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Tegucigalpa, Honduras
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Mr. Rafael Rosario, Project Officer
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USAID/Honduras
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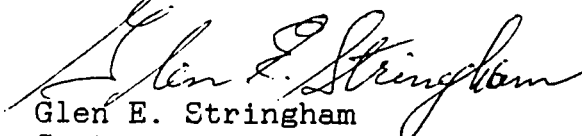
SUBJECT: Final Report

Dear Mr. Rosario:

With the enclosed report, I bring to an end my work as a consultant for USAID to the Honduran government under the contract listed above. The work has been personally rewarding to me and I trust it has fulfilled the expectations of USAID when the contract was offered to me.

I have appreciated the support, both administrative and technical, that has been accorded to me by USAID through you and Armando Busmail. It has made my stay here most enjoyable.

Sincerely,


Glen E. Stringham
Contractor

FINAL REPORT
ON-FARM IRRIGATION DEVELOPMENT ASSISTANCE

submitted by
Dr. Glen E. Stringham
Contractor

NPSTC #522-0268-C-00-0160-00

IRRIGATION DEVELOPMENT PROJECT

Project #522-0268

USAID/Honduras

Tegucigalpa, Honduras

13 September 1993

ACKNOWLEDGEMENT

As my work in Honduras ends I wish to acknowledge the support of all with whom it has been my privilege to work for the past three and one-half years. I appreciate the cooperation of all the PRORIEGO staff in both the central and regional offices. The central office staff have been most helpful with administrative details and with local logistical support when needed. In the regions I have been received most cordially and treated with the greatest respect. Their willingness to accept suggestions and to listen to new ideas has been a source of great satisfaction, and together, some very significant changes in irrigation methodology in Honduras have been achieved. I would like to give special thanks to Ing. Orlando Avilés, Director of the Dirección General de Recursos Hidricos without whose support many of the advancements made in irrigation development during my time here would not have been possible. This has been true of Rafael Rosario, Project Officer in USAID, as well. I have especially appreciated his willingness to support me in whatever direction I felt it was necessary to go to meet the changing conditions of the work to which I have been assigned. His liaison officer, Armando Busmail, has also been most helpful with administrative details of the contract. Ing. Roberto Rivera Lanza is another person to whom special thanks is due. He was most helpful in my orientation when I first arrived and has continued to be of help and a source of information throughout my entire stay.

My work in Honduras has been a very gratifying experience. I have often had occasion to remark that here I have used everything I have learned about irrigation since I was a boy on an irrigated farm in Canada to the very latest discoveries I made as a research scientist at Utah State University. It has been a pleasant "cap" to a rewarding career in irrigation.

EXECUTIVE SUMMARY

The work of the consultant under this contract has extended over a period of three and one-half years. A major activity of the consultant was to visit the sites of and review the designs for proposed on-farm irrigation systems to ensure that the irrigation systems under consideration were adequate to meet the needs and expectations of the clients. More than 170 irrigation projects or potential projects were visited and discussed, more than half of them a number of times, and the designs for the irrigation systems on 56 were reviewed in detail and recommended for approval to the Director of PRORIEGO.

All of the visits and reviews were used as training exercises for the PRORIEGO personnel and water users who participated in those activities. It is estimated that more than 2000 man-hours of training occurred in this manner. In addition a total of 31 formal courses, seminars and workshops were presented to more than 500 participants for a total of more than 2500 man-hours of training.

Honduras now has a corps of well trained irrigation designers. They have had valuable experience with both good and bad designs, and their technical knowledge of good irrigation design has been updated. They are now well acquainted with modern irrigation techniques and with the equipment used to produce modern irrigation systems. Local clients can now rely on them for professional designs which, if properly managed, will increase their production.

An improved irrigation infrastructure is needed in Honduras. It is almost impossible to buy new irrigation equipment without a special order from outside the country. Replacement parts are even more difficult to obtain. Availability of equipment is now one of the limiting factors to continued growth of irrigated agriculture in Honduras.

The capacity to design and construct good irrigation systems is now ahead of the ability of water users to efficiently use the water now available to them. As a next step in the advancement of irrigation development a training program is needed for extension agents who can in turn train the water users. Such a program will require that the agents themselves learn how to irrigate and how to teach the principles and practices they learn to water users.

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INTRODUCTION

In March of 1990, a contract was entered into between the contractor and USAID/Honduras for services to the Government of Honduras in the development of on-farm irrigation systems. The work was to be done through the PRORIEGO program, sponsored by USAID and the Government of Honduras and under the direction of the Dirección General de Recursos Hídricos in the Secretaria de Recursos Naturales. Prior to the initiation of the contract, the consultant had made three previous trips to Honduras to work with PRORIEGO under a contract with USAID through Colorado State University and WINROCK International. Under those contracts a series of norms and standards for the design and construction of small irrigation systems was written. The current contract was for a period of two years to assist in the incorporation of those standards in the design and construction of on-farm irrigation systems through PRORIEGO. Later, the contract was extended to the end of September 1993, making a total length for the contract of three and one-half years.

STATEMENT OF WORK

The statement of work was incorporated in the contract through a General Objective and, in the original contract, six Specific Objectives. As the work progressed, the needs of the program changed and hence the work of the contractor, with the approval of the Director of PRORIEGO, and with the concurrence of the USAID Project Officer, was modified to meet those needs. In the contract extension, the number of Specific Objectives was reduced to four to reflect the change. For clarity, both sets of specific objectives are listed. However this report will follow the set as listed in the contract extension as it more nearly reflects the contractor's activities during execution of the contract.

General Objective

To coordinate and improve the effectiveness of PRORIEGO's components related to the design and construction of irrigation systems and on-farm water management.

Specific Objectives of the Original Contract

1. Develop the project implementation schedule of construction and rehabilitation of irrigation systems.
2. Plan implementation of activities in water management and water use at the farm level under irrigation systems supported by the project.

3. Coordinate the development of plans for each irrigation system, focusing on the proper use of irrigation water at the farm level, maintenance of the irrigation systems, and the application of modern production technologies for irrigated crops.
4. Coordinate the agricultural production specialists and economists to develop a farm plan and budget for each project beneficiary, that will include calculations of the total area to be irrigated, crops and crop rotation, production schedules, water requirements and seed bed layouts.
5. Design and coordinate the implementation of a training program for project technicians and farmers that will enable them to use on-farm management schemes that will make efficient use of available water for maximum economic production.
6. Present a series of seminars on the use of irrigation design and construction standards and norms to contractors, design engineers and technicians.

Specific Objectives of the Contract Extension

1. Provide irrigation consulting services to workers in both the public and private sectors in areas which include, but are not limited to:
 - a. Design of on-farm irrigation systems;
 - b. Construction of on-farm irrigation systems;
 - c. On-farm water management;
 - d. Selection of irrigation equipment; and
 - e. Operation and maintenance of canal systems.
2. Provide training to irrigation engineers and supervisors in both the public and private sectors on subjects which include, but are not limited to:
 - a. Design of on-farm irrigation systems;
 - b. Construction of on-farm irrigation systems;
 - c. On-farm water management;
 - d. Design and construction of irrigation distribution systems; and
 - e. Operation and maintenance of irrigation distribution systems.
3. Provide technical review services to the director of PRORIEGO for:

- a. New on-farm irrigation systems submitted for credit and construction assistance;
 - b. Rehabilitation designs for on-farm irrigation systems; and
 - c. Designs for new, or the rehabilitation of existing, irrigation distribution systems.
4. Provide technical assistance to the director of PRORIEGO, at his request, on subject matter relating to irrigation development in Honduras which includes, but is not limited to:
- a. Irrigation policy;
 - b. Long range planning for irrigation development; and
 - c. Assist in coordinating the work of short-term technical consultants.

ACTIVITIES AND ACCOMPLISHMENTS

The activities of the contractor are detailed in the monthly reports submitted to both the Director of PRORIEGO, and the Project Officer in USAID. Therefore, the activities reported here will be summaries of those reports.

The work of the contractor was to advise, train and consult with engineers, technicians and water users on various aspects of irrigation system design. Therefore, his accomplishments are more subjective than objective, and the report will reflect that.

In this section, each of the objectives listed in the contract extension will first be listed, followed by a narrative of the types of activities performed under that objective and concluded with the contractor's evaluation of the accomplishments achieved for each. It is to be noted that some areas of the objectives overlap and so activities and accomplishments will overlap as well. Undue repetition will be avoided.

Objective #1

Provide irrigation consulting services to workers in both the public and private sectors in areas which include, but are not limited to:

- a. Design of on-farm irrigation systems;
- b. Construction of on-farm irrigation systems;
- c. On-farm water management;
- d. Selection of irrigation equipment; and
- e. Operation and maintenance of canal systems.

Activities:

Providing the consulting activities as listed in the above objective was one of the most effective ways of inducing the changes in irrigation design that have occurred in the past three years. The PRORIEGO project required that all irrigation designs for projects financed under its auspices be approved by the Director. The Director in turn required that all such projects be submitted to the consultant for his review and recommendation before the director would give his approval. As a result, the problems raised by the consultant had to be answered and the design changed accordingly. Many of the changes were resisted by both the designers and the project owners, but in most cases, they complied. With the passage of time and through experience with both good and marginal designs, the resistance to suggestions became less and less pronounced as the rationale behind them became clearer, until, at the present time, consultation is sought early in the design when it can be most effective and the discussions focus on alternatives, clarify ideas, and check for mistakes.

The consultancies took two major forms considered to be of equal importance. One was consultations in the office of the consultant or the engineer, and the other was site visits to the projects. The office consultations served to check the details of the engineering design and the suitability of a particular design to a particular field was checked by the site visits. The site visits often uncovered inadequacies in field information on which the designs were made and they had to be changed accordingly. This emphasized the importance of the field visits by the designers.

Over the life of the contract more than 400 consultations were made on 172 projects. Approval was recommended on 56. As a result of the consultations, many projects proved to be uneconomical or the owners simply decided not to build them. Some were built with private funds and needed no approval from PRORIEGO.

Accomplishments:

1. Honduras now has a corps of engineers, residing in both the public and private sectors, who are competent irrigation design engineers.
2. Irrigation designs are more compatible with physical conditions of each project.
3. The designers have had sufficient experience that they can truly be consultants to their clients and help them select, from among the various alternatives available, which one will be the best for the clients' particular needs.

4. The designers have a much broader view of irrigation system design and can present designs that are much more flexible than here-to-fore.
5. Field data for making the designs is much better as closer supervision of topographers and agronomists in collecting the basic data has been imposed.
6. The designers are more flexible in their designs so they are more inclined to design according to the wants of their clients rather than enforcing their own designs upon him.
7. Clients and engineers are working more as a team because the designs are done in less of a vacuum, with the client giving more input into the design during its early stages.

Objective #2

Provide training to irrigation engineers and supervisors in both the public and private sectors on subjects which include, but are not limited to:

- a. Design of on-farm irrigation systems;
- b. Construction of on-farm irrigation systems;
- c. On-farm water management;
- d. Design and construction of irrigation distribution systems; and
- e. Operation and maintenance of irrigation distribution systems.

Activities:

The training activities of the consultant were numerous and varied, ranging from one-on-one discussions with individuals and small groups to formal courses, seminars and workshops. The theoretical courses and seminars were emphasized in the first two years of the consultancy while the practical aspects of irrigation were emphasized in the seminars and workshops of the last year and a half.

One-On-One Training

All of the consultations, project reviews, and field visits described in the previous section were training opportunities of the very best kind, i.e., one-on-one training between trainer and trainee in the solution of specific problems which the trainee had to solve. In this environment, complete attention was focused on the problem at hand and everything from the basic fundamentals of

irrigation to specifics of application to a specific site became the subject of the discussion. Thus, basic principles, the practical application of those principles, irrigation system alternatives available from which to select a particular system, and the rationale for selection or rejection of a system were all discussed.

Site visits to projects during construction provided many opportunities to discuss construction methods and equipment used. Construction specifications, i.e. trench width, depth, backfill and compaction requirements for pipe lines; canal width, depth and structure placement for open channels; advantages and disadvantages of various types of equipment; and other aspects of construction became the topics of discussion.

These consultations also provided opportunity to discuss the non-technical and/or social aspects of irrigation. Such topics included the real wants and desires of the client; respect for the water rights of previous developments and for other downstream users, including needs for culinary purposes; impact of development on the natural drainage patterns and the effect of modifying those patterns on the project itself and on the surrounding farms as well as life-style changes imposed on the users by an irrigation project.

Courses

A second major training activity was the presentation of a number of courses to various groups involved in irrigation development. The courses generally extended over a period of three to five days and emphasized the basic concepts of irrigation. Subjects treated included: basic hydraulics of both overland flow and pipeline systems; soil-moisture-plant relationships; evapotranspiration; land leveling; and the design of furrow, border, sprinkle and trickle irrigation systems.

The objective of the courses was to emphasize basic principles, provide opportunity to discuss the application of those principles through the use of specific design examples, and fill in knowledge gaps in the background training of the participants.

Seminars

The seminars were often a combination of classroom work and field exercises. The classroom work emphasized the principles, and the field exercises focused on the practical application. These were usually one day or less in duration. Participants included engineers, economists, agronomists, topographers, bankers, irrigation equipment dealers, construction contractors and others of similar type educational background.

Workshops

The workshops emphasized the practical aspects of irrigation. On-farm water management and the management of the delivery system, i.e. the canals and pipelines, was stressed because management, particularly on-farm management, is probably the single most important element of a successful irrigation project. It has been stated that a good water manager can make a poor system successful while a poor manager can cause a good system to fail. Hence the emphasis on management.

Participants in the workshops were predominantly campesinos. Government officials working with the irrigation districts usually set up the workshops and participated in them. The workshops exposed some of the ways in which management of the irrigation distribution system affected on-farm management and has resulted in some needed changes.

A general observation should be made about the training activities carried on by the consultant. It was found that short, high impact training sessions were the most viable. Most of the participants have careers to which they must attend, and it is difficult to break away from those activities to attend a training course of extended duration. It was found that a series of one-day training activities spread out over a period of several months would have more consistent attendance than a single training activity extending over a period of 4 or 5 consecutive days. In the latter part of the consultancy, the training activities of the consultant reflected that procedure.

Accomplishments:

1. Most of the accomplishments listed under Objective #1 can also be attributed to the training activities of this objective.
2. It is estimated that more than 2,000 man-hours of training occurred in the one-on-one training activities.
3. A total of 31 courses, seminars and workshops were presented to an accumulated total of more than 500 participants. It is estimated that these activities contributed to more than 2500 man-hours of training.
4. Since at least one, and often two or three, local engineers and technicians accompanied the consultant to all site visits and participated with him in all of the training activities, both formal and extension type information transfer techniques were taught and demonstrated. These techniques are now being used by the participants in transferring what they have learned to their clients and to the campesinos with whom they work.

Objective #3

Provide technical review services to the director of PRORIEGO for:

- a. New on-farm irrigation systems submitted for credit and construction assistance;
- b. Rehabilitation designs for on-farm irrigation systems; and
- c. Designs for new, or the rehabilitation of existing, irrigation distribution systems.

Activities:

The technical review services provided to the Director of PRORIEGO, was provided by visiting each site for which a design had been made and reviewing the technical design for each project. Site visits were essential as it was discovered that designs were being made by engineers who had never visited the site. They were relying on information gathered by topographers and agronomists who really did not understand what information was needed. Hence, topographic maps did not include obstructions in the field such as rock outcrops, large trees, buildings, location of the source of water, topographic details of supply canals and pipelines, fences, etc. Hence many of the designs had to be redone after the needed information was gathered. It was further found that designers had very little contact, if any, with the project owner. They were relying on second hand information for their designs. The site visits changed that. Policy statements were made requiring site visits and discussions with the owners, on the part of the designers, before approval of any project was given.

The technical reviews considered such topics as, land slopes, direction of irrigation, location of canals and structures, structure construction and installation, furrow stream size, pipe sizes and pipeline safety devices, pump installations, sprinkler sizes and distribution patterns, application and infiltration rates, pressure requirements and pressure losses; filters and filter requirements; and adaptability of the system to the particular field. At first, the reviews often required a complete redesign, but with time and experience, fewer changes were made as the designs improved.

The above reviews were not limited to designs made under the auspices of PRORIEGO. A number of other nations, besides the U.S., have technical assistance programs for irrigation development in Honduras as well. Technical reviews were requested for projects supported by both the Canadian and Spanish governments. Those for the Canadian government were in the Guayape Valley near Juticalpa in east central Honduras and for the Spanish government, in the regions around Ocotepeque in the south west near the borders of both Guatemala and El Salvador.

Accomplishments:

1. The accomplishments listed under Objective #1 also apply to this objective.
2. Irrigation system designs are better than when PRORIEGO started.
3. Irrigation systems are more flexible and better suited to the particular projects for which they are designed.
4. Project owners are more involved with the designs and are better satisfied with the systems once they are installed.

Objective #4

Provide technical assistance to the director of PRORIEGO, at his request, on subject matter relating to irrigation development in Honduras which includes, but is not limited to:

- a. Irrigation policy;
- b. Long range planning for irrigation development; and
- c. Assist in coordinating the work of short-term technical consultants.

Activities:

In the course of reviewing the irrigation designs for the various PRORIEGO projects, it became evident that certain practices needed to be changed. To illustrate, it had become the practice to design moveable sprinkle systems with plastic pipe, usually 2 inch pipe. Quick-couplers for such systems did not exist, therefore, the designs specified that connections be made with plastic unions, the type that are used for regular plumbing. This required that every time the pipe was moved, all the unions had to be uncoupled and then reconnected. In the process, the threads would fill with sand and dirt, threads would get crossed in the process and the joints would leak. This was an intolerable situation. Therefore, on the recommendation of the consultant, a PRORIEGO policy was developed that after a specific date, such systems would no longer be approved for PRORIEGO financing. Policies were also developed for the installation of buried plastic pipe and to clarify PRORIEGO's relationship with design contractors.

As PRORIEGO moved from providing irrigation designs for clients internally, to the use of private contractors for those designs, set of specifications for the contracts was needed. The consultant was asked to assist in the production of those specifications.

The consultant participated in a number of other policy making activities as requested by the Director of PRORIEGO.

The director of PRORIEGO, is also the director of the Dirección General de Recursos Hídricos and is responsible for all irrigation development in Honduras. On a number of occasions, the consultant assisted in reviewing proposals for irrigation projects sponsored by other entities. Two examples will be described to illustrate the type of assistance given.

Kuwait Fund for Arab Economic Development

The government of Kuwait is funding the rehabilitation of the entire Flores Irrigation District, including the rehabilitation of and enlargement of the Coyolar dam and reservoir, and all canals in the distribution system. Since the work will be done by contract, it was necessary to have an outline for preparing the scope of work and terms of reference for those contracts. The consultant was asked to review the outline for completeness and suitability. This he did, and as a result, several modifications were made in both content and wording of the document.

A number of suggestions were also made with regards to types of rehabilitation to perform. One such suggestion was that a proposed lining for all the canals be modified so that a concrete pipe fitted with automatic control valves could be used on at least one lateral. This lateral was to be used as an alternate prototype to the proposed lining of the whole system.

Agencia Española de Cooperación Internacional

The Agencia Española de Cooperación Internacional (AECI) is financing the economic development of the tri-country (Honduras, Guatemala and El Salvador) region where the three countries meet. One of the proposed projects in Honduras is the development of an irrigation district to serve the lands around the cities of Santa Anita and Santa Fe in Ocotepeque.

The consultant made two trips to the area with the engineers who had the contract for doing the design, reviewed the design at various stages of its development, and insisted on several modifications to the design to make it compatible with local conditions. In addition, alternatives to the final design were suggested which would reduce the cost of construction.

The system thus contemplated would be ideal to install as an automated pipeline canal system as was proposed for the Flores lateral. The suggestion is still open for consideration.

Accomplishments:

1. Policies were developed to improve technical development of PRORIEGO projects. Those policies are of such a nature that they will carry over into the design of future projects when the PRORIEGO project itself closes.
2. Assistance was given to help smooth over the transition from "in-house" designs to contracted designs.
3. Most of the results of the assistance given to non-PRORIEGO entities are yet in the future as they must wait for the field work to be done.

FUTURE CONSIDERATIONS

A major limitation to continued development of an irrigated agriculture in Honduras is the non-availability of suitable irrigation equipment. Virtually all of it must be imported on a job by job basis. There is no "irrigation store" in the country where a farmer can buy new equipment or repair parts for existing equipment. Strong support should be given to the establishment of an in-country source of supply on a walk-in basis.

Water users need to be trained how to manage their water. PRORIEGO succeeded in developing well trained engineers and technicians for the design and construction of on-farm irrigation systems. That expertise is now well ahead of the ability of water users to efficiently and effectively use the water. The inability to properly manage irrigation water applies to all water users, educated or uneducated, rich or poor. There are a few exceptions, but very few. So, training in **on-farm water management** will be the key to the future of a successful irrigated agriculture in Honduras.

The on-farm water management training should emphasize field work rather than theoretical classroom lectures, although both are important. The field training should be done by those who know field practices and who, themselves, know how to irrigate. This in turn requires a cadre of well trained extension agents. Since field training in irrigation is generally lacking among the extension agents in Honduras, it needs to be developed by formal in-service training activities coupled with field experience under the tutelage of experts who know how to irrigate and can teach by doing. The training should be given in Honduras, but augmented with short periods (2 weeks) of exposure to irrigation practices and extension methods in irrigation in countries having a well developed irrigated agriculture.

FACTORS CONTRIBUTING TO THE SUCCESS OF THE CONSULTANCY

It is believed that the consultant has been successful in helping to improve on-farm irrigation in Honduras. However, many factors have contributed to that success, principally the support and cooperation of all PRORIEGO staff. Three other factors required for the success of the consultant, and which he especially wishes to recognize as they may impact on other similar projects, were: the administrative support, transportation, and his role as a consultant, not as a line officer.

Administrative Support

The administrative support to the consultant has been outstanding. USAID adopted the role of a facilitator and ensured that the needed resources were available to the consultant. Thus he was free to make decisions, travel, make and change plans as needed and in general be a resource to the people he had been contracted to help. Without that kind of support, much less would have been accomplished.

The director of PRORIEGO was equally helpful. He did not in any way attempt to interfere with planned activities, but was free with suggestions and requests for help. Furthermore, he was very supportive of changes suggested and was instrumental in bringing them about. One action, in particular, was critical in bringing about the changes that have occurred. He declared, at the beginning of the consultancy, that any project designs approved by him would first have to be reviewed by the consultant. Even though the consultant was not given the authority to "approve" a design, and rightfully so, the designers knew that he must be satisfied with a design for it to go forward. At the beginning, there was some resistance on the part of the designers to that requirement, but, as mentioned before, it softened with time, and the designers and consultant became working partners rather than antagonists over design details. The result was overall improvement in the system designs.

Transportation

As a condition for accepting the contract the consultant requested that a suitable vehicle be assigned for his exclusive use. His prior experience in international consulting had shown the general inability of host governments to assign vehicles and drivers to consultants to meet their day-to-day needs without putting stress on the host country fleet. The arrangement was generally unsatisfactory to both. With the freedom which an assigned vehicle gave to the consultant, he was able to respond to requests for assistance, sometimes on rather short notice, plan training activities, and move about as needed without interfering

with the regular work of the local offices. When he would visit the field offices, he would come with transportation which they did not need to supply or support, and they traveled with him in his vehicle at his expense to visit project sites. Thus he was viewed as a resource to help in their work and not a hindrance to it. It also relieved the central office of having to provide a car and driver when the consultant needed one.

A Consultant - Not a Line Officer

With the one exception noted above, the consultant had no "responsibility" for any program or activity except his own. Thus he was never viewed as a competitor for office, or promotion, or power. He was an advisor. His suggestions were suggestions, not mandates. Even in the role assigned by the Director of PRORIEGO as reviewer of all project designs, it was recognized by all designers that, if they disagreed with the consultant, they had the right, and responsibility, to present their views of the disagreement to the Director. The final decision was his. A number of suggestions made by the consultant, particularly in construction, were not adopted.

The above are three of the principal contributing factors to the success of the consultancy. Another, which should not be left unmentioned, was the general support of the entire PRORIEGO staff and the program itself. On another occasion, the consultant had the opportunity to write his views of the success of the PROKIEGO program, and to make this record complete, that document is included as APPENDIX I of this report.

CONCLUSIONS

Much has been accomplished during the time of this consultancy. Irrigation system designers have been trained and are now competent to do independent designs. Training has been given to water users who are now more aware of what irrigation must do and how to do it. Technical designs for irrigation projects have been improved and are more flexible in management constraints. Water users and design engineers are working together to meet the needs of the water users more adequately.

Working relationships between the consultant and PRORIEGO personnel have been excellent. A feeling of mutual respect has dominated all activities and created a healthy environment in which the needed changes could be made.

APPENDIX I

PRORIEGO IN REVIEW
Thoughts and Comments

by

Glen E. Stringham
Consultant

INTRODUCTION

My association as a technical consultant in irrigation to PRORIEGO began with a three months assignment in 1988. That was followed by two more three month assignment in 1989 and a full time appointment from March 1990 through September 1993. In that time, I have become well acquainted with many of its strengths and weaknesses and its successes and failures. In the process I have developed some rather definite opinions as to its overall success, which I will attempt to express in this paper. It should be noted, however, that the opinions expressed herein rely more on personal observations and private conversations with participants at all levels of involvement, including campesinos with farms of one Ha or less, farmers with large land holdings, and representatives from both the U.S. and Honduran governments, than they do on statistical data. Therefore, the opinions expressed are mine alone and I accept full responsibility for them.

WHY PRORIEGO

The purpose of PRORIEGO, as I understand it, was two-fold:

1. Increase the amount of irrigated land in Honduras; and
2. Convince the banking industry that money lent for irrigation development is a good investment.

Prior to the initiation of PRORIEGO, a number of irrigation projects, both public and private, had been built and had met with varying degrees of success, the best of which were in the banana plantations and sugar cane fields. Others were marginal, despite a sophisticated infrastructure, or failed completely. Enough of the private projects had ended in failure that the banking industry was reluctant to lend money for future development. The reasons for the failures were many and varied, but can be summarized as follows:

1. Lack of understanding of basic irrigation principles AT THE FARM LEVEL on the part of both water users and system designers, hence poor water management. Contributing to poor management were operating procedures imposed on the farmers by the system design.
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2. Inadequate design at the farm level. Most irrigation system designers simply did not have enough field experience to design systems that could match production needs with the available soil and water resources.
3. Inadequate, improper or nonexistent maintenance of the delivery and distribution systems.

PRORIEGO sought to tackle these problems by creating a program of irrigation development under the following general components:

1. Improve design and construction of irrigation systems;
2. Promote irrigation and provide extension and training programs for irrigated agriculture;
3. Involve the banking industry in private irrigation development by:
 - a. improving the on-farm irrigation system design;
 - b. doing the economic studies necessary to ensure project feasibility;
 - c. establish a credit pool, with loan monies from USAID, earmarked for irrigation development;
 - d. guarantee loan repayment in case of project failure.
4. Strengthen local government, irrigation district and private sector institutions which are necessary to support a viable irrigation industry.

SUCCESS OR FAILURE

All four components of project were addressed during the life of the project. Some efforts met with outstanding success, while others were less satisfactory.

DESIGN AND CONSTRUCTION

The initial project proposal set a goal of constructing irrigation systems for 6,000 Has of land. The area for which irrigation systems were actually built under PRORIEGO sponsorship was between 4,000 and 5,000 Has. In my opinion, getting 4,000 Has of irrigation in operation should be considered an unqualified success even though that is only two thirds of the projected goal. In retrospect, it may well be that the 6,000 Ha target was unrealistic because:

1. So little hard data was available at the time the project was written that no person, no matter how expert, could have accurately predicted the area that could be brought

under irrigation during the seven year life of the project.

2. Those who drafted the project had enough vision to understand the need for and the potential of irrigation development but they had NO CONTROL over the most important resource for project success, THE FARMER AND HIS LAND.
3. The farmers, the ones who would use the water, pay for irrigation systems, and reap the benefits, had virtually no input into the project development.
4. Policy concerning who should be the beneficiaries of the project changed during the life of the project. One such change, shifting from small land owner clients to large land owner clients and farming cooperatives, virtually wiped out one full year of design effort.

It is therefore my opinion that the 6,000 Ha target was either a best ESTIMATE, given inadequate data and resource control, or it was the minimum number of Has required to justify the cost of the project. In either case, the success or failure of the project should not rely too heavily in the 6,000 Ha figure.

In evaluating the success of PRORIEGO, another figure to consider is the hundreds of Has installed as a spin-off of the project. PRORIEGO policy limits the area one land owner can develop with direct PRORIEGO assistance. Consequently, those who could have paid for an irrigation system with their own resources, used PRORIEGO assistance to develop a "pilot" project or as "seed money" for a larger development. Once the pilot project proved successful, more land was put under irrigation with money from other sources. Furthermore, other land owners, seeing the success of the irrigation projects, have begun to buy and install their own systems. I do not have exact count, but I estimate that another 1,000 Has of development should be attributed to PRORIEGO.

PROMOTION, EXTENSION AND TRAINING

I am not too familiar with the details of the promotion work done earlier, but apparently it was very successful. However, with the closing of the WINROCK contract and with the end of the project itself in sight, the promotion has gradually diminished and very little is being done now.

Formal extension activities of the project met with limited success. In 1990 such activities were terminated and left to other entities outside of the project.

Training has been a major part of the project. It has taken the form of formal training at educational institutions outside of Honduras; formal training courses, seminars, workshops and field days in country; and one-on-one training in the field during site visits and project reviews in the normal course of the work. Practical experience has been the great synthesizer of these training activities. Enough designs have been made and projects installed, with both good and bad results, that the designers are beginning to understand how the basic concepts of irrigation apply to irrigation system design and to incorporate them in their designs rather than follow a rigid lock-step formula as was previously done. While we sometimes wish this synthesizing of training and experience could be faster, the pace in PRORIEGO has not been unreasonable. Designers are learning to successfully combine the science and art of irrigation to produce realistic designs.

PRORIEGO's role in this process has been indispensable. As a result of the project, there now exists in Honduras a core of well trained irrigation design engineers who can continue the irrigation development, with local support, when PRORIEGO ends.

PRORIEGO has expended considerable effort, through its consultants, to reach the water users with its training programs. A number of workshops, seminars and field days have been presented in which water users have been the principal participants. For these groups, demonstrations of basic principles in the classroom have been reinforced by field visits to see how those principles apply to field conditions. The results have been rewarding even though significant changes are yet in the future. The users are beginning to understand that just because the surface of the soil is wet, it does not follow that the soil reservoir has been filled. This has come as a surprise to many of them, but they understand the concept and a few are beginning to make the necessary changes.

INVOLVEMENT OF THE BANKING INDUSTRY

PRORIEGO has been very successful in addressing the concerns of the banking industry. When the project started, loans for irrigation development were difficult to obtain. The emphasis of the project in the early years was to assist small farmers, with special attention given to land owners under the agrarian reform law. This did not work. Banks would not lend money to farmers who had no education, no experience with irrigation, and no clear title to their land, especially when the cost of the projects often exceeded the value of the land. This sort of experiment was too risky for banks to consider as a sound investment. For this reason most of the early PRORIEGO designs were never used. The farmers could not afford them and neither could the banks.

When design emphasis was changed from small farms to large farming enterprises and cooperatives with established credit lines, loans were forthcoming and projects were built. Much of the success with the banks was due to the thorough work done by the economists in preparing project justification documents. Only designs which could be economically justified were submitted to the banks. When loan repayments began, (some loans were completely repaid after one or two crops) confidence in PRORIEGO designs grew. As more successful projects were built, confidence expanded from PRORIEGO designs to other well documented irrigation projects as well. This confidence still exists. So, PRORIEGO has been very successful in changing the attitude of the banking industry from negative to positive with regards to irrigation projects.

INSTITUTIONAL DEVELOPMENT

PRORIEGO has been instrumental in bringing to Honduras experts in various aspects of irrigation. Many of their suggestions have been implemented at all levels of both government and private institutions. Institutional decision makers now better understand both the potential and limitations of irrigation systems. This understanding is reflected in the changes that have occurred in their respective institutions. This institutional strengthening, while nebulous to describe and difficult to pinpoint, is an exceptionally valuable contribution to the legacy of PRORIEGO and should be considered in the subjective phase of its evaluation.

For the remainder of this discussion, I shall consider the following "institutions": consulting engineers, whether as part of a consulting firm or as individuals providing irrigation consulting services; irrigation districts who supply water to farmers; irrigation equipment suppliers; the Honduras government through Recursos Hídricos; and the agricultural sector as a whole.

Consulting Engineers

As mentioned before, Honduras now has irrigation engineers capable of designing good irrigation projects AT THE FARM LEVEL. I emphasize the FARM level of design because that is where the action is. Irrigation development is often considered to be only the design and construction of dams, canals, structures and other physical facilities that are essential components of any irrigation project. The required design work at the farm level is either minimized or ignored. Somehow, farmers are supposed to intuitively know what to do and it is assumed that irrigation will "happen". That is FAR from the truth. The irrigation "dinosaurs" sitting empty and unused or in severe states of disrepair to be found around the world give mute evidence to the fact that not enough attention was paid to the farmer and his system. Again, IRRIGATION HAPPENS ON THE FARM, not in the canal.

The contribution of PRORIEGO in preparing these engineers has been indispensable. Many, if not most, of the irrigation engineers now working as private consultants or in industry, were trained in and through PRORIEGO and its programs. In addition to the formal training activities, the projects built under PRORIEGO auspices have provided the field experience which is absolutely necessary for competent engineering design. Without the synthesis of theory and practice which those projects provided, all the training that has been done would amount to little more than another academic exercise in futility. As it is, on-farm irrigation system designs in Honduras are better than they were before PRORIEGO. Management of irrigation systems at the farm level is better because the systems, products of improved designs fostered by PRORIEGO, have given farmers the necessary control to properly manage their water. These are just some of the reasons why I consider PRORIEGO to have been successful in strengthening the irrigation consulting institutions of Honduras.

Irrigation Districts

Only a limited effort has been made by PRORIEGO to have direct input into the operation and management of existing irrigation districts. The inputs with the most impact are the visits of two irrigation consultants from the U.S., Drs. Lyman Willardson and Gary Merkley, and the trip to California by Ramón Chacón and Carlos Merlo, engineers who had managerial responsibilities with the irrigation districts in Comayagua. These activities have resulted in the following changes:

1. The water users associations of the districts have been revitalized and strengthened.
2. Most of the operation and maintenance decisions have been transferred to the water users associations.
3. Maintenance of all laterals are now in the hands of the water users.
4. An improved records keeping system for water deliveries, operational water losses, maintenance and rehabilitation costs, and overall operating costs has been established.
5. Water measuring devices are being installed throughout the districts where they were virtually non-existent before.
6. District chiefs, who are government engineers, are more aware of the needs of water users and of the impact that district decisions impose upon them. They are responding to those needs with improved delivery methods, delivery schedules and maintenance procedures.

7. Water users are demanding more technical assistance and training to improve water management on their farms.

Coupled with these activities, a number of workshops have been held with water users relating to on-farm water management. They have resulted in an increased understanding of what irrigation really is and in some small changes which are now appearing in the way water is used and managed.

Again, PRORIEGO input, although relatively small in comparison to the irrigation design component, has had a significant impact in strengthening the irrigation district institutions of Honduras.

Government Entities

The chief government entity that has been the recipient of PRORIEGO institution building is the Dirección General de Recursos Hídricos (DGRH) of the Secretaría de Recursos Naturales. PRORIEGO has been under the general direction of DGRH, and thus PRORIEGO's Honduran personnel have indirectly been part of the DGRH personnel pool. A major part of the budget for PRORIEGO administrative and technical services has been supported by grant funds, and since some personnel have had what amounts to a dual appointment, there has been an indirect financial support to DGRH by the PRORIEGO project. Therefore, with the general strengthening of PRORIEGO personnel there has been an effective strengthening of DGRH also.

Another benefit of the administrative financial backing to DGRH has been the flexibility necessary to modernize the offices and make them more efficient. Computers have been installed in both the central and field offices, office equipment and communications networks have been updated, operating procedures have been streamlined and personnel reduced. The positive impact of improvements made in DGRH have been noted in other government agencies and serve as a model for them to emulate. The influence of all these changes will still be with DGRH after the project closes, and it is not inconceivable that the impact may be felt more fully in the future than it is now.

Irrigation Equipment Suppliers

At the beginning of the PRORIEGO project, the availability of irrigation equipment in Honduras was deplorable. Equipment for any new project, with the exception of plastic pipe, had to be ordered on a project by project basis from foreign sources. No business firm in Honduras was willing to stock and support an irrigation equipment supply store. In general terms, this condition still exists. There are two or three companies, whose main business is to sell plastic pipe, who have small stocks of pipe fittings and a very limited stock of sprinkler and trickle irrigation equipment.

Fittings for quick-couple aluminum moveable systems, such as riser valves and hydrants cannot be purchased locally. Equipment for surface irrigation, such as ditchers, land planes, well shaped siphon tubes, gates for gated pipe, riser valves and hydrants, etc., are all virtually unavailable except by special order.

As designs for better systems has progressed, so has the demand for better equipment. The demand for more sophisticated equipment has put intense pressure on businesses to provide better service for the irrigation industry. As a result some companies have tried to fabricate their own fittings. While noteworthy, they have not been very successful. In recent months, there appears to be some interest in opening an "irrigation store".

It is my opinion that irrigation development in Honduras has reached a plateau beyond which it cannot rise unless irrigation equipment is more generally available, not only for new systems, but for replacement parts and repairs as well.

Agricultural Sector

If the aggregate of agricultural producers, i.e., the farmers, can be considered as an "institution", then PRORIEGO has succeeded very well in strengthening it. Owners of successful irrigation projects know its benefits well, and some have made small fortunes. Small private irrigation projects, with and without PRORIEGO assistance, are springing up all over the country. There is more demand for better equipment and a greater interest in better water management. There also seems to be a much greater awareness on a national scale of the important role that irrigation can play in agricultural development as well as in the overall economic development of Honduras. A few national leaders have recognized this for some time, but it has only recently enjoyed national prominence. Much of this increase in general interest can be attributed directly to PRORIEGO.

SOME OTHER THOUGHTS

Emphasis thus far has been on the tangible accomplishments of PRORIEGO. Its success, however, has not been achieved without its share of problems, and in some instances, it has been achieved in spite of its problems. Typical of the problems in projects of this type, to which PRORIEGO fell victim, are the "start-up" problems of mission definition and team building, the relatively short life of the project, and definition of the clients who should benefit from the project.

START-UP

Typically USAID technical assistance projects, such as PRORIEGO, are created in response to needs expressed by foreign governments. After considerable discussion, a project is designed and a project paper written and approved. Based on that paper a request for technical assistance is made to potential contractors, bids are received and a contract let. The contractor then assembles his team and sends them to the country requesting the assistance. The members of the team may or may not be acquainted with each other. Usually a counterpart team from the host country is formed as well. It is this conglomerate team that is expected to produce the results conceived in the original request.

In the process of bringing a project into being, objectives and goals are defined and redefined, sifted and resifted until what is put on paper comes as close as possible to the philosophical, fiscal and technical aspects of the original idea. However, to put on paper all of the nuances contained in the objectives as conceived by the writers is difficult. The result is that the team who must do the work may have different ideas among themselves of what is expected and collectively may differ with what the project sponsors conceived. In the case of PRORIEGO, one such conflict frequently arose over the dichotomy of having many small projects with small credit demands versus a few large projects which demanded large credit outlays. Which yard stick was the most important? Was it the number of farms and Has developed or dollars in credit outlays? That conflict was not limited to the action team but extended to the highest levels of project supervision and was not resolved until about two years into the project, when it was discovered that small farmers could not get credit no matter how good the design. Other conflicts arose and had to be resolved before the program moved forward.

These difficulties are not surprising when one considers that it is nearly impossible to write a project that can be implemented without change. Actual conditions at the time of implementation force adaptation. Such adaptations are difficult at best and catastrophic at worst and are complicated by the fact that the action team has not been party to the discussions which led to project development. Until that background is understood, the action team cannot implement the project as it was conceived. This process requires time that is rarely provided for in contracts. Such was the case with PRORIEGO, and I might add, the situation was not unique.

A second major start-up problem in foreign aid projects is the "team building" process. Members of project teams must be experts in their field, experienced, and capable of independent action. Unfortunately, a diversity of competence can be difficult to blend. When a contractor forms his team, he may or may not know how well one or more members will react to a particular group with whom he

has never worked. Some of these difficulties are exposed only when the team attempts to work together. Most often, the necessary adjustments are made, either by the team members themselves or by their supervisors. Sometimes the complement of team members must be changed. Some of these difficulties occurred in PRORIEGO.

PROJECT LIFE

Unfortunately, the life of technical assistance projects is most often too short to accomplish its goals, and particularly so in agriculture. A typical project of four or five years, is barely enough time to implement some of the technical changes required. The time required for the cultural metamorphosis inherent in agricultural change is even longer. This is an element of human nature that even the best technical planners have not yet been able to accelerate. The result is that a project ends just when it begins to have an impact. This is particularly true in the developing world where the majority of its farmers have little or no education. Adding to the problem is the "normal" two year contract given to the technical team with the option to extend for another two years if it is mutually agreeable. If a new team member is added mid-stream, he must go through all the "start-up" processes, which takes time not only for him but for the continuing team members also, and the project ends about the time it is ready to go. It appears to me that three to four years is the time needed to surmount all the start-up problems and be in a position to make a project work.

Agricultural project development seems to follow a logarithmic growth curve. They start slowly and during the early months, the growth curve rises slowly and nothing much seems to be happening. But later, results are more apparent and near the close of the project the growth curve is steep and results follow in rapid succession. Fortunately, the designers of the PRORIEGO project had enough vision to program its life for seven years, enough to get past initial problems and still have three to four years of productive work time. PRORIEGO was well into its fourth year by the time it functioned as it should. However in June 1991, with 27 months left in the project and as it was functioning on the steep part of the curve, both additional money for credit and support for technical assistance, the life blood of the project, were cut off.

In lieu thereof, it was hoped that the technical assistance part of the project, i.e. the design of irrigation systems, could be transferred to the private sector in six months. To facilitate this transfer, a direct subsidy was paid to private consultants for project designs, a service which had previously been provided without cost. Project owners had to pay the balance. After the six month period the entire design cost was to be shifted to the farmer. To meet the anticipated need for private consultants, some of the designers left PRORIEGO and started their own consulting

firms, and others left to work with existing consulting firms. A few were hired by pipe manufacturing companies. The pipe companies offered free designs to their clients on condition that if the project was built, the client would buy all his pipe from that company. Clients of the private consultants had to pay for the design themselves.

The scheme worked for farmers who had large farms or other sources of income and could afford the cost of the design. It also worked for farmers who took the option of the free designs in exchange for future business. But many of the farmers who took the latter option, chose, after the design was complete, not to build the systems because costs were too high to finance themselves, or because they could not get the needed credit. This left the pipe companies to pay the design cost, which typically ranged between Lps 40,000 and Lps 100,000. As a result some of them are beginning to require a contract with the client that guarantees construction of the project or else payment for the cost of the design in case the client opts not to build the project. The net result is that the wealthier farmers can move ahead with their projects while the medium sized and small farmers are left without access to the technical assistance they need.

The final result of the cutoff has been a sharp decrease in the number and size of projects built through PRORIEGO. However, the ones that are built are being done by the private sector. If the technical assistance and credit had been continued for another 18 months, the results of PRORIEGO would have been even more spectacular than they have been.

CLIENTS

The criticism that PRORIEGO assistance has been granted to the more affluent portion of the agricultural sector is basically true. Its principal clients, with some exceptions, particularly in the early years of the project, have been: professional people who also have farms; corporations; banana cooperatives; and other entities that already had sufficient resources to install their own systems without help. It is my opinion that giving assistance to this clientele has been an important, if not essential, step in the irrigation development of the country. What that group lacked before was confidence. With PRORIEGO help, they gambled and WON! Many are now doing what they could have done in the first place, but needed the PRORIEGO push to start.

These clients are also the business men, the innovators, the financiers and political leaders of the country. They now know from their own experience what irrigation can do and are in a more sympathetic frame of mind when financial help is sought by others and when irrigation schemes come before their governing bodies. Furthermore, these clients hire people. Those whom they hire are

not blind to the benefits that accrue from irrigation, and when and if the opportunity arises to capitalize on what they learn, they will do so. And lastly, these clients have neighbors who can see over the fence. They too, are not blind to the benefits of irrigation. That they will adopt the methods of the innovators has already been demonstrated by the fact that a number of them now own irrigation systems, installed both with and without PRORIEGO help, where before they had none.

One of the predominant reasons for installing irrigation systems has been to take advantage of the export market for fresh vegetables in the United States and Europe during their winter months. Now that the irrigation systems are installed, emphasis needs to be put on using them in the production of basic grains and other agricultural products for the local market during the summer months when the export market is closed. Unfortunately, as the situation now is, many of the farms with expensive irrigation systems lie idle for nearly half of the year wasting the potential of both the land itself, and the irrigation systems available to them. Prolonged periods of no rain during the "rainy" season are not uncommon and when they occur, crops suffer stress and production is reduced. It is not improbable, that under such conditions, that one good irrigation would make the difference between success and failure of a crop. If the export market can pay for the irrigation system, then its use in times of emergency is an added bonus to both the farmer and the country.

THE FUTURE

As projects such as PRORIEGO draw to their conclusion, the inevitable question of "what next" arises. It is my opinion that the next step that must be taken is the training of water users in water management ON THE FARM. The expertise in design and construction is now well ahead of the ability of water users to efficiently and effectively use the water. The inability of water users to properly manage their water applies to ALL WATER USERS, educated or not and rich or poor. There are a few exceptions to that statement, but very few. So, TRAINING will be the key to the future of a successful irrigated agriculture in Honduras.

Future training must emphasize field work rather than theoretical classroom lectures, although both are important. The field training must be done by those who know field practices and who, themselves, know how to irrigate. This in turn requires a cadre of well trained EXTENSION AGENTS. Since field training in irrigation is generally lacking among the extension agents in Honduras, it must be developed, just as the design capability has been developed, i.e. by formal in-service training activities coupled with field experience under the tutelage of, initially, foreign experts who know how to irrigate and can teach BY DOING. Furthermore, that training must be concentrated in Honduras, but

augmented with short periods of exposure to foreign practices in irrigation. The experts must do their training in Honduras.

Honduras has an ideal facility for extension training of the type mentioned above. That facility is the Centro de Entrenamiento de Desarrollo Agricola (CEDA). It has the classrooms, the land, the water and the irrigation systems, all types, to provide the required training.

The International Rice Research Institute (IRRI) in the Philippines has developed a program to train extension agents in rice agriculture which brings the trainees to the Institute for a period for training. During that period, in addition to the classroom work, each trainee is required to raise a crop of rice under the direction of the Institute trainers. They must do ALL of the work: prepare the field, plant the crop, do the irrigating, apply the fertilizers and pesticides, and do the harvesting. When they leave, they know how to raise rice.

With the facilities at CEDA, a similar program could be developed for Honduras. Each agent could be assigned a small field, i.e. one-half Ha, and required to grow a dry-season crop with irrigation under the direction of irrigation experts who themselves can DO all that the trainees are required to do. When an extension agent graduates from such a program, he could go to the field, at first still under the tutelage of the trainers, and be recognized by the water users as a reliable, knowledgeable, source of information on water management. It would only be a short time until he would be prepared to stand alone as an expert in on-farm water management. It is my opinion, that a program such as this, or one similar to it, is not only feasible for Honduras, but essential to its future for a stable irrigated agriculture.

CONCLUSION

To summarize, I consider the PRORIEGO project to be an outstanding success. It has provided formal training and field experience for irrigation system designers and produced a competent core of well trained practitioners. It has been instrumental in opening up credit sources for the purchase and installation of irrigation systems. It has strengthened institutions involved in the irrigation sector of the agricultural community. It has opened the minds of the country's leaders to the great potential of a well managed irrigated agriculture. It has raised the vision of its farmers to where they can see a brighter future in agriculture. It has opened the door to an export market that will generate foreign exchange. It is a model which can be duplicated, not only in Honduras but in other countries as well. And, it has opened the door to making Honduras self-sufficient in its food supply.