BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION (695)
	PN-AAK-332	AA50-0000-G512

3. TITLE AND SUBTITLE (240) A review of the scope of work and contract between the Ministry of Rural Affairs and Agriculture of the Government of Bolivia and the Consortium for International Development . . .

4. PERSONAL AUTHORS (100)

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5. CORPORATE AUTHORS (101)

Consortium for Int. Development

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1978		

9. REFERENCE ORGANIZATION (130) CID

10. SUPPLEMENTARY NOTES (500)

(In Working paper no. 006/78)

11. ABSTRACT (950)

12. DESCRIPTORS (920)		13. PROJECT NUMBER (150)
Bolivia Agricultural research Agricultural technology Small farmers Resources	Project Management project control	511045100
		14. CONTRACT NO.(140) AID-511-95-T
		15. CONTRACT TYPE (140)
		16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

PN-AAK-3[illegible]

CONSORTIUM FOR INTERNATIONAL DEVELOPMENT

Colorado State University
Oregon State University
Texas Tech. University
University of California
University of Arizona
Utah State University

WORKING PAPER No.
DOCUMENTO DE TRABAJO No.

LA PAZ, BOLIVIA

006/78

A review of the scope of work and contract between the Ministry of Rural Affairs and Agriculture of the Government of Bolivia and the Consortium for International Development in relation to the Congressional Mandate to the United States Agency for International Development to work with the small farm sector.

Submitted to USAID/Bolivia

May 5, 1978

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I. Introduction

The review team was requested by USAID to review the Contract between the Government of Bolivia represented by the Ministry of Rural Affairs and Agriculture of Bolivia and the Consortium for International Development and its related plan of work. As requested by Frank B. Kimball, Mission Director, USAID/Bolivia, during the orientation of the team, the review was not to be an evaluation of CID but of the scope of work and contract in context of the Congressional Mandate that USAID work with the small farm sector. It was indicated that CID has a contract providing for a specific course of work and that USAID/Bolivia feels satisfied with the performance. The team was asked to review the small farm sector and give advice and recommendations as to whether a change in the contract or scope of work would improve USAID's efforts in assisting the low income farmer. The team was asked to consider the resources and constraints surrounding the project and be practical in making recommendations that can be implemented.

The objectives of the project as expressed in Appendix A for the stated contract (GOB/AID-511-92) are as follows:

"A. To develop improved agricultural technologies and more modern management practices germane to the small farm sector of the intermountain valleys of Central Bolivia and the newly developing agricultural areas of the lowlands of Eastern Bolivia (technology development).

B. To extend to small farm operators in the regions of interest the improved technologies and more modern production practices (technology extension).

C. To develop the capability of the Ministry offices of Economics and Statistics, Marketing, and Planning to generate basic data, analyze problems and opportunities, formulate and implement coordinated policies and programs for the sector, including improved organization and administration of public services (sectorial management).

D. To assist in improving the operational capacity of other auxiliary technical services such as soil and irrigation, higher agricultural education, etc."

Section 103A of the Foreign Assistance Act contains the following language for text and purpose which directs the nature and work of the project to the small farm sector and thus are guiding principles for USAID work.

"Text

Section 103A. Agricultural Research.--Agricultural research carried out under this Act shall (1) take account of the special needs of small farmers in the determination of research priorities, (2) include research on the interrelationships among technology, institutions, and economic, social, and cultural factors affecting small-farm agriculture, and (3) make extensive use of field testing to adapt basic research to local conditions. Special emphasis shall be placed on disseminating research results to the farms on which they can be put to use, and especially on institutional and other arrangements needed to assure that small farmers have access to both new and existing improved technology.

Purpose

This section requires that all agricultural research carried out under the FAA (including, without limitation, research under Sections 103, 107, Title XII or any other provision authorizing such research) take account of the special needs of small farmers, including research on the relationships among tehcnology, institutions, and economic, social, and cultural factors affecting small farm agriculture, and (3) make extensive use of testing to adapt research to local conditions. Special emphasis shall be placed on extension and dissemination methods."

The objectives of IBTA, with respect to the project, are contained in the document "Estructura Organizativa Operativa y Procedimental del IBTA" and are as follows:

"3. Objectives

3.1 General Objectives

The general objectives of IBTA are the production of results of agricultural investigation and experimentation, as well as the promotion of the integral development of rural families.

3.2 Specific Objectives

- To obtain through its programs of investigation and experimentation, as well as the promotion of the integral development of rural families.
- To create necessary conditions for the improvement of medium level technology through investigation and its

rapid transfer to the largest quantity of agricultural people through the medium of extension.

- To orient the plans and programs of the generation and transfer of technology as an education function to bring up changes required to improve the integral development of farmers, procuring increase distribution of their incomes and quality of life.
- To integrate the activities of investigation and extension in order to accelerate the development process."

Taking into account the charge given the review team, the goals, objectives, resources and constraints of CID, USAID, and IBTA, the team conducted its review. The review was made during the period April 24 through May 5, 1978 according to the following schedule:

April 24 - 25	La Paz
April 26 - 28	Cochabamba
April 29 - May 2	Santa Cruz
May 3 - 5	La Paz

In La Paz, discussions were held with members of USAID/Bolivia, members of the CID team, officials of Ministry of Agriculture and Campesino Affairs (MACA) and Bolivian Institute of Agriculture and Animal Technology (IBTA).

While in Cochabamba, visits were made to the Toralapa, San Benito, and Pairumani Agricultural Experiment Stations where relevant activities were reviewed and discussions held with station and other personnel including

members of the CID team. One day was spent in the areas of Itapay, Charamoco, Vinto and Parotani visiting on site with small farmers regarding their operations and problems. In Santa Cruz, visits were made to the CIAT Agricultural Experiment Station at Saavedra, and to the Yapacani area where a visit was made with a small farmer. Discussions were held with CID personnel. While in Cochabamba and Santa Cruz, contacts were made with IBTA and CIAT officials. (Appendix I provides a list of individuals contacted during the review.)

II. Characterization of the Small Farmer

The governing and operating documents for the CID-MACA project and all USAID programs place special emphasis on providing assistance for the small farmer. The term "small farmer" is not defined in any of the documents and thus there is opportunity for misunderstanding to arise as a result of individual interpretation of the term. The review team thought it might be helpful to include in its report a description of what it sees the small farmer to be. Hopefully a description of the problems commonly shared by this significant group of Bolivian farmers can serve as guidelines to orient agricultural research and other programs toward their solution.

Some of the characteristics which describe the small farmer are:

1. A relatively limited amount of resources, particularly capital and land, labor may also be limited in the sense of a relative high opportunity cost.

   In the long time established sections of Bolivia, the practice of fallowing farm land and population density are relatively high, so that farmers are forced to generate off-farm income and/or to be engaged in a variety of tenure systems (share cropping) in order to have sufficient income to support family needs. The trade-off between land and capital scarcity will determine the strategies for fertility maintenance within the farming system. Under conditions of land and capital scarcity, family labor will tend to have a relatively high opportunity cost, as long as other sectors of the economy are able to provide employment opportunities.

These circumstances call for technology alternatives which are simultaneously land-saving, capital-saving, and possibly labor-saving. Such technological improvements may appear to be impractical, however, the possibility of developing substitution technologies rather than investment ones should not be discounted. Since investment technologies tend to be relatively labor-intensive, their development should be preceded by a careful study of sources of family income.

2. A limited access to resources from outside the system, particularly capital and adequate marketing conditions due to constraints such as: farm size, land tenure arrangements, education, and infrastructure.

   As investment technologies are developed, it will be necessary to provide an integrated delivery system to accompany them. This type of system will provide credit, availability of modern inputs, lower marketing risks and, as a consequence, improvement of relative prices.

3. A considerable proportion of agricultural production is allocated for family subsistence.

   The fact that small farmers exist largely on a subsistence level, creates a welfare buffer against lower prices. Due to the inelastic demand of agricultural products, a shift in supply via technological change will reduce the farmer's income. In view of this, small farmers may capitalize part of the increased production via higher levels of family consumption. On the other hand, better prices and marketing conditions without accompanying changes in productivity will provide less benefit to the small than to the large farmers.

4. A high degree of economic efficiency within the relatively complicated system of farming due to the small farmers responsive behavior and rationale management of available limited resources.

"Farming system" here is defined as the farmers' priorities and the way he manages his available resources to meet those priorities in the face of uncertainties. For small farmers, the production system is usually rather complex as a consequence of the characteristics described above. Often one observes crop associations with species of different types, a variety of ways to maintain fertility, methods of weed cultivation as they relate to the use of weeds for animal feed, etc.

Since this system is highly efficient, little can be gained from agronomic research oriented to a rearrangement of the known factors of production. Input-output and input-input relations used by farmers are generally found to be close to optimum levels in view of the constraints and risk aversion under which they operate. There are two ways to improve such a system: first, better relative prices which will allow the farmer to improve crop management by such methods as selecting better seed, using higher levels of fertilization, better weed control, etc. Second, the introduction of innovative practices that will improve his production capacity by employment of substitution and/or investment technologies such as new improved varieties that will yield more under the farmers management conditions, new methods for disease control, etc. Various combinations of these two procedures can be utilized.

5. A latent demand for technology to improve the farming system which is not expressed due to the lack of economic and political power.

This characteristic is responsible for the breakdown often observed in the necessary linkage between agricultural research oriented toward small farmers (supply of technology) and the adoption of recommended technological alternatives (demand for technology).

A low degree of adoption of recommended practices by a small percentage of farmers observed in many programs oriented toward the small farmer, are indicators of such a breakdown.

In view of the complex nature of the farming system employed by small farmers, a critical evaluation of the system is required in order to adequately identify major needs and/or development opportunities. These needs and/or development opportunities which are rather clear for commercial farmers are not so clear far small ones: thus the latent demand. Evaluation is needed before agronomic research is conducted to know why farmers manage their enterprises in the way they do, to know their perceptions regarding various hazards and to know what production and social compromises are required by their circumstances.

Without this information, one is likely to face the hazard of recommending technological alternatives which do not fit the needs of the farmer and consequently will not be adopted.

III. Findings and Discussion*

The review team attempted to understand the research and extension programs available as provided by IBTA, CID, and CIAT to meet the needs of the small farmers in the Cochabamba and Santa Cruz areas. What follows is a brief description, evaluation, and analysis of these programs.

The agronomic research effort

Five major crops have been selected for technological improvement: potato, corn, wheat, rice and soybean. The priority arrangement for the solving of problems associated with these crops apparently have been defined by CID and Bolivian personnel rather than by the small farmers themselves. As we observed, the methodological approach utilized for the improvement of these crops has the following components: (1) a strong breeding program that involves introduction of genetic materials, crossing with local materials, and evaluation both at the experiment station and with cooperating farmers; (2) exploratory and optimization studies of bilateral relationships: fertilizer-crop, insecticide-crop, herbicide-crop, land preparation-crop, irrigation-fertilizer-crop; (3) back up activities. A balance has been sought between the on-experiment station work and the trials conducted in farmers' fields. The experience with off-experiment station research has frequently shown that those experiments are costlier and have lower accuracy than those run in the experiment station.

We found no systematic effort to understand the factors of crop quality as understood by small farmers in any crop nor to describe the farming

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*For a conceptual framework which is related to and provides a basis for the discussion regarding the findings, see Appendix II.

systems of production in the area as practiced by the small farmer, although this has been done in isolated instances. In general, the concept has been one of scale neutrality as well as the belief that research will produce something that will be attractive to all farmers.

Essentially, the same disciplinary approach followed in the experiment station (exploratory work) has been followed in the farmer's field trials. Variety, fertility and pesticide trials are conducted in farmer fields, but not integrated in the sense that interaction across factors may be evaluated. Practically, no climatic or edaphic records (other than soil fertility tests) are kept for the experiments even though a sizeable number of on-farm trials are lost due to climatic damage, (drought, frost) to weed infestation, and pests. Other experiments may be harvested after undergoing several degrees of damage by the same factors and go unrecorded. The reason for this has been both methodological and due to lack of resources necessary to keep the detailed records. It is not clear to what extent the trials in farmer fields correspond to the farming system of small farmers since the information does not show in the written reports. For example, the fertility experiments in the Toralapa region are conducted in an effort to calibrate soil tests that will permit diagnosis of fertilizer needs. The fertility treatments on potatoes have been imposed on the manure as applied by the small farmer, whatever that amount, which was properly recorded for each experiment. However, what was needed more than the effect of phosphorus fertilizer additions to the manure treatment was a measure of the interaction, manure by fertilizer, so that a

recommended rate of fertilizer can be determined after one knows the rate of manure that the farmer is going to apply.

There is a number of limitations with this methodological approach for optimizing inputs at the farmer level: (1) The lack of knowledge of factor interactions will not allow sets of unbiased technologies sensitive to price variation both of input and output. Neither will it allow the design technology for several levels of capital nor of risk. (2) Since the uncontrolled factors of production are not recorded at the site of experiment, the production factors that would permit more accuracy in the recommendations cannot be established. (3) There is no way to relate agronomic risk to a climatic factor such as precipitation, which in turn would allow a more viable technology.

A note on the calibration studies for diagnosis of fertilizer needs. It is felt because of the limitations of transportation, extension service assistance, and the problem of accuracy of laboratory soil tests, that Bolivia is not ready for a diagnostic system that relies so heavily on large scale laboratory facilities. It would seem more reasonable to maintain a modest soils laboratory in Cochabamba that would serve as a back up to the optimization studies, but not as a basis for the establishment of a large scale diagnosis program in the near future.

The extension effort

The program seems well oriented but incomplete in its scope and perhaps in its priorities. Most of the effort has been made in the necessary area of getting farmers acquainted with the modern technology, but little effort

has been made to acquaint the research worker with the traditional technology, or with the way the technology developed by the research worker performs at the farmers level. In other words, the extension effort should provide a two way channel of communication between the research worker and the small farmer. This should include production technology, credit, access to inputs, access to market, and farmer organizations. Unless sufficient action is taken in these areas, the adoption of new technologies will not take place in subsistence type farming. Even though the efforts of the extension worker are critical in the credit area, he must not take the place of the credit agency, in the same sense that he should not take the place of the research worker to develop the production technology. But he should assist the farmers in the process of obtaining the credit, as well as inform the credit institution about the operational barriers faced by the farmers. A similar role should be served by the extension worker in the other areas enumerated.

Perhaps more comment is warranted regarding visits with personnel and observation of specific projects and programs. Much was seen that reveal dedicated and resourceful effort toward the needs of farmers. The establishment of a plant pathology service, the initial stages for the development of an insect museum, the formulation of a soil moisture program, all applicable to most farmers and crops, are to be recognized and commended.

V. Recommendations

It is recognized that a review team does not become all wise or infallible in a period of two weeks. However, it is our responsibility to evaluate and make recommendations based upon our observations and from the perspective of interested outsiders. The following recommendations are submitted for those concerned. They provide a framework or master plan for action and can serve as a guideline when decisions are made and action can be taken. We do not see that all recommendations can be implemented immediately. Hopefully, however, they can serve as an immediate stimulus to become a part of the thinking and commitment for action for all involved.

1. It is recommended that an in-depth survey of small farmers needs and problems be designed and conducted through the cooperative efforts of the social and biological scientists. This might be termed a proposal for action.

   A basic assumption of this proposal is the belief that a more client-oriented adaptive research will help to better accomplish the objectives of the project. Experience with agricultural research oriented to small farmers has shown that too often agronomists have waited until new technological alternatives have been painstakingly developed on experiment stations under controlled conditions before taking them to farmers' fields, only to discover that they are not adapted to some aspect of the farming systems. Too often social scientists have waited until new technological alternatives have been introduced, and perhaps rejected, before studying farmer reactions to them.

An obvious solution to such events is for agronomists and social scientists to work closely from the inception of a program to insure that the work will be farmer rather than discipline-oriented.

We believe that CID's contribution to Bolivia's efforts to cope with the small farmers' problems can be enhanced through this activity, especially now that its staff is well balanced with social (economists and extensionists) and biological scientists.

More specifically, the activities can be described by the following sequence:

1) A program region is selected, defined, and described using secondary data.
2) Informal surveys of farmers and markets in the regions are conducted to provide a firm information base from which to launch a more systematic survey of farmers' circumstances and systems.
3) A basic farmer survey is designed and conducted, the purposes of which are to obtain information to guide the development of the on-farm research trials and to orient longer-run research efforts on the basis of the identified development opportunities.
4) On-farm trials are conducted on representative farms of the region, in an attempt to solve some of the constraints, the release of which, will permit the improvement of the small farmers' system of farming.

(For detailed information regarding procedures to be followed, the design, including sample questions, and the conducting of the questionnaire and on-farm trials, see Appendix III.)

2. Human Resource Development

The intense shortage of qualified people to serve in positions of responsibility and assume the leadership necessary to develop Bolivian agriculture was expressed repeatedly to team members in each area visited. There also exists a critical shortage of lesser trained people at the technician level to assume responsibility and perform the daily activities associated with on-going projects and to make it possible to instigate new programs. If such people were available to work with CID team members, it would be possible to multiply the effectiveness of team members and thus enhance their contribution to the program objectives.

A program has been initiated to increase the involvement of agriculture students from the Universities by employing them to work with experiment station and CID personnel in on-going projects in the preparation of their theses for the Ingeniero Agrónomo degree. The number of students taking advantage of this opportunity has been discouragingly low probably because the amount of money offered for stipends is not high enough to attract their participation.

Perhaps the budget could be rearranged to provide for higher pay to the students. If this is impossible, the stipend rate could be increased and the number of student positions available decreased. Even though the latter recommendation would seem to defeat the purpose of the recommendation, i.e., increasing the number of students participating, it is our feeling that it could help. Since students are

not now being attracted by the low stipend and perhaps those who are attracted are not of the highest ability, a higher stipend could make it possible to attract a limited number of high ability students to the project.

Increased participation of quality students would have immediate and long reaching consequences. The efforts of team and experiment station personnel would be multiplied, it would increase the supply of local trained people, and would serve as an incentive for students to continue their education to the gaining of Master's and Doctoral degrees and thus increase the country's supply of professionally trained manpower.

3. It is recommended that CID, IBTA, and CIAT develop the necessary facilities so that information on yields and other factors can be made available soon after harvesting. This does not necessarily mean sophisticated computer facilities. In fact, very inexpensive two memory pocket computers are sufficient, and college students can easily be trained to perform the necessary data processing.

   CID quarterly reports do not contain all of the relevant experimental information. Perhaps, in addition to these more complete timely reports, a more formal type of yearly report should be produced and circulated as sources of information within the Ministry as well as within the university system. These reports could involve (1) Introduction, (2) Description of Problem, (3) Review of Literature,

(4) Hypotheses and Assumptions, (5) Methodology, (6) Results and Discussion, (7) Conclusions and Recommendations, (8) New Problems Found, (9) Bibliography.

4. As the review team traveled in the Cochabamba area, it was observed that a large number of the small farmers maintain a flock of sheep. Data obtained from the 1972 survey conducted by Utah State University indicate that 63 percent of the farmers raise sheep. A cursory observation indicated that the quality of the sheep could perhaps be improved with respect to both wool and meat production. It is, therefore, recommended that a sheep improvement program of the nature of the one established by Utah State University on the Altiplano in 1971-74 be introduced to the intermountain valleys. This program involved shearing and wool improvement and marketing, ram production and marketing, crossbreeding and commercial sheep production, and forage improvement.

   It is not known by the review team why the apparently successful Altiplano program has not been adopted by the farmers in the intermountain valley areas of Bolivia. Perhaps there is valid reason. If not, it would appear that the expertise and technology developed in the Altiplano could form a vital part of the program to improve the standard of living of the small farmer in other parts of Bolivia.

5. Orientation of New Personnel

   Over the years much has been learned about agricultural improvement programs in developing countries. Several regional programs and international centers have been established to coordinate, facilitate, and

promote diverse efforts. The review team suggests that opportunity be provided for new CID technicians to visit some of these centers and programs such as Mexico (CIMMYT, Chapingo), Guatemala (ICTA), Costa Rica (CATIE), Colombia (CIAT), Ecuador (INIAP), Perú (CIP, La Molina), before assuming assignment in the host country. Becoming familiar with what is being done in these programs could provide opportunity to build on existing programs, avoid duplication of effort, serve as a source of relevant data and biological materials, etc., and thus enhance their effectiveness once they arrive on site to commence their own activities.

6. Problems in Delivery of Equipment

As the review team met with team personnel, considerable concern and frustration was expressed over the long delay in the delivery of equipment and materials ordered under the USAID 053 Loan and CID programs. The carrying out of work schedules, and the initiation of projects and research programs have been impossible because the equipment and materials have not arrived as expected and needed.

It is recommended that USAID and CID investigate the problem to determine where the delays occur and to see if remedies can be applied.

7. The review team feels that perhaps the most important contribution the CID project can make to Bolivia is in the area of education, both formal and informal. It is suggested that CID personnel try to allow more time for the in-service education of their Bolivian counterparts

and for the promotion of their work with government officials. If a CID scientist uses 90% of his time to run field experiments along with his Bolivian counterpart, he will have little or no impact within IBTA as an institution. Instead he should try to get the higher IBTA officials of the project area, interested in the kind of work he is doing. Also, he should try to get his support for more personnel at the same time he is showing the higher official the real opportunities for agricultural development. Our impression of some Bolivian officials is that they are only anecdotically acquainted with small farmer needs and are not fully aware of the complexity of the problems involved in the development of the sector, especially with the small farmer subsector.

8. The review team was informed that Dr. LeBaron's and Dr. Walker's positions on the team will soon become vacant. It is our suggestion that it would be helpful to the work of the contract to fill Dr. Walker's position with a potato breeder, Ph.D. level, fluent in Spanish who would be responsible to advise on the potato breeding program as well as the experiment station physical development, get acquainted with the factors of potato quality as seen by small farmers,* to better understand the degree of stability of local varieties as compared to introduced ones, and perform exploratory trials with small farmers. This person should spend at least two months in CIP becoming acquainted with its methods of research.

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*Help in the area could be obtained from CIP instalations in Perú.

We suggest that Dr. LeBaron's position be filled with a production agronomist, Ph.D. level, with a strong background in soils, statistics, and microeconomics, and fluent in Spanish who would be responsible for the planning, conducting, data processing, technology design and reporting of all exploratory and optimization work on potatoes, corn, wheat, and barley conducted on farmers' fields; and teach in the San Simón University of Cochabamba and direct thesis studies. With the new organization of IBTA experiment stations, extension personnel will be integrated under the director of the experiment station. This review team explored with Ing. Jaime Salamanca the possibility of involving some or all of the extension personnel in the conduct of on-farm research. If the report is true that more technical personnel will be approved for IBTA, the efficiency of the production agronomist could be greatly enhanced if four to six equipped brigades were assigned to work with him. We also feel that the person appointed should spend approximately two months in Mexico: CIMMYT and Chapingo, becoming acquainted with the research conducted in those centers oriented toward small farmers.

9. The review team suggests that Cassava in the Santa Cruz area should be included as one of the crops covered by the program of work. This plant is one of the principal sources of carbohydrates for the small farmer in the area, and has an export potential as flour and can be used in animal feed.

V. Summary and Conclusions

The review team was impressed with the quantity and quality of work being performed by the CID team and the Experiment Station personnel, especially in view of the limited resources, both human and physical, with which they have to work. The nature of the programs are significant to Bolivian agriculture and important and effective work is being done.

As a result of discussions with CID, USAID/Bolivia, Government, and Experiment Station personnel, on-site evaluations, reading of Contract, plan of work, statement of objectives and progress reports, the review team concludes that the CID Contract, as initially conceived, is within the requirements of the Congressional Small Farm Mandate. Perhaps the acceptance of some recommendations would require Contract amendment. In any event, some "fine tuning" of the plan of work would be appropriate in order to incorporate recommendations contained in Section IV of this report.

Members of the review team wish to express appreciation to all the individuals in CID, USAID, IBTA, and CIAT who have been so kind and helpful in making arrangements, attending to our needs, and in making our time as productive as possible. We realize we have imposed on full schedules and holiday plans and interrupted in many ways. However, the attitude of those individuals we have contacted has been pleasant and helpful. We say thanks.

It is our hope that our evaluation has been accurate and that our recommendations are valid and can play a part in helping to reach the significant objective of improving the standard of living of the small farmer in Bolivia.

APPENDIX I

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APPENDIX II

A conceptual framework which is related to and provides a basis for the discussion regarding the findings, Section III of the Report.

It is now widely recognized that normally a good production technology plus an extension service are necessary but insufficient to achieve irreversible adoption. Systems for credit, input availability, marketing and farmer organizations are also necessary. However, normally, the latter services tend to be adequate in areas where commercial farming is predominant. That is why, in these conditions, isolated efforts on technology development and extension seem sufficient to induce technological changes. On the other hand, areas of subsistence farming will normally have very limited access to the systems of credit and input availability, marketing and farmer organization. This will be due in many cases to a very limited infrastructure development, as well as to a very limited individual capacity of the small farmer to obtain the kind of assistance from the public sector that commercial farmers have. It has been shown in several countries, including Bolivia, that an isolated government effort on developing production technology and on extension service for the small farmer will not have an impact on increasing land productivity, unless complementary act-on is taken in the areas of credit, input-output market, and farmer organization.

This review team was told by Bolivian officials that the problems they are concerned with are largely social in nature and that they anticipate that the project being evaluated would be of primary assistance in the alleviation

of these problems. The Government of Bolivia's primary concern is not with increased food production at the national level, since the sector's balance of payments has been positive in the last five years. Rather they want an increased productivity of the land that will help the rural population improve its quality of life, and bring about cheaper food for the urban sector. The way to achieve the government goal is very much in phase with the mandate of the project to provide assistance to the small farmer. The project under evaluation is focused on an increased productivity of land by the small farmer. There is no doubt that some of that increased production will stay on the farm to provide for more abundant food, but the rest will have to be marketed so that the small farmer can obtain the means to purchase the inputs of the new technology, as well as other services for his livelihood. However, it is also well known that the limited capacity of the country to absorb an increased production of potatoes, corn, and barley would likely result in a decreased price for the staples which would be most adverse to producers, discouraging them from increased productivity. On the other hand, the real possibilities for export have not been analyzed in depth. There is no experience in international market for disease free potato seed grown in the highlands, for corn, rice, and other staples. In addition, there is the problem of high transportation costs. There is, on the other hand, a big deficit in wheat in the country which could be used as a substitute crop for potatoes, corn, and barley if their productivity per unit land were increased. This seems to be one possible alternative for development of the small farmer, if the project succeeds in developing the kind of technology as well as the proper incentives are created by the government for partial crop substitution. In which case,

the government should have to protect this development by balancing out the production of wheat in the Santa Cruz area through mechanization which is well on its way to being developed (CIAT. Ing. Vaca Diez).

When working with the small farmer, we must recognize the diversity in his sources of income, i.e., (1) off-farm, (2) annual crops, (3) fruits, and (4) animals. The small farmer will normally judge a technological innovation not only from the standpoint of net income, but also the degree of competition with his other activities, the risk involved, and access to the market of inputs and outputs. Only when the net result is positive will he adopt irreversibly.

Achievements of traditional technology are becoming increasingly recognized by agronomists and other professionals. When the interaction of farmer and crop has involved many generations in an area as well as the domestication of the crop, there is considerable knowledge, genetic resources, taste preference and specialization involved in the traditional technology, much of which remain esoteric to the outsider. That is no doubt the case with potatoes corn and quinoa in the Andean region, where specific standards of quality have been reached, as well as a degree of stability to ecological variation thru time: drought, frost, etc., which, of course does not rule out the presence of disease (virus, blights), pests, etc., that might at times seem to be important limiting factors. However, yields of up to 25 ton/ha of local potatoes have been harvested experimentally on unirrigated farmer fields in the Toralapa region, where virus and nematodes have been reported to be damaging to the crop. No special efforts have been made in Bolivia to understand the factors of the quality as held by farmers. In fact, tuber quality is so

important to the small farmer that he will not shift to another variety simply because it is resistant to nematodes. it will also have to meet his quality standards.

Another area of agronomists misunderstanding of traditional technology is that of the farming systems of production. This concept involves components such as rotation of mono and polycrops, short and long term resources of production (labor force, traction, energy) and the uses of the individual crops. One farming system in the Toralapa region involves a rotation involving one year of potatoes. one year of oats or barley, one year of quinoa or lupino, and two years of iddle land. According to Ing. Gonzalo Claure, five tons or less of manure plus some fertilizer plus two spravings, all provided by a "rescatador," are invested in the potato crop. The other crops go unfertilized. In the Santa Cruz area, small farmers use the slash-burn system that involves growing rice associated with corn for two years after the land has been cleared and then letting the land go back to its native vegetation for six years. It should be pointed out that no fertilizer or herbicide are required, although a limited protection against pests is required. A farmer we interviewed near the Yapacaní area stated that he harvested approximately 600 Kg of rice plus 1200 Kg of corn from one hectare. Farming systems like the two described have been developed thru generations of trial and error and have the merit of being effective for the prevailing social and economic conditions. In fact, many of these low energy requirement farming systems may challenge the degree of efficiency per unit of fosil energy invested by the modern agricultural enterprise as normally conceived by the agronomist. Certainly, Bolivia is not a country in which we may conceive an agriculture

heavily dependent on imported inputs to be competitive in the short run for the international markets. It seems that the limited availability of modern inputs in Bolivia points at a technology development that differs frequently from he model for industrialized countries.

A concept of scale neutrality has been used by agricultural economists to imply that any technological innovation will be equally beneficial to the farmer regardless of farm size. An example of this is the development of a nematode resistant potato variety since no matter how much land is planted by the farmer, the benefit of the resistance will be there. Scale neutrality is a fact when only the size of the farming enterprise varies, however there are many differences other than farm size between a large and a small farmer. Cultural traits (taste, values, other), availability of capital, degree of formal education, etc., can make the concept of scale neutrality misleading. A small farmer will be more likely to use labor intensive farming systems of production, whereas the larger farmer will use a more capital intensive farming system. The best corn variety grown as a monocrop is not necessarily the best to grow in association with beans. Take the case of nematode resistant potato as a technological innovation. The new variety would be adopted by a commercial farmer if there were a market for it. On the other hand, the small farmer might decide to retain his local variety if the new variety did not meet his quality standards. Nematode resistance is not an eat or starve issue to the small farmer since his variety has a certain degree of tolerance to the nematode infestation. Wheat, on the other hand, is closer to a scale neutral situation than potatoes, since wheat is not native to the Andean region, but, even in this case, a very definite situation of rejection of an improved

variety was encountered by the review team in the area of Cochabamba. A small farmer was going to quit growing the improved Chinoli variety of wheat and go back to the local variety, Barba negra, apparently only on the grounds of taste.

Appendix III

Proposal for action - Detailed information for the formulation and conduct of an indepth survey to determine the needs and problems of small farmers as a guide to research and extension activities.

This Appendix pertains to recommendation 1) in Section IV of the Report. The following describes each of the steps in the above sequence so as to provide guidelines for their implementation.

1. Selection of the region

The region is a geographically identifiable area, within which there may be several agroclimatic zones. It should be selected on the basis of the quantity of priority crops, their relative importance in the region, the promise for improvement, and perhaps other considerations as: political environment, infrastructure, availability of services, etc.

The size of the region should be large enough to demonstrate the feasibility of the approach, and small enough to be manageable with the available resources and technicians.

Once the region has been selected, the first task is to tentatively identify agroclimatic zones within the region, and to discover the nature of institutional factors affecting agricultural production in the area. An agroclimatic zone can be defined as a geographically identifiable portion of the program region where soil, topographic, irrigation, or climatic factors create production opportunities which are distinctly different

from the other zones in the region. The first approximation of this zoning can be based on the technician's knowledge of farming systems and practices in the area. If all farmers follow essentially the same practices and use the same type of variety for a crop that can be considered the major enterprise, then the region could well be considered one agroclimatic zone. If there are systematic differences in those practices, and these differences are thought to be due to agroclimatic factors, then more than one zone should be defined. If these differences appear to be caused by economic factors such as: tenure, farm size, marketing conditions, they should be considered as characteristics of farming systems within a zone.

The following kinds of information, if they are available, will be useful in making tentative zone distinction:

(1) Soil and Topography

a) Identification of different soil types in the area, their relative extensiveness, their local names and any selective use of soil types by local farmers. Chemical and mechanical analysis of soils in the area offers information on specialized use of soil types by farmers.

b) Information on the topography of the area by topographic maps, preferably about 1:50,000, will be extremely valuable in conducting field operations. This information is likely to be very important regarding soil erosion and the need to explore farmers management operations for conservation practices.

(2) Rainfall data

Monthly rainfall averages provide the rainfall profile for the area which, unless irrigation is used, is a good guide for the cropping calendar. In some cases, climatic maps are available showing isotherms and isoprecipitation contours. The objective is to make crude estimates of rainfall reliability for two months of the growing season. Low reliability shows where farmers face a hazard in management and how they have evolved strategies to partially off-set it. Information for availability of irrigation should also be obtained.

(3) County level production data

Acreage and yield data at the county or village level is very useful to calculate production densities (ratio of major crop enterprises to all crops). A look at trends in these data may be instructive if they are available.

(4) Institutional factors affecting production in the region.

The primary concern here is to discover what government programs are supposed to be affecting production of certain crops, and how they are supposed to function. The following categories can be considered:

a) Credit: type, extent and history in the area, sources, government agricultural credit banks.

b) Inputs: seed, fertilizer and other inputs, types of programs offered. Sources, government banks, government agencies, extension service.

c) Price supports: nature and extent of current price support or purchase activities. Sources, government support/purchase agency. Cooperative organizations.

2. Informal surveys

The purpose of this activity is to improve the general understanding of farmer circumstances to provide more focus for the basic farmer survey to follow. It will help to identify problems, clarify terminology (units of measurement) and eliminate useless lines of inquiry. The sampling procedure should be to traverse the study area and visit with farmers as they are encountered. To insure some degree of representation, several villages or points may be chosen on the map across the area, and then interview farmers or groups of farmers encountered en-route connecting these points.

No formal questionnaires are needed at this stage, but work sheets are necessary with a list of questions such as those listed below. Answers should be recorded separately. New questions should be added and others eliminated as responses suggest.

- What are the most important crops here?
- What varieties are raised here?
- What are the special characteristics of each: grain type (shape, texture, color), drought resistance, etc.?
- Are particular varieties used in particular places (soils, topography) or under particular circumstances?
- What percentage of the crops are intercropped or associated?
- What rotations are commonly followed?
- What land preparation(s) are generally used? What equipment?
- How are the crops planted, harvested, when?
- What are the most serious problems in growing the more important crops? insects? weather?

- Name some places where the production can be sold. What are current prices?
- How long and how do farmers usually store their production on the farms? Is there serious damage to stored grain?
- Is land rented here? On what terms? (sharecropping systems).
- Name some places where inputs can be sought.
- What is the cost of hiring labor, tractors, draft animals?
- Are there agencies where credit can be obtained to purchase inputs? Are they satisfactory? Why?
- Do local lenders loan money? On what terms?

These visits to farmers should be complemented with visits to different kinds of markets: retail grain and wholesale grain markets, retail input markets, custom operators and banks to find out about the producers used in each case.

The data from the presurveys should be analyzed with two objectives in mind: one is the contribution of the information to design a concise, well focused, basic farmer survey. The other is the contribution of the information to better define the boundaries of the agroclimatic zones. Zoning is seen to be as very important stage, since it will help to reduce the variability that comes from agroclimatic conditions, cultural practices and economic conditions, to a manageable level.

3. The basic farmer survey

The primary objectives of the basic survey are as follows:

(a) To obtain information for pre-evaluation of available technological

components (varieties, fertilizer recommendation, pesticides against specific diseases) under a variety of farmers' circumstances. Data are needed to evaluate the potential for yield increases, compatibility with farmers' farming systems, associated risk, and costs.

(b) To obtain information about where on-farm trials should be located if they are to be representative of the program region.

(c) To obtain information about current cultural practices which will provide the reference treatment for on-farm trials.

(d) To provide information for agronomists, plant breeders, pathologists and others in orienting their basic research programs toward the needs and/or developing opportunities identified.

These objectives provide the criteria for choosing what data will be useful for other purposes. While these are the primary objectives, the data will be useful for other purposes, namely:

(a) To guide the development of extension efforts designed to increase productivity and solve productivity-related problems.

(b) To assist policy makers in assessing the performance of credit, input and price support programs.

There are three important issues in conducting the survey: the design of the questionnaire, the sample size, and the selection of the sampling units. For each of these issues, many degrees of complexities may be exercised. An adaptive research approach should be practiced taking into account the real availability of information, resources and manpower.

The design of the questionnaire is of basic importance. The pre-surveys will probably show there are many enterprises within the farming system.

The complexities of trying to cope with the management details of all enterprises in the system places a heavy burden on the respondent. Major enterprises should be identified together with the promise for improvement in order to focus the research. This does not mean to ignore the relationships between the identified major enterprises and the other farm and family activities. The critical points of interaction amongst enterprises should be given explicit consideration. Examples are the role of rotations, associated crops, periods of labor shortage on the farm, feeding of crop residues, etc. But the importance of these relationships is evaluated by direct farm questioning and by references from market conditions, rather than by whole-farm planning.

The following is a tentative list of the topics to be explored through the questionnaire:

(a) Practices utilized by the identified enterprises.

In this section, questions will be asked relative to what, when, where, why, and how do they produce. In certain cases, it will be necessary to explore the topics in more detail, for instance varieties:

(1) End use-product characteristics

i. Palatability

ii. Processability

iii. Storability

(2) Growth characteristics and by-product considerations

i. Plant habit

ii. Length of season

iii. By-product suitability

The objective of this section should be the description of the local farming system, enterprise pattern and detail of the end uses of products, food supply (main and preferred staples and relishes), cropping calendar, main sources and uses of cash, husbandry (husbandry practices for the crops under research).

(b) Contracting/renting possibilities

It is possible to contract for or rent equipment, what equipment and what the current cost.

(c) Disposition of crops

What proportion of grain goes to landlord or other creditors, what percent of grain is usually sold immediately, sold after storage, fed to animals, consumed by family.

(d) Farmers opinions on hazards

Yield variability. What variation in yield does the farmer expect from his major crops? Range--What are the major causes of poor yields of major crops in most recent five years? Pest and diseases--Types of pests and diseases faced. Frequency of the attacks and perceptions of severity of effects.

(e) Knowledge and experience with modern inputs

Has the farmer heard of using a given input? Is he using it? Quantities used? Where can they be obtained? Problems?

(f) Labor availability

Use of family labor, of hire labor, off-farm job, what type, what seasons, what proportion of the time.

(g) Would the farmer like to host an on-farm trial?

The development of the questionnaire should include the pre-testing, the selection and training of the interviewers, and finally the field operation.

The sample size is the next point of concern. The usual rules for determining sample size are not directly relevant to this kind of basic farmer survey. The objective here is not to estimate population means, but to observe the distribution of farmers with respect to a number of different characteristics. A certain number of questionnaires should be planned for each agroclimatic region, 30-50 have been used in other studies. The number of available interviews, available time and financial resources, will decide the appropriate sample size. For example, if we have four interviewers and five weeks to complete the survey, the sample size can be estimated (assuming that each interviewer is able to complete 1-1/2 questionnaires per day), this will give a total of 180 questionnaires. Each agroclimatic zone will be assigned a given number of questionnaires depending on the relative variability of the characteristics under study: the results of the pre-survey. The opinion of local technicians will help at this stage.

The selection of the sampling units is related to the sampling procedure, that is, the procedure by which some fraction of the elemental units of a target population are selected for study. There are two considerations to guide the development of the sampling procedure: the procedure should yield a sample which is representative of the population, yet at the same time, it must be economical to implement.

Sampling from maps or aerial photos provide excellent results since they are good sampling frames.

A map (photo) may be used for simple probability sampling in the following manner: Delineate the program region and agroclimatic zones on the map (preferably 1:50,000) and make marks to allow identification of all points in the region with coordinates. Randomly select points on the map by drawing pairs of coordinates until the quota of points for each zone is obtained.

A few more should be drawn for "non-response substitutes." Identify each point on the ground and then identify the crop enterprise(s) field which is closest to that point. The cultivator of that field will be the selected elemental unit. Note that in this method the probability of selection of a given farmer will be proportional to his acreage of crop enterprises, so that weighing of the data will be required if summaries are to be made on the basis of farmers as the elemental unit.

A map may also be used as the sampling frame for the first stage of a multi-stage sampling procedure.

More complex sampling procedures can be practiced depending on the availability of information.

It should be kept in mind that the objective is to provide a sample representative of the distribution of circumstances in each zone. Normally, variables like total family income and net benefit accruing from

each enterprise, will not be included. The assumption that farmers maximize profits or minimize losses subject to certain capital and risk constraints can be taken for granted.

4. On-farm production research

The results of the surveys of the farmers and the local institutions proposed above will define the viable alternatives for development. The survey will reveal where the emphasis should be placed on crops according to the small farmer standards of quality, and crops to be marketed outside the farm and the project area. Also, the information on the scarcity of capital and inputs will allow the researcher to visualize the proper technological level.

It seems obvious that a systematic effort to understand the factors of quality as felt by the small farmer should be undertaken at least for crops of potatoes and for corn. At the same time, more knowledge should be gathered about the degree of homeostasis (stability thru time) of local varieties. In other words, how a variety grown in situ responds to different stresses as: drought, frost, disease, lack of fertilizer, weed competition, etc. This kind of work may be conducted at the experiment station (fractions of 2^n type of experiments), as well as in farmer fields. The knowledge from these kinds of effort should be helpful in defining the breeding program for both crops, potatoes and corn. Current efforts to develop tolerance to nematodes and to clean the seeds of potatoes from virus, should be continued and enriched by the new knowledge on quality and homeostasis.

The research effort on farmers fields should be reoriented, specifically in the stage of input optimization. The proposed changes are (1) Research should be conducted within the farming systems prevailing in the region, recognizing the constraints of small farmers and de-emphasizing the exploration of technological possibilities that are not feasible to farmers (30 kg of Temik/ha, 300 kg of either N or P/ha, low concentration sources of fertilizers, etc.). (2) Integrate the variety, fertility, protection and irrigation trials into experiments in which factor interactions may be evaluated.* (3) Describe the experimental site as completely as possible, but at least record (a) rainfall, (b) soil moisture at two or three stages, (c) soil physical properties related to moisture: physiographic position slope, depth, texture, wilting percentage and field capacity, (d) fertility tests, (e)damages to crop due to pests, diseases and climatological events. (4) Increase the number of on-farm trials disproportionately over those within the experiment station. Some factors of production, such as rates of fertilizer, should be conducted mostly outside the experiment station, since they vary so much from field to field.

The potato crop in Toralapa and rice and corn in Santa Cruz area have mostly been experimented within farmer fields which is not the case

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*This may be done after exploratory work has been conducted and the variables have been narrowed down: for instance, to two or three genetic materials, two or three rates of fertilizers, manure, irrigation, etc., that cover the critical part of the economic factor space.

with corn and wheat. The research in these two crops is almost exclusively conducted within the experiment station and is limited largely to the breeding component. It is absolutely essential that both exploratory and optimization research be conducted with these two crops in farmer's fields. It seems impossible that the same rates of fertilizer are recommended for corn grown under total irrigation as for corn grown with supplementary irrigation as for rainfed corn in the Cochabamba valley, where definite soil physical gradients are obvious.

Every effort should be made to analyze results on the exploratory and optimization studies and develop technology on short-term basis. Climatic as well as edaphic and management information should be summarized after every season. At the same time, weather historical information must be studied and used to stratify production conditions. Also, price variation of outputs as well as market possibilities must be examined and put together with the agroclimatic and experimental data to design technology for small farmers. The several levels of agroclimatic risk, the marketing risks as well as farmers expectations must be understood before recommending technology to small farmers. In view of the short-term nature of the project, there is a need to develop new technology in the early stages. For this, it seems appropriate to take the technology development in a series of approximations, hoping to progress towards ahigher precision level. As an example, there might be a single production recommendation for potatoes in the Toralapa region after the first year of work and advance to two (recognizing two agroclimatic conditions) recommendations

for the second year and so on, until a reasonable level of precision is reached (maybe 6 to 10 sets of recommendations).

In addition to this process, technologies that require different amounts of limited capital should be introduced. This is because farmers will vary in their perception of risk and their willingness to invest.

When enough knowledge is available on factor interactions, several kinds of demonstration plots may be designed to show small farmers some of the alternatives available to them.