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FARMERS' PARTICIPATION IN AND THEIR PERCEPTIONS OF THE EFFECTIVENESS OF A FARMER-CONTROLLED IRRIGATION SYSTEM IN THE DOMINICAN REPUBLIC

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# FARMERS' PARTICIPATION IN AND THEIR PERCEPTIONS OF THE EFFECTIVENESS OF A FARMER-CONTROLLED IRRIGATION SYSTEM IN THE DOMINICAN REPUBLIC

By

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# ABSTRACT

## FARMERS' PARTICIPATION IN AND THEIR PERCEPTIONS OF THE EFFECTIVENESS OF A FARMER-CONTROLLED IRRIGATION SYSTEM IN THE DOMINICAN REPUBLIC

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This study was designed to analyze and describe the relationship between farmers' participation in and their perceptions of the effectiveness of the farmer-controlled irrigation system, Canal Ulises Francisco Espaillat (CUFE), in Santiago, Dominican Republic. Specifically, three research questions were addressed: Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system? Are there demographic characteristics that are related to farmers' participation in the irrigation system? Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system, after statistically controlling for selected demographic characteristics of the farmers?

Using stratified random sampling, the researcher selected 201 farmers from a list of 2,015 farmers who were receiving assistance from the CUFE irrigation project. These farmers were chosen from the five irrigation sectors into which the irrigation project is divided.

The research methodology included a combination of survey and analytical research. A questionnaire was used for data collection. In terms of reliability, the instrument had an alpha higher than .70. A panel of experts from the Department of Agricultural and Extension Education at Michigan State University and the Instituto Superior de Agricultura in the Dominican Republic reviewed the instrument to ensure its validity. Data were gathered through personal interviews with the farmers, with help from members of the National Institute of Hydraulic Resources and the farmer-controlled CUFE irrigation system in Santiago, Dominican Republic. Parametric and nonparametric statistics were used to analyze the data.

Major findings of the study are as follows: There was a strong relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system. Demographic characteristics of the farmers were moderately related to participation. Finally, the strong relationship between farmers' participation in and their perceptions of the effectiveness of the system remained, even after controlling for selected demographic characteristics of the farmers. All of these findings were significant at the .05 level.

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# CHAPTER I

# INTRODUCTION TO THE STUDY

## Introduction

The past 20 years have witnessed rapid growth in irrigated land area throughout the world, especially in tropical developing countries (Albernethy, 1984). For instance, the Dominican Republic has made a large investment in infrastructure to develop and use its water resources for agricultural development. It has invested more than $3 billion U.S. in developing irrigation systems. This effort has resulted in the irrigation of 76% (236,000 hectares) of the best land in the country (Reynoso, 1992). A major goal of the Dominican government's irrigation program is to increase agricultural productivity in the country.

Despite these efforts to develop irrigation systems, many problems related to overall system effectiveness remain. For example, poor planning, design, implementation, and maintenance have reduced the capacity of the irrigation systems to reach the desired level of effectiveness. Some experts think that many of these problems have arisen because of a lack of farmer participation in the overall management of the systems. Effectiveness of the irrigation systems may also be adversely affected by a lack of proper management by the

government and, to a greater extent, lack of participant involvement in the operation and maintenance of the systems (Shivakoti, 1991). What can be done to alleviate these problems is not fully understood.

To address the problems mentioned above, the Dominican government, through the National Institute of Hydraulic Resources (INDRHI), created an On-Farm Water Management Project (Projecto Manejo de Agua a Nivel de Fincas, PROMAF) in 1985. A major organizational strategy of the Water Management Project is the integration of farmers into the irrigation project through Water Users Associations. The purpose of the Water Management Project is to help the people who are involved in agricultural production better understand irrigation management and resource conservation as a means of contributing to increased agricultural production in the Dominican Republic (Reynoso, 1992).

Through PROMAF, Water Users Associations were formed in two regions of the Dominican Republic, the YSURA Project in Azua (southern region) and the Canal Ulises Francisco Espaillat Project (CUFE) in Santiago (northern region). These projects fall under Public Law 5852 on Publics Dominium of Water Terrestres (water flowing over the ground) and Distribution. This law legalized the formation of Water Users Associations (Juntas de Regantes). Consequently, INDRHI transferred the administration, operation, and management of the irrigation systems to farmers. This policy represents a change in the bureaucratic management of irrigation as it moves from a centralized to a devolutional[1] form of management. INDRHI anticipates that the participation of

farmers in actual operation and maintenance activities will improve the management of the system and irrigation service to farmers and, hence, will encourage them to pay their irrigation fees.

The theory of level and point of control in rural development programs has been used to categorize and define irrigation systems as "delivery systems" and "acquisition systems" (Axinn, 1987). According to this theory, the ways in which farmers judge and perceive the outcomes of irrigation system management will differ between systems controlled by users (acquisition systems) and nonusers (delivery systems). To ensure genuine participation, programs should be designed in such a way that the people who will use those programs have roles in planning, design, and implementation. But the viewpoints of these users/farmers typically have been ignored in the planning and execution of irrigation activities. Chambers (1989) said this situation reflects the "center-outward, core-periphery" perspective, which continues to dominate much development thinking. Thus, this investigation of farmers' participation in and their perceptions of the effectiveness of a farmer-controlled irrigation system will provide useful information to farmers, project planners, and the government of the Dominican Republic.

## Background of the On-Farm Canal Ulises Francisco Espaillat (CUFE) Irrigation Project

The CUFE Water Users Association (Junta de Regante) was formed on October 9, 1987, and incorporated under Public Law 520 in June 1989. It is in

the area of influence of the Alto Yaque del Norte Irrigation District and is financed by the U.S. Agency for International Development (USAID). The CUFE Water Users Association comprises five farmer associations located in five sectors, into which the project is divided. These sectors are Santiago, Bombeo, Villa Gonzalez, Navarrete, and Ponton.

The CUFE Water Users Association has 2,015 farmers in an area of 6,042.6 hectares under irrigation. This farmer population comprises private and land reform farmers. Land reform farmers are those who have received a parcel of land from the Dominican government. There are 1,056 private farmers and 959 land reform[2] farmers in the project. The private farmers in the CUFE account for an area of 4,642.4 hectares and land reform farmers an area of 1,400.2 hectares.

The main crops cultivated in the area covered by the CUFE are plantains, tobacco, bananas, beans, yucca, rice, pasture, and vegetables. The area covered by the CUFE Water Users Association is located in the Cibao Valley in the northeastern region, which has been described as the richest agricultural region of the country.

The objectives of the CUFE Water Users Association are:

1. To administer, operate, and maintain the irrigation system and conserve its natural resources and environment in the area covered by the system.

2. To develop profit-making production systems, including sustainable agricultural production, industrialization, and marketing of farmers' agricultural products, in order to increase the quality of life of the farmers in the project.

The CUFE Water Users Association is directed by a General Assembly, which elects an irrigation board composed of a president, vice-president, secretary, treasurer, and three local representatives. The CUFE Water Users Association is an organization comprising two levels: a nucleus of irrigators and an association of irrigators. The **nucleus of irrigators** is composed of farmers who use a particular unit of irrigation; that is, they irrigate their land from the same ditch. These farmers meet regularly to study and analyze the problems in their area. In addition, they are responsible for accomplishing organizational norms, cleaning the ditch and the principal canal, using the irrigation system correctly, cooperating on the collection of fees, and participating in training activities.

The **association of irrigators** is the second level of the organization. It represents all of the users in the area of the irrigation project and is composed of representatives of the nucleus of irrigators. This association handles problems related to the management of the irrigation system and provides technical assistance with problems brought by the nucleus of irrigators to the Water Users Association to be analyzed.

Other activities that the CUFE is carrying out in the project are:

1. Allocating and distributing water.

2. Maintaining canals.

3. Meeting with extension agents.
4. Resolving conflicts.
5. Coordinating cultivation practices.
6. Making decisions on courses to offer.
7. Evaluating the management and operation of the irrigation system.

## Problem Statement

Numerous researchers have found that farmers'/users' participation in the development and management of their irrigation systems is critical to the success of those systems (Chambers, 1989; Coward, 1976; Food & Agricultural Organization [FAO], 1985; Hunt, 1990; Uphoff, 1986). Most of these research efforts were carried out in Asia, where conditions are markedly different from those in Latin America. For instance, in the Dominican Republic, most small farmers grow basic food crops such as beans, rice, bananas, and plantains. They also produce vegetables and fruits for local use and export. These efforts are hampered because farmers have little knowledge of on-farm water management. In addition, as in most Latin American countries, the Dominican Republic's irrigation systems have been and still are controlled by the government.

Today these conditions are changing, and governments are relinquishing the management and control of irrigation systems to farmers. The Dominican Republic does not have a long history of farmers' involvement in water management. Consequently, there is a relative lack of experience with farmer-

managed irrigation systems on the part of both the water users and the institutions involved in water resource development. Thus, research on farmer-controlled irrigation systems in the Dominican Republic is necessary to determine the extent to which farmers' participation influences their perceptions of the effectiveness of irrigation systems.

The present research was undertaken to investigate the relationship between farmers' participation in and their perceptions of the effectiveness of a farmer-controlled irrigation system in the Dominican Republic. The findings from this study will fill a need for information on farmer-managed irrigation systems.

## Purpose of the Study

The researcher's purpose in this study was to describe and analyze the relationship between farmers' participation in and their perceptions of the effectiveness of the farmer-controlled irrigation system, Canal Ulises Francisco Espaillat (CUFE), in Santiago, Dominican Republic. Specifically, the research was focused on ascertaining farmers' participation in their irrigation system and their perceptions of effectiveness in regard to the management and use of that system.

## Importance of the Study

The information generated through this study can provide guidelines for development practitioners and advisors in the area of irrigation management in designing, implementing, planning, and evaluating programs. In making the

management of irrigation systems self-sustaining, development practitioners need to be aware of the forces that help individual development and those that hinder it. This study can provide insight into how developers might overcome these problems.

The findings from this study will be useful to farmers, planners, and administrators of national government irrigation systems and international aid agencies. Over the long term, these findings can be used to promote decentralized, small-scale, natural resource management, influence the allocation of development resources to the grass-roots level, and foster self-reliance and sustainability within communities. The findings, which apply specifically to the Dominican Republic, could also provide insight into irrigation management in Latin American countries and other developing countries.

This study will add a new theoretical dimension regarding farmers' participation in irrigation management programs in the Dominican Republic. Also, the information generated through this study will be helpful in conducting survey research in other international contexts.

## Research Questions

The following questions were posed to guide the collection of data in this study.

1. Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system?

2. Are there demographic characteristics that are related to farmers' participation in the CUFE irrigation system?

3. Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system, after statistically controlling for selected demographic characteristics of the farmers?

## Hypotheses

The following hypotheses, stated in the null form, were formulated to test the data collected in this study.

> Null Hypothesis 1: There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system.
>
> Null Hypothesis 2: There is no relationship between selected demographic characteristics of the farmers and their participation in the management of the CUFE irrigation system.
>
> Null Hypothesis 3: There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system, after statistically controlling for selected demographic characteristics of the farmers.

## Limitations of the Study

The primary limitation of the study is that it covered the perceptions of only the CUFE farmer-controlled irrigation project participants in the zone of influence of the Alto Yaque del Norte Irrigation District. Also, the study focused on only one aspect of farmers' participation in irrigation: irrigation management. Irrigation management can be physical, ecological, political, economic, social, cultural, and/or organizational. This broad range of concerns could not be

treated in depth in this dissertation because it was beyond the scope of the study. The main focus of this research was the human aspect of irrigation management. Irrigation can be considered a social activity because of the physical and social interdependence of people who are obligated to share limited natural resources. The success of water management projects is therefore based on the connections made with farmers.

Another limitation of the study was the cross-sectional time frame used in the research. Cross-sectional studies permit analysis of events at one point in time. Thus, it would be difficult to assess the evolution of the success of farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system.

A questionnaire was used in interviewing the farmers. Thus, the data collection was limited to responses to items included in the questionnaire.

Finally, the study included only a sample of farmers who belonged to the CUFE in the zone of influence of the Alto Yaque del Norte Irrigation District and who were receiving assistance from the irrigation project in question. It did not include all of the farmers involved in irrigation within the project.

## Definition of Terms

The following terms are defined in the context in which they are used in this study.

Agency-/government-managed system: An irrigation system that an agency/the government operates and maintains or has invested a large amount of money in the construction or rehabilitation of physical structures.

Demographic characteristics: Personal characteristics of the respondents, including age, educational level, on-farm income, ownership, farm size, land production, farm labor, farm location, farm sector location, and time spent farming. These characteristics were measured separately and did not form a composite variable.

Effectiveness: A measure of farmers'/users' perceptions of the efficacy of their irrigation system. Parameters of effectiveness included timing, value and quantity of water received for use, management of water distribution, and control and maintenance of canals. Also, data about effectiveness of the system were collected from records of INDRHI and the farmer association that was managing the CUFE irrigation project.

Farmer-managed system: An irrigation system operated and maintained by community or local people as opposed to one that is managed by outsiders who are not accountable to the community--for instance, the government.

Irrigation management: Farmers' participation in such activities as planning, design, implementation, water allocation, operation, maintenance, and funding of an irrigation system.

Irrigation system: A farmer- or agency-managed system consisting of water that is delivered to crops, structures that control water to and from fields, and organizations that manage the structures and the water (Uphoff, 1986).

Irrigation unit: A group of 10 to 25 farmers who take water from the same irrigation ditch.

Participation: Inclusion of the intended beneficiaries of a project in the solving of their own problems (McPherson & McGarry, 1987). Participation refers to the degree to which respondents actually have taken part in the On-Farm Water Management Project. It was measured by asking respondents how frequently they had participated in irrigation activities developed by the Water Users Association. Farmer-participation activities investigated in this study included allocating and distributing water, meeting with extension agents, coordinating cultivation practices, maintaining canals, making decisions on courses to offer, resolving conflicts, and evaluating the management and operation of the irrigation system in their sector.

Perception: What the individual respondents saw and believed about the effectiveness of the CUFE irrigation project.

Water Users Association: An organization composed of several farmer associations. This nonprofit organization is composed of farmers who are responsible for the operation, administration, and maintenance of the irrigation system. The association designs and manages institutions and physical

structures to distribute water in an economical, efficient, and secure way--and with the highest degree of control possible.

## Overview

Chapter I contained an introduction to the study and background on the CUFE irrigation project. This was followed by a statement of the problem under investigation and the purpose and importance of the study. The research questions and hypotheses were set forth. Limitations of the study and definitions of key terms also were presented.

Chapter II is a review of literature relevant to the current study. Topics that are discussed include participation as a broad concept, the importance of farmers' participation in development projects, and constraints on farmers' participation. Literature on farmers' participation in irrigation management systems in general, as well as participation in various aspects of such systems, is also reviewed.

The methods and procedures used in conducting the study are explained in Chapter III. The design of the study is discussed, followed by the research questions and hypotheses. The dependent and independent variables are set forth next, followed by a discussion of the population and the sample drawn for the study. Development of the instrument and issues of reliability and validity are examined, and the data-collection and data-analysis methods used in the study are explained.

The results of the data analyses are presented in Chapter IV. Chapter V contains a summary and discussion of the findings, conclusions and recommendations for the CUFE irrigation project, and recommendations for further research.

# ENDNOTES

[1]The concept of devolution suggests that authority is given to persons or institutions at the local level (see Uphoff, 1986, p. 222).

[2]The relative benefits of communal and individual land tenure have been considered in the Dominican Republic since shortly after the arrival of Columbus. Before the Agrarian Reform Law of 1962, the extent of land redistribution in the Dominican Republic consisted of the colonization projects initiated under the Trujillo dictatorship. Not properly a land reform program, the colonies were an attempt to settle sparsely populated areas with landless *campesinos* and foreign immigrants (Meyer, 1989). The first Agrarian Reform Law was passed on June 14, 1962. This law established the Instituto Agrario Dominicano (IAD) to administer the reform program, giving it the responsibility to redistribute state and privately owned lands to the rural poor.

After Trujillo's death, the state confiscated his lands, and the State Sugar Council (CEA) was established to manage his former estates. The colonization projects of earlier years were transferred to the IAD, as was the power to collect the "*cuota parte*" lands in payment for irrigation services. The *cuota parte* law specifies that those landowners who had benefited from state irrigation projects were to give up a certain percentage of their land (usually 25% to 30%) to the state.

The bulk of the land for distribution initially consisted of public land formerly owned by Trujillo and his family, as well as some donations by the more recently formed State Sugar Corporation. Also, the IAD purchased privately owned lands and distributed them with the approval of the president of the Republic. Parcels average approximately 50 *tareas* (15.9 *tareas* equal 1 hectare) and are assigned to the beneficiaries with provisional title only (Delgado, 1983, p. 12). The state retains the right to withdraw the land in the case of inadequate performance on the part of the beneficiary, or in the case of the beneficiary's abandonment of his family or of the parcel of land. Parcels may not be sold or rented without the consent of the IAD, although family members may inherit the usufructuary rights.

Among the other activities undertaken by the IAD are the establishment of irrigation projects, credit programs, and other services such as agricultural extension, marketing, and cooperatives, as well as the inventorying and titling of state lands.

Agrarian reform in the Dominican Republic has had a particular impact on the rice sector, where agrarian reform lands produce close to half of the rice in the country. Like many countries in Latin America, the Dominican Republic, from

time to time, has shifted its strategy between individual and collectively organized reform projects. Within the rice sector, land has been expropriated to individual beneficiaries as well as to collective units. Interestingly, many of the individual beneficiaries have associated themselves for purposes of credit, input purchases, rice marketing, and capital equipment. At the same time, collectives have divided their land into individual parcels and have insisted that the government legalize their "associative" management structure. The associatives were, in fact, legalized in 1985, after most of the collectives had already broken down in 1983.

# CHAPTER II

# REVIEW OF LITERATURE AND RELATED RESEARCH

## Introduction

Literature on various aspects of participation is explored in this chapter. In reviewing the available literature, it was difficult to get a feeling for participation as a dynamic or intrinsic factor in irrigation projects that are dominated by professionals and governed by complex organizational and managerial arrangements for water distribution, as is the case in the Dominican Republic.

The review is organized as follows. First, the discussion is centered on participation as a broad concept. Then, writings on the importance of farmers' participation in development projects and constraints on farmers' participation are reviewed. Finally, the literature is reviewed in regard to farmers' participation in irrigation management systems (effectiveness of irrigation systems, water allocation and distribution, maintenance and operation, and conflict management). Also discussed is farmers' participation in planning, design, and implementation of irrigation schemes; irrigation management activities; issues in irrigation management, and financial aspects of irrigation management.

## The Concept of Participation

To approach the question of participation, Uphoff (1991) recommended looking at the results of participation as coming from different approaches, assumptions, and mechanisms. He noted that participants, themselves, may be more crucial to project success than is any purely quantitative expression of participation. Thus, in accord with his advice, the researcher examined various studies to summarize notions, methodologies, and mechanisms pertaining to participation.

Cook (1991) discussed a common notion of participation held by planners. She pointed out that, all too often, planners expect rural people to participate in the costs and benefits of a project without taking part in actual decision making. However, if participation is to mean more than cost sharing, there are several basic issues that require social assessment. Cook asserted that it is of utmost importance to determine who can participate, how they can do so, and how many people can participate. These points can be addressed by using a methodology employed in social analysis of rural road projects in Liberia and Madagascar. This methodology entails assessing the potential for local participation by analyzing local institutions, labor requirements, migration patterns, and cultural constraints.

Cernea (1991) argued that the concept of participation has been more a proposition with heated ideological exhortations than concrete procedures applicable by project and agency staff. Many good things have been said about

participation, but several theoretical, empirical, and methodological questions need to be addressed in order to incorporate participation as an important tool for development. In this sense, Cernea asked several pragmatic questions: Are the social sciences able to offer a methodology for organizing actual participation in different cultural contexts? Do social scientists have sets of procedures and methods that are transferable to planners and managers? What should be done during project preparation to shape the project so that it elicits and depends on participation? What should be done to organize participation during implementation?

To approach these questions about participation, Cernea (1991) proposed what he called "social engineering." According to him,

> The social engineering action model is rooted in knowledge of the social fabric and dynamics. It postulates the translation of social science knowledge into new know-how and change tools, and it uses this knowledge purposively to organize new social action and relationships. (p. 29)

In buttressing his view, Cernea quoted Rossi and Whyte:

> Social engineering consists of attempts to use the body of sociological knowledge in the design of policies or institutions to accomplish some purpose. Social engineering can be accomplished for a mission-oriented agency or for some group opposed to the existing organizational structure, or it may be undertaken separately from either. . . . When conducted close to the policy-making centers, it is often termed social policy analysis. . . . When practiced by groups in opposition to current regimes, social engineering becomes social criticism. (p. 1)

In summary, Cernea (1991) advocated a systematization, conceptualization, and codification of the know-how produced by the social sciences. He

pointed out that, without the know-how to organize it, participation will remain a hot ideology lacking a social technology.

Kottak (1991) noted that a "people orientation" involves considerably more than encouraging direct participation in project design and implementation. He pointed out that many of the underlying principles of social structure, which are explicit in sociological models, are buried in cultural practice and are not necessarily articulated conceptually by members of a cultural group. Yet these principles must be understood and taken into account when development interventions are designed and implemented. Kottak concluded that there is a general need for social engineering. The sociocultural characteristics of affected people must be systematically taken into account when designing and implementing sound development strategies. Sociocultural engineering for economic development is not simply socially desirable; it is demonstrably cost effective.

Pottier (1993) presented a different view from the social engineering perspective proposed by Cernea and Kottak. Pottier pointed out that there is a need to demonstrate that buzzwords of the 1980s--sustainability, grass-roots development, and participatory research--stemmed from a thorough questioning of former paradigms. Pottier advocated looking at a broader perspective, proposing consideration of a number of fundamental issues that were ignored in the past, such as the human factor, socioeconomic differentiation, importance of decision making within the household, long-term survival strategies, the cultural

construction of ideas and practices, gender issues, division of labor, and patterns of responsibility. To this long list one might add equity, efficiency, empowerment, and accountability (Chambers, 1993; Uphoff, 1991).

Pottier (1993) advised identifying problems of practical participation: *ex ante* and *ex post facto* appraisal. Hence, whereas Cernea and Kottak advocated a crystallization of social science knowledge, Pottier argued that "the social worlds within which development efforts take shape are essentially fluid" (p. 7).

Cohen and Uphoff (1977) said that there are many kinds of participation to be considered, but they focused on four that seem most significant to rural development activities. These are (a) participation in decision making, (b) participation in implementation, (c) participation in benefits, and (d) participation in evaluation. Taken together, these four kinds of involvement appear to encompass most of what would generally be referred to as "participation" in rural development activities.

Chambers (1993) has been one of the most influential proponents and investigators of new methodologies with which to study participation. He has long been involved in testing and proposing different methodologies. Chambers raised such fundamental questions regarding participation as: Who gains and who loses? Knowledge for whom? Whose priorities prevail when setting the agenda for project development? Chambers (1991) stressed two points: (a) the sustainability of development and (b) empowerment of people. He noted,

> With more attention paid to the issue of sustainability through the participation and empowerment of rural people, especially the poor, it is

> increasingly recognized that it matters who generates and "owns" knowledge, and whose capacity to learn and analyze is enhanced. Participatory research, participation action research, participatory agricultural research, and participatory rural appraisal are all finding their places in the new vocabulary of development. (p. 517)

## The Importance of Farmers' Participation in Development Projects

Over the past few years, development specialists have expressed growing concern about the lack of progress for the rural poor (Cohen & Uphoff, 1977). Many authors have pointed out the importance of people's participation in development projects. Toward this end, new approaches have been proposed, to secure greater participation in development efforts by those who are supposed to benefit from them.

Cohen and Uphoff (1977) asserted that, in assessing participation in any situation, the participation variables to be studied and measured must be selected with care. For example, participation in rural development activities includes such variables as (a) people's involvement in making decisions about what would be done and how, (b) their involvement in implementing programs and decisions by contributing various resources or cooperating in specific organizations or activities, (c) their sharing in the benefits of development programs, and/or (d) their involvement in efforts to evaluate such programs.

These kinds of participation (decision making, implementation, benefits, and evaluation), in principle, form something of a cycle for rural development activity. In thinking about and attempting to establish measures of

developmental participation, these four kinds of participation are fundamental. Interactions among them are illustrated in Figure 1. These four variables provide a model for specifying the causal relationships in a dynamic system that may either create or resolve rural poverty.

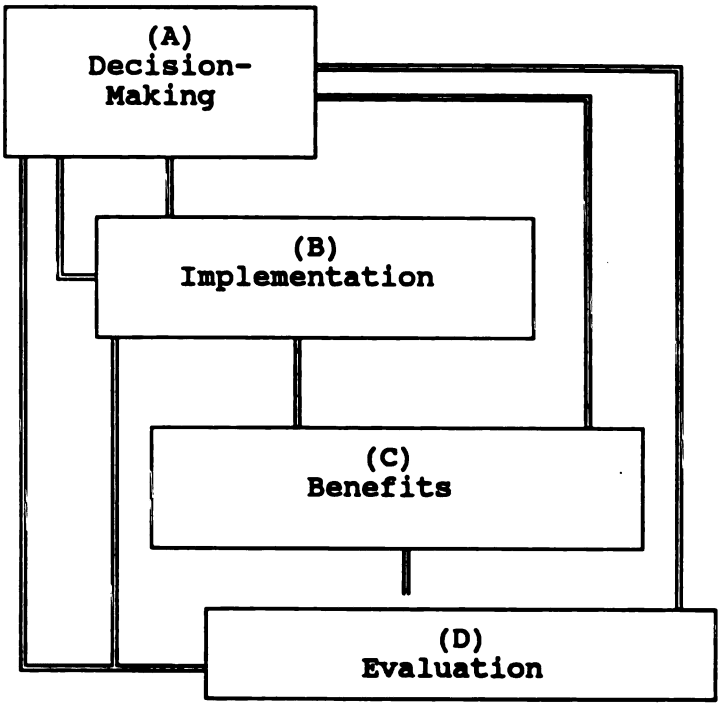


Figure 1: Four kinds of participation.

Source: Cohen, J. M., & Uphoff, N. T. (1977, January). Rural development participation: Concepts and measures for project design, implementation and evaluation. Ithaca, NY: Cornell University, Center for International Studies, Rural Development Committee.

The International Fund for Agricultural Development (IFAD) has found that project beneficiaries, when given the chance, are eager to participate in schemes designed to benefit them (Lineberry & Jazairy, 1989). IFAD also has found that farmers' acceptance of and commitment to project objectives are crucial elements for successful project implementation and sustainability. A development process that involves people provides a basis not only for improvement of their material well-being, but also for progress in their social and cultural life.

According to Lynch (1985), farmer participation can be classified as direct or indirect. Direct participation occurs when community members contribute their labor for construction or maintenance. They participate in the decision-making process through referenda at general meetings, and they evaluate system performance. In indirect participation, a community elects representatives to a local organization that makes policy decisions about the use of irrigation water. Indirect participation is what happens, for example, when the community hires and delegates responsibility to ditch tenders or technicians to supervise water delivery or to deal with equipment maintenance.

It has been well established that the organization and participation of beneficiaries in rural development projects are essential for the success and sustainability of such projects. This is true not only for the implementation and monitoring of the project but for the definition and continuous redefinition of its priorities, as well (Alamgir, 1988; Korten, 1980).

Cohen and Uphoff (1977) suggested that one should be prepared to consider the following factors affecting the development and management of irrigation systems when choosing and interpreting measures of participation:

1. Physical and Biological Factors: Things like the seasonality of production where this occurs due to rainfall, temperature or soil patterns, the isolation of a project area due to terrains, or dispersed rather than concentrated settlement of the population will affect measures such as meeting attendance, for example.

2. Economic Factors: The availability or scarcity of land, labor and capital within the project area, also the development of skills and transportation and infrastructure communication will affect the capacity of local people to participate in implementation and possibly also in decision making.

3. Political Factors: Certain kinds of participation in decision making should not be expected and made into criteria of participation when, for example, the prevailing national ideology is not supportive of "democratic" procedures, but alternative, equivalent modes of participation may exist and deserve consideration.

4. Social Factors: The disposition of local people to take leading roles in project participation will be influenced by the existing social stratification (how rigid or nonrigid it is), by the strength of ties to the nuclear or extended family, the existence of clan or similar social organizations, and the extent and depth of cumulative and cross-cutting social cleavages such as race or religion.

5. Cultural Factors: The participation of the poor in local organizations will be affected by values discouraging conflict, by deferential attitudes toward authority, or by beliefs opposing social equality. The initiative that women can take in project activity will also be conditioned by cultural norms.

6. Historical Factors: Where, for example, there has been unfortunate experience with "cooperatives," such as through embezzlement or use of force to get nominal participation, one should not expect that participation in cooperatives as such would be tapping the potential for participation in a community. Some sensitivity to previous experience should be manifested in choosing measures. (pp. 18-19)

The importance of people's participation in development projects has been pointed out. For example, a study by Development Alternatives, Inc. (1975), of 36 rural development projects in 11 African and Latin American countries indicated a clear connection between project success and small farmers' involvement in decision making and in commitment of resources to the project.

According to Miller (1979), there are three pertinent aspects of participation. These are (a) participation in decision making, which is the process of discussion to reach collective consent on a plan, program, or project; (b) participation in the use of action based on collective decisions that have been made, which is meant to include active involvement in terms of self-help labor, provision of local building materials, and supervision of construction; and (c) participation in an equitable sharing of benefits from the action and in sharing costs incurred in undertaking the action.

Casley and Kumar (1987) said that participants' cooperation is a key determinant to success in a development project. In the Philippines, a council monitoring a five-year plan for the development of an agricultural irrigation project became an effective decision-making body through the skillful use of information and the varied composition of its membership. Casley and Kumar went on to say that projects that do not take into account users' needs, or that merely make a cursory assessment of such needs, tend to produce expensive systems that are largely irrelevant to the requirements of high-priority users.

In their study of participation in irrigation projects in northwestern Indian villages, Shingi and Bluhm (1987) concluded that participation was affected by the degree of (a) dependence on the gains from the activity in which participation was required, (b) dependence on the group effort to achieve these gains, (c) certainty that common resources would be managed properly, (d) certainty that the gains would be distributed equitably, (e) certainty that others had limited opportunity to exploit the situation for their own self-interest, and (f) certainty that returns would be commensurate with risk and investment.

Chambers (1983) said that common people throughout the world recognize participation as a power. Putting these people's own knowledge and skills to work in development projects will strengthen their confidence in their ability to act toward solving their problems. Through participation, farmers learn to plan, find solutions to their own problems, gain self-confidence, and derive satisfaction from having made significant achievements.

Despite findings concerning the benefits of farmers' participation, the process of involving them has not been easy. Mkandawire and Chipande (1988) found that, in the Salina Agricultural Development Division (from the 1982/83 to the 1985/86 growing season), farmers with less than one hectare of land had the least contact with extension workers using various extension-farmer contact strategies. Poor or smallholder farmers sometimes do not participate in development programs because they lack information about the existence and availability of such programs (Griffith, 1978).

Constraints on Farmers' Participation

Hunt (1990) suggested that farmers will participate in irrigation systems if organizational control over water exists, whereas they will not take part if there is no such control. Hunt also said that, unless the irrigation work demands can be met by the pool of available labor, participation is unlikely. Also, if the price structure affects participation, as it may well do, then price would be a plausible candidate for social constraint. Lynch (1986) argued that farmers will not be willing to participate if the proposed demands for irrigation system labor occur at a time when those farmers do not have surplus time.

Bagadion and Korten (1985) and Uphoff (1986) argued that the attitudes of state government bureaucrats should be taken into account when considering farmer participation. Negative attitudes on the part of these personnel might constitute a social constraint on farmers' participation (Hunt, 1990).

According to Freeman, Bhandarkar, Shinn, Wilkins-Wells, and Wilkins-Wells (1989), organizations are instruments for bringing people together to do collectively what they cannot do as well individually. Given the tight interdependence in irrigation systems and the fact that water control depends on collection actions, Freeman et al. concluded that water control can be enhanced only through disciplined organizations. They further argued that maximum local control over water is best secured by a sociotechnical middle-level command area, which makes staff members responsible to local authorities, recruits local staff from command-area labor markets, provides for routine maintenance by

local specialized personnel, and provides a combination of share types that maximize flexibility within physical and technical constraints.

## Farmers' Participation in Irrigation Management Systems

Irrigation systems, in which effective water management depends on the interrelated actions of a unified group of water users, are some of the most highly developed and complex examples of common property regimes (Chambers, 1988; Leonard & Marshall, 1982). Studies conducted in other countries have indicated that certain farmer-managed irrigation systems were functioning better than those managed by nonusers or public agencies (Hilton, 1990; Laitos, 1986; Ostrom, 1990; Tang, 1989). However, some nonuser-controlled irrigation systems were maintaining systems effectively (Abel, 1975; Levine, 1981), whereas others were not effective even though they had ample resources and technical backing (Hilton, 1990; Ostrom, 1990).

According to Thompson (1990), centralized bureaucratic agencies, by themselves, cannot provide sufficient management and other resources, even in small-scale irrigation systems, to manipulate water flows below the outlet, maintain each field channel, and resolve every conflict. In small systems, day-to-day management decisions generally are made without any involvement of government or other centralized authorities. Farmers are aware of the whole system and are active in project-level decision making. They have the knowledge and incentive to take part in planning and resource allocation. According to Lowdermilk (1985) and McCall (1988), operational plans that are

drawn up with farmers' participation and based on their knowledge are more likely to be accepted by the village irrigation institution, its constituency (the water users), and the community in general.

Effectiveness of Irrigation Systems

Johnson (1990) said that, to increase the efficiency of irrigation systems, it is necessary to improve the systems' water management as well as on-farm water management; the farmer is a prerequisite for the latter improvement. Furthermore, Johnson considered that, to improve general operational efficiency, it must be recognized that irrigation development is now primarily a management responsibility, not a design and construction task. One should not, however, underestimate the magnitude of management problems. Such problems are not simply engineering concerns but involve many disciplines. For instance,

1. Responsibilities are fragmented and cut across many construction, operational, agricultural, and financial agencies, which do not coordinate to provide services to farmers.

2. Most government irrigation agencies are not accountable to the farmers they serve, either for funds or for employment evaluation.

3. There are usually no effective means for monitoring and evaluating the performance and effectiveness of the system.

4. Irrigation agencies in most countries are staffed with operatives who are poorly trained, supervised, motivated, and rewarded.

5. Many agencies are plagued by pervasive corruption, overstaffing, and undisciplined employees.

6. Water users within sections of a public irrigation system usually do not organize, cooperate, or participate in operating and maintaining the system.

Coward (1980) suggested organizing a group, such as a farmers' association--preferably at the farmers' initiative or, if necessary, with initial government assistance--to help in attaining the objectives of irrigation projects. Barker, Coward, and Levine (1984) expanded this view to incorporate local groups in matters of system operation at the local level, as well as in decisions regarding modifications to and elaboration of the physical structures and their outputs.

Svendsen and Small (1990) said that efforts to improve the understanding of farmers' perceptions of system performance are useful because they enable farmers to better understand and adapt their behavior to their role as managers of the system. Thus, the role and functions that farmers perform as members of a particular irrigation system and the benefits they receive from the system may well reflect the individuals' perceptions about a particular system's effectiveness. Bottrall (1981) pointed out two major advantages, besides improved water-course management, that emanate from water users' associations. First, the associations can help provide a point of contact between small farmers and the government for other supporting services like agricultural extension, credit, input,

supply, and marketing. Second, the associations provide a foundation on which a system of representative farmer participation at the project level can be built.

Water Allocation and Distribution

Martin and Yoder (1987) argued that irrigation water allocation and distribution are distinctive and important functions for any irrigation system. According to them, water association is the assignment of entitlement to water from an irrigation system, and it has two dimensions. The first dimension distinguishes the fields or the farmers who have access to the system's irrigation from those who do not. The second involves the quantitative allocation of water in the system among the farmers or the fields. According to Freeman (1990), in the world of large-scale gravity-flow irrigation, it is the state bureaucracy that captures the water supply in remote watersheds and constructs, at great cost, the impressive engineering works to store and deliver water. However, all this investment is exploited only to the degree permitted by local organizations, which, at some point in the delivery system, must assume responsibility for delivering water to individual irrigators.

Local organizations must reconcile main-system water supplies with farmers' water demands. The organizational conditions under which that water is, or is not, delivered have everything to do with the productivity of irrigation water. Indeed, Patil (1987) suggested that, if the water distribution system can be managed by project staff, there will be less need for farmers' participation.

Easter (1986) said that a major constraint on the efficient and equitable distribution of water is the lack of knowledge about irrigation technology. Thus, effective information systems are needed, which will allow the exchange of agronomic and water-availability information between farmers and the managers of the system. Easter said that this information exchange often requires an agricultural extension service and regular training sessions for farmers and agents about water-use technology. In addition, there must be some way of integrating and coordinating the activities of the agricultural extension service and those managing the irrigation system. Without coordination, it is hard to achieve effective exchange of information.

According to Easter (1977), water management problems can be divided into two major categories: (a) problems associated with irregularities in water allocation and water distribution and (b) problems related to maintenance of channels and irrigation structures. Easter pointed out that, in large-scale gravity-flow irrigation systems, irrigation officials determine water requirements and procedures of allocating water from the storage tank to main canals and then to branch and distributor channels.

Water allocation has been considered a major problem in most centrally managed irrigation systems (Easter, 1977). Irrigation agencies throughout the world have introduced water allocation and distribution schedules based on the defined service area, reduction of seepage losses in water delivery, and crop water requirements. The Warabandi system in India and Pakistan and the

rotation system in Sri Lanka basically use such administrative methods of water allocation. The proposed rotation schedule of water delivery in the study area indicates preset times of water issues to distributors from the branch canal. The irrigation officials determine the amount of water that should be released to meet crop water requirements, and these procedures are altered from time to time. Individual farmers receive water based on the number of acres and types of crops they cultivate. Farmers complain that fixed turns create water shortages when water flows in channels are highly variable. Easter said that farmers are informed about methods of water allocation at meetings or through farmer representatives or local irrigation officials, and no organized procedures for water allocation are agreed to by all parties. The irrigation officials often alter water allocation procedures according to site-specific problems rather than farmers' demand for water. The irrigation agency often complains about farmers' violations of accepted rules and regulations.

Wade (1982) described a number of tactics that are used by individual farmers and farmer groups that pressure irrigation officials to issue more water; such actions reduce the availability of water to others. He also pointed out that some irrigation officials create a water-stress situation among farmers and then use their discretionary power to reduce water stress only for those who pay bribes. When both irrigation officials and farmers violate agency rules and regulations and adopt illegal water management practices, water distribution problems at the local level tend to increase.

Bromley, Taylor, and Parker (1980) argued that small and relatively powerless farmers encounter the problem of unpredictable water supplies due to lack of enforcement of water allocation rules and regulations. They also asserted that farmers who face water management problems because they do not have the money to bribe officials who control the water flow tend to withdraw from collective action.

Tapay (1987) argued that it is not only technical inefficiency that is responsible for the poor performance of irrigation systems. Rather, social factors, specifically the need for an effective irrigation organization, influence the efficiency of irrigation systems.

Maintenance and Operation

In a case study on the Philippines, Tapay (1989) described the organizational structure of large-scale irrigation systems and different farmer participatory approaches that have been used in recent years. She evaluated the effect of farmers' participation on the performance of the irrigation systems concerned. In starting several pilot projects on farmers' participation, the National Irrigation Administration made the following assumptions:

1. Because the farmers have to pay for the construction costs of the improvements on the system, they should have a considerable say in what is built.

2. Farmers' involvement in the planning and construction develops their sense of ownership of the system and, therefore, their desire to operate and maintain it properly.

3. Farmers' knowledge of local conditions can contribute to better planning and design of the system and help acceptance of the improvements after completion. (Tapay, 1989, p. 10)

A prerequisite to choosing a strategy for involving farmers in irrigation development is a basic, deliberate decision by the irrigation agency regarding the level of involvement it wants from farmer beneficiaries of the irrigation system (Bagadion, 1985). According to Hunt (1990), if the farmers can be brought in to participate in maintenance at the tail-end of the canal, then the distribution of water will be more effective, production will increase, and there will be more efficient use of water, land, and capital. Farmers' participation in operation and maintenance is therefore seen as a solution to a widespread, vexing, and costly problem. Nobody believes that the farmers should or can participate only as individuals in this work. Rather, farmer participation would be on a group basis, and the current consensus is that such groups should be small (roughly a score or two of farmers). Each large canal project would then have many groups of farmers, which would be responsible for operation and maintenance in their own area by getting the work done and relieving the system managers of direct responsibility. Thus, one problem involved in achieving farmer participation is persuading all (or almost all) farmers in large bureaucratic canal irrigation systems to join small groups that will perform the maintenance and allocate the water (Hunt, 1990).

Routine maintenance activities at the local level can be done by irrigation officials, farmer organizations, and/or individual farmers. According to Bottral

(1981), farmers usually develop ad hoc informal arrangements for maintaining field channels, but it is not their responsibility to maintain irrigation structures and larger irrigation canals. Bottral observed that some farmers do not contribute their resources for maintenance work and do not adhere to accepted rules and regulations. Also, there are differences in the number of times that field channels are cleaned and irrigation structures are repaired.

Hunt (1990) asserted that the conventional explanation that farmers' attitudes are responsible for lack of maintenance is incorrect. A better explanation, according to him, is "organizational control over water." Hunt contended that farmers are unlikely to participate in maintenance activities without some clear benefits, which he believed are partly to be found in control over acquisition and allocation of the water. In a Mexican case study, he found that the level of farmer participation had more to do with the nature of organizational control over the water than with the size of the system.

According to Parlin and Lusk (1991), many economic, social, and political factors may stimulate or discourage farmers' participation in meetings and in construction and maintenance activities. These factors include (a) the role of irrigated agriculture in the household economy, (b) the timing of agricultural activities, (c) the distribution of land and wealth in the command area, (d) demographic phenomena and local organizational capacity, (e) agency behavior rights in the infrastructure, (f) involvement of farmers in phases of project

development, (g) empowerment of local organizations, and (h) the relationship of contributions to control.

In a survey carried out in Sri Lanka in March 1980, it was found that 36% of farmers rated bad channel maintenance as the major cause of water problems in the pilot area (Wijayaratna et al., 1980). With the formation of farmer organizations, farmers properly cleaned all of the field channels (sometimes distributor channels as well) before each season commenced. Farmers provided their labor free for this purpose.

Conflict Management

Water scarcity generates conflicts (Bottral, 1981; Coward, 1980). Hariss (1977) believed that the potential for conflict increases when water supplies are both uncertain and scarce. Hunt and Hunt (1976) also agreed with the proposition that, the greater the degree of water scarcity, the more serious water conflicts will be. Those at the tail end of the water course often are in conflict with those who are closer to the water source (Bolin, 1990). Although conflict is common among irrigators within the same community, dissension tends to be expressed more strongly between communities (Bolin, 1990; Hunt & Hunt, 1976). Within a community, water disputes are resolved by informal mechanisms of cooperation among farmers, such as water sharing and close water supervision, and through water tribunals and physical rehabilitation works that increase water supplies.

Wade (1976, 1988) and Uphoff, Wickramasinghe, and Wijeratna (1990) argued that relative water scarcity affects crop losses and farmers' economic well-being. As the degree of water scarcity increases, the magnitude of water management problems also increases, and farmers look for immediate solutions to these problems. Uphoff et al. supported the proposition that farmers are more willing to participate in collective action when water is relatively scarce because free riding does not then become a deterrent to such participation.

Planning

In assisting small-scale "communal" irrigation systems throughout the Philippines, the National Irrigation Administration (NIA) sought to involve farmers from the inception of the project--including planning the project's scope, deciding the layout of the proposed system, and carrying out the construction of the needed dams, canals, and canal structures (Korten & Siy, 1989). Through such activities, the agency encouraged the farmers' irrigation association to develop the skills in decision making, resource mobilization, and conflict resolution that it would need in operating and maintaining the irrigation system. Furthermore, Korten and Siy stated that a growing body of research has shown that conventional programs encourage dependency and that, once government assistance is withdrawn or reduced, little lasting effect remains. In recognition of these findings, the policies of programs in fields such as health, education, nutrition, irrigation, forestry, pasture development, fisheries, housing, and

population are increasingly specifying that the beneficiaries should participate in project planning and execution.

In assessing a pilot project in the Philippines, Korten and Siy (1989) found that, although there had been many problems and there was still much room for improvement, the basic processes for inducing farmers' participation had been developed. Some key lessons that were learned from the initial pilot projects were as follows: Sufficient lead time should be given to community organizers for mobilizing farmers before construction. In the smaller of the two communal projects (planned for 600 hectares), such preconstruction activities required 10 months. Engineers and organizers needed to work closely to integrate the technical and organizational activities into one process. Agency policies and procedures that obstructed farmers' participation needed to be discarded or modified. Farmers were willing to participate extensively in planning and construction, and such participation enabled them to suggest canal locations appropriate to their needs. Furthermore, the labor and materials that farmers contributed to the project reduced government expenditures.

The operation of an irrigation system requires a fairly high level of cooperation among farmers with regard to the distribution of water and coordination of cultivation practices. However, it is often very difficult to achieve such cooperation (Chambers, 1980). In Asia, planting schedules were drawn up at regional headquarters and imposed on the farmers without previous consultation. The farmers were expected to carry out the various instructions

blindly. Potential water users were given little information about water requirements.

According to Bryant and White (1984), it is important for planners and local administrators to recognize the importance of participation and to appreciate the fact that farmers and peasants are capable of rational behavior. Development planners need to understand the cognitive map of rural people, the ways in which they perceive benefits, costs, and risks. The need to consider how to involve farmers in defining, developing, administering, and evaluating programs.

Design

According to Smout (1990), irrigation design is not a direct deductive process that generates a unique solution. Particularly in designing the general concept and the canal layout, the engineer attempts to satisfy various objectives (e.g., close fit with the farming system, low capital cost, high efficiency, and simple operation and maintenance) and considers various possible solutions before developing the design that seems most suitable. The chosen design is therefore not the only one or necessarily the best one possible, and the experienced designer is well aware that another engineer would probably develop a different solution. Smout suggested that it is important to remember this when designing works that serve farmers directly, such as small-scale irrigation schemes and tertiary canal systems on large schemes, because the

engineer may not be able to take account of all of the local factors in selecting a suitable design.

Vermillion (1989) described the alterations that farmers made to engineers' designs on a project in Indonesia, including destroying works after construction. These alterations were made because farmers had better knowledge of the locale and because some of their criteria differed from those of the engineers. Elsewhere, engineers observed that farmers modified structures and canals because they misunderstood the designs or because minorities tried to get unfair shares of water. Many of these changes (and waste of resources) could be avoided by involving farmers at key points in the design process, to enable the designer to take account of their objectives and to explain important aims and constraints (e.g., water availability). The failure of many such schemes can be broadly attributed to insufficient attention to social aspects of project design and procedures for water control, problems that could be avoided if local people were consulted.

Implementation

According to Chambers (1980), few instances have been recorded in which irrigation staff considered involving water users in the planning or implementation phases of irrigation schemes. In general, many factors existed that were counterproductive to such approaches. First, the staff were reluctant to look for opportunities to involve farmers in managing the irrigation scheme.

Furthermore, they considered themselves the only people who were competent to handle operation and management.

Singh (1986) said that no rural development project can be implemented on a national scale without the active and widespread participation of its clientele. Therefore, those responsible for project implementation must discover the factors that motivate the local people to participate in a project and, based on this first-hand knowledge, formulate a specific strategy to enlist their participation.

Smout (1990) concurred that, in order to create a structure for participation, a water users association (WUA) is usually set up on each scheme, with all the beneficiary farmers as members. The WUA is, in principle, independent of the agency and government and is responsible to its members. However, it usually is set up with assistance from the agency and is constituted according to standard agency regulations. Smout also said it is important for the WUA to be oriented toward involving farmers in the immediate practical tasks, with flexibility to develop as the scheme progresses and the necessary tasks change, until eventually it takes on its long-term operation and maintenance role.

Ansari (1989) wrote that, at the planning stage of a small-scale irrigation scheme in Nepal, the beneficiary group was identified, which could elect a construction committee and later become a WUA. The committee had to raise a certain proportion of the estimated cost of the scheme and deposit the cash in a construction committee account.

Johnston and William (1982) reported that, even when a development organization does reach the poor, it too often functions as a one-way conduit of implementation through which services, solutions, and prescriptions invented somewhere else are imposed on the rural community. In general, development workers see this as a two-part problem. First, it is necessary to design local organizations that link rural poor people with one another and with the larger social system. Second, it is necessary to design higher-order support organizations that protect the local groups, help them perform their problem-solving functions, and integrate their needs with those of society.

Irrigation Management Activities

According to Uphoff (1986a), one type of irrigation management activity focuses directly on the water. Water must be acquired, allocated, distributed, and, if there is excess, drained. A second type of management activity deals with the physical structures for controlling the water. These structures must be operated and maintained. A third type of activity focuses on the organization that manages the water and structures; these activities include decision making, resource mobilization, communication, and conflict management. Uphoff (1986b) suggested that, when this commitment to participation in irrigation schemes is put into practice, it appears to have four main elements: (a) participation in the procedures of water use within the system; (b) acquisition of the water, its allocation among participants, its distribution on an agreed-upon basis, the tackling of any drainage problems; (c) participation in the structures that develop

the scheme, including participation in the design, construction, operation, and maintenance of the actual irrigation system; and (d) participation in the organization of effort, which is vital for the day-to-day functioning of the scheme, such as decision making and local resource mobilization.

According to Bottral (1981), farmers' ability to organize for water management is a function of eight factors, one of which is the size of the irrigation command area. Other factors are farm size, social stratification, farmers' educational and irrigation experience, whether the system is channel based or village based, and the adequacy and predictability of water deliveries to farms. In their research in Pakistan, Mizra, Freeman, and Echert (1975) found that the fewer the farmers in a community, the easier it was to use them for maintenance work. On the other hand, the number of problems related to water management decision-making and maintenance problems increased when the number of farmers on a water course increased.

Coward (1976, 1980) observed that small groups in a water course can manage conflict better than large groups because differences among individuals in terms of social class, conformity to norms, and disparities of landholding can be reconciled more easily. It also is easier for the leader to communicate with members when the group is small. The distance to travel and time lost are important incentives for individual farmers to cooperate with local leaders. The performance of the leader is high when he or she is able to supervise and manage the behavior of members. Parker and Bromley (1978) also noted that,

the larger the number of irrigators along a water course, the greater the chances of interruptions to water flows. Thus, water control is relative to the number of farmers on the water course as well as the number of farmers located upstream.

In his study of the effects of irrigation projects in West Java, Schwarzweller (1987) concluded that not all villages were affected in the same way and not all families gained equally. Therefore, he suggested that variability should be considered in the planning and implementation of irrigation projects and programs of agricultural development elsewhere. However, not all activities are equally important in each environment, and the irrigation management institutions will reflect the relative importance of activities in a particular location (Martin & Yoder, 1987).

A report by the Food and Agriculture Organization (FAO) (1982) suggested that, to encourage participation, some sort of farmers' organization is essential. In many countries, the Water Users Association has served as a valuable medium to encourage and achieve farmers' participation. The motivation for promoting farmers' participation in decision making has increased in recent years.

Issues in Irrigation Management

Wade and Seckler (1990) identified water users' participation as one of the eight most critical issues in the management of large public surface irrigation systems. They argued that discussing these issues will enable management/ organizational specialists to identify and comprehend the irrigation-specific

questions so that they can bring management insights to bear on these questions. Specifically, the eight issues the authors addressed were:

1. Defining the objectives and monitoring the results.

2. Integrating the design of physical and managerial systems.

3. Establishing rights to water: legal versus social control.

4. Establishing accountability, incentives, and service charge.

5. Defining relationships between the irrigation organization and the other input/output services.

6. Outlining what will be the organizational linkage between canal operations and maintenance and planning, design, and construction.

7. Involving water users in the design, operation, and management of irrigation systems.

8. Establishing personnel policy (Wade & Seckler, 1990).

Studies of WUAs worldwide have contributed to an understanding of the costs, benefits, and situational determinants that impede or enhance farmers' involvement in irrigation organizations (FAO, 1985; Uphoff, 1985). Social scientists have given considerable attention to the problem of involving farmers and other water users in managing and developing irrigation projects (Parlin & Lusk, 1988; Uphoff, 1985). Researchers have found that the main lesson learned in this line of research has been that involving farmers in planning, design, water allocation, and conflict management has positive effects on project outcomes. Studies in the Philippines and Sri Lanka, for instance, have indicated

reductions in conflict and deviance, in addition to improved water application efficiencies (Bagadion, 1985; Uphoff, 1986).

Peterson (1984) wondered why, despite all of the advances in knowledge of irrigation technology, irrigation systems and the schemes they serve fall so notoriously short of reasonable expectations. He said that authorities now generally believe that the difficulty lies in the failure to operate irrigation schemes systematically. Water deliveries to fields do not match crop needs, even though other production requirements such as seeds, pesticides, fertilizer, labor, and technical knowledge are available in a timely fashion. The farmers who are responsible for managing the crops are normally not involved in planning and managing the water and other input delivery systems (Peterson, 1984). Thus, it is crucial that appropriate institutions be selected to manage a resource, to present the problems that can result from a mismatch between the organization and the type of good (Goetze, 1986). Throughout history, people's progress, in general, has depended on how they have organized their collective lives, and the progress of irrigation systems now, as always, depends on the quality of their irrigation organizations (Parlin & Lusk, 1991).

Johnson (1991) asserted that, to improve general operational efficiency, it must be recognized that irrigation development is now primarily a management task, not a design and construction effort. He said, however, that the magnitude of the management problems should not be underestimated; they are not simply engineering problems, but cut across many disciplines.

In Sri Lanka, system administrators appointed an irrigation assistant for each unit (250 farmers) to organize turnout groups in the Mahaweli irrigation system, oversee water allocation and distribution, check canal and other maintenance, and resolve conflicts–roles formerly assumed by the irrigation headman (Parlin, 1985). Findings of the USAID-sponsored midterm evaluation of the Mahaweli scheme suggested that cultivators frequently complained that they seldom saw the irrigation assistant and that he often preferred to give orders rather than soliciting the ideas and suggestions of water users themselves (Nott, 1985; Scudder, 1985).

According to Bottrall (1981), water users' accomplishment of their set tasks will not occur spontaneously; the users need to be stimulated by the irrigation organization or a government institution. It may seem an elementary point that the management of irrigation projects should be considered an evolutionary process, with a progression over time from a relatively high degree of central control toward increasing farmer participation and autonomy of decision making.

Financial Aspects of Irrigation Management

According to Korten and Siy (1989), indigenous organizations that collect fees normally have one or more fee collectors whose job is to personally contact each farmer within their area of jurisdiction. The more effective organizations often have clear sanctions for members who are delinquent in paying fees or providing labor contributions. Furthermore, Korten and Siy stated that,

occasionally, farmer-managed irrigation systems have developed sophisticated and modern financial practices. For example, in a study of the largest farmer-managed irrigation system in the Philippines, which serves 4,600 hectares, the following practices were revealed: The collector remitted his collections to the association treasurer when the total reached 500 pesos. The treasurer deposited remittances in the bank when these reached 1,000 pesos, and he seldom kept more than 2,500 pesos in his possession. Only authorized farmers handled bank transactions. The financial records of the association were audited each year by designated farmers, who also prepared an annual financial report, a copy of which was furnished to association members.

Such modern practices are rare, however. More often, indigenous groups acknowledge their weakness in handling money matters and avoid accumulating funds that could become a source of temptation for members or officers. Whenever possible, these associations demand labor rather than money from their members. Their fees are assessed only on an "as needed" basis, such as when materials need to be purchased to repair a major canal (Korten & Siy, 1989).

Barker and Herdt (1985) noted that national governments are beginning to provide more technical and financial assistance to small community systems. Apt examples are Indonesia's Sederhana program and the communal project started under the Philippine National Irrigation Administration. In the Asian context, irrigation system management is gradually evolving, with the more highly

developed systems in East Asia becoming farmer oriented. However, given the rapid development and growing importance of irrigation in South and Southeast Asia, these transformations are well behind schedule.

## Chapter Summary

The review of literature was intended to introduce the theoretical and conceptual framework for understanding farmers' participation in and their perceptions of the effectiveness of farmer-controlled irrigation systems. The review was focused on studies that guided the researcher in selecting the variables to use in examining the factors that affect farmers' participation in and their perceptions of the effectiveness of the farmer-controlled irrigation system, Canal Ulises Francisco Espaillat (CUFE), in Santiago, Dominican Republic.

Many insights gained from the literature review guided the study. For instance, in their model, Cohen and Uphoff (1977) proposed the idea that farmers' participation in decision making, implementation, benefits, and evaluation forms a cycle for rural development activities. This model was useful in constructing the instrument used to gather data for this study.

Lynch (1985) classified participation as (a) **direct participation**, in which community members contribute their labor for construction or maintenance, and (b) **indirect participation**, in which community members elect representatives to a local organization to make decisions about the use of irrigation water. Although this classification was not used in the present study, it was used in formulating relevant items for the questionnaire.

Johnson (1990) remarked on the importance of on-farm water management to improve the effectiveness of irrigation systems. Both he and Repetto (1986) noted that most government irrigation agencies are not accountable to the farmers they serve. As the needs of the clientele are changing rapidly along with changes in society, the irrigation system in the Dominican Republic is moving from a centralized (government-managed) to a decentralized (farmer-managed) one, based on the irrigation system transfer that the government is carrying out. However, as pointed out in the literature review, this new approach in irrigation is not free from problems.

The usefulness of improving the understanding of farmers' perceptions of irrigation system performance was pointed out in the literature review. However, when undertaking studies of farmers' perceptions, researchers need to be cautious because, as Svendsen and Small (1990) pointed out, the role and functions that a farmer performs as a member of a particular irrigation system and the benefits he or she gains from the system may well reflect the individual's perceptions about the particular system's effectiveness.

Many problems in irrigation systems also were mentioned in the literature. For instance, Wade (1982) described a number of tactics, such as payment of bribes, that individual farmers and farmer groups use to pressure irrigation officials to issue more water. Such actions reduce the availability of water to others. Wade pointed out that tactics such as these violate agency rules and regulations. Bromley et al. (1980) also mentioned the problem of lack of

enforcement of water-allocation rules and regulations. Thapaye (1987) remarked that inefficiency of irrigation results not only from technical ineptitude but also from social factors, thus recognizing the need for an effective irrigation organization.

In summary, many studies of irrigation management throughout the world have contributed to an understanding of the costs, benefits, and situational determinants that impede or enhance farmers' involvement in irrigation organizations. Social scientists have given considerable attention to the problem of involving farmers and other water users in managing and developing irrigation projects. Researchers have found that involving farmers in planning, design, water allocation, and conflict management has positive effects on project outcomes. This study was a first step toward gaining a better understanding of problems faced by on-farm water management projects in the Dominican Republic.

# CHAPTER III

# METHODS AND PROCEDURES

## Introduction

The researcher's purpose in this study was to describe and analyze the relationship between farmers' participation in and their perceptions of the effectiveness of the farmer-controlled irrigation system, Canal Ulises Francisco Espaillat (CUFE), in Santiago, Dominican Republic. Specifically, the research was focused on ascertaining farmers' participation in their irrigation system and their perceptions of effectiveness in regard to the management and use of that system.

The research design and methods used in the study are explained in this chapter. The design of the study is discussed first, followed by the research questions and hypotheses. The dependent and independent variables are listed next. The population and sample are described. The development of the instrument, including validity and reliability checks, is explained. Finally, the data-collection and data-analysis procedures are discussed.

## Design of the Study

The research methodology included a combination of survey and analytical research. The purpose of a survey is to obtain a statistical profile of the study population (Babbie, 1981). The study was concerned with existing conditions or relationships, practices that prevailed, beliefs, attitudes, and points of view held by farmers about participating in the management of the CUFE irrigation project.

Survey research is a widely used method of data collection in the social sciences. Surveys are well suited to many important tasks in irrigation research. Freeman, Lowdermilk, and Early (1978) identified the following uses of survey research methods in irrigation studies:

> Describing the structure of a policy problem.
>
> Providing data for better estimation and specification of gaming/simulation models that can be manipulated for analytical purposes.
>
> A survey can yield distributions of preferences for alternate policies and problems.
>
> Descriptive facts generated in survey research can be employed to educate clients--officials and farmers.
>
> Survey research can contribute to effective field work by identifying deviant cases that do not exhibit behavior expected either by theory or experience.

In this study, nonparametric tests were used to measure the relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of that system, based on data collected from the survey respondents. In addition, in order to compare farmers'

perceptions with reality, it was necessary to gather information from the administrators of the irrigation project and the INDRHI. The instrument used to collect these data (see Appendix B) was developed similarly to the one used with farmers, except the former instrument was not field tested.

## Research Questions

The following questions were posed to guide the collection of data for this study:

1. Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system?

2. Are there demographic characteristics that are related to farmers' participation in the irrigation system?

3. Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system, after statistically controlling for selected demographic characteristics of the farmers?

## Hypotheses

Null Hypothesis 1: There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system.

Null Hypothesis 2: There is no relationship between selected demographic characteristics of the farmers and their participation in the management of the CUFE irrigation system.

Null Hypothesis 3: There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system, after statistically controlling for selected demographic characteristics of the farmers.

Dependent and Independent Variables

In this study, two dependent variables and ten independent variables were used in the analyses. The dependent variables were:

1. **Farmers' participation**: The degree to which respondents actually had taken part in the On-Farm Water Management Project. This variable was measured by using items about allocating and distributing water, meeting with extension agents, coordinating cultivation practices, maintaining canals, making decisions on courses to offer, resolving conflicts, and evaluating the management and operation of the irrigation system in their sector. Each item taken into account to determine farmers' participation was measured using a Likert-type scale. That is, farmers were asked to respond to statements on the questionnaire, using a scale ranging from Never to Always. Therefore, it is important to remark here that after combining items about farmers' participation, the researcher arrived at means for each question used to define participation. Thus, the variable **participation** was used in the analysis as a continuous variable.

2. **Farmers' perceptions of system effectiveness**: the degree to which respondents actually perceived the effectiveness of the irrigation system. Parameters of effectiveness included timing, value and quantity of water received for use, management of water distribution, and control and maintenance of canals.

The independent variables in this study were the demographic characteristics of the respondents. These included:

1. **Age**: Biological age of the respondent at the time of the interview.
2. **Educational level**: The amount of formal education the respondent had received.
3. **Time farming the land**: The number of years the respondent had been involved in farming.
4. **Farm ownership**: Whether the respondent owned the farm, rented it, or was a sharecropper.
5. **Farm labor**: The type of labor on the respondent's farm.
6. **Farm size**: The actual land area cultivated by the respondent.
7. **Location of the farm in relation to the irrigation ditch**: Whether the farm was located at the beginning, middle, or end of the irrigation ditch.
8. **Farm production**: The crop(s) the farmer was producing.
9. **Farm sector location**: The sector in which the farm was located (Santiago, Bombeo, Villa Gonzalez, Navarrete, or Ponton).
10. **On-farm income**: The gross income the farmer received from the sale of agricultural products the preceding year.

## The Population

According to Rossi (1983), there are two types of populations: target population and survey population. The target population is the collection of elements that a researcher would like to study, whereas the survey population is the one that is actually sampled and from whom data may be obtained.

Babbie (1983) defined the target population as "all members of a real or theoretical and hypothetical set of people to which we wish to generalize the results of our research" (p. 97).

The target population of this study comprised farmers from the CUFE irrigation project, Alto Yaque del Norte Irrigation District. Because of the difficulties of gaining access to the total farmer population, the researcher surveyed only those farmers who were clients of the CUFE irrigation project. This irrigation project consists of five sectors: Santiago, Bombeo, Villa Gonzalez, Navarrete, and Ponton. The area of each sector and the number of users of the irrigation system in each sector are shown in Table 1. The survey population consisted of the CUFE users in these sectors.

Table 1: Area and number of users for each sector.

| Sector | Area (in Hectares) | No. of Users |
|---|---|---|
| Santiago | 917.3 | 283 |
| Bombeo | 1,385.6 | 502 |
| Villa Gonzalez | 1,229.7 | 479 |
| Navarrete | 1,192.8 | 353 |
| Ponton | 1,317.3 | 398 |
| Total | 6,042.7 | 2,015 |

## The Study Sample

Babbie (1983) defined sampling as the selection of a number of subjects from a defined population. The size of the sample depends on the details of the

analysis. A basic principle is that a sample will represent the population from which it is selected if all members of the population have an equal chance of being selected for the sample.

The sample for this study was drawn from a list of farmers belonging to the CUFE irrigation system in Santiago, Dominican Republic. The stratified sample consisted of 201 farmers from the five sectors, chosen from a list of 2,015 farmers who were members of the project in question, using a table of random numbers. This table has a 95% confidence level and a 5% sampling error. Only those farmers who were on the CUFE irrigation project's list of farmers were surveyed. This list did not include all farmers in the region.

The distribution of the stratified sample of users of the CUFE irrigation project, by sector, is shown in Table 2. The 201 farmers thus selected served as the respondents in this study. All of the farmers who were selected agreed to respond to the personal interviews.

Table 2: Stratified sample of the CUFE Water Users Association, by sector.

| Sector | No. of Users | Sample Members |
|---|---|---|
| Santiago | 283 | 28 |
| Bombeo | 502 | 50 |
| Villa Gonzalez | 479 | 48 |
| Navarrete | 353 | 35 |
| Ponton | 398 | 40 |
| Total | 2,015 | 201 |

In addition, a number of irrigation units from each sector were randomly selected. For instance:

N = sample size (201 farmers)
n = n1, n2, n3

where: n1 = number of head-of-irrigation-ditch farmers per irrigation unit by sector, n2 = number of middle-of-irrigation-ditch farmers, and n3 = number of tail-end-of-irrigation-ditch farmers selected for the stratified sample. n1, n2, and n3 are proportional to their share in the stratified sample.

This type of selection was done at the suggestions of the manager of the CUFE Water Users Association, extension agents of the CUFE, and INDRHI personnel. This decision was made because it is useful to evaluate farmers' participation in and their perceptions of the effectiveness of the whole system from the beginning to the end of the canal, which are the bases of the system organization.

Because of the lack of computers to use in selecting a random sample of farmers and irrigation units in the five irrigation sectors, the researcher put into a paper bag pieces of paper with the number of units for each sector, to help in the random selection process. The researcher randomly selected, first, the number of units and, second, the farmers in each unit. This process was used for each of the five sectors, in order to select the irrigation units for the study. In selecting the farmers from each irrigation unit, the researcher, with the help of CUFE irrigation project personnel, divided each irrigation unit geographically into three equal zones. Thus, three farmers were randomly selected from each

irrigation unit: one from the beginning of the irrigation ditch, one from the middle, and one from the tail end of the ditch.

The numbers of irrigation units that were randomly selected, by sector, are shown in Table 3. This stratified sample had an equal proportion of head-, middle-, and tail-end of-irrigation-ditch farmers. This allowed generalization of the findings to the whole population of farmers in the CUFE irrigation project.

Table 3: Stratified sample of irrigation units, by sector.

| Sector | Total Units | Randomly Selected Units |
|---|---|---|
| Santiago | 27 | 10 |
| Bombeo | 37 | 17 |
| Villa Gonzalez | 45 | 16 |
| Navarrete | 29 | 12 |
| Ponton | 58 | 14 |
| Total | 196 | 69 |

The descriptive characteristics of the random sample can be generalized to the entire population. In random sampling, every unit in the population has an equal and independent chance of being selected for the sample. Random selection of the sample members eliminates any selection bias and allows generalization of the findings to the population with a known margin of error.

## Development of the Instrument

After a careful review of related literature, the researcher developed a questionnaire to use in gathering information from the farmers who were included in the sample. Questions were based on the researcher's own insights and on input provided by a focus group consisting of the researcher, professors at the Instituto Superior de Agricultura in the Dominican Republic, and personnel of the CUFE irrigation project, Santiago, Dominican Republic. Such input ensured the validity of the instrument.

The questionnaire was divided into three parts. The first part contained 17 closed- and open-ended questions about farmers' participation. Farmers responded to each closed-ended participation item using a Likert-type scale ranging from 1 (never) to 5 (always). The second part contained 20 questions about perceived effectiveness of the system. Farmers responded to each perceived-effectiveness item using the same scale as in the first part of the questionnaire. The third part of the instrument included 10 items concerning demographic characteristics of the respondents. (See Appendix A for a copy of the questionnaire.)

### Validity

Validity means the extent to which an instrument allows one to observe or measure what he or she intends to observe or measure (Gorden, 1969). In this study, attention was given to the validity of the questionnaire--that is, whether it was really measuring what it was supposed to measure. To ensure the validity

of the questionnaire, the researcher contacted other researchers to solicit their suggestions for improving the instrument. A panel of experts from the Department of Agricultural and Extension Education at Michigan State University and the Instituto Superior de Agricultura, Dominican Republic, also reviewed the instrument to ensure its validity.

Reliability

In face-to-face interviewing, which was used in this study, reliability can be determined by field testing the instrument. According to Gorden (1969), reliability means the degree to which a given observation or measurement could be repeated by an independent observer. Reliability depends on maintaining generally good interpersonal relations with the respondents and includes being aware of the potential inhibitors that might make the respondents unwilling or unable to give valid information. In addition, maintaining reliability involves using both verbal and nonverbal means to help the respondent become more willing and able to give valid information, detecting symptoms of resistance in the respondent, and refraining from pressuring the respondent for information before he or she is willing or able to give it (Gorden, 1969). These factors are vitally important to achieving reliability in face-to-face interviewing.

To improve the reliability of the instrument, it was pilot tested with 12 farmers who were not included in the sample. Ideally, these farmers were typical of the respondent population. As a result of this pilot test, further refinements

were made in the Spanish version of the instrument before it was administered to the actual sample.

Sheatsley (1983) recommended pretesting an instrument with 12 to 25 people and using several interviewers for the pretest if more than one will be administering the final questionnaire. These requisites for instrument pretesting were met.

Cronbach's alpha was used to assess the homogeneity measure of reliability. Two variables with their items were analyzed: participation and perceived effectiveness of the system. To determine reliability, the resulting data were entered into the computer using the Statistical Package for the Social Sciences (SPSS/PC+) and were analyzed using Cronbach's reliability coefficient. An alpha of .70 was set as an acceptable level of reliability. Cronbach's alpha is used when measures have multiple scored items, such as a Likert-type scale (Ary, Jacobs, & Razavieh, 1990), which was the type of scale used in this study to measure farmers' participation and perceived effectiveness of the system.

Cronbach's alphas for the participation and perceived effectiveness items are shown in Table 4. As shown in the table, both sets of items had an alpha higher than .70. Thus, both sets of items were within the acceptable limit of reliability.

The researcher submitted a copy of the research proposal and instrument to the Michigan State University Committee on Research Involving Human Subjects (UCRIHS) for review and approval. That approval was granted (see

Appendix C). This review is required to ensure that all human rights are protected in the study. Because the sample of this study spoke Spanish, the researcher translated the English version of the instrument into Spanish before administering it to the subjects.

Table 4: Cronbach's alphas for the participation and perceived effectiveness items.

| Item | Alpha |
|---|---|
| Participation | .80 |
| Effectiveness | .90 |

## Data-Collection Procedures

In developing countries, specifically the Dominican Republic, where mass communications are not available to the entire rural and urban population, it is difficult to use communications media such as mail or telephone to obtain information for a survey. In such instances, interpersonal communication, such as face-to-face interviews, is the best way to gather data. The interviewer can use clues other than the content of responses to assess their validity (Borg & Gall, 1983).

Interpersonal communication also has its institutionalized form in the small group or committee. Here, too, there is face-to-face engagement with persons who are able to respond to the entire spectrum of verbal and nonverbal signs. Where information must be gathered from an illiterate or semi-literate population,

face-to-face interviewing may be the only effective instrument. This method is useful for obtaining background information about a problem situation, collecting information and ideas from a selected sample within a target population, and eliciting information from experts or professionals, e.g., agency representatives (Delp, 1977).

The advantages of the personal interview method often outweigh its disadvantages. The flexibility of this data-collection method sometimes makes it the only choice for projects that demand direct contact, a special location, or special selection of respondents who qualify for the survey (Alreck & Settle, 1989). The central aim of any data-gathering methodology is to enhance both the reliability and validity of the information obtained.

Data were gathered during October and November 1994. The principal investigator contracted with members of the INDRHI and the CUFE irrigation project team to administer questionnaires to all participants in the area identified for the study. The interviewers were trained regarding the questionnaire and the data that were to be obtained through individual questions. Data were collected through personal interviews with the farmers in their fields.

In this study, both quantitative and qualitative data were collected from selected farmers in the CUFE irrigation project, Alto Yaque del Norte Irrigation District, who had been chosen according to the stratified random sampling procedure. The study findings are generalizable to the entire population of farmers who belong to the CUFE irrigation project.

## Data-Analysis Procedures

This study was conducted to describe a given state of affairs; therefore, descriptive statistics (means, frequency, and percentage) were used in analyzing farmers' participation and their perceptions of effectiveness. Descriptive statistics also were used to analyze and present the demographic characteristics of the respondents and findings concerning farmers' participation.

To answer Research Question 1 (Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system?) and to test the first null hypothesis (There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system.), the following steps were followed: All of the participation items were combined to form a single variable called participation. This variable was analyzed by using the Spearman correlation coefficient with all of the items regarding effectiveness of the system. All of the effectiveness items were combined to form a single variable called effectiveness. This variable was analyzed using the Spearman correlation coefficient with all of the participation items. To determine the overall relationship between participation and effectiveness, both combined variables, participation and effectiveness, were analyzed using the Spearman correlation coefficient.

To answer the second research question (Are there demographic characteristics that are related to farmers' participation in the irrigation system?) and to test the second null hypothesis (There is no relationship between selected

demographic characteristics of the farmers and their participation in the management of the CUFE irrigation system.), the following procedures were followed: First, all of the participation items were combined into a single variable called participation. To determine whether there was an association between the demographic variables and participation, the Spearman correlation coefficient was used. Moreover, analysis of variance (ANOVA) and follow-up procedures (Tukey test) were used to determine differences in means for the variable participation with respect to the demographic characteristics.

Finally, to answer Research Question 3 (Is there a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system, after statistically controlling for selected demographic characteristics of the farmers?) and to test the third null hypothesis (There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system, after statistically controlling for selected demographic characteristics of the farmers.), the following procedures were used: Questions measuring participation were combined to form a single dummy dependent variable. The same procedure was used with questions measuring effectiveness. To determine the relationship between these two dependent variables after statistically controlling for demographic characteristics, multiple regression was used. A stepwise method was employed.

Results of the data analyses are presented in Chapter IV.

# CHAPTER IV

# FINDINGS

## Introduction

The study findings are presented in this chapter. Attention is given to interpreting the data according to the research questions posed in Chapter 1. Cases with missing values for any variable were excluded from all analyses. In the tables containing responses of farmers, the frequency column usually does not total 201--that is, the total sample. This is because some farmers did not answer specific items, or it may be due to interviewer error. The findings are presented in the following order:

1. General description of the respondents.
2. Descriptive findings about farmers' participation.
3. Relationship between farmers' participation and perceived effectiveness of the system.
4. Demographic characteristics related to farmers' participation in irrigation.
5. Relationship between farmers' participation and perceived effectiveness of the system, after statistically controlling for demographic characteristics.

## General Description of the Respondents

### Age

Age refers to the biological age of the respondent. The mean age of respondents participating in the CUFE irrigation project was 49.26 years; they ranged in age from 19 to 77 years. For analysis purposes, the respondents were categorized into the following age groups: (a) youngest through 29 years, (b) 30 through 39 years, (c) 40 through 49 years, (d) 50 through 59 years, (e) 60 through 69 years, and (f) over 70 years. The distribution of respondents according to age category is shown in Table 5. As shown in the table, the greatest proportion of respondents (78.9%) was between 40 and 69 years old. Only 3% of the respondents were under 30 years old. These findings indicate that most users of the CUFE irrigation system are relatively mature.

Table 5: Distribution of respondents by age category.

| Age Category | Frequency | Percent |
|---|---|---|
| Youngest to 29 years | 6 | 3.0 |
| 30 to 39 years | 28 | 14.0 |
| 40 to 49 years | 76 | 39.0 |
| 50 to 59 years | 49 | 25.0 |
| 60 to 69 years | 29 | 14.9 |
| Over 70 years | 8 | 4.1 |
| Total | 196 | 100.0 |

Educational Level

Educational level refers to the amount of formal education the respondents had received. Respondents were asked to indicate their educational background in terms of the following levels: (a) without formal education, (b) primary, (c) intermediate, (d) secondary, (e) postsecondary. The educational level of the respondents is shown in Table 6. The greatest proportion of respondents (85%) had been exposed to formal education. This suggests that the respondents could comprehend the questionnaire items.

Table 6: Distribution of respondents by educational level.

| Educational Level | Frequency | Percent |
|---|---|---|
| Nonformal education | 30 | 15.0 |
| Primary education | 118 | 59.0 |
| Intermediate education | 36 | 18.0 |
| Secondary education | 9 | 4.5 |
| Postsecondary education | 7 | 3.5 |
| Total | 200 | 100.0 |

Time Farming the Land

Time farming the land refers to the number of years the respondents had been farming. The distribution of respondents according to their years of farming is shown in Table 7. The greatest proportion of respondents (65.5%) had been

involved in farming the land fewer than 11 years. This means that most of the farmers had not been cultivating their land for a long period of time.

Table 7: Distribution of respondents by years of farming.

| Years of Farming | Frequency | Percent |
|---|---|---|
| 1 to 5 years | 44 | 22.0 |
| 6 to 10 years | 87 | 43.5 |
| 11 to 15 years | 38 | 19.0 |
| 16 to 20 years | 19 | 9.5 |
| More than 20 years | 12 | 6.0 |
| Total | 200 | 100.0 |

Farm Ownership

Farm ownership indicates which of the respondents were land holders at the time of the interviews. The distribution of farmers according to farm ownership is shown in Table 8. Most of the farmers (76.5%) rented the land. The remaining 23.5% of the respondents owned the land or were sharecroppers.

Table 8: Distribution of respondents by farm ownership.

| Farm Ownership | Frequency | Percent |
|---|---|---|
| Own the farm | 31 | 15.5 |
| Rent the farm | 153 | 76.5 |
| Sharecrop | 16 | 8.0 |
| Total | 200 | 100.0 |

Farm Labor

Farm labor indicates the type of labor working on the farm. The types of labor used by the farmers are reported in Table 9. The greatest proportion of respondents (66.5%) used paid labor on their farms. Very few farmers (9.6%) used their family members as labor.

Table 9: Distribution of respondents by type of farm labor.

| Type of Labor | Frequency | Percent |
|---|---|---|
| Family labor | 19 | 9.6 |
| Paid labor | 131 | 66.5 |
| Both types of labor | 47 | 23.9 |
| Total | 197 | 100.0 |

Farm Size

Farm size refers to the actual land area cultivated by the respondents, measured in hectares. The number of hectares the farmers cultivated is indicated in Table 10. The predominant farm size in the CUFE irrigation project was between .5 and 6 hectares; 95% of the respondents' farms were that size.

Farm Location in Relation to the Irrigation Ditch

Farm location indicates where the farm is located in relation to the irrigation ditch--that is, at the beginning, middle, or end of the ditch. Farm-location data were gathered so that the researcher could select farmers from

different parts of the CUFE irrigation project for this study. The distribution of farms in relation to the irrigation ditch is shown in Table 11. The frequencies represent the stratified random sample of respondents from beginning-, middle-, and end-of-ditch farms in all of the sectors into which the irrigation project is divided.

Table 10: Distribution of respondents by farm size.

| Farm Size (in Hectares) | Frequency | Percent |
|---|---|---|
| 0.5 to 4.0 | 167 | 83.0 |
| 4.5 to 6.0 | 24 | 12.0 |
| 6.5 to 8.0 | 3 | 1.5 |
| 8.5 to 10.0 | 3 | 1.5 |
| 10.5 to 12.0 | 2 | 1.0 |
| 12.5 to 14.0 | 1 | 0.5 |
| 14.5 to 16.0 | 1 | 0.5 |
| Total | 201 | 100.0 |

Table 11: Distribution of farms in relation to the irrigation ditch.

| Farm Location | Frequency | Percent |
|---|---|---|
| Beginning | 69 | 34.6 |
| Middle | 65 | 32.7 |
| End | 65 | 32.7 |
| Total | 199 | 100.0 |

Farm Production

Farm production indicates the crops farmers were producing. The crops that farmers were cultivating at the time of data collection are shown in Table 12. The major crops under the influence of the CUFE irrigation project were beans, rice, yucca, pasture, and tobacco. These crops represented 83.8% of the crops cultivated under the irrigation project. Tobacco (26.7%) was the main crop cultivated in the project. Vegetables, plantains, and bananas represented 16.2% of the crops cultivated in the area of the irrigation project's influence.

Table 12: Distribution of respondents by crops they were cultivating.

| Crop | Frequency | Percent |
|---|---|---|
| Tobacco | 53 | 26.7 |
| Beans | 35 | 17.7 |
| Pasture | 32 | 16.2 |
| Yucca | 24 | 12.1 |
| Rice | 22 | 11.1 |
| Plantains | 18 | 9.1 |
| Vegetables | 10 | 5.1 |
| Bananas | 4 | 2.0 |
| Total | 198 | 100.0 |

Farm Sector Location

Farm sector location is important because it is possible that farmers' participation and their perceptions of the effectiveness of the irrigation project varied by location. The distribution of respondents by farm sector is shown in Table 13. Respondents were randomly selected for the study from the different sectors. Forty-eight percent of the sample were from the Bombeo and Villa Gonzalez sectors. These two sectors had the largest number of farmers of all of the sectors in the irrigation project.

Table 13: Distribution of respondents by farm sector.

| Farm Sector | Frequency | Percent |
|---|---|---|
| Santiago | 28 | 13.9 |
| Bombeo | 50 | 24.9 |
| Villa Gonzalez | 48 | 23.9 |
| Navarrete | 35 | 17.4 |
| Ponton | 40 | 19.9 |
| Total | 201 | 100.0 |

On-Farm Income

On-farm income refers to the gross income individual farmers received from the sale of agricultural products during the preceding year, as reported by the respondents. At the time of data collection, the exchange rate was 12.5 pesos per U.S. dollar. The distribution of farmers by yearly on-farm income is

shown in Table 14. Most of the farmers (50.5%) had an on-farm income of more than 15,001 pesos per year. The rest of the farmers in the sample (49.5%) earned between 1,000 and 15,000 pesos annually.

Table 14: Distribution of farmers by yearly on-farm income.

| Income (in Pesos) | Frequency | Percent |
|---|---|---|
| 1,000 to 3,000 | 8 | 4.1 |
| 3,001 to 5,000 | 19 | 9.8 |
| 5,001 to 8,000 | 29 | 15.0 |
| 8,001 to 15,000 | 40 | 20.6 |
| More than 15,001 | 98 | 50.5 |
| Total | 194 | 100.0 |

Descriptive Findings About Farmers' Participation

As shown in Table 15, 95.52% of the farmers never or seldom participated in discussing construction of new canals. This finding is not surprising because in the CUFE irrigation project there was no construction of new canals at the time of data collection. According to the manager of the CUFE irrigation system, if new canals are to be constructed, farmers will be encouraged to participate.

About three-fourths (76.61%) of the farmers in the irrigation project rarely participated in water distribution (Table 16). This is because there is plenty of water to be distributed among farmers. Also, farmers perceived that there was

no need for them to participate in water distribution because the associations had been appointing officials who were receiving sufficient remuneration. This has eliminated the practice of paying bribes to receive water.

Table 15: Farmers' participation in discussing construction of new canals.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 187 | 93.03 |
| Seldom | 5 | 2.49 |
| Sometimes | 7 | 3.49 |
| Most of the time | 2 | 0.99 |
| Always | 0 | 0.00 |
| Total | 201 | 100.00 |

Table 16: Farmers' participation in water distribution.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 96 | 47.76 |
| Seldom | 15 | 7.46 |
| Sometimes | 43 | 21.39 |
| Most of the time | 18 | 8.96 |
| Always | 29 | 14.43 |
| Total | 201 | 100.00 |

There was good communication between farmers and extension agents. Results in Table 17 show that 89.88% of the farmers in the CUFE irrigation system sometimes or always communicated problems related to irrigation to the

extension agents belonging to the five sectors into which the irrigation project is divided.

Table 17: Farmers' participation in discussing problems with extension agents.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 4 | 2.03 |
| Seldom | 18 | 9.13 |
| Sometimes | 73 | 37.06 |
| Most of the time | 51 | 25.89 |
| Always | 51 | 25.89 |
| Total | 197 | 100.00 |

As shown in Table 18, 79.50% of the farmers in the CUFE irrigation project never participated in the coordination of cultivation practices. This is because they have freedom to select what crops they want to grow on their land. The CUFE irrigation system does not require farmers to cultivate specific crops.

Table 18: Farmers' participation in the coordination of cultivation practices.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 159 | 79.50 |
| Seldom | 4 | 2.00 |
| Sometimes | 10 | 5.00 |
| Most of the time | 14 | 7.00 |
| Always | 13 | 6.50 |
| Total | 200 | 100.00 |

According to Table 19, 94.54% of the farmers in the CUFE irrigation system sometimes or always participated in the maintenance of canals. However, farmers do not have to participate directly in this activity. They can hire personnel to perform this crucial activity.

Table 19: Farmers' participation in the maintenance of canals.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 6 | 2.98 |
| Seldom | 5 | 2.48 |
| Sometimes | 21 | 10.45 |
| Most of the time | 77 | 38.31 |
| Always | 92 | 45.78 |
| Total | 201 | 100.00 |

Most of the farmers in the project never participated in decision making about what courses the CUFE irrigation project will offer (Table 20). This means that the CUFE, in this case, is using a top-down approach. Farmers pointed out that they would like to have courses related to their needs.

As shown in Table 21, 96.48% of the respondents participated in requesting irrigation equipment. This participation includes assistance with association meetings, contact with extension agents, or direct contact with the manager of the CUFE. Despite the high level of farmer participation, their requests usually are not fulfilled promptly because the CUFE project does not provide all of the irrigation equipment. Sometimes the CUFE has to ask the INDRHI for such equipment.

Table 20: Farmers' participation in decision making about courses to be offered by the CUFE irrigation project.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 159 | 79.50 |
| Seldom | 1 | 0.50 |
| Sometimes | 15 | 7.50 |
| Most of the time | 8 | 4.00 |
| Always | 17 | 8.50 |
| Total | 200 | 100.00 |

Table 21: Farmers' participation in requesting irrigation equipment.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 7 | 3.52 |
| Seldom | 20 | 10.05 |
| Sometimes | 23 | 11.55 |
| Most of the time | 63 | 31.66 |
| Always | 86 | 43.22 |
| Total | 199 | 100.00 |

Ninety-seven percent of the farmers indicated a high level of participation in the management and operation of the CUFE irrigation system (Table 22).

Table 22: Farmers' participation in the management and operation of the CUFE irrigation system.

| Value Label | Frequency | Percent |
|---|---|---|
| Never | 6 | 3.00 |
| Seldom | 12 | 6.00 |
| Sometimes | 15 | 7.50 |
| Most of the time | 97 | 48.50 |
| Always | 70 | 35.00 |
| Total | 200 | 100.00 |

To determine the strength of the association between the items described above and overall farmer participation, Spearman correlation coefficients were calculated. All of the items were associated with farmers' participation at the .05 level of significance (Table 23). The item with the strongest correlation was farmers' participation in discussing problems with extension agents ($r = .81$, $p < .05$). The item with the weakest correlation was farmers' participation in discussing construction of new canals ($r = .31$, $p < .05$).

Table 23: Correlation coefficients between farmers' participation and items pertaining to farmers' participation.

| Item No. | Farmer Participation Item | Corr. Coeff. |
|---|---|---|
| 1 | Participation in discussing construction of new canals | .31* |
| 2 | Participation in water distribution | .64* |
| 4 | Participation in problem discussion with extension agents | .81* |
| 5 | Participation in the coordination of cultivation practices | .58* |
| 7 | Participation in the maintenance of canals | .72* |
| 9 | Participation in decision making about the courses to be offered by the CUFE | .67* |
| 12 | Participation in decision making to request irrigation equipment | .72* |
| 15 | Participation in the management and operation of the irrigation system | .52* |

*Significant at the .05 level.

## Relationship Between Farmers' Participation and Perceived Effectiveness of the System

Null Hypothesis 1: There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system.

Identification of the possible relationship between farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system was the central objective of the study. A Spearman correlation coefficient was used to determine the relationship between these variables. In interpreting the correlation coefficient, the descriptors proposed by Davis (1971) were used. This

is the most commonly used convention for describing measures of association. The descriptors of correlation coefficients (whether positive or negative) are:

| Coefficient | Descriptor |
|---|---|
| 0.70 or higher | Very strong association |
| 0.50 to 0.69 | Substantial association |
| 0.30 to 0.49 | Moderate association |
| 0.10 to 0.29 | Low association |
| 0.01 to 0.09 | Negligible association |

The relationship was analyzed in three steps. In the first step, scores on individual items concerning perceived effectiveness of the irrigation system were correlated with the combined farmer-participation score to identify the items that had a relatively high association with farmer participation. In the second step, scores on individual items concerning farmer participation were correlated with the combined effectiveness-of-the-system score to identify the items that had a relatively high association with perceived effectiveness of the system. Third, scores on both of the combined variables, farmer participation and perceived effectiveness of the system, were correlated to determine whether there was an association between them. Results are shown in Tables 24, 25, and 26, respectively.

Correlations between the combined farmer participation variable and selected items concerning perceived effectiveness of the system are shown in Table 24. For this analysis, Spearman correlation coefficients were computed. As shown in the table, there was a low to very strong association between items concerning the perceived effectiveness of the system and farmers' participation.

The services that the farmers were receiving from the Water Users Association extension agent (Item 28) showed the highest correlation with participation ($r$ = .72, $p < .05$). It appears that most of the respondents regularly used agents' services. In contrast, the overall effectiveness of the irrigation system in meeting farmers' needs (Item 34) had the lowest association with participation ($r$ = .25, $p < .06$).

Table 24: Correlation coefficients between farmers' participation and items pertaining to perceived effectiveness of the system.

| Item No. | Effectiveness Item | Corr. Coeff. |
|---|---|---|
| 16 | Sufficiency of water quantity | .46* |
| 17 | Availability of water on time | .52* |
| 18 | Effectiveness of payment for water use | .52* |
| 19 | Effectiveness of the Water User Association services | .64* |
| 20 | Effectiveness of water distribution | .58* |
| 24 | Effectiveness of canal maintenance | .52* |
| 28 | Effectiveness of the extension agent in problem solving | .72* |
| 32 | Improvement of the effectiveness of the irrigation system | .53* |
| 34 | Effectiveness of the irrigation system in meeting farmers' needs | .25* |

*Significant at the .05 level.

The association between perceived effectiveness of the system and farmers' participation is shown in Table 25. As shown in the table, all of the

farmer-participation items had a low to very strong association with perceived effectiveness of the system. Farmers' participation in the maintenance of canals (Item 7) had the highest correlation with the perceived effectiveness of the system ($r = .72$, $p < .05$). On the other hand, farmers' participation in discussing the construction of new canals in the system (Item 1) had the lowest association with the perceived effectiveness of the system ($r = .15$, $p < .05$).

Table 25: Correlation coefficients between perceived effectiveness of the system and items pertaining to farmers' participation.

| Item No. | Farmer Participation Item | Corr. Coeff. |
|---|---|---|
| 1 | Participation in discussing construction of new canals | .15* |
| 2 | Participation in water distribution | .41* |
| 4 | Participation in problem discussion with extension agents | .64* |
| 5 | Participation in the coordination of cultivation practices | .42* |
| 7 | Participation in the maintenance of canals | .72* |
| 9 | Participation in decision making about the courses to be offered by the CUFE | .49* |
| 12 | Participation in decision making to request irrigation equipment | .47* |
| 15 | Participation in the management and operation of the irrigation system | .43* |

*Significant at the .05 level.

To determine the relationship between all of the items concerning farmers' participation and perceived effectiveness of the system, a correlation coefficient

was computed between the combined items corresponding to farmers' participation and perceived effectiveness of the system (see Table 26). This correlation coefficient was .72, significant at the .05 level. This means that there was a very strong association between farmers' participation in the irrigation system and their perceptions of the effectiveness of the system. Thus, the first null hypothesis--that there is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system--was rejected at the .05 level of significance.

Table 26: Relationship between farmers' participation and perceived effectiveness of the system.

| | Correlation Coefficient |
|---|---|
| Farmer participation and perceived effectiveness of the system | .72* |

*Significant at the .05 level.

## Relationship of Demographic Characteristics to Farmers' Participation in Irrigation

Null Hypothesis 2: There is no relationship between selected demographic characteristics of the farmers and their participation in the management of the CUFE irrigation system.

Spearman correlation coefficients were used to determine the relationship between the farmer-participation variable and all of the demographic variables.

The Spearman correlation coefficients between the demographic characteristics and farmers' participation are shown in Table 27.

Table 27: Correlation coefficients between demographic variables and farmers' participation.

| Demographic Variable | Correlation Coefficient |
|---|---|
| Age | -.16* |
| Farm size | -.11 |
| Farm ownership | .05 |
| Educational level | .03 |
| On-farm income | .10 |
| Farm location | -.11* |
| Time farming | -.04 |
| Farm labor | .38* |
| Farm production | -.37* |
| Farm-sector location | .05 |

*Significant at the .05 level.

There was a moderate to negligible correlation between farmers' participation and the various demographic characteristics included in this study. There was a moderate association between farmers' participation and farm labor ($r = .38$, $p < .05$) and farm production ($r = -.37$, $p < .05$). A low association was found between farmers' participation and age, on-farm income, and farm location. A negligible association was found between farmers' participation and

farm size, farm ownership, educational level, time farming, and farm-sector location.

Based on the preceding findings, the second null hypothesis--that there is no relationship between selected demographic characteristics of the farmers and their participation in the management of the CUFE irrigation system--was rejected at the .05 level of significance for age, farm location, farm labor, and farm production. Although there was a low association between on-farm income and participation, this correlation was not significant at the .05 level.

To analyze the data further, ANOVA was used to determine whether there were differences in means on the combined variable participation, with respect the following demographic characteristics: educational level, time farming, farm ownership, farm labor, farm location, farm production, farm sector, and on-farm income. In those cases in which the means differed statistically, a Tukey post-hoc test was used to determine specifically which group or groups differed significantly from the others.

Results of the ANOVA between educational level and participation are shown in Table 28. No significant difference (at the .05 level) in participation was found with respect to level of education. This means that farmers with low as well as high levels of education participated in the different activities that the CUFE was conducting.

Table 28: Results of the ANOVA between educational level and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 4 | 2.122 | 0.531 | 0.960 | .43 |
| Explained | 4 | 2.122 | 0.531 | 0.960 | .43 |
| Residual | 195 | 107.720 | 0.552 | | |
| Total | 199 | 109.842 | 0.552 | | |

Results of the ANOVA between time farmers had been cultivating their land and participation are shown in Table 29. An overall significant difference (at the .05 level) was found among farmers with different years of land cultivation with respect to participation in the various activities the Water Users Association was carrying out in the project. A Tukey post-hoc test was run to specify which group of farmers with different years of farming differed significantly from the others in terms of participation. This test indicated that there was no significant difference (at the .05 level) among groups of farmers with varying years of land cultivation with regard to participation. This result seems to contradict what was found using the ANOVA. However, the Tukey test is very precise, and this may be the reason why the test did not detect differences among groups of farmers with different years of farming.

Table 29: Results of the ANOVA between time farming and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 4 | 5.838 | 1.460 | 2.735 | .03* |
| Explained | 4 | 5.838 | 1.460 | 2.735 | .03* |
| Residual | 195 | 104.066 | 0.534 | | |
| Total | 199 | 109.904 | 0.552 | | |

*Significant at the .05 level.

Results of the ANOVA between farm ownership and participation are shown in Table 30. No significant difference (at the .05 level) was found among groups of farmers who owned, rented, or shared crops with respect to participation in the different irrigation activities that the Water Users Association was carrying out.

Table 30: Results of the ANOVA between farm ownership and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 2 | 0.949 | 0.475 | 0.859 | .43 |
| Explained | 2 | 0.949 | 0.475 | 0.859 | .43 |
| Residual | 195 | 104.066 | 0.534 | | |
| Total | 199 | 109.904 | 0.552 | | |

Results of the ANOVA between farm labor and participation are shown in Table 31. No significant difference (at the .05 level) was found among groups of farmers who farmed the land with their families, those who paid nonfamily labor, and those who used both family and nonfamily labor, with respect to participation.

Table 31: Results of the ANOVA between farm labor and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 2 | 22.172 | 11.086 | 25.148 | .000* |
| Explained | 2 | 22.172 | 11.086 | 25.148 | .000* |
| Residual | 194 | 85.523 | 0.441 | | |
| Total | 196 | 107.695 | 0.549 | | |

*Significant at the .05 level.

A Tukey post-hoc test was run to determine which group or groups differed significantly from the others in terms of participation. Results are shown in Table 32. The group of farmers who used family labor differed significantly (at the .05 level) from those who used both family and nonfamily labor. Also, the group of farmers who used nonfamily labor was significantly different from the group of farmers who used both family and nonfamily labor. However, no difference was found between the group of farmers who used family labor and those who used nonfamily labor with regard to participation in various activities in the CUFE project.

Table 32: Results of the Tukey post-hoc test for farm labor and participation.

| Type of Labor | Mean | Family Labor | Nonfamily Labor | Both |
|---|---|---|---|---|
| Family labor | 2.22 | | | |
| Nonfamily labor | 2.27 | | | |
| Both | 3.05 | * | * | |

*Denotes pairs of farmer groups that differed significantly at the .05 level.

Results of the ANOVA between farm location with respect to the secondary canal and participation are shown in Table 33. No significant difference (at the .05 level) in participation was found among respondents whose farms were located at the beginning, middle, or end of the secondary canal.

Table 33: Results of the ANOVA between farm location and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 2 | 1.475 | 0.737 | 1.342 | .26 |
| Explained | 2 | 1.475 | 0.737 | 1.342 | .26 |
| Residual | 196 | 107.663 | 0.549 | | |
| Total | 198 | 109.138 | 0.551 | | |

Results of the ANOVA between farm production and participation are shown in Table 34. A significant difference (at the .05 level) in participation was found among groups of farmers who cultivated various crops.

Table 34: Results of the ANOVA between farm production and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 7 | 28.884 | 4.126 | 9.945 | .000* |
| Explained | 7 | 28.884 | 4.126 | 9.945 | .000* |
| Residual | 190 | 78.829 | 0.415 | | |
| Total | 197 | 107.712 | 0.547 | | |

*Significant at the .05 level.

To determine which group or groups of farmers differed significantly from the others, a Tukey post-hoc test was run. Results of this analysis are shown in Table 35. The farmers who produced beans differed significantly (at the .05 level) in participation from those who produced rice, yucca, pasture, and tobacco. Farmers who produced pasture differed significantly from those who produced plantains and yucca. No significant differences were found between other pairs of farmers.

ANOVA was performed to determine whether farmers' participation differed according to the sector location of their farm in the irrigation project. Results of the analysis are shown in Table 36. A significant difference (at the .05 level) in farmers' participation was found with respect to their farm-sector location.

Table 35: Results of the Tukey post-hoc test for farm production and participation.

| Crop | Mean | 7 | 8 | 2 | 3 | 6 | 4 | 5 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| 7. Pasture | 1.90 | | | | | | | | |
| 8. Tobacco | 2.29 | | | | | | | | |
| 2. Rice | 2.30 | | | | | | | | |
| 3. Vegetables | 2.49 | | | | | | | | |
| 6. Yucca | 2.55 | * | | | | | | | |
| 4. Plantains | 2.56 | * | | | | | | | |
| 5. Bananas | 2.93 | | | | | | | | |
| 1. Beans | 3.13 | * | * | * | | * | | | |

Table 36: Results of the ANOVA between farm-sector location and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 4 | 67.789 | 16.947 | 78.868 | .000* |
| Explained | 4 | 67.789 | 16.947 | 78.868 | .000* |
| Residual | 196 | 42.116 | 0.215 | | |
| Total | 200 | 109.905 | 0.550 | | |

To determine in which sectors farmers differed significantly from those in other sectors in terms of participation, a Tukey post-hoc test was run. The results of this analysis are shown in Table 37. Farmers located in the Bombeo sector differed significantly (at the .05 level) from those in all the other sectors with respect to participation. Participation of farmers located in the Villa

Gonzalez sector differed significantly (at the .05 level) from that of farmers located in the Ponton, Navarrete, and Santiago sectors.

Table 37: Results of the Tukey post-hoc test for farm-sector location and participation.

| Farm Sector | Mean | 2 | 5 | 4 | 1 | 3 |
|---|---|---|---|---|---|---|
| 2. Bombeo | 1.89 | | | | | |
| 5. Ponton | 2.17 | * | | | | |
| 4. Navarrete | 2.28 | * | | | | |
| 1. Santiago | 2.41 | * | | | | |
| 3. Villa Gonzalez | 3.44 | * | * | * | * | |

*Denotes pairs of groups that differed significantly at the .05 level.

Results of the ANOVA between on-farm income and participation are shown in Table 38. A significant difference (at the .05 level) in participation was found among farmers classified by on-farm income.

Table 38: Results of the ANOVA between on-farm income and participation.

| Source | df | Sum of Squares | MS | F | p |
|---|---|---|---|---|---|
| Main effects | 4 | 6.621 | 1.655 | 3.097 | .017 |
| Explained | 4 | 6.621 | 1.655 | 3.097 | .017 |
| Residual | 189 | 101.008 | 0.534 | | |
| Total | 193 | 107.629 | 0.558 | | |

To determine which on-farm-income group or groups differed significantly from the others, a Tukey post-hoc test was run. The results of this analysis are shown in Table 39. A significant difference (at the .05 level) in participation was found between farmers whose on-farm income was RD$3,001 to RD$5,000 and those whose on-farm income was RD$8,001 to RD$15,000. No other significant differences in participation were found, based on on-farm income.

Table 39: Results of the Tukey post-hoc test for on-farm income and participation.

| On-Farm Income | Mean | 2 | 3 | 5 | 1 | 4 |
|---|---|---|---|---|---|---|
| Group 2 | 2.03 | | | | | |
| Group 3 | 2.36 | | | | | |
| Group 5 | 2.47 | | | | | |
| Group 1 | 2.67 | | | | | |
| Group 4 | 2.71 | * | | | | |

*Denotes pairs of groups that differed significantly at the .05 level.

Key: Group 1 = RD$1,000 to RD$3,000
Group 2 = RD$3,001 to RD$5,000
Group 3 = RD$5,001 to RD$8,000
Group 4 = RD$8,001 to RD$15,000
Group 5 = More than RD$15,001
RD$ = Dominican Republic currency; at the time of data collection, the exchange rate was US$1 = RD$12.5.

## Relationship Between Farmers' Participation and Perceived Effectiveness of the System After Statistically Controlling for Demographic Characteristics

Null Hypothesis 3: There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system, after statistically controlling for selected demographic characteristics of the farmers.

A previous analysis revealed that farmers' participation and perceived effectiveness of the system had a very strong association ($r = .72$, $p < .05$) (see Table 26). However, that analysis did not account for possible confounding variables.

To determine whether a relationship existed between farmers' participation and perceived effectiveness of the irrigation system after statistically controlling for demographic characteristics, multiple regression was used. For this analysis, the dummy variable participation was used as a dependent variable. To run the analysis, three procedures were used. First, all selected demographic variables were loaded into the equation and regressed with participation. The model used in this analysis was:

$$Partic = a + Q$$

Where: Partic = farmer-perceived participation
a = constant
Q = selected demographic variables

Second, all selected demographic variables were loaded into the equation and regressed with effectiveness. The model used in this analysis was:

$$Effect = a + Q$$

Where: Effect = farmer-perceived effectiveness of the system
a = constant
Q = selected demographic variables

Third, all of the demographic variables, simultaneously, were entered into the equation with participation and regressed with effectiveness. To conduct this analysis, the following model was used:

$$Effect = a + Partic + Q1 + Q2 + \ldots\ldots + Qn$$

where: Effect = effectiveness of the irrigation system
a = constant
Partic = farmer-perceived participation
Q1 = age, Q2 = educational level, Q3 = time farming, Q4 = farm size, and Q5 = on-farm income

All of the continuous demographic variables (age, educational level, time farming, farm size, and on-farm income) were included in the equation. The other demographic variables (ownership, farm labor, farm location, farm production, and farm sector) were not included in the equation because they were categorical variables. This means that, in order to be included in the equation, they would have had to be converted into dummy variables. However, to have included so many variables in the equation would have weakened the strength of the multiple-regression analysis. According to Norusis (1993), including a large number of independent variables in a regression model is not a good strategy. He also pointed out that it is often difficult to interpret a model with many variables.

As shown in Table 40, farm size and educational level, even though they were significant, did not influence participation ($\underline{B}$ = -0.01 and $\underline{B}$ = -0.00,

respectively). According to this analysis, it is safe to say that the demographic variables used in this study were not strongly associated with participation (R Square = 0.06).

Table 40: Relationship between farmers' participation and demographic variables.

| Variable | B | SE B | Beta | T | Sig. of T |
|---|---|---|---|---|---|
| Farm size | -0.01 | 0.01 | -0.19 | -2.39 | .018* |
| Time farming | 0.08 | 0.05 | 0.12 | 1.62 | .108 |
| Educational level | -0.00 | 0.00 | -0.18 | -2.41 | .017* |
| Age | 0.02 | 0.06 | 0.02 | 0.29 | .770 |
| On-farm income | 0.07 | 0.05 | 0.11 | 1.37 | .173 |
| Constant | 2.74 | 0.33 | | 8.28 | .000 |

*Significant at the .05 level.

Multiple R = 0.25
R Square = 0.06
Adjusted R Square = 0.04
Standard Error = 0.74

Table 41 shows that the variables farm size, time farming, and educational level were associated with farmers' perceptions of the effectiveness of the CUFE irrigation system ($t$ = -3.23, $p$ = .001; $t$ = 2.62, $p$ = .009; $t$ = -2.01, $p$ = .046, respectively). Age and on-farm income were not significant ($t$ = 0.39, $p$ = .699; $t$ = -0.26, $p$ = .797, respectively). Table 32 also shows that of the variables that were significant, time farming was the most important relative variable (Beta = 0.19). The variables included in the model explained 11% of the variation in farmers' perceptions of system effectiveness (R Square = 0.11). In summary,

according to this analysis, it is safe to say that the variables used in this study were not strongly associated with farmers' perceptions of the effectiveness of the CUFE irrigation system (R Square = 0.11).

Table 41: Relationship between farmers' perceptions of the effectiveness of the irrigation system and demographic variables.

| Variable | B | SE B | Beta | T | Sig. of T |
|---|---|---|---|---|---|
| Farm size | -0.02 | 0.01 | -0.25 | -3.23 | .001* |
| Time farming | 0.12 | 0.05 | 0.19 | 2.62 | .009* |
| Educational level | -0.13 | 0.06 | -0.15 | -2.01 | .046* |
| Age | 4.98E-04 | 0.00 | 0.03 | 0.39 | .699 |
| On-farm income | -0.01 | 0.05 | -0.02 | -0.26 | .797 |
| Constant | 4.16 | 0.33 | | 12.48 | .000 |

*Significant at the .05 level.

Multiple R = 0.33
R Square = 0.11
Adjusted R Square = 0.08
Standard Error = 0.74

A further analysis was run to determine the relationship between farmers' participation and perceived effectiveness of the system, after statistically controlling for age, educational level, time farming, farm size, and on-farm income--this time entering the variables simultaneously into the multiple-regression equation. The results of this analysis are shown in Table 42.

A significant relationship (at the .05 level) was found between farmers' participation and perceived effectiveness of the system, after statistically controlling for the demographic variables. The results also indicated that

participation was by far the most important variable in explaining the perceived effectiveness of the system (Beta = 0.71, $p < .05$). Other important variables were size of the farm (Beta = 0.16, $p < .05$) and on-farm income (Beta = 0.10, $p < .05$). All of the other variables had negative beta values. Moreover, the results from this analysis indicated an R Square = 0.59. This means that the variables used in the analysis explained 59% of the variation in farmers' perceptions of the effectiveness of the system.

Table 42: Relationship between farmers' participation and perceived effectiveness of the system, after controlling for the demographic variables.

| Variable | B | SE B | Beta | T | Sig. of T |
|---|---|---|---|---|---|
| Participation | 0.73 | 0.52 | 0.71 | 14.09 | .000* |
| Farm size | 0.00 | 9.0E-04 | 0.16 | 3.04 | .003* |
| Time farming | -0.07 | 0.04 | -0.09 | -1.79 | .074 |
| Educational level | -0.14 | 0.04 | -0.16 | -3.22 | .002* |
| Age | -0.01 | 0.00 | -0.12 | -2.13 | .035* |
| On-farm income | -0.07 | 0.03 | 0.11 | 2.08 | .039* |
| Constant | 2.16 | 0.27 | | 7.99 | .000 |

*Significant at the .05 level.

Multiple R = 0.76 Adjusted R Square = 0.56
R Square = 0.58 Standard Error = 0.51

These results led to the rejection of the third null hypothesis (There is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system, after

statistically controlling for selected demographic characteristics of the farmers.). That is, farmers' participation in the management of the farmer-controlled irrigation project (CUFE) was related to their perceptions of the effectiveness of the system, after statistically controlling for selected demographic characteristics of the respondents.

The findings are discussed more fully in Chapter V. Conclusions drawn from the study findings are explored, and recommendations are made for the CUFE irrigation project.

# CHAPTER V

## DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Three research questions were posed in this study. The first research question concerned whether there is a relationship between farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system. The second research question sought to identify the demographic characteristics that were related to farmers' participation in the CUFE irrigation system. The last research question concerned whether there was a relationship between farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system, after statistically controlling for selected demographic characteristics of the respondents.

This was a descriptive and analytical study. The target population was members of the CUFE Water Users Association in Santiago, Dominican Republic. The 201 sample members were randomly selected from the five sectors (Santiago, Bombeo, Villa Gonzalez, Navarrete, and Ponton) into which the CUFE is divided.

The questionnaire developed for this study included items concerning farmers' participation in the irrigation system, their perceptions of the

effectiveness of the irrigation system, and demographic characteristics of the respondents. The instrument was administered to the farmers in their homes and fields.

Descriptive statistics such as frequency, mean, standard deviation, and range were used in reporting the demographic characteristics of the respondents. Also, Spearman correlation coefficient, one-way ANOVA, the Tukey post-hoc test, and regression analysis were used to analyze the data and interpret the results. The findings from the data analyses are discussed in the remainder of this chapter.

## Summary and Discussion of the Findings

Seventy-seven percent of the farmers who participated in this study were between 40 and 69 years old. The mean age of the respondents was 49.3 years. Eighty-five percent of the sample had been exposed to formal education, and 3.5% of them had pursued postsecondary studies.

The greatest proportion of respondents (43.3%) had been involved in farming between 6 and 10 years. Regarding farm ownership, 76.5% of the farmers rented, 15.5% owned their farms, and 8% were sharecroppers. In addition, 66.5% of the respondents used paid labor, and 9.6% employed their family members as labor. Ninety-five percent of the respondents' farms were between .63 and 6.25 hectares; only 10 had farms larger than 6.25 hectares. The mean farm size was 2.72 hectares. The findings also indicated that 50.5%

of the respondents had on-farm incomes of more than 15,001 pesos per year (more than US$1,200).

The first research question concerned whether there was a relationship between farmers' participation in and their perceptions of the effectiveness of the CUFE irrigation system. The relationship was determined in the following three steps.

First, scores on individual items concerning perceived effectiveness of the system were correlated with the combined farmer-participation score to identify the items that had a relatively high association with farmer participation. It was found that farmers received sufficient water to cover their crop needs. This finding supports the CUFE's view that there is enough water to cover the crop needs of all its farmer members. Before the CUFE Water Users Association took control of the management of the irrigation system, few farmers were receiving enough water because they were paying bribes to the officials in control of the water distribution in the area. In this regard, Wade (1982) pointed out that some irrigation officials create a water-stress situation among farmers and then use their discretionary power to reduce water stress only for those who pay bribes. The CUFE has been able to eliminate this corruption problem through greater farmer participation in the system. However, the CUFE Water Users Association does not have enough control over the amount of water farmers are using on their farms. According to some technicians working for the INDRHI, farmers are

using and receiving more water than their crops require. Consequently, water is being wasted through runoff and percolation.

A substantial correlation also was found between farmers' participation and availability of water on time. This finding suggests that farmers who were participating in the CUFE Water Users Association activities perceived that they received water on time. This fact is critical for the effectiveness of the system, especially when many farmers are irrigating from the same canal. Farmers' participation is important when the number of farmers is large and it is necessary to be clear whose turn it is to water. As Parker and Bromley (1978) pointed out, the larger the number of irrigators along a water course, the greater the chances of interruption of water flows.

Another substantial correlation was found between farmers' participation and the effectiveness of the Water Users Association's fee collection. When the INDRHI managed this irrigation system, the fee collection reached 15%; with the CUFE's management of the system, fee collection was increased to 65%. This increase in the collection of fees has allowed the CUFE to do a better job of selecting and paying ditch riders, thereby contributing to the efficiency of the system. This suggests that farmers are participating in paying their fees for water use in the irrigation project. According to the CUFE, the fees that are collected are used for operating and maintaining the system and for paying staff salaries. This highlights the importance of farmers' participation in paying fees for the water they use. This finding is in accord with Korten and Siy's (1989)

contention that effective organizations collect fees normally and have clear sanctions for members who owe fees. For instance, the CUFE penalizes those farmers who do not pay fees for water use by cutting off their water services.

A substantial association was found between farmers' participation and the services provided by the Water Users Association. This indicates that farmers who were participating in the CUFE Water Users Association perceived that the services offered by the Association were effective. This finding is in accord with what was found by the International Fund for Agricultural Development--that the beneficiaries, when given a chance, are eager to participate in projects designed to benefit them (Lineberry & Jazairy, 1989). It was found that farmers contributed to the success of this irrigation project by performing the following roles in the CUFE Water Users Association:

1. Determining the most rational use of water.
2. Keeping the system functioning through their labor participation.
3. Collecting cash or materials required to keep the system going.
4. Controlling water distribution and resolving disputes that normally occur among beneficiaries.

Farmers' perceptions of the effectiveness of water distribution and allocation were substantially associated with their participation in the CUFE irrigation project. This finding implies that the effectiveness of distribution of water can be increased through farmers' participation. In these kinds of complex designs, equity in water distribution can be achieved only with a high level of

farmer participation. With the CUFE's management of the irrigation system, all of the sectors into which the irrigation project is divided can have water simultaneously. However, not all irrigation units in each sector can have water at the same time because the irrigation system was established to operate with rotating water turns. The CUFE has improved the determination of water-distribution needs through extension agents. They elaborate and present an operation plan to be discussed with the association directors and farmer representative of each irrigation unit, by sector. They determine watering turns and the quantity of water to be received by farmers, based on farmers' crops, the area under cultivation, and farm location. The extension agents keep and are responsible for the keys to open the ditch gates in each irrigation sector.

A substantial association was found between farmers' participation in and their perceptions of the effectiveness of canal maintenance. This means that if farmers are willing to participate in maintaining canals, the canals are going to be clean and the structures repaired to allow water to flow to the farms. This finding is in accord with Hunt's (1990) contention that, if farmers can be encouraged to participate in maintaining the canals, the distribution of water will be more effective, production will rise, and there will be more efficient use of water.

A very strong association was found between farmers' participation and their perceptions of the effectiveness of extension agents' problem-solving ability. This finding suggests that, when farmers perceive that the agents serving them

are skillful in solving problems, they are more willing to participate. Thus, if farmers' participation is desirable, extension agents should be trained in problem solving.

In addition, there was a substantial association between farmers' participation and their perceptions that the effectiveness of the irrigation system had been improved. This finding suggests that, when farmers participate more, they perceive that the system's effectiveness is improving. This finding emphasizes the importance of farmers' participation in improving the effectiveness of the irrigation system.

In what may, at first, appear to be an anomaly, farmers' participation had a low association with their perceptions of the effectiveness of the irrigation system in meeting their needs. This finding suggests that, overall, farmers did not perceive their participation as essential in the CUFE project's meeting all of their needs. However, as the preceding discussion suggests, participation is important when focusing on specific activities. Thus, it is desirable for the CUFE irrigation project to increase farmers' participation in additional specific activities, such as marketing their products, which, according to some farmers, is a great need in the project.

In the second step of the analysis for Research Question 1, scores on items concerning farmer participation were correlated with the combined effectiveness-of-the-system score to identify the items that had a relatively high association with perceived effectiveness of the system. A low association was

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found between farmers' perceptions of the effectiveness of the irrigation system and their participation in discussing the construction of new canals. This low association was found because farmers have not had an opportunity to participate in discussions of new canal construction in the CUFE irrigation project. Until now, the project has not constructed new canals. The canals that are in operation in the project area were constructed by the INDRHI without participation by the beneficiaries. However, according to the CUFE's manager, if new canals are constructed, farmers' participation will be taken into account.

A moderate association was found between farmers' perceptions of the effectiveness of the irrigation system and their participation in water distribution and allocation. Farmers participate in water distribution and allocation through the election of one member from their irrigation unit. The farmer thus selected is responsible for keeping the extension agent informed when farmers in that unit need to water their land. The extension agent is in charge of opening and closing the ditch gate of the irrigation unit.

Also, a substantial association was found between farmers' perceptions of the effectiveness of the irrigation system and their participation in discussing problems with extension agents. This substantial association is not surprising because of the many functions extension agents have to perform in the CUFE project. Extension agents are regularly in contact with farmers, either personally or through the irrigation unit representative. In these contacts, the extension agents coordinate with farmers the water distribution plan, watering turns by

crops, maintenance of the canals, and fee collection. Thus, farmers who were in frequent communication with the extension agents perceived the irrigation system as more effective than did those who had less frequent contact with the agents.

A moderate association also was found between farmers' perceptions of the effectiveness of the system and their participation in the coordination of cultivation practices. Farmers help each other with coordinating cultivation practices. CUFE personnel are involved in coordinating the operation and maintenance of the irrigation system, but they do not take part in other agricultural activities, such as agricultural marketing, cultivation practices, and so on.

A very strong association was found between farmers' perceptions of the effectiveness of the irrigation system and their participation in the maintenance of canals. This strong association was found because farmers have been participating in the various activities that the CUFE is carrying out in maintaining the canals. Such activities include selecting farmers who are responsible for cleaning canals and repairing and installing ditch gates. The extension agents coordinate these activities with the association directors and the nucleus representatives in each sector.

A moderate association was found between farmers' perceptions of the effectiveness of the irrigation system and their participation in decision making concerning courses to be offered by the CUFE. When deciding what courses to

offer, the CUFE does not take into consideration all of the farmers' information needs. This is unfortunate because it was found that farmers differ in the type of information they need, depending on the crop they are cultivating.

Another moderate association was found between farmers' perceptions of the effectiveness of the irrigation system and their participation in decision making with regard to requesting irrigation equipment. Farmers request equipment from the CUFE irrigation project through various sources, which include extension agents, the manager of the CUFE irrigation project, the president of the association in their sector, and the nucleus representative. The source most often used by farmers to request equipment to clean the canals is the extension agent, followed by the president of the association in their respective sector. Farmers contact extension agents because these individuals are their most direct contact with the CUFE irrigation project. However, despite farmers' request for equipment, the CUFE project does not have enough equipment to fulfill all of the farmers' requests. Thus, the CUFE irrigation project coordinates with the INDRHI for more equipment. The INDRHI plays a helpful role in this irrigation system, not only in terms of equipment but also in water distribution. One of the main activities of the INDRHI in the CUFE irrigation project is to distribute water from a dam according to the availability of water and the need of farmers outside the project.

A moderate association was found between farmers' perceptions of the effectiveness of the irrigation system and their participation in the management

and operation of the irrigation project. Farmers had this perception because they were directly or indirectly involved in the management and operation of the CUFE irrigation system. Farmers participate directly in the management of the irrigation system when they are elected to represent their nucleus in the CUFE irrigation project. Indirectly, farmers have a vote through the nucleus representative they elect. These representatives represent their sectors' associations in the CUFE irrigation project. The farmers participate in the operation of the irrigation system when they pay irrigation fees. They also participate in the operation of the system when they pay for canal cleaning or clean the canals themselves.

In the third step of the analysis for Research Question 1, scores on both of the combined variables (farmer participation and perceived effectiveness of the system) were correlated to determine whether there was an association between them. A very strong association was found between the two variables. Therefore, Null Hypothesis 1--that there is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system--was rejected at the .05 level of significance.

The second research question concerned whether selected demographic characteristics of the respondents were related to their participation in the irrigation system. Two steps were followed in answering this question. First, the Spearman correlation coefficient was used to determine the relationship between the farmer-participation variable and the demographic variables. A correlation

was found between farmers' participation and the demographic characteristics of age, farm location, farm labor, and farm production. However, these correlations were not strong. This finding means that these demographic characteristics of the respondents had a low effect on farmers' participation in the activities that the CUFE was carrying out in the irrigation project. Thus, Null Hypothesis 2--that there is no relationship between selected demographic characteristics of the farmers and their participation in the management of the CUFE irrigation system--was rejected at the .05 level of significance for the above-mentioned demographic characteristics.

Second, to analyze further the data for Research Question 2, ANOVA was used to determine whether there were differences in means on the combined variable participation, with respect to the demographic characteristics of the respondents. In those cases in which the means differed statistically, a Tukey post-hoc test was used to determine specifically which group or groups differed significantly from the others.

No significant difference in farmers' participation was found with respect to educational level, farm ownership, or farm location. This finding suggests that the subgroups into which respondents were divided on these demographic characteristics did not differ significantly with regard to participation in the activities the CUFE was carrying out in the irrigation project. On the other hand, a significant difference in farmers' participation was found with regard to time farming, farm labor, farm production, farm-sector location, and on-farm income.

Farmers who had been cultivating their land for varying lengths of time differed in their participation in the activities the CUFE was carrying out in the project. However, it was not possible to determine which group of farmers differed from the others because the Tukey post-hoc test was not able to determine mean differences among specific groups of farmers. This may be because the level of significance was not strong. No significant difference in participation was found between the group of farmers who used family labor and those who paid nonfamily labor. This means that both groups of farmers had similar participation in the irrigation project. However, farmers who used both paid labor and family labor differed in their participation from those who used either family or nonfamily labor.

With respect to farm production, it was found that farmers who produced beans, plantains, and yucca differed in participation from those who produced pasture, tobacco, rice, vegetables, and bananas. This finding suggests that the participation of farmers in the CUFE irrigation project activities varied according to the crops they were cultivating. Another finding is that farmers in the various sectors--that is, farmers in Bombeo, Ponton, Navarrete, Santiago, and Villa Gonzalez--differed in their participation in the various irrigation activities of the CUFE irrigation project. This finding suggests that the sector where the farms are located can influence farmers' participation in the various activities of the CUFE irrigation project. It might be hypothesized that these differences were due to demographic characteristics of the respondents in those sectors. Finally,

it was found that farmers' participation in the CUFE irrigation project activities varied according to their on-farm income. Farmers who earned between RD$1,000 and RD$3,000 differed significantly from those who earned between RD$8,001 and RD$15,000.

The third research question concerned whether there was a relationship between farmers' participation in and their perceptions of the effectiveness of the irrigation system, after statistically controlling for demographic characteristics. To answer this question, multiple regression was used. First, all selected demographic variables were loaded into the multiple regression equation and regressed with participation. Second, all of the selected demographic variables were loaded into the equation and regressed with effectiveness to determine the relationship. Third, all selected demographic variables and participation, simultaneously, were loaded into the equation and regressed with effectiveness.

In the first procedure, it was found that farmers' participation and selected demographic variables were not strongly associated statistically. In the second procedure, it was found that there was not a strong association between farmers' perceptions of the effectiveness of the irrigation system and demographic variables. However, it was necessary to determine how all of the demographic variables interplayed and affected farmers' participation and their perceptions of the effectiveness of the irrigation system. This step was accomplished by running a multiple regression with all of the demographic variables entered into the equation simultaneously. The results indicated that the relationship between

farmers' participation and their perceptions of the effectiveness of the irrigation system was still significant after statistically controlling for the demographic variables. Results of this final analysis also showed that farmer participation was, by far, the most important relative variable in the equation. This finding suggests that the relationship between farmers' participation in different activities the CUFE irrigation project was carrying out and their perceptions of the system's effectiveness was very strong. Moreover, the results of this analysis indicated an R square = 0.58. This means that the variables used in the model explained 58% of the variation in farmers' perceptions of the effectiveness of the system. Thus, Null Hypothesis 3--that there is no relationship between farmers' participation in the management of the CUFE irrigation system and their perceptions of the effectiveness of the system, after statistically controlling for selected demographic characteristics of the farmers--was rejected at the .05 level of significance.

The preceding findings suggest that farmers' participation in irrigation systems needs to be taken into account in activities related to the operation and maintenance of the systems. This is because, as shown in this study, farmers' perceptions of the effectiveness of an irrigation system are highly influenced by their participation in the system.

## Conclusions and Recommendations

1. Through the questionnaire responses, it was found that there were certain problems related to water management in the CUFE irrigation project.

There is no control over the amount of water that farmers receive for their crops. The amount of water farmers receive usually surpasses the agronomic requirements of their crops. This can have a negative effect on soil conservation because when farmers flood their farms for a long period of time, it could produce salinization. This lack of water control could cause runoff and percolation, imposing problems on the supply of water to other farmers. To solve these problems, water management must focus on controlling water such that relatively small volumes are placed in particular crop root zones in adequate amounts. Water must be moved at the proper time in the required amount so that plants can give the maximum yield. Water management requires a great deal of skilled labor. However, extension agents and farmers in the CUFE project lack the necessary skills to perform successfully the above-mentioned practices. Extension agents in the CUFE do not have a degree in water management. They need to be trained in water management in order to transfer technical information on both agronomics and water management to the farmers. Extension agents need to be trained in particular water management problems identified by both farmers and extension agents. At the farm level, farmers should be trained to adapt the disciplinary knowledge received from the extension agents to their particular situation.

2. Farmers' participation in the CUFE project was related to their perceptions of the effectiveness of the irrigation system. Thus, such participation should be promoted and encouraged so that farmers believe they have an

important role in the project and will benefit from it. Their enthusiastic and active participation is the most important factor for the success of the project. To increase farmers' participation in the CUFE, it is recommended that farmers be approached when they have surplus time. It is important to make clear to farmers that the benefit they will receive from participating in the various activities carried out by the project will exceed the cost they incur by participating.

3. It was found that the CUFE irrigation project has not been evaluated regularly. Such evaluation is necessary, in order to determine what additional strategies are needed to increase farmers' participation in and the effectiveness of the irrigation system. It is important that the Water Users Association design a scheme of on-going evaluation, with the aim of determining the effectiveness, impact, and sustainability of the irrigation system. Once this evaluation scheme is in place, it could easily be conducted during farmers' meetings. This evaluation could be very useful in rapidly assessing any problem that needs immediate action. It is recommended that when these evaluations are performed, farmers' involvement be considered. This is crucial for the knowledge farmers have of the irrigation system.

4. Through the questionnaire responses, it was found that problems related to the management, operation, and maintenance of the irrigation system were organizational in nature--that is, the differentiation and coordination of functions and responsibilities. It is recommended that in order to improve the existing organizational structure of the project, all participants must know the

rules that guide the organization. These rules must be clear and consistent, be perceived as unbiased, be a source of reward, and be supported by norms of farmers. If these rules are adhered to, organizational participants will support their organization and employ it for water allocation and distribution, maintenance of canals, and conflict management.

5. Through the study it was found that the CUFE Water Users Association lacks linkages with other agencies in the agricultural sector, such as the Ministry of Agriculture. It is recommended that the CUFE irrigation project seek to network with institutions working in the area of development, such as nongovernmental organizations (NGO) involved in irrigation or the agricultural sector. With this linkages, the CUFE irrigation system could obtain information about how to improve water management and direct attention from within the association outward to its human and institutional environment.

## Recommendations for Future Research

1. It is recommended that a study be conducted to determine the real economic impact of the CUFE irrigation project on its members. Such a study is necessary to determine whether, in reality, the CUFE irrigation project has increased the economic return to farmers.

2. Because this study was confined to beneficiaries of the CUFE irrigation project in Santiago, Dominican Republic, the findings represent only those respondents' perceptions. However, with a few modifications to the instrument, this study could be replicated elsewhere, in order to gather

information on various issues concerning different farmer-managed irrigation projects.

3. A study could be conducted among nonparticipants in the CUFE irrigation project to determine their perceptions of the effectiveness of the CUFE irrigation system, in order to compare their perceptions with those of farmers who are participating in the project.

4. A study could be conducted among CUFE members to assess their motivations for participating in the Water Users Association's activities.

5. A study could be conducted between CUFE land reform farmers and private farmers, in order to compare their participation in and perceptions of the effectiveness of the irrigation system.

# APPENDICES

# APPENDIX A

# FARMERS' QUESTIONNAIRE

# FARMERS' QUESTIONNAIRE

Please take a few minutes to read/listen to and answer this questionnaire. Your responses will be kept confidential, and no attempt will be made to identify individual respondents. Your participation is voluntary; you may choose not to participate, or you may refuse to participate in certain procedures or to answer certain questions. It is not necessary for you to put your name on the questionnaire.

Circle a response for each statement; rate each statement on a scale from 1 to 5: 1 = Never, 2 = Seldom, 3 = Sometimes, 4 = Most of the time, 5 = Always.

## PART I: PARTICIPATION

1. I have been visited by the INDRHI and other irrigation organizations to discuss the construction of new canals in my irrigation sector. 1 2 3 4 5

2. I have participated in water distribution to other farmers in my irrigation sector. 1 2 3 4 5

3. How have you participated in the distribution of water to other farmers in your irrigation sector?

   _____ Electing the irrigation unit representative
   _____ Opening the floodgate to other farmers' farms
   _____ Other _____

4. I talk with the Water Users Association extension agent in my sector about irrigation problems. 1 2 3 4 5

5. I have participated in coordinating cultivation practices in my irrigation sector. 1 2 3 4 5

6. How have you participated in the coordination of cultivation practices?

   _____ Individually
   _____ With a group
   _____ Other_____

7. I have participated in the maintenance of canals in my irrigation sector. 1 2 3 4 5

8. How have you participated in the maintenance of canals in your irrigation sector?

_____ Paying others to maintain the canal
_____ Doing the labor by myself
_____ Other_____

9. I have participated in decision making regarding courses for the Water Users Association to offer. 1 2 3 4 5

10. In what courses have you participated?_____
_____

11. What kinds of courses would you like the Water Users Association to offer? _____

12. I have participated in decision making about requesting irrigation equipment to maintain drainage in my sector. 1 2 3 4 5

13. How have you participated in requesting irrigation equipment to maintain the drainage in your sector?

_____ Through meetings
_____ Through the extension agent
_____ Through the unit representative
_____ Through the manager of the Water Users Association
_____ Other _____

14. How can you improve your irrigation management skills in your irrigation sector?

_____ Through activities related to irrigation management
_____ Talking with the Water Users Association extension agent about irrigation problems in my sector
_____ Participating in all programmed meetings in my sector
_____ Getting good communication with the Water Users Association extension agent
_____ Training in water use
_____ Other _____

15. Overall, how would you evaluate the management and operation of the irrigation in your sector?

_____ 1 Inferior _____ 2 Regular _____ 3 Neutral
_____ 4 Good _____ 5 Very good

## PART II: EFFECTIVENESS

16. The quantity of water from the irrigation system is sufficient to meet the needs of my particular crop. 1 2 3 4 5

17. Water is available when my crops need it most. 1 2 3 4 5

18. I pay on time for the water I use for my crops. 1 2 3 4 5

19. I am satisfied with the Water Users Association service in my sector. 1 2 3 4 5

20. The distribution of water in my sector is effective. 1 2 3 4 5

21. I have problems associated with water allocation and distribution. 1 2 3 4 5

22. What kinds of problems?

____ The head-of-canal farmer takes almost all of the water
____ I do not receive the shift of water on time
____ The canal structure is broken
____ Other _____

23. How can these problems be resolved?

____ Training the farmers in irrigation management
____ Bringing more floodgates into the affected area
____ Talking with the Water Users Association extension agent in your sector
____ Creating the right shift of water
____ Employing people who are well trained in the area of irrigation management
____ Other _____

24. The canals are clean, and irrigation structures are quickly and adequately repaired. 1 2 3 4 5

25. I have problems related to maintenance of canals and irrigation structures. 1 2 3 4 5

26. What kinds of problems?

____ Sometimes the canals are broken by farmers who do not belong to the Water Users Association
____ The canals are not well cleaned
____ Other _____

27. How can these problems be resolved?

____ Training the farmers in irrigation management
____ Informing the extension agent
____ Other _____

28. The extension agent takes care of my complaints. 1 2 3 4 5

29. Water scarcity creates conflicts in my irrigation system. 1 2 3 4 5

30. What kinds of conflicts?

____ Conflict with other farmers because everybody wants water at the same time
____ Other _____

31. How can these problems be resolved?

____ Training the farmers through meetings about water management
____ Having the extension agent visit the sector more often
____ Creating a water shift
____ Modifying the irrigation structure
____ Other _____

32. I have participated in the activities that the Water Users Association plans to improve the effectiveness of the irrigation system. 1 2 3 4 5

33. What kinds of activities should the association undertake to improve the overall effectiveness of the irrigation system?

____ Offer courses on irrigation management
____ Employ more extension agents
____ Have the extension agent visit more frequently
____ Better organize the Water Users Association
____ Other _____

34. Overall, how would you evaluate the effectiveness of the irrigation system in meeting your needs?

____ 1 Inferior ____ 2 Regular ____ 3 Neutral
____ 4 Good ____ 5 Very good

35. I am pleased with the transference of the irrigation system from the INDRHI to us. 1 2 3 4 5

The following questions are designed to provide basic demographic information for analysis of data. Please check the appropriate response for each question.

## PART III: DEMOGRAPHIC AND GEOGRAPHIC CHARACTERISTICS

36. Size of your farm_____

37. Ownership of your farm:

____ Own
____ Rent
____ Share crop

38. Your educational level:

____ Primary
____ Intermediate
____ Secondary
____ University

39. What is your annual on-farm income?

____ $1,000-$3,000
____ $3,001-$5,000
____ $5,001-$8,000
____ $8,001-$15,000
____ $15,001 or more

40. Where is your farm located on the canal?

____ At the beginning of the canal
____ In the middle of the canal
____ At the end of the canal

41. How long have you been farming this land?

____ 1 to 5 years
____ 6 to 10 years
____ 11 to 15 years
____ 16 to 20 years
____ 21 years or more

42. Your age: _____

43. How do you farm?

____ With my family
____ I pay the labor
____ Both

44. What crops do you grow on your farm?

____ Beans
____ Rice
____ Vegetables
____ Plantains
____ Bananas
____ Yucca
____ Sorghum
____ Pasture
____ Tobacco

45. In what sector is your farm located?

____ Santiago
____ Bombeo
____ Villa Gonzalez
____ Navarrete
____ Ponton

# APPENDIX B

# EXTENSION AGENTS' AND MANAGERS' QUESTIONNAIRE

## EXTENSION AGENTS' AND MANAGERS' QUESTIONNAIRE

This questionnaire was used in interviewing extension agents working for the CUFE irrigation project and INDRHI, in order to better understand the on-farm irrigation management situation in the project in question.

1. Is the association involved in the selection of farmers who are responsible for cleaning the canals? How?

2. Do farmers take part in the maintenance of the canals? How? When?

3. What kind of help does the association give in the maintenance of the canals?

4. Do farmers participate in making decisions to construct new canals in the system? How?

5. In what kinds of decision making are farmers allowed to participate?

6. What mechanism does the association use in making decisions regarding allocation and distribution of water to farmers? Why?

7. What kinds of cultivation practices does the association recommend to farmers? Why?

8. Do farmers use the cultivation practices recommended by the association?

9. With what kinds of irrigation problems does the association assist farmers? Why?

10. Is the quantity of water sufficient to meet the needs of farmers' crops? Why? or Why not?

11. Is water available when the crops need it the most?

12. Does the association have problems related to the maintenance of canals and irrigation structures? Why?

13. Are the canals cleaned and irrigation structures repaired?

14. What strategies is the association using to clean the canals? Why?

15. Does water scarcity generate conflicts in the irrigation system? Why?

16. Are water needs met throughout the project?

17. Does the association address the main needs of the irrigation system? How?

18. What is the main need in the irrigation system? Why?

19. What kinds of activities is the association undertaking to help solve this problem? Why and How?

# APPENDIX C

## LETTER OF APPROVAL FROM THE UNIVERSITY COMMITTEE

## ON RESEARCH INVOLVING HUMAN SUBJECTS

MICHIGAN STATE
UNIVERSITY

September 6, 1994

TO: Yonis Reyes
1615 D Spartan Village
East Lansing, MI 48823

RE: IRB#: 94-364
TITLE: THE RELATIONSHIP BETWEEN PERCEIVED USER PARTICIPATION IN AND EFFECTIVENESS OF A FARMER CONTROLLED IRRIGATION SYSTEM IN THE DOMINICAN REPUBLIC
REVISION REQUESTED: N/A
CATEGORY: 2-I
APPROVAL DATE: 09/01/94

The University Committee on Research Involving Human Subjects (UCRIHS) review of this project is complete. I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project including any revision listed above.

**RENEWAL:** UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Investigators planning to continue a project beyond one year must use the green renewal form (enclosed with the original approval letter or when a project is renewed) to seek updated certification. There is a maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for complete review.

**REVISIONS:** UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB # and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

**PROBLEMS/ CHANGES:** Should either of the following arise during the course of the work, investigators must notify UCRIHS promptly: (1) problems (unexpected side effects, complaints, etc.) involving human subjects or (2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of any future help, please do not hesitate to contact us at (517) 355-2180 or FAX (517) 432-1171.

Sincerely,

David E. Wright

David E. Wright, Ph.D.
UCRIHS Chair

DEW:pjm

cc: Kirk Heinze

OFFICE OF
RESEARCH
AND
GRADUATE
STUDIES

University Committee on Research Involving Human Subjects (UCRIHS)

Michigan State University
225 Administration Building
East Lansing, Michigan
48824-1046

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