positively related to residential connection growth rate, village population is a negative determinant. Credit availability, literacy, institutional development, and poverty in the village do not appear to be related to residential connection growth rate.

The explanatory power of village size possibly results from the fact that smaller population villages also tend to have a smaller geographical area; this is, in fact, borne out by the data in table 8-5:

Table 8-5. Village Population Broken Down by Geographical Area

Population	Average geographical area (acres)
< 1000	763.83
1000 - 1999	1706.46
2000 - 2999	2101.92
> 2999	2976.03

Source: Present study.

Given the smaller geographical area, the layout of electric lines becomes simpler, and this may make it simpler for households and firms to obtain connections. For the same line length, a large percentage of households are able to obtain connections,[5] explaining higher than average growth rate of residential connections.[6]

5. This was also found in ORG (1977).

6. The finding may also be caused by the fact that the denominators of the dependent variable and independent variable are highly correlated.

However, it is interesting to note that increasing man/land ratio is positively related to residential growth rate. This reflects that population density is a positive determinant, which is natural, since greater density implies larger concentration of households for the same geographical area, again implying greater possibility of access given the same line length.

The finding relating to village size and man/land ratio may seem contradictory because increasing population could possibly be related to a greater man/land ratio for villages. However, according to our data, the correlation between man/land ratio and village size is only 0.027, which is not a significant relationship.

It would appear from these two explanators that the layout and length of electric lines have an important bearing on successful response in the residential sector. Further, the finding above indicates that rural electrification can be successful in larger villages too, if the man/land ratio in the village is higher.

That regularity of supply has a positive impact on the rural electrification growth rate is quite an important finding. It is less likely that households will switch to electricity if the experience of others who possess it shows that the investment is not commensurate with expected supply regularity. Given that convenience is perceived as an important benefit of rural electrification, irregular supply will surely impede rural electrification acceptance. This finding may have implications for policies on investment in distribution as opposed to generation, which also was found to be important from the discussion above on village size and man/land ratio.

External contact of village leaders seems to improve rural electrification growth rates, perhaps because of the leaders' exposure to conditions outside the village. For instance, exposure to urban areas may produce a positive response, arising out of a possible demonstration effect. It is pertinent to note that credit, literacy, and poverty, which have been identified as having important preconditions from previous studies, along with the level of institutional development, do not have a bearing on rural electrification success in the residential sector. This finding is similar to that in the agricultural sector.

The absence of an explanatory power of credit for both agricultural and residential sectors may have something to do with intervening institutional changes. The data relates to 1966, and it is well known that credit availability levels in India took a quantum leap only during the 1970s. During this period, banks were nationalized, priority sector lendings were established, and agencies such as MFAL and SFDA were created. This may not, therefore, be reflected in 1966 levels of credit.

The lack of explanatory power of literacy and poverty levels in the village is rather surprising. Further, the interpretation from those variables explaining rural electrification success suggests that power generation and manner of distribution are more prominent, and neither of these factors have much to do with literacy and poverty in the village. A similar argument may hold for the lack of a relationship with level of institutional development.

Impact of Rural Electrification on Social Development--Village Level

In the analysis of the impact of rural electrification on social development, we consider both demographic and social indicators. The control variables used in the analysis are similar to those in the agricultural sector analysis. They are:[7]

- Length of electrification (YSE)
- Intensity of electrification (HHCAP)
- Rate of growth of electrification (HHYSE).

HHCAP is the measure of number of residential connections per 1,000 persons in the village. HHYSE is merely HHCAP divided by the number of years since village electrification (YSE). The interpretation of HHYSE is that it represents the measure of the rate at which the village has been responding to the availability of rural electrification.

7. Also see volume 2, appendices 3-1 and 3-3.

The variables considered in the analysis are:

- Births per 1,000 persons (CBR)
- Deaths per 1,000 persons (CDR)
- Percent child deaths to total births (CDEAT)
- Permanent outmigration per 1,000 persons (OUTMP)
- Seasonal outmigration per 1,000 persons (OUTMS).

The social variables[8] considered in the analysis are:

- Progressiveness of village leaders (PROGR)
- Perception of control over future (CONFU)
- Quality of life perception (QOLP)
- Percent men and women sterilized, to total population (STERL)
- Number of newspapers per 1,000 persons (NEWSP).

It must be emphasized here that especially at the village level, the relationship between rural electrification and social indicators is expected to be indirect and to occur over the long term. Further, there is the question of causality, particularly with respect to the following variables--PROGR, CONFU and NEWSP. Hence, for these variables in particular, and others in general, statements of association may not necessarily constitute a statement on impact of rural electrification. However, the findings that social development indicators do not have a very important bearing on the rural electrification growth rate may lend some credence to the cross-sectional statements on impact. With this limitation in view, we proceed with a description of village level analyses.

Rural Electrification and Birth Rates (CBR)

The relationship here, if any, is expected to be long term and indirect. Through improvements in economic development, literacy and other factors, rural electrification may have an impact on birth rates. The data on CBR against YSE, HHCAP and HHYSE is shown in tables 8-6, 8-7, and 8-8.

8. For definitions, see volume 2, appendix 3-3.

Table 8-6. Birth Rates (CBR) and Years Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	8.08 (27)	13.47 (40)	14.00 (65)
Andhra Pradesh	16.40 (1)	9.05 (12)	12.69 (23)
Maharashtra	13.18 (4)	24.41 (13)	16.81 (19)
Punjab	-	18.41 (5)	15.52 (19)
West Bengal	6.78 (22)	2.08 (10)	0.94 (4)

Table 8-7. Birth Rates (CBR) and Per Capita Household Connectors (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	13.10 (26)	14.65 (39)	15.51 (23)	16.50 (7)	20.11 (22)
Andhra Pradesh	20.06 (2)	11.51 (17)	15.67 (16)	21.19 (1)	-
Maharashtra	21.15 (8)	20.27 (16)	16.68 (6)	16.20 (5)	9.55 (1)
Punjab	-	-	6.00 (1)	13.33 (1)	20.61 (21)
West Bengal	8.21 (16)	8.60 (6)	-	-	-

Source: Present study.

Against all three control variables, birth rates appear to increase with increasing rural electrification effect. For example, the birth rate (CBR) increases from 8.08 to 14.00 in the case of nonelectrified villages and villages electrified for more than 10 years, respectively. Similarly, from 13.10 for O+NE villages, CBR goes up to 20.11 for villages with more than 60 residential connections per 1000 persons. In the cases of rate of household connections (HHYSE), CBR goes up from 13.10 for the O+NE villages to 19.73 for villages with HHYSE greater than 3.5. Multiple regressions to explain CBR, by considering factors such as literacy, access to health facilities, geographical isolation, percentage child deaths, media access and female labor force participation were conducted, but no significant results emerged. The conclusion from the tabular data, although inconclusive, are counterintuitive. If there is a relationship between rural electrification and birthrates, it is a positive one.

Table 8-8. Birth Rates (CBR) and Rate of Household Connections (HHYSE)

State	O+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	13.10 (26)	14.58 (38)	13.83 (15)	14.53 (14)	19.73 (25)
Andhra Pradesh	20.06 (2)	13.97 (16)	15.57 (9)	10.78 (7)	7.06 (2)
Maharashtra	21.15 (8)	18.87 (17)	14.34 (4)	20.71 (4)	18.34 (3)
Punjab	-	-	6.00 (1)	11.00 (2)	21.21 (20)
West Bengal	8.21 (16)	4.90 (5)	3.96 (1)	23.12 (1)	-

Source: Present study.

Rural Electrification and Death Rates (CDR)

As for birthrates, the rural electrification impact, if any, would be expected to occur over the long term and indirectly. Death rates (CDR) against year since electrification (YSE), household connections (HHCAP), and rate of household connections (HHYSE) are shown in tables 8-9, 8-10 and 8-11. There is no relationship between death rates and length of rural electrification, intensity of rural electrification, and rates of growth of rural electrifiction. Multiple regressions to look for alternative explanators did not provide significant results.

Table 8-9. Death Rates (CDR) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	2.97 (27)	5.75 (40)	5.38 (65)
Andhra Pradesh	8.99 (1)	4.00 (12)	4.70 (23)
Maharashtra	7.20 (4)	9.90 (13)	7.70 (19)
Punjab	-	7.70 (5)	4.90 (19)
West Bengal	1.97 (22)	1.49 (10)	0.47 (4)

Source: Present study.

Table 8-10. Death Rates (CDR) and Per Capita Household Connections (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	5.38 (26)	6.09 (39)	6.75 (23)	7.39 (7)	10.15 (22)
Andhra Pradesh	10.27 (2)	4.37 (17)	6.49 (16)	5.12 (1)	-
Maharashtra	8.32 (8)	8.56 (16)	8.32 (6)	8.65 (5)	7.64 (1)
Punjab	-	-	1.40 (1)	3.33 (1)	10.27 (21)
West Bengal	3.30 (16)	4.38 (6)	-	-	-

Source: Present study.

Table 8-11. Death Rates (CDR) and Rate of Household Connections (HHYSE)

State	O+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	5.38 (26)	6.47 (38)	6.57 (15)	5.64 (14)	6.89 (25)
Andhra Pradesh	10.27 (2)	5.22 (16)	7.24 (9)	3.70 (7)	4.98 (2)
Maharashtra	8.32 (8)	8.49 (17)	7.16 (4)	10.72 (4)	7.29 (3)
Punjab	-	-	1.40 (1)	3.33 (2)	7.02 (20)
West Bengal	3.30 (16)	3.67 (5)	3.41 (1)	3.47 (1)	-

Source: Present study.

Rural Electrification and Child Deaths (CDEAT)

Data relating to CDEAT against YSE, HHCAP and HHYSE do not indicate a positive rural electrification effect (tables 8-12, 8-13, and 8-14). Also multiple regressions to look for alternate explanators did not provide significant results.

Table 8-12. Child Deaths (CDEAT) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	13.06 (27)	23.06 (40)	25.73 (61)
Andhra Pradesh	14.80 (1)	21.95 (12)	31.12 (23)
Maharashtra	23.34 (4)	26.02 (13)	23.95 (19)
Punjab	-	46.00 (5)	21.00 (19)
West Bengal	11.11 (22)	9.09 (10)	-

Table 8-13. Child Deaths (CDEAT) and
Per Capita Household Connections (HHCAP)

State	0+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	9.95 (26)	23.97 (39)	33.32 (23)	30.80 (7)	19.67 (22)
Andhra Pradesh	20.57 (2)	22.97 (17)	33.72 (16)	21.43 (1)	-
Maharashtra	18.45 (8)	30.69 (16)	30.68 (6)	18.84 (5)	25.00 (1)
Punjab	-	-	42.86 (1)	100.00 (1)	19.42 (21)
West Bengal	4.37 (16)	8.89 (6)	-	-	-

Source: Present study.

Table 8-14. Child Deaths (CDEAT) and
Rate of Household Connections (HHYSE)

State	0+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	>3.5 conn. per YSE
Pooled	9.95 (26)	26.18 (38)	31.78 (14)	18.20 (13)	21.99 (25)
Andhra Pradesh	20.57 (2)	26.70 (16)	31.94 (9)	16.20 (7)	33.33 (2)
Maharashtra	18.45 (8)	30.26 (17)	28.64 (4)	23.67 (4)	23.48 (3)
Punjab	-	-	42.86 (1)	14.28 (2)	23.96 (20)
West Bengal	4.37 (16)	10.67 (5)	-	-	-

Source: Present study.

Rural Electrification and Permanent Outmigration (OUTMP)

Past evidence has shown that rural electrification has had a positive effect in stemming permanent outmigration from rural areas.

Our village level data, of OUTMP against YSE, HHCAP and HHYSE do not show a clear or conclusive rural electrification effect in relation to permanent outmigration (tables 8-15, 8-16 and 8-17). Also, multiple regressions did not provide satisfactory explanators of OUTMP. But it can be said that permanent outmigration apparently is far higher in electrified villages and warrants further investigation.

Table 8-15. Permanent Outmigration (OUTMP) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	2.11 (27)	5.86 (41)	15.45 (54)
Andhra Pradesh	4.96 (1)	16.22 (12)	33.45 (23)
Maharashtra	1.99 (4)	1.40 (14)	2.12 (18)
Punjab	-	3.84 (5)	2.68 (9)
West Bengal	2.00 (22)	0.67 (10)	0.86 (4)

Source: Present study.

Table 8-16. Rate of Outmigration (OUTMP) and Per Capita Household Connections (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	2.21 (36)	5.94 (41)	17.54 (27)	15.67 (8)	3.24 (21)
Andhra Pradesh	3.12 (2)	13.96 (16)	37.04 (17)	109.61 (1)	-
Maharashtra	2.90 (9)	0.75 (14)	2.31 (8)	2.15 (5)	-
Punjab	-	3.57 (1)	0.40 (1)	1.25 (2)	3.24 (21)
West Bengal	1.89 (25)	0.63 (10)	0.52 (1)	-	-

Source: Present study.

Table 8-17. Permanent Outmigration (OUTMP) and Rate of Household Connections (HHYSE)

State	O+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	2.07 (35)	13.25 (38)	11.79 (17)	20.10 (15)	8.48 (27)
Andhra Pradesh	3.12 (2)	30.43 (16)	21.37 (9)	40.80 (7)	22.40 (2)
Maharashtra	2.26 (8)	1.06 (12)	1.18 (6)	2.22 (6)	3.66 (4)
Punjab	--	3.57 (1)	0.40 (1)	1.67 (1)	8.07 (21)
West Bengal	1.93 (25)	0.50 (9)	0.62 (1)	0.92 (1)	--

Source: Present study.

Rural Electrification and Seasonal Outmigration (OUTMS)

Among the various demographic indicators considered, the one indicator on which rural electrification might have slightly faster impact (though this would still occur indirectly and over the long term) is seasonal outmigration. Since rural electrification leads to increases in irrigation and cropping intensity, a natural corollary may be intensification of labor requirements in agriculture,[9] and hence reduction in seasonal outmigration. The relationship between OUTMS against YSE, HHCAP and HHYSE is shown in tables 8-18, 8-19 and 8-20. There appears to be, prima facie, a positive rural electrification effect. OUTMS goes down from 3.98 per 1,000 population for nonelectrified villages to 0.79 for villages electrified for more than 10 years. However, it increases in the middle category.

Table 8-18. Seasonal Outmigration (OUTMS) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	4.21 (17)	7.65 (33)	1.12 (45)
Andhra Pradesh	-	7.11 (12)	1.23 (23)
Maharashtra	7.33 (4)	10.57 (14)	0.95 (18)
Punjab	-	-	-
West Bengal	3.25 (13)	2.73 (7)	1.30 (4)

Source: Present study.

When the intensity of rural electrification (HHCAP) is controlled for, the effect is more striking. OUTMS goes down steadily from 7.16 for 0+NE villages to 0.00 for villages with more than 60 connections per 1,000 persons. In the case of HHYSE, it goes down from 7.21 for 0+NE villages to 0.46 for villages with HHYSE greater than 3.5; however, the relationship is not as marked as in the case of HHCAP.

9. It may be recalled from chapter 5 that we could not conclusively answer this question.

Table 8-19. Seasonal Outmigration (OUTMS) and Household Connections (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	7.16 (26)	3.75 (38)	1.64 (26)	0.78 (5)	-
Andhra Pradesh	2.56 (2)	5.05 (16)	1.64 (17)	-	-
Maharashtra	13.93 (9)	3.98 (14)	1.18 (8)	0.78 (5)	-
Punjab	-	-	-	-	-
West Bengal	3.71 (15)	0.72 (8)	5.21 (1)	-	-

Source: Present study.

Table 8-20. Seasonal Outmigration (OUTMS) and Rate of Household Connection (HHYSE)

State	O+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	7.21 (25)	4.18 (36)	0.77 (6)	2.88 (13)	0.46 (4)
Andhra Pradesh	2.56 (2)	4.88 (16)	-	4.37 (7)	-
Maharashtra	15.67 (8)	4.65 (12)	0.77 (6)	1.14 (6)	0.46 (4)
Punjab	-	-	-	-	-
West Bengal	3.32 (15)	2.10 (8)	-	-	-

Source: Present study.

Given the prima facie strength of association, we proceed to look at correlations between OUTMS and HHCAP for the non-O+NE villages. The correlation is -0.29, significant at 99 percent (n = 82). Given the strong association between HHCAP and OUTMS, we proceed to conduct a multiple regression by controlling, in addition, for:

- Cropping intensity (CRINT)
- Use of innovations (INNOV)
- Percent adults educated (ADEDN)
- Literacy (LIT71)
- Media access (MEDAC).

All the variables considered in the equations are expected to negatively influence seasonal outmigration. The regression equation is as follows:

$$OUTMS = 13.58 - (0.01)\ CRINT - (7.84)\ INNOV - (0.05)\ ADADN - (0.12)\ LIT71 + (0.01)\ HHCAP - (0.08)\ MEDAC$$

$$n = 82$$

$$R = 0.48$$

$$F_{6,75} = 3.7$$

the summary statistics being:

Table 8-21. Explanators of Seasonal Outmigration (OUTMS)

Variable	b	beta	t	Simple R
CRINT	-0.01	-0.075	-0.46	-0.277
INNOV	-7.84	-0.214	-1.34*	-0.339
ADEDN	-0.05	-0.098	-0.94	-0.250
LIT71	-0.12	-0.282	-2.18**	-0.414
HHCAP	0.01	0.072	0.31	-0.288
MEDAC	-0.08	-0.067	-0.62	-0.216

Source: Present study.
*Significant at 80 percent.
**Significant at 95 percent

The results indicate that literacy (beta = -0.282) and use of innovations (beta = -0.214) are the strongest explanators of reduction in seasonal outmigration. It is pertinent to note that rural electrification intensity (v = -0.288) and cropping intensity (vl = -0.277) are, when individually taken, negatively related to seasonal outmigration. It is possible that their effects are suppressed in the analysis.

The evidence overall is that rural electrification is negatively associated with seasonal outmigration when considered individually;

however, there are also other factors which influence reduction in seasonal outmigration.

Rural Electrification and Progressiveness of Village Leaders (PROGR)

The coefficient of progressiveness does not vary significantly when rural electrification is controlled for, except to some extent for HHYSE. The data are shown in tables 8-22, 8-23, and 8-24. Overall, there appears to be no significant association between rural electrification and progressiveness of village leaders.

Table 8-22. Progressiveness of Leaders (PROGR) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	0.77 (27)	0.75 (40)	0.77 (65)
Andhra Pradesh	0.83 (1)	0.71 (12)	0.77 (23)
Maharashtra	0.66 (4)	0.72 (13)	0.75 (19)
Punjab	-	0.80 (5)	0.78 (19)
West Bengal	0.79 (22)	0.83 (10)	0.78 (4)

Table 8-23. Progressiveness of Leaders (PROGR) and Per Capita Household Connections (HHCAP)

State	0+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	0.78 (40)	0.73 (37)	0.77 (26)	0.76 (8)	0.78 (21)
Andhra Pradesh	0.80 (2)	0.72 (17)	0.77 (16)	0.73 (1)	-
Maharashtra	0.70 (9)	0.72 (13)	0.77 (8)	0.74 (5)	0.71 (1)
Punjab	-	0.69 (1)	0.83 (1)	0.83 (2)	0.78 (20)
West Bengal	0.80 (29)	0.82 (6)	0.73 (1)	-	-

Table 8-24. Progressiveness of Leaders (PROGR) and Rate of Household Connections (HHYSE)

State	O+NE	<1.5 Conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	>3.5 conn. per YSE
Pooled	0.78 (40)	0.75 (34)	0.76 (16)	0.72 (15)	0.82 (27)
Andhra Pradesh	0.80 (2)	0.75 (16)	0.76 (9)	0.70 (7)	0.77 (2)
Maharashtra	0.70 (9)	0.72 (12)	0.74 (5)	0.75 (6)	0.76 (4)
Punjab	-	0.69 (1)	0.83 (1)	0.63 (1)	0.83 (21)
West Bengal	0.80 (29)	0.81 (5)	0.83 (1)	0.77 (1)	-

Source: Present study.

Rural Electrification and Village Leaders' Perception of Control Over Future

The data are shown in tables 8-25, 8-26, and 8-27. Here again, rural electrification and village leaders' perception of control over their future do not seem to be associated.

Table 8-25. Control over Future (CONFU) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	3.31 (27)	2.95 (40)	2.96 (65)
Andhra Pradesh	3.25 (1)	2.79 (12)	2.98 (23)
Maharashtra	2.94 (4)	2.63 (13)	3.01 (19)
Punjab	-	3.50 (5)	2.85 (19)
West Bengal	3.38 (22)	3.30 (10)	3.19 (4)

Table 8-26. Control over Future (CONFU) and Per Capita Household Connections (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	3.15 (40)	2.85 (37)	3.03 (26)	2.97 (8)	2.96 (21)
Andhra Pradesh	2.79 (2)	2.73 (17)	2.95 (16)	3.00 (1)	-
Maharashtra	2.51 (9)	2.87 (13)	3.19 (8)	2.80 (5)	3.00 (1)
Punjab	-	2.67 (1)	3.00 (1)	3.38 (2)	2.96 (20)
West Bengal	3.37 (29)	3.21 (6)	3.00 (1)	-	-

Table 8-27. Control over Future (CONFU) and Rate of Household Connections (HHYSE)

State	O+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	3.15 (40)	2.95 (34)	3.09 (16)	2.82 (15)	2.77 (27)
Andhra Pradesh	2.79 (2)	2.93 (16)	2.86 (9)	2.64 (7)	2.63 (2)
Maharashtra	2.51 (9)	2.94 (12)	3.45 (5)	3.00 (6)	3.00 (4)
Punjab	-	2.67 (1)	3.00 (1)	2.25 (1)	2.75 (21)
West Bengal	3.37 (29)	3.10 (5)	3.25 (1)	3.50 (1)	-

Source: Present study.

Rural Electrification and Quality of Life Perception of Village Leaders

The effect of rural electrification in economic and social sectors is ultimately meant to be in improvements in quality of life. This is a difficult term to measure, and we are not suggesting that the leaders' response to a 7-point scale is a definitive indicator of rural quality of life, but it is certainly a suggestive indicator.

The data are shown in tables 8-28, 8-29, and 8-30. When length of rural electrification is controlled for, QOLP increases from 3.11 for nonelectrified villages to 3.86 for villages electrified for more than 10 years, or an increase of approximately 24 percent.

Similarly, QOLP goes up from 3.09 (for O+NE villages) to 3.81 (for villages with HHCAP greater than 60) when intensity of rural electrification is controlled for--an increase of about 23 percent. The

Table 8-28. Quality of Life (QOLP) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	3.11 (27)	3.70 (40)	3.86 (65)
Andhra Pradesh	4.50 (1)	4.79 (12)	4.60 (23)
Maharashtra	3.00 (4)	2.64 (13)	3.08 (19)
Punjab	-	4.15 (5)	3.94 (19)
West Bengal	3.07 (22)	3.65 (10)	2.63 (4)

effect is also similar in the case of HHYSE: there is an increase of about 21 percent in QOLP, from 3.09 (O+NE villages) to 3.73 (villages with HHYSE ≥3.5). It would thus appear that rural electrification has a positive and favorable impact on village leaders' perception of rural quality of life.

Table 8-29. Quality of Life (QOLP) and
Per Capita Household Connections (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	3.09 (40)	3.89 (37)	4.09 (26)	3.63 (8)	3.81 (21)
Andhra Pradesh	4.09 (2)	4.76 (17)	4.58 (16)	5.50 (1)	-
Maharashtra	2.58 (9)	2.90 (13)	3.13 (8)	3.35 (5)	3.00 (1)
Punjab	-	4.67 (1)	5.00 (1)	3.38 (2)	3.85 (20)
West Bengal	3.18 (29)	3.46 (6)	3.00 (1)	-	-

Table 8-30. Quality of Life (QOLP) and
Rate of Household Connections (HHYSE)

State	O+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	3.09 (40)	3.90 (34)	4.16 (16)	4.03 (15)	3.73 (27)
Andhra Pradesh	4.09 (2)	4.69 (16)	4.70 (9)	4.82 (7)	4.25 (2)
Maharashtra	2.58 (9)	3.07 (12)	3.00 (5)	3.07 (6)	3.25 (4)
Punjab	-	4.67 (1)	5.00 (1)	4.75 (1)	3.77 (21)
West Bengal	3.18 (29)	3.20 (5)	4.25 (1)	3.50 (1)	-

Source: Present study.

Rural Electrification and Success in Sterilization (STERL)

Here again, rural electrification might have only a very indirect and long-term impact. The intervening variables may be factors such as literacy, man/land ratio, female labor force participation, and access to health facilities.

The data are shown in tables 8-31, 8-32 and 8-33. Rural electrification appears to be negatively associated with percentage of men and women sterilized in the village across all three control variables. In the case of YSE, the percentage goes down from 9.68 percent to 7.9 percent;

for HHCAP, it goes down quite significantly, from 10.54 percent to 3.00 percent. Finally, for HHYSE, it goes down from 10.54 percent to 4.70 percent. The direction of the relationship between rural electrification and STERL may explain increasing birth rates at increasingly higher levels of rural electrification. However, simplistic associations between rural electrification and demographic indicators may not provide conclusive answers. Yet, if these findings hold in later analysis, they would contradict many of the assumptions regarding the relationship between rural electrification and birth control.

Table 8-31. Sterilization (STERL) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	9.68 (27)	9.43 (40)	7.90 (65)
Andhra Pradesh	14.93 (1)	7.78 (12)	10.84 (23)
Maharashtra	13.89 (4)	10.98 (13)	9.46 (19)
Punjab	-	1.27 (5)	2.80 (19)
West Bengal	8.63 (22)	13.32 (10)	8.55 (4)

Table 8-32. Sterilization (STERL) and Per Capita Household Connections (HHCAP)

State	O+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	10.54 (40)	8.31 (37)	11.59 (26)	7.61 (8)	3.00 (21)
Andhra Pradesh	16.42 (2)	5.73 (17)	13.31 (16)	14.39 (1)	-
Maharashtra	13.63 (9)	9.24 (13)	10.16 (8)	8.29 (5)	13.92 (1)
Punjab	-	2.67 (1)	2.86 (1)	2.53 (2)	2.45 (20)
West Bengal	9.18 (29)	14.52 (6)	4.12 (1)	-	-

Table 8-33. Sterilization (STERL) and Rate of Household Connections (HHYSE)

State	0+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	≥3.5 conn. per YSE
Pooled	10.54 (40)	8.96 (34)	11.97 (16)	7.36 (15)	4.70 (27)
Andhra Pradesh	16.42 (2)	8.16 (16)	12.89 (9)	7.22 (7)	14.09 (2)
Maharashtra	13.63 (9)	9.69 (12)	9.10 (5)	7.75 (6)	12.24 (4)
Punjab	-	2.67 1)	2.86 (1)	4.22 (1)	2.37 (21)
West Bengal	9.18 (29)	11.00 (5)	27.16 (1)	9.13 (1)	-

Source: Present study.

Rural Electrification and Newspaper Readership (NEWSP)

The availability of rural electrification and consequent socioeconomic development may lead to an increase by rural population in happenings in the outside world, quite possibly leading to habits such as cinema viewing, radio listening, and newspaper reading.

The data on NEWSP against YSE, HHCAP and HHYSE are shown in tables 8-34, 8-35, and 8-36. Length of rural electrification appears to be positively associated with newspaper readership, since number of newspapers per 1,000 persons increases from 2.29 to 6.00, or more than 160 percent. When HHCAP is the dependent variable, NEWSP increases from 1.71 (0+NE) to 7.17 (above 60 connections per 1,000 persons). In fact, in the middle ranges, it increases markedly, and then declines marginally. The finding is similar in the case of HHYSE.

Table 8-34. Newspaper Readership (NEWSP) and Year Since Electrification (YSE)

State	Not electrified	Electrified <10 years	Electrified >10 years
Pooled	2.29 (19)	2.48 (40)	6.00 (64)
Andhra Pradesh	6.20 (1)	2.52 (12)	5.99 (23)
Maharashtra	-	1.01 (14)	1.59 (18)
Punjab	-	4.95 (5)	6.30 (19)
West Bengal	2.07 (18)	3.33 (9)	24.46 (4)

Table 8-35. Newspaper Readership (NEWSP) and
Per Capita Household Connections (HHCAP)

State	0+NE	1-20 conn.	21-40 conn.	41-60 conn.	Above 60 conn.
Pooled	1.71 (32)	2.37 (39)	7.91 (27)	3.73 (6)	7.17 (20)
Andhra Pradesh	3.42 (2)	2.07 (16)	7.03 (17)	14.61 (1)	-
Maharashtra	0.47 (9)	0.72 (14)	2.58 (8)	1.55 (5)	-
Punjab	-	-	1.00 (1)	-	7.17 (20)
West Bengal	2.08 (21)	5.45 (9)	72.41 (1)	-	-

Table 8-36. Newspaper Readership (NEWSP) and
Rate of Household Connections (HHYSE)

State	0+NE	<1.5 conn. per YSE	1.5 - 2.49 conn. per YSE	2.5 - 3.49 conn. per YSE	>3.5 conn. per YSE
Pooled	1.86 (31)	6.11 (37)	3.38 (16)	2.40 (15)	5.64 (27)
Andhra Pradesh	3.42 (2)	6.58 (16)	4.23 (9)	1.94 (7)	5.15 (2)
Maharashtra	0.29 (8)	0.77 (13)	2.77 (5)	1.29 (6)	2.17 (4)
Punjab	-	-	1.00 (1)	10.00 (1)	6.35 (21)
West Bengal	2.31 (21)	13.86 (8)	1.14 (1)	4.62 (1)	-

Source: Present study.

Impact of Rural Electrification on Social Development--
Household Level

At the household level, we again examine a number of social indicators between electrified and nonelectrified households. The indicators could be broadly categorized as demographic variables, asset ownership and incomes, lifestyle variables, and quality of life perception.

The demographic variables in the analysis are household size, number of children born (during last three years), number of deaths (total), number of child deaths, number of members migrating, number of members returning (from permanent migration), and number of school-going children.

The asset ownership and income variables considered are number of household assets, pattern of ownership of electric appliances, and total household income.

The lifestyle variables considered are number of waking hours (wife), number of waking hours (child), time of going to sleep (respondent, wife and child), cinema viewership, newspaper readership, and community participation. The quality of life variables are perception-based indicators derived from a 5-point scale. Quality of life, in relation to father's time, compared to five years ago, compared to neighborhood, and expected in the future are examined.

Tests of statistical significance have been conducted. Where a statement is made in relation to social groups as a whole, we have taken the unweighted average of means of various social groups in an attempt to reflect our original intention of a "quota" sample of equal number across all social groups. The social groups considered in the analysis are: (1) large farmer, (2) medium farmer, (3) small farmer, (4) shopkeeper, (5) artisan, and (6) agricultural laborer.

Demographic Variables

The data are shown in tables 8-37 to 8-43. The findings are summarized in the following paragraphs. The average household size, across both electrified and non-electrified households, seems to decrease with a decrease in the socio-economic scale. Generally, rural electrification households are larger in size, though the difference is significant only in the case of large farmers and agricultural laborers (table 8-37).

Table 8-37. Average Household Size--Electrified versus Nonelectrified Households by Social Group

Social group	Average household size		
	Electrified households	Nonelectrified households	t statistic
Large farmer	9.18 (45)	7.25 (24)	2.05*
Medium farmer	6.02 (45)	6.03 (35)	-0.02
Small farmer	6.51 (37)	6.31 (32)	0.36
Shopkeeper	5.66 (29)	6.32 (25)	-0.93
Artisan	6.41 (29)	5.47 (25)	1.26
Agricultural laborer	5.73 (26)	4.90 (41)	1.49**
Pooled	6.59	6.05	

Note: Figures in parentheses indicate sample size.

Source: Present study.

*Significant at 95 percent.

**Significant at 85 percent.

Table 8-38. Number of Births--Electrified versus Nonelectrified Households by Social Group

Social group	Number of births		
	Electrified households	Nonelectrified households	t statistic
Large farmer	0.76 (45)	0.75 (24)	-0.12
Medium farmer	0.33 (45)	0.43 (35)	-0.71
Small farmer	0.35 (37)	0.50 (32)	-0.87
Shopkeeper	0.38 (29)	0.44 (25)	-0.35
Artisan	0.59 (29)	0.31 (36)	-0.46
Agricultural laborer	0.15 (26)	0.34 (41)	-1.34*
Pooled	0.43	0.46	

Note: Figures in parentheses indicate sample size.

Source: Present study.

*Significant at 80 percent.

Table 8-39. Number of Members Died--Electrified versus Nonelectrified Households by Social Group

Social group	Number of members died		
	Electrified households	Nonelectrified households	t statistic
Large farmer	0.20 (45)	0.25 (24)	-0.50
Medium farmer	0.11 (45)	0.14 (35)	-0.39
Small farmer	0.11 (37)	0.06 (32)	0.74
Shopkeeper	0.10 (29)	0.20 (25)	-0.87
Artisan	0.10 (29)	0.19 (36)	-0.87
Agricultural laborer	0.00 (26)	0.17 (41)	-6.40*
Pooled	0.10	0.17	

Note: Figures in parentheses indicate sample size.

Source: Present study.

*Significant at 99 percent.

Table 8-40. Number of Children Died--Electrified versus Nonelectrified Households by Social Group

Social group	Number of children died		
	Electrified households	Nonelectrified households	t statistic
Large farmer	0.04 (45)	0.08 (24)	-0.61
Medium farmer	0.02 (45)	0.05 (35)	-0.65
Small farmer	0.00 (37)	0.00 (32)	0.00
Shopkeeper	0.00 (29)	0.00 (25)	0.00
Artisan	0.10 (29)	0.11 (36)	-0.11
Agricultural laborer	0.00 (26)	0.05 (41)	-0.68
Pooled	0.03	0.05	

Source: Present study.

Table 8-41. Number of Seasonal Migrants--Electrified versus Nonelectrified Households by Social Group

Social group	Number of seasonal migrants	
	Electrified households	Nonelectrified households
Large farmer	0.02 (45)	0.00 (24)
Medium farmer	0.00 (45)	0.00 (35)
Small farmer	0.00 (37)	0.00 (32)
Shopkeeper	0.00 (29)	0.00 (25)
Artisan	0.00 (29)	0.00 (36)
Agricultural laborer	0.00 (26)	0.03 (41)
Pooled	0.01	0.01

Source: Present study.

Table 8-42. Number of Return Migrants--Electrified versus Nonelectrified Households by Social Group

Social group	Number of return migrants	
	Electrified households	Nonelectrified households
Large farmer	0.04 (45)	0.00 (24)
Medium farmer	0.00 (45)	0.00 (35)
Small farmer	0.03 (37)	0.00 (32)
Shopkeeper	0.07 (29)	0.00 (25)
Artisan	0.00 (29)	0.00 (36)
Agricultural laborer	0.00 (26)	0.00 (41)
Pooled	0.02	0.00

Note: Figures in parentheses indicate sample size.

Source: Present study.

Chapter 9

RURAL ELECTRIFICATION AND EQUITY

The question of rural electrification and equity has seldom been considered in previous studies except, to some extent, in those by ASCI (ASCI, 1980) and the Organizational Research Group (ORG, 1979). ASCI concluded that the distributional impact of rural electrification is not favorable because of inequalities in the distribution of land holdings and social/economic status. However, ORG (1979) did not fully support the contention that rural electrification favored only the higher socioeconomic classes. ORG (1979) indicated that the lower percentage response among small and medium farmers, if any, was determined not by "access," but rather by certain structural characteristics of the farms, such as size of holdings and extent of fragmentation. Below, we address a wider set of equity issues than in previous studies.

The availability and use of rural electrification at the village and household levels may have important consequences for rural equity. One can conceptualize the availability and equity as depicted in figure 9-1. Rural electrification is first available as an <u>input</u> at the village level, and therefore, for use at the household level. Given the availability of rural electrification, there is a <u>process</u> of response to rural electrification. For example, it is possible that the more affluent sections take advantage of rural electrification first, followed by less affluent sections, and so forth. This response leads to the <u>use</u> of rural electrification for both <u>productive</u> and <u>nonproductive</u> purposes. Examples of productive uses might be utilization in agriculture or industry, while nonproductive uses could be rural electrification residential connections.[1] Both these uses lead to certain <u>outputs</u>. In the context of productive use, the output may cause

1. Of course, a part of residential connections may be productively used for household industry or for commercial purposes.

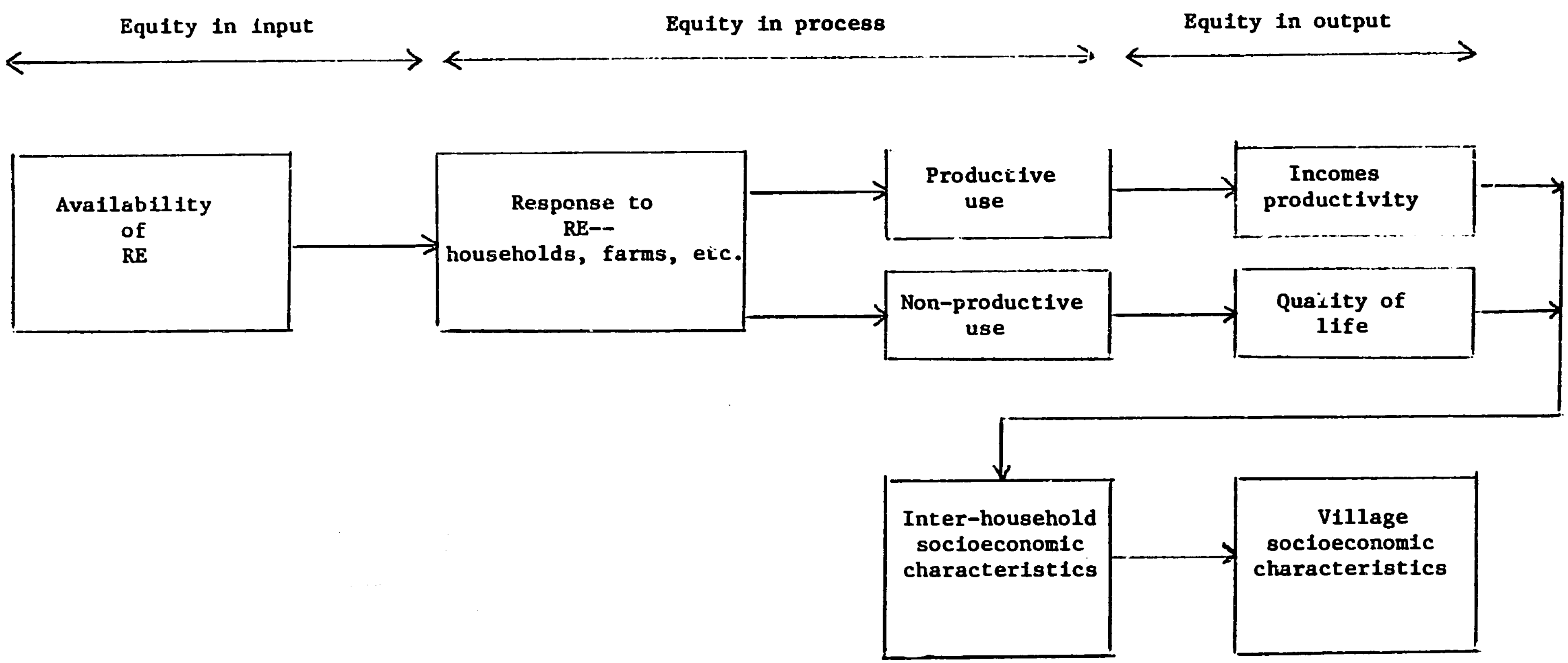

Figure 9-1. Rural electrification and equity--conceptual framework.

Source: Present study.

increases in distribution of incomes, employment and productivity, while in the case of nonproductive use, the output may be the enhancement of certain intangible attributes such as the perception of quality of life. The household level changes may ultimately result in certain alterations at the village level in terms of equity of benefits derived from rural electrification. An additional dimension would be whether the benefits of using of rural electrification accrue equally to the head of the household, his wife, and his children.

The question of equity is present in each of these stages of the output process output. Obviously, this is a complex process with many different linkages, and we have been able to look only at certain aspects of these linkages in a cross-sectional framework. Thus the analysis here should be viewed as somewhat tentative and as a first step in the data analysis.

In the context of the conceptual framework discussed above, we post the following questions:

a. Is the <u>availability</u> of rural electrification at the village level determined by certain environmental inequities (for example, village size, geographical isolation)?

b. Given the availability of rural electrification, does the process of response to rural electrification reflect an inequitable pattern? For instance, do more affluent villagers take advantage of rural electrification first?

c. Are there certain socioeconomic inequities which hinder or facilitate the growth rate of rural electrification once a village has been electrified?

d. Do the outputs from the use of rural electrification result in equal realization of benefits across various socioeconomic classes?

e. Within the household, does the use of rural electrification result in equal distribution of benefits, particularly for women and children?

Because the nature of response and benefits are qualitatively different, in the analysis below we propose to analyze these questions by disaggregating for productive and nonproductive uses of rural electrification. For productive rural electrification use, rural electrification in agriculture is analyzed (since it forms the major portion of village economic activities), while for nonproductive use, rural electrification in residential units is investigated.

Equity in Village-level Rural Electrification Availability

Certain structural characteristics of the village may determine whether a village has access to electricity. Examples of such characteristics are size of the village and geographical isolation of the village. For example, a policy that seeks to maximize the coverage of access by villages to electrification could be unbiased in relation to whether larger villages get electrified first; however, a policy that seeks to maximize population coverage would have an inherent bias in covering larger villages first. Similarly, the degree of geographical isolation may determine whether rural electrification lines are extended to a village. It may be both difficult and costly to provide rural electrification to villages in remote areas, and hence, there may be a bias in the choice of villages. However, in the case of India's rural electrification policy, the focus has been primarily on village coverage. Hence, a bias of larger villages being electrified first would not be expected.

The data of average population and average geographical isolation scores of villages electrified by the first 20 years since electrification (of villages for our sample) are listed in table 9-1. Correlations between years since electrification (YSE) and average population (POP81) and YSE and average geographical isolation (GEOIS) are:

YSE and POP81: R = -0.094
YSE and GEOIS: R = -0.43.[2]

The correlation between YSE and POP81 is not significant, while that between YSE and GEOIS is negative and significant at 99 percent. This

2. See chapter 5, "Preconditions for Rural Electrification Success in the Agricultural Success."

Table 9-1. Years Since Electrification, Average Population and Geographical Isolation

Years since electrification	Average population (POP81)	Average geographical isolation (GEOIS)
1	1050	60.00
2	2144	53.75
3	3069	47.50
4	1915	61.67
5	1300	57.50
6	1000	70.00
7	2184	48.00
8	1678	41.25
9	1132	39.55
10	4745	36.25
11	1936	40.10
12	1480	33.13
13	2120	41.25
14	800	25.50
15	2005	39.00
16	1494	29.30
17	2024	53.50
18	1624	41.29
19	1295	34.38
20	1812	64.00

Source: Present study.

finding would suggest that the availability of rural electrification for electrified villages in our sample has not been significantly determined by the size of the village, while rural electrification availability certainly has had a bias towards more accessible villages. But the finding relating to village size has to be qualified with the statement that it relates only to villages in our sample and, moreover, only to electrified villages. It is pertinent to add that the nonelectrified villages in the sample generally have much smaller populations.

Rural Electrification and Equity--Productive Use (Agricultural Sector)

The level of agricultural response to rural electrification at the village level is broken down by geographical isolation of the village in table 9-2 below.

Table 9-2. Geographical Isolation and Number of Connections

GEOIS	<20.00	20-44.99	45-69.99	≥70.00
ACNSA	27.41	25.51	9.12	13.95

Source: Present study.

It would appear that agricultural response (ACNSA) gets increasingly lower in the more geographically isolated villages. There also appears to be a "threshold" effect, in that villages above and below an index score of 45 for the geographical isolation index show a wide difference in response levels, while those within the two categories do not. Thus, as would be expected, geographical isolation appears to lead to inherent biases in response to rural electrification at the village level. The more isolated electrified villages have a much lower response rate.

However, within the village, given rural electrification availability, do the more affluent farmers get agricultural connections first? To answer this, the average number of years for a large farmer, medium farmer and small farmer to get a connection (in relation to the year of village electrification) was compared in table 9-3.

Table 9-3. Average Number of Years to Obtain Connection, by Farmer Category

Type of farmer	Average number of years
Large farmer (LF)	6.92(24)
Medium farmer (MF)	8.06(16)
Small farmer (SF)	7.05(19)

Note: Figures in parentheses indicate sample size.

Source: Present study.

The t-statistics, to test for significant differences, are:

$$t_{LF,MF} = 0.679$$
$$t_{LF,SF} = 0.811$$
$$t_{MF,SF} = 0.165$$

All computed t's are not significant, suggesting that there are no statistically significant differences.

It would appear there is no intra-village bias in <u>access</u> of various farmer categories to agricultural connections.

This finding is corroborated by the response of village leaders. The answers to the question "Has rural electrification in this village gone to influential people or to anyone who wanted it?," the response of village leaders, statewide and pooled, appear statistically in table 9-4.

Table 9-4. Has Rural Electrification in this Village Gone to Influential People or to Anyone Who Wanted It?

	Percent leaders saying		
State	"To anyone who wanted it"	"Mainly to influential people"	Sample base
Andhra Pradesh	79.27	20.73	81 (100%)
Maharashtra	95.88	4.12	97 (100%)
Punjab	90.00	10.00	60 (100%)
West Bengal	63.41	36.59	41 (100%)
Pooled	85.00	15.00	279 (100%)

<u>Source</u>: Village Leader Schedule, present study.

However, both findings do not rule out the likely possibility that a higher percentage of large farmers have connections because of higher incomes.

Rural Electrification and Equity--Non-Productive Use

An analysis similar to that in the case of productive use of rural electrification has been conducted. Data on household connections per 1000 persons (HHCAP) in relation to GEOIS are presented in table 9-5.

Table 9-5. Geographical Isolation (GEOIS) and Number of Household Connections (HHCAP)

GEOIS	<20.00	20-44.99	45.00-69.99	≥70.00
HHCAP	62.4	42.97	19.14	23.74

Source: Present study.

The results are similar to ACMSA findings; per capita household connections are much lower in geographically isolated villages. There also appears to be a threshold effect for geographical isolation. Moreover, it should be remembered from the analysis of preconditions that size of village is negatively related to residential connection growth rate.

The availability at the intra-village level is compared across different social groups in table 9-6. For residential connections, there apparently are no significant differences among farmer categories and shopkeepers (who take on an average 6-7 years to obtain connections). Artisans in the village take approximately 9 years to obtain connections, while agricultural laborers take more than 10 years. Since artisans and laborers are predominantly lower class, there would appear to be some social class inequity in the access to household connections at the intra-village level.

Table 9-6. Average Number of Years Since Village Electrification for Various Social Groups to Obtain Residential Connection

Social group	Average number of years to obtain residential connection
Large farmer	5.97 (36)
Medium farmer	6.97 (39)
Small farmer	7.22 (27)
Shopkeeper	6.72 (25)
Artisan	8.93 (28)
Agricultural laborer	10.39 (23)

Note: Figures in parentheses indicate sample size.

Source: Present study.

Regarding the impact of rural electrification on women and children, village leaders possessing household connections were asked who have been the major beneficiaries of rural electrification in their households. The response of village leaders is shown in table 9-7.

Table 9-7. Who Has Benefitted the Most from Having Electricity in the Household?

State	Percent saying			Sample base (electrified households only)
	Respondent himself	His wife	His child	
Andhra Pradesh	10.30	39.18	50.52	97 (100%)
Maharashtra	20.40	26.53	53.07	49 (100%)
West Bengal	10.26	11.54	78.20	13 (100%)
Punjab	15.38	15.38	69.24	78 (100%)
Pooled	12.66	26.16	61.18	237 (100%)

Source: Present study.

The major beneficiary of rural electrification in the household is the child, according to a little more than 61 percent of village leaders. The reasons cited by village leaders were:

Child can read at night	95.86 percent
Child can read early in the morning	13.10 percent
Radio listening possible	2.76 percent.

(Percentages add up to more than 100 because of multiple answers.)

More than 26 percent of the leaders felt that the wife had benefitted the most, while only about 13 percent of village leaders felt that they themselves had benefitted the most. The major source of benefit in both cases appears to come from being able to "work at night." The percentages are as follows:

Wife can work at night	85.48 percent
Leader can work at night	70.00 percent.

Thus, the impact of residential connections has been quite favorable on women and children in the household.

Summary

The findings relating to availability of, response to and output of electricity for productive and non-productive purposes, at the village and household levels is summarized below:

1. At the village level, rural electrification availability, whether for agriculture or household use, has had a bias toward more accessible villages.

2. Within the village, there is no bias in access of various categories to agricultural connections.

3. Within the village, there appears to be social class inequity in the access to household connections.

4. The impact of residential connections has been favorable on women and children in the household.

In sum, (a) there appears to be a certain inequity that guides the availability of rural electrification; (b) response to rural electrification for nonproductive uses at the macro level also reflects this inequity, especially for villages which are geographically isolated, and, (c) there appears to be no bias in the case of access to agricultural connections by farmers. A limited bias is apparent in the case of access to residential connections in different occupational categories. The productive uses of rural electrification overall would appear to guide and be guided by greater equity than the nonproductive uses.

Chapter 10

SUMMARY OF FINDINGS AND FUTURE POLICY ISSUES

The findings of the study are first summarized by reviewing the findings from all the substantive chapters. In this chapter, we review Temporal Response, Preconditions for Successful Rural Electrification, Village Level Impact of Rural Electrification, Household Level Impact of Rural Electrification, Rural Electrification and Regional Balance, and Rural Electrification and Equity. Following this we examine certain policy issues that future rural electrification policy in India might consider from the point of view of benefits of rural electrification.

Temporal Response

In all three sectors--agricultural, industrial and residential--a critical finding is that the rate of temporal response does not slacken over a 20-year period since village electrification.[1] Although the patterns in the three sectors are somewhat different from each other, the second decade on the whole displays a higher connection growth rate than the first.[2]

The pattern of agricultural response exhibits a step change effect, that is, the rate of response during the second decade goes up perceptibly in comparison to the first. At the end of 20 years, an average electrified village has approximately 25 agricultural connections. In the industrial sector, response to rural electrification exhibits a flattened U-shaped pattern. There is a relatively high response during the first five years, followed by a decline, at which rate the response remains steady for the

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1. See chapters 5, 6 and 8.

2. Excluding the first three years in the residential sector (see chapter 8).

next 10 years and then subsequently rises perceptibly over the next five years. At the end of 20 years, an average electrified village should have approximately three industrial connections. In the residential sector, there is a marked initial response, possibly reflecting pent up demand for the first three years after electrification. Following this, from a base of around 2.78 connections per year, there is a steady increase in the rate of response over the next 17 years. At the end of 20 years, an electrified village should have approximately 86 residential connections.

Data were also collected in the study on connected loads for each connection in the village.[3] Analysis of this data shows that the average connected load is 3.44 kW (per agricultural connection), 10.82 kW per industrial connection and 0.52 kW per residential connection (see table 10-1). Using these figures, we estimate that the average connected load created for the village as a whole at the end of 10 years for all agricultural, residential, and industrial sectors, should be approximately 82.95 kW against average transformer capacity of 94.15 kW (see table 10-1). This is about an 88 percent of load realizable.

Preconditions for Rural Electrification Success

A major finding regarding growth rates in agriculture and residential sectors in some instances relate to physical characteristics such as ground water availability or population density. In the agricultural sector, the determinants are low kharif area, high man/land ratio, adequate ground water and absence of canal irrigation. Factors such as level of use of innovations, literacy, credit, poverty, cropping intensity, institutional development, village size, external contact of village leaders, and supply regularity do not appear to be strong determinants of agricultural rural electrification success. The major determinants of residential rural electrification growth rates are low village size (population), high man/land ratio, regular electricity supply and high external contact of village leaders. Credit, literacy, institutional development and village poverty apparently are not strong determinants.

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3. See "SEB Proforma," volume 2, appendix 4.

Table 10-1. Average Connected Load Per Village and Per Agricultural/Industrial/Residential Connection (in kW)

	Average connected load (kW) per			
	Village*	Agricultural connection	Industrial connection	Residential connection
Andhra Pradesh	61.88	3.52	11.89	0.41
Maharashtra	85.14	2.96	9.76	0.32
Punjab	158.40	3.81	10.76	0.58
West Bengal	70.11	3.73	10.81	0.77
Pooled	94.15	3.44	10.82	0.52

Source: Present study.

*For connected load of village, the following conversion factor has been used: 1 kVA = 0.85 kW, based on discussions with officials at Maharashtra State Electricity Board (Bombay) and Rural Electrification Corporation (New Delhi). This is the standard conversion factor used in translating transformer capacity (in kVA) to the connected load realizable in the village, under assumption of average consumption conditions.

Impact of Rural Electrification: Village Level

In the agricultural sector, rural electrification has significant and positive impacts on gross irrigated area, cropping intensity, cropping pattern, use of innovations and labor productivity (see chapters 5, 6, 7, and 8). We have not found that rural electrification has a significant direct impact on yield[4] and income from agriculture. The impact of rural electrification on agricultural employment appears mixed. Female employment declines and male employment holds steady. This trend in agricultural employment is, however, accompanied by significant employment shifts to secondary and tertiary sectors. A suggestive finding that emerges is that impact of rural electrification seems to taper off after a certain degree of rural electrification intensity, occurring somewhere around 25 connections per 1,000 acres net sown area.

4. Improvements in yield are seen to come largely via increased innovation use, which in turn is strongly affected by rural electrification.

In the industrial sector, rural electrification seems to lead to significant and positive impacts on industrial growth, number of industries, size of capital, full-time employment, labor productivity, fuel costs, return on gross fixed assets, and product diversity. Seasonal employment decreases. There is a significant structural shift to the secondary economic sectors and in particular to nonhousehold manufacture. This shift does not appear to be at the expense of household manufacture. However, rural electrification apparently does not lead to significant improvements in capacity utilization.

In the services sector, rural electrification appears to lead to the setting up of a larger number of shops in the village (per capita), and engenders a structural shift in employment to the tertiary sector. But overall, institutional development is not positively associated with rural electrification.

In the social sectors, rural electrification has less significant impacts on the whole, except in the case of seasonal migration, quality of life perception of village leaders and newspaper readership. But rural electrification apparently is negatively or not significantly associated with birth rates, death rates, child deaths, progressiveness of village leaders, perception of control over future, and success levels of sterilization programs.

Impact of Rural Electrification: Household, Farm, and Firm Level

At the farm level, electrified farms are slightly larger (though not significantly so) and have a significantly lower number of fragments (that is, extent of scatteredness is low). Rural electrification has positive and significant impacts on gross area irrigated, use of innovations and a somewhat more limited impact (though positive) on farm income. Electricity is preferred as the mode of irrigation by approximately 90 percent of the farmers, while only 8 percent prefer diesel.

At the firm level (nonhousehold manufacture), rural electrified manufacturing units compared to nonelectrified units are larger and have higher full-time employment, lower part-time employment, higher labor productivity, lower fuel costs, higher returns on gross fixed assets and greater product diversity. Capital productivity is, however, lower and capacity utilization remains the same. Also, the probability that any industry (in an electrified village) will start with electricity is quite high.

Rural electrification firm-level (household manufacture) is characterized by larger numbers of items being processed, greater family employment, longer working hours during evening/night, significantly higher incomes, and marginally higher family labor productivity and lower seasonality.

In comparing electrified and nonelectrified service establishments, rural electrification seems to lead to larger size (as proxied by number of items sold), longer working hours during evening/night, higher incomes, and higher per employee incomes. Employment per shop remains the same.

At the household level, compared to the control group, rural electrified households have lower birth rates, lower death rates (total and child deaths) and larger numbers of children attending school, but these results, in most cases, are not statistically significant. Rural electrified households have a larger number of assets and higher incomes. With regard to lifestyle, rural electrification does not lead to any changes in the number of waking hours, time of going to sleep and cinema viewership habits. However, time spent by children in reading/studying, newspaper readership, and community participation are higher in rural electrified households. Rural electrified households are also generally more optimistic about their quality of life when compared with their "fathers' time" and their "neighborhood."

In relation to preference for energy sources, 98 percent of the households prefer electricity for lighting purposes. Also, the cost of lighting with electricity (as opposed to kerosine) is slightly lower, but it should be cautioned that both are subsidized by the state. The energy source preferred for cooking is firewood, followed by animal dung and agricultural waste. Only 2.7 percent of the households prefer electricity for cooking.

Rural Electrification and Regional Balance

Rural electrification contributes in a positive, though limited way in creating regional balance. In particular, rural electrification might help to increase yields in rabi villages, which, prior to rural electrification, probably had lower yields (vis-a-vis certain agricultural indicators) in relation to kharif villages.

Future Rural Electrification Policy Issues

The study has produced certain findings that may have important bearing on macro-level policy in relation to the role of rural electrification in rural development in general, and in relation to the manner of provision of rural electrification.

First, our study uncovers many positive contributions of rural electrification in rural development. In relation to the agricultural sector, rural electrification was found to be positively associated with the two most critical agricultural inputs--irrigation and use of innovations. In the industrial sector, rural electrification may have been responsible for a small spurt in industrial growth, as well as in streamlining industrial operations. In the services sector, rural electrification again was found to have positive consequences. In the social sectors, the effects were less pronounced, but nevertheless consequential. In general, rural electrification was found to be associated with structural changes and economic diversification in rural areas. All these findings underscore the importance of rural electrification in comparison with other inputs into rural development. Purely from the benefit point of view, rural electrification is a necessary input into rural development. There appears to be sufficient justification for continued investments in rural electrification in India.

Second, our study indicates that, while no population bias in provision of rural electrification in India was found, the geographically isolated villages apparently receive rural electrification later than other villages. This may arise due to the policy focus on area and village coverage rather than population coverage. The more accessible villages are not necessarily larger villages. This suggests that a policy shift toward population coverage rather than village coverage might alter this maldistribution.

Third, our study addressed the question of pursuit of an intensive versus extensive strategy of electrification. The results were mixed in that both year of electrification and intensity of electrification had significant impacts on a wide range of socioeconomic indicators. It was found, for example, that it takes more than 10 years for response levels to significantly justify the connected load capacity provided for an average village. This suggests that the full capacity of investment is met only at the end of more than a decade. On the other hand, our evidence from village level impact of rural electrification on the agricultural sector shows that beyond a certain degree of intensity, growth of positive impacts resulting from rural electrification tend to decelerate. It may thus be prudent to consider the possibility of spreading certain investments (for example, transformer capacity) thin, and augmenting them at a later stage, say, at the end of a decade if the village response levels are sufficiently high during the first decade. On balance, the findings of the present study tend to favor an extensive strategy of rural electrification but with attention to more rapid load development.

Fourth, it would appear that rural electrification policy has to be framed for a 20-year framework. From our temporal response analysis, two decades seem to be the period over which one must judge effectiveness and returns of rural electrification. Considering that a large portion of rural electrification investments in India have been post-1966, the returns would really be expected to flow from about the second half of the 1980s and onward.

Fifth, in the preparation of rural electrification project reports it may be useful to consider factors found to be major determinants of high rural electrification growth rates in the agricultural and residential sectors. They were: high man/land ratio, adequate groundwater, absence of canal irrigation, low kharif area, supply regularity, low population and external contact of village leaders. All factors, except the last mentioned, are easily measurable indicators, and hence may be incorporated in assessments of rural electrification project viability.

In conclusion, rural electrification is an important and justifiable input into rural development. Our findings indicate that rural electrification significantly benefits rural development and quality of life.

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