Social Science Research at the International Potato Center

Report of the Second Social Science Planning Conference
From left to right: M. Potts, R. Buse, V. Ruttan, J. Ashby, G. Scott, S. Ruano, A. Monares, C. Samaniego, D. Horton.
SOCIAL SCIENCE RESEARCH AT THE INTERNATIONAL POTATO CENTER

REPORT OF THE SECOND SOCIAL SCIENCE PLANNING CONFERENCE

Held at CIP – Lima, Peru
September 7-11, 1981
This is the Report of the twenty-fourth Planning Conference sponsored by the International Potato Center to develop guideline recommendations for the Center's research program. It is the second Planning Conference concerned with Social Science, the first Conference being held in Lima on August 8-12, 1977. In the 23 previous Planning Conferences 219 participants from 32 countries have contributed by presenting papers, discussing research strategies and formulating recommendations for future CIP research.

Social scientists contribute to the advancement of CIP's mandate of developing and disseminating knowledge for greater utilization of the potato as a basic food through research, training and distribution of information on socioeconomic aspects of potato production. Noteworthy is the close integration of social science and biological research. Interdisciplinary methods have been developed for identifying farmer's production problems and evaluating new technologies at the farm level. Broader issues of potato culture, marketing, consumption and farmer adoption of new practices are part of the Social Science Department's research to develop a "social science of the potato."

O. T. Page
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invited Participants</td>
<td>7</td>
</tr>
<tr>
<td>CIP Participants</td>
<td>8</td>
</tr>
<tr>
<td>Agenda</td>
<td>9</td>
</tr>
<tr>
<td>Conclusions and Recommendations for the Second Social Science Planning Conference</td>
<td>16</td>
</tr>
<tr>
<td>Welcome and Opening Remarks</td>
<td>21</td>
</tr>
<tr>
<td>Position Paper</td>
<td>23</td>
</tr>
<tr>
<td>Comments</td>
<td>30</td>
</tr>
<tr>
<td>Farm-Level Research on Agronomic Constraints to Potato Production: Some Lessons from the Mantaro Valley</td>
<td>32</td>
</tr>
<tr>
<td>Comments</td>
<td>45</td>
</tr>
<tr>
<td>Use of Improved Potato Seed in the Andean Region: An Agro-Economic Analysis</td>
<td>48</td>
</tr>
<tr>
<td>Comments</td>
<td>62</td>
</tr>
<tr>
<td>An Interdisciplinary Team Approach to the Design and Transfer of Post-Harvest Technology</td>
<td>66</td>
</tr>
<tr>
<td>Comments</td>
<td>79</td>
</tr>
<tr>
<td>On-Farm Research to Optimize Potato Productivity in Developing Countries</td>
<td>81</td>
</tr>
<tr>
<td>Reflections on On-Farm Potato Research in the Philippines</td>
<td>91</td>
</tr>
<tr>
<td>Comments</td>
<td>101</td>
</tr>
<tr>
<td>Peruvian Potato Agriculture in Comparative Perspective</td>
<td>105</td>
</tr>
<tr>
<td>Comments</td>
<td>116</td>
</tr>
</tbody>
</table>
Potato Consumption in Developing Countries  Susan V. Poats ................................................................. 119
Comments  Frank Cancian ........................................... 136

Estimating the Demand for Potatoes in Developing Countries and the Role of Economic Research at CIP
Gregory Scott ............................................................ 138
Comments  Kenneth J. Brown ....................................... 146

Comments  Frank Cancian ........................................... 150

Socioeconomic Analysis in the Generation of a New Technology: True Potato Seed  Aníbal Monares ........................................... 153
Comments  Robert H. Booth ........................................ 158

Future Involvement of the Department in Optimizing Potato Productivity  Douglas Horton ........................................... 161
Comments  Patricio Malagamba .................................... 165

"Pure" Social Science Research vs. Interdisciplinary Research with Biologists  Susan V. Poats ........................................... 166
Comments  Jacqueline A. Ashby  Orville Page .................... 167

What Should Our Roles Be in Working with National Programs  Michael J. Potts ........................................... 170
Comments  Sergio Ruano  Haile Kidane-Mariam ................ 171

Social Science Department Publication Policy
Social Science Department Staff ................................... 175
Comments  Dana Dalrymple  Herndn Rincón ..................... 178

Comments on National Programs and Social Science Training  Kuldeep Mathur  Garry Robertson .................. 182

General Comments on Planning for CIP's Social Science Program  Ralph K. Davidson ........................................... 185

Annex: Publications Policies and Activities at the International Agricultural Research Centers: A Social Science Perspective  Dana Dalrymple .................. 188
## INVITED PARTICIPANTS

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
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Robert Rhoades
Hernan Rincon  
Garry Robertson
Roger Rowe  
Richard Sawyer
Gregory Scott
AGENDA

Monday, September 7

Session I

PROGRAM OVERVIEW

Chairperson, morning session
Kenneth Brown

09:00 Welcome and Opening Remarks
Richard Sawyer

09:30 Review of Recommendations of First Social Science Planning Conference, 1977
Orville Page

09:50 Position Paper
Douglas Horton

10:20 Coffee

10:50 Comments:
- Vernon Ruttan
- Edward French

11:20 Discussion

12:10 Summary of Discussion
Carlos Aramburu

12:20 Lunch
Monday afternoon

Session II

ON-FARM RESEARCH RECOMMENDED BY THE
1977 PLANNING CONFERENCE

Chairperson, afternoon session
Susan Poats

13:30 Farm-Level Research on Agronomic Constraints to Potato Production: Lessons from the Mantaro Valley
Douglas Horton

13:50 Use of Improved Potato Seed in the Andean Region: an Agro-Economic Analysis
Anibal Monares

14:10 An Interdisciplinary Team Approach to the Design and Transfer of Post-Harvest Technology
Robert Rhoades

14:30 Coffee

15:00 Comments:
- Carlos Samaniego
- Rueben Buse
- Sergio Ruano

15:30 Discussion

16:20 Summary of Discussion
Stephen Biggs
Tuesday, September 8

Session III

CURRENT RESEARCH ACTIVITIES

Chairperson, morning session
Orville Page

08:30  On-Farm Research to Optimize Potato Productivity in Developing Countries
       Roger Cortabaoui

08:50  Reflections on On-Farm Potato Research in the Philippines
       Michael Potts

09:10  Peruvian Potato Agriculture in Comparative Perspective
       Robert Rhoades

09:30  Potato Consumption in Developing Countries
       Susan Poats

09:50  Coffee

10:20  Comments:
       - Stephen Biggs
       - Carlos Aramburu
       - Frank Cancian

10:50  Discussion

11:50  Summary of Discussion
       Carlos Samaniego

12:00  Lunch
Tuesday afternoon

Session IV

FUTURE RESEARCH AREAS

Chairperson, afternoon session
Michael Potts

13:00 Estimating the Demand for Potatoes in Developing Countries and the Role of Economic Research at CIP
Gregory Scott

Robert Rhoades

13:40 Socioeconomic Analysis in the Generation of a New Technology: True Potato Seed
Anibal Monares

14:00 Future Involvement of the Social Science Department in OPP
Douglas Horton

14:20 Coffee

14:50 Comments:
- Kenneth Brown
- Frank Cancian
- Robert Booth
- Patricio Malagamba

15:30 Discussion

16:20 Summary of Discussion
Dana Dalrymple
Wednesday, September 9

Session V

RELATIONSHIP AMONG SOCIAL SCIENTISTS,
BIOLoGISTS AND REGIONAL AND NATIONAL
PROGRAM PERSONNEL

Chairperson, morning session
Primo Accatino

08:30 "Pure" Social Science Research
 vs. Interdisciplinary Research
 with Biologists
Susan Poats

08:40 Comments:
- Jacqueline Ashby
- Orville Page

09:00 Discussion

09:30 What Should Our Roles Be in the
Regional Programs?
Roger Cortbaoui

09:40 Comments:
- Kirby Davidson
- Primo Accatino

:00:00 Coffee

10:20 What Should Our Roles Be in
Working with National Programs?
Michael Potts

10:30 Comments:
- Sergio Ruano
  - Haile Kidane

10:50 Discussion on Roles of Social
Scientist in Regional and Na­
tional Programs
11:30  Summary of Discussion
       Kuldeep Mathur

Session VI

PUBLICATIONS AND TRAINING

Chairperson, Manuel Piña

11:40  Social Science Departmental Publication Policy
       Gregory Scott

11:50  Comments:
       - Dana Dalrymple
       - Hernan Rincon

12:10  Discussion

12:30  Lunch

Wednesday afternoon

13:30  Social Science Training
       Roger Cortabaoui

13:40  Comments:
       - Kuldeep Mathur
       - Garry Robertson

14:00  Discussion

14:30  Summary of Discussions
       Rueben Buse

14:40  Coffee
Session VII

PLANNING FOR CIP'S SOCIAL SCIENCE PROGRAM

Chairperson, Roger Rowe

15:00 Outline of a Plan
Douglas Horton

15:10 Comments:
- Kirby Davidson
- Vernon Ruttan

15:40 Discussion

16:30 Summary of Discussion
Jacqueline Ashby

Thursday, September 10

FORMULATION OF RECOMMENDATIONS

09:00 A Committee of three will formulate recommendations arising from presentations and discussions during the first three days of the Conference.

Other participants will have the opportunity of visiting CIP facilities.

Friday, September 11

Final Session

PRESENTATION, DISCUSSION AND RATIFICATION OF RECOMMENDATIONS
CONCLUSIONS AND RECOMMENDATIONS
FOR THE SECOND SOCIAL SCIENCE PLANNING CONFERENCE

A. Introduction

The International Potato Center (CIP) is one of thirteen international agricultural research centers supported by the Consultative Group on International Agricultural Research. The objective of the CGIAR-supported system is to develop improved agricultural technology which will increase food production and improve the welfare of poor people in developing countries. Within this context CIP has the mandate to expand the production and use of the potato as a food crop in developing countries, giving special attention to the technology needs of resource-poor farmers. CIP's profile statement declares that "CIP has a priority obligation to help national programs emerge which are capable of producing their own production-oriented research." To help achieve this objective, CIP is working to strengthen the capabilities of national potato programs.

The general philosophy of the CGIAR system and CIP's mandate provide the framework for this review of the Social Sciences at CIP. CIP's mandate implies that poor farmers and poor consumers are the ultimate relevant judges as to what is the appropriate production technology. The CGIAR mandate implies that the overall objective can be achieved by increasing incomes of resource-poor potato farmers and by reducing the cost of food (potatoes) to poor consumers in developing countries. Research which focuses only on increasing incomes of producers will not always result in cheaper food for poor consumers in developing countries, and research which focuses only on producing cheap potatoes for consumers will not always result in increased incomes for resource-poor farmers. CIP research needs to focus on both of these issues in order to reduce poverty.

The mandate and CIP's priority view of strengthening the capabilities of national programs imply a strong regional program to implement the mandate and achieve the objectives. This provides a framework within which to view the planning of the Social Science Department's research and training objectives. We endorse a high priority being given to the development of social science capacity in the regional and national programs, with the Social Science Department in Lima providing
the essential backup. Social science capacity in the regions needs to be supported and promoted by well-qualified experienced social science researchers who will assist in the effort to strengthen national social science capabilities in the national potato programs.

The group highly commends the work of the Social Science Department, in particular for taking a lead in some interdisciplinary research projects. We agree in principle with the basic plan for the future developed by the department. We are concerned, however, with the multiple responsibilities of the Social Science Department in comparison with the resources available to meet those responsibilities. We suggest, therefore, concentration in priority areas and moves to acquire additional, special project funding.

Within this framework we review the plans of the Social Science Department for its work in CIP Lima and its work in the Regions.

B. Lima-Based Research and Training

The Social Science Department has two main responsibilities: (a) undertake research to assist CIP in understanding the present position and future role of the potato and to identify criteria for designing and selecting alternative technologies for priority countries and groups, and (b) provide the essential backup for regional and national research and training programs.

1. Technology Assessment. Emphasis should be on developing socio-economic criteria for selecting alternative technologies in the context of their implications for resource-poor farmers and low-income consumers. Because of its current priority within CIP the group gives high priority to the systematic analysis of the implications of the introduction of alternative components of true seed technology into different farming systems. Greater collaboration with breeders should be developed in the future.

2. Demand and Consumption Studies. The committee endorses an increasing emphasis on demand and consumption studies so as to: (a) develop basic information on actual and potential use of potatoes as a food for poor people, and (b) assist CIP policy makers in identifying potential priority countries and beneficiary groups within countries.

3. Comparative Potato Agriculture. The committee encourages continued analysis of agroecological zones and farming systems to: (a) improve the methodology, and (b) develop the application of this framework in interdisciplinary research for use in identifying potential regions for increasing potato production.
C. Regional Research and Training

1. General. We are concerned with the limited amount of training of national social scientists in potato research. We encourage developing interdisciplinary teams at the national level.

   The group believes that whenever possible CIP should promote three basic principles for strengthening national program social science capabilities:

   - The integration of research with training.
   - The participation of national social scientists in research activities.
   - The creation of opportunities for national social scientists to participate in the analysis of potatoes in an interdisciplinary framework.

2. Optimizing Potato Productivity (OPP).

   a. The group supports the present move towards phasing the Social Science Department out of primary responsibilities for OPP within CIP. However, ongoing social science input to OPP on a collaborative basis should be continued.

   b. The group supports a transition from in-depth research in the Mantaro Valley to the application of on-farm research methods in national programs. Emphasis should be given to the early publication of the results of the Peruvian studies.

   c. The group recommends integration of the "Farmer-Back-to-Farmer" research philosophy and the OPP methodology. In this respect, we recommend that the responsibility of social science involvement in OPP focus on: (a) analyzing farmer circumstances in a farming systems framework, (b) methods for monitoring and acting upon feedback from farmers, and (c) analyzing the implications of technology adoption for different social groups.

3. Analysis of Technology Generation and Diffusion Process. The primary objective of this research should be to highlight institutional models for improving national research and production systems. We suggest that research in this area start with storage technology and proceed to other technologies as they become available.

4. True Potato Seed. We strongly endorse the new research on true potato seed which will require a substantial research effort in selected countries. Local analysis of the implications should assist in setting priorities for potential priority regions. Within the
overall research effort special attention should focus on: (a) how the new system fits within existing farming systems, particularly that of resource-poor farmers, and (b) institutional requirements of the true seed for a new seed supply system in contrast with existing seed systems. Understanding of present more successful seed systems will help national programs build better systems utilizing true seed and/or tuber seed.

5. **Demand and Consumption in the National Context.** We endorse cooperative work on analysis of demand for and consumption of potatoes in selected countries in the context of their national food and agriculture policy.

**D. Research Publications and Training Materials**

1. **Publication of Research Findings.** We place high priority on the publication of research findings by CIP staff and CIP-stimulated research. More emphasis should be on writing for professional peer-group journals both in developed and developing countries. There is also a continuing need for working papers and concise documents for national and international policy makers. More extensive research monographs may occasionally be justified.

2. **Training Materials.** As part of the backup to the regional research and training program, research-oriented training materials need to be prepared. Experiences of OPP and other research projects need to be consolidated and processed in manuals and other training materials for teaching purposes.

**E. Resource and Staff Requirements**

1. The group recommends facilitating the better access of CIP social scientists to broader social science materials. This may entail increased library acquisitions, short-term study leaves, and specific linkages to colleagues in other countries for this purpose.

2. The group recommends use of short-term consultants to complement the work of CIP social scientists.

3. We endorse the search for special and other funds to finance:
   - the placement of social scientists in the regions, and
   - in-service training of national social scientists through participation in cooperative research projects.
F. Organizational Recognition

In view of the vital role and responsibilities of the Department we suggest that consideration be given to providing more explicit organizational recognition to social science work in the future.
WELCOME AND OPENING REMARKS

Richard L. Sawyer

CIP is one of thirteen Centers funded through the Consultative Group for International Agricultural Research. Since the first Center IRRI was funded in 1960, 645 million dollars have been spent in core programs of the Centers through 1981. Potatoes, the fourth most important world food crop and the best balanced nutritionally of the major food crops, have received only 5.7% of the resources going into the present CGIAR Centers.

The potato is the least exploited of the major food crops. Less than 1% of the genetic variability in CIP's world potato collection has been exploited in the development of present day varieties. The concentration on cereals, the cereal mentality, which has existed in the world until now by most foreign technical assistance agencies working to solve world food problems, is a tremendous barrier which has to be broken down in order to utilize for developing countries the natural comparative advantages of the potato.

CIP's investment in potato improvement is almost equally divided between (a) research for the development of technologies and (b) the transfer of technologies and training of nationals. The Social Science Department is located in the transfer of technology branch of CIP. However, social scientists are very much involved in the total program from planning to implementation of the nine research thrusts and their transfer to the seven regions of the world where CIP has regional stations staffed by international level potato scientists.

CIP's Social Science Department got off to a very slow start, mainly because the first social scientist wanted to go directly to growers fields and by-pass national social scientists. However, despite this start, the department has made rapid strides in recent years. At the meeting in the Philippines, on the utilization of social scientists other than economists in international center activities it was embarrassingly obvious that CIP was providing a far better scientific climate for social science involvement than other Centers. I would also point out that a social scientist, Dr. Gelia Castillo, is one of the very effective members of CIP's Board of Trustees which certainly has affected social science involvement.
I am very pleased with the quality of non-CIP participants here today. Recognizing the ability of social scientists to be outspoken with their recommendations, a few ground rules should be identified at the start of the conference. I shall try to identify the most important ones but I am sure others may have to be mentioned as the week progresses.

Each of you have received a profile of CIP, its long term plan through the year 2000. This in general terms indicates the program of the Social Science Department for the coming years. You are here to help plan the specifics within the general plan, and not to work outside of the general plan.

CIP is a mature Center, facilities were completed in 1977 and no real growth has occurred since 1979. As indicated in the profile, CIP does not expect to grow further. We expect programs to change by terminating things in the present program in order to make room for new priorities. The Social Science Department is as large as it is going to be in relation to the biological science departments. Some short term increases in numbers of social scientists for the transfer of technology in the regions may be possible when there is sufficient justification to command the attention of special project funding.

We expect the mix of economists, sociologists and anthropologists within the department to change as priorities change. But the total number of social scientists will remain the same.

Finally, this is the twenty-fourth international planning conference for activities at CIP since we became an international center in 1972. During the past ten years a total of 220 senior internationally known scientists from developing and developed countries have participated in these planning conferences to help CIP review progress and determine where we should go during the next five years.

I wish to thank each of you for taking time from your busy schedules to come here this week and hope your participation will be valuable for your own programs back home.

Please let me know if we can do anything here to make your stay more comfortable. Our facilities are internationally modest in comparison with many of our sister Centers. We have tried to develop facilities which are examples for what nationals in developed country programs should have if there is a proper investment in agricultural research. Only 3.39% of the total capital expenditure going into the thirteen CGIAR Centers since their initiation has been spent by CIP at its four locations in Peru and the seven regional headquarters around the world. So if you are not pampered as you expected, recognize that CIP invests in program activities rather than facilities.
POSITION PAPER*

International Planning Conferences are convened periodically to review work in each of CIP's major research areas and to establish guidelines for the next five years. To date, 23 Planning Conferences have been held, involving 209 scientists and policy makers from 32 countries. This 24th Planning Conference is the second for the social sciences.** This position paper briefly states the philosophy and role of the social sciences at CIP, the areas in which we have worked in the past, and our priorities for the next five years.***

A. Background

Our planning for the social sciences takes as its starting point the present status of potato production and use in developing countries, CIP's overall goals, and long-term plan.

Potatoes, which originated in the Andean mountain region of South America, are for many developing areas a new, and still minor, food crop. Most research on the potato has been conducted in Europe and North America, where potatoes have achieved the status of a basic staple food. Varieties and production systems developed for these northern latitude, industrialized countries have been introduced into the tropics with limited success.

Research is needed to develop and adapt technologies for potato production and use which are appropriate for the ecological and socioeconomic conditions of developing areas. In some areas, including coastal Peru, the "southern cone" of South America (Brazil, Argentina and Chile), and the Indo Gangetic Plain, large-scale producers employing high-yielding technology supply urban market. But in much of the tropics potatoes

* Paper prepared by the staff of the Social Science Department.
** The first Social Science Planning Conference was held in August 1977.
*** The evolution of the Social Science Department's program is outlined in a background paper prepared for the Planning Conference, and available from the Department on request.
are scattered throughout mountainous areas often inhabited by marginal ethnic groups. Little is known about the socioeconomic or technological aspects of potato production and use in such regions.

CIP's mandate is to expand production and use of the potato as a food crop in developing countries, giving special attention to the technology needs of poor farmers. CIP's activities focus on research, training and dissemination of information.

During the 1970's CIP established its research program and regional networks. Four priority areas were identified for technology development:

- True potato seed (TPS)
- Storage and processing
- Adapting the potato to extreme hot and cold tropical environments
- Developing germplasm resistant to major pests and diseases.

CIP's research is expected to result in a flow of potential new technologies to national potato programs. CIP's regional teams are working to strengthen the capacities of national programs to receive and evaluate these technologies, establish viable seed programs, conduct their own production-oriented research, and make appropriate technologies available to farmers.

In the 1990's CIP's work will focus increasingly on maintenance, utilization and distribution of germplasm, operation of a global communication network on potatoes, and training in new research techniques. These are considered to be the major activities for which the institution has a long-term comparative advantage (Sawyer, 1981).

B. Philosophy of the Social Science Department

CIP will be successful in achieving its mandate only to the extent that large numbers of farmers in developing countries use new technology generated by CIP and cooperating institutions to produce more, better, and cheaper potatoes.

Many past attempts to transfer technology to farmers in developing countries have failed because the technology offered did not solve economically important problems or because the proposed solutions were socially unacceptable to the potential users. As a result, farmers did not accept recommendations, preferring to continue with their present production practices. For this reason it is important to focus research and technology transfer programs on solution of economically important problems. In addition, potential solutions should be evaluated in terms of their acceptability to the potential users of the technology.
In most parts of the developing world where potatoes are, or may be, grown ecological and socioeconomic conditions differ radically from those of the northern latitude, industrial countries. In these areas, where we are working on the frontiers of knowledge, social scientists can make significant contributions to the identification of relevant research problems and the design of potential solutions, their diffusion, and final evaluation of impact. While the contributions of social scientists in problem identification and evaluation are, by now, rather generally accepted, the role of social scientists in the actual design and transfer of technologies is less well understood. We believe that the interaction of social scientists and their biological colleagues can help guide research toward solution of relevant problems in ways which will be socially and economically acceptable to the potential users of the technology. Hence, involving social scientists in the entire research/diffusion process can increase the probability of success with the final product.

For these reasons, we need to maintain strong, positive links with our biological colleagues within CIP, collaborating in the identification of needs and generation of technologies appropriate for producers and consumers in developing countries.

Patterns of potato production and technological change in developing countries can only be understood in the context of broader farming systems, which are the historical product of such variables as ecology, market forces, farm size and tenure, and ethnicity. Diverse social science perspectives and methods are necessary to understand the role of potatoes in these systems and the potential for change.

In order to deal adequately with the diversity and complexity of potato agriculture in the developing world, the department has adopted a broad social science orientation. The permanent staff includes not only economists but anthropologists and sociologists. We reject the dichotomy of a "tradition-bound, subsistence-oriented peasant" in contrast to an "economizing, market-oriented farmer" acting on strictly profit motives. We also reject a narrow professional division of labor, with economists looking only at market behavior and anthropologists and sociologists looking at customs and traditions.

C. Roles for Social Scientists at CIP

The status of potato production and research, our philosophy, and the special skills and perspectives we bring to the institution suggest three key roles for social scientists:

Role 1. As members of interdisciplinary teams, we work directly with biological scientists in research problem identification, design, and transfer of improved potato technology appropriate to the needs of developing country producers and consumers.
Role 2. As social science researchers, we play a leading role in formulating an applied social science of the potato, relevant to potato agriculture in developing countries.

Role 3. As members of CIP's regional research program, we stimulate national programs to include social science perspectives in their work.

D. Evolution of the Social Science Program

At the inception of the Social Science Program in 1973, the backstopping role for regional and national programs received greatest attention. Over time, priority has shifted to social science research and collaboration with biological scientists in design and transfer of new technology (Table 1).

In 1976 and 1977 energies were directed to (a) assembly of published information on potato production and use in developing countries, and (b) country-level studies. These activities led to the publication of bibliographies, statistical compilations, and a series of Country Studies. From 1977 to 1980 the department concentrated on interdisciplinary farm-level research in the Mantaro Valley of highland Peru. In this work social scientists played a leading role involving biological scientists in farm-level research. This work has contributed to the development of highly successful seed storage technology, better understanding of the socioeconomics of potato technology (particularly seed), and development of procedures for conducting farm-level research. In 1979 the department began a transition from in-depth research in the Mantaro Valley to application of on-farm research methods with regional and national programs and comparative studies of potato farming systems, marketing and consumption. These studies are providing valuable new perspectives on potato production, marketing and use under a range of developing country conditions.

Over the years, social scientists have participated in a number of training courses and seminars, emphasizing the use of socioeconomic perspectives and procedures in the design, evaluation and transfer of technology. Most recent training has focused on farm-level procedures for problem identification and evaluation of technologies under farmers' conditions. Six theses in the social sciences have been supervised by members of the department.

E. Priorities for the Next Five Years

This section outlines the proposed direction for CIP's social science program over the next five years. In developing priorities and strategies,
we have taken into account present staffing and core budget. This proposal is presented for the critical review of the planning group.

Activities proposed for the coming five years place highest priority on the following:

Role 1. Broadening the scope of interdisciplinary teamwork with CIP biological scientists;

Role 2. Consolidation and synthesis of the research findings to date, completion of research on marketing and consumption and expanding research on acceptance and impact of new technologies.

Role 3. Intensifying socioeconomic work in the regions.

In each of these areas, our work will relate to CIP's major priorities for the 1980's: seed systems, post-harvest technology, expanding potato production in non-traditional areas, and development and distribution of improved germplasm.

1. Interdisciplinary Teamwork. For the next 2 to 3 years, interdisciplinary teamwork of the headquarters staff will focus on three areas: seed, post-harvest technology and expanding potato production in new areas. By the end of the five-year period greater attention will be given to collaborative research with breeders.

   a. Seed. We will participate actively in the new research on true potato seed as an alternative to conventional vegetative reproduction.

   b. Post-Harvest Technology. The post-harvest team is beginning work on development of appropriate technology for storing consumption potatoes under tropical conditions.

   c. Potatoes in New Areas. Building on our work on potato farming systems and trends in potato production and use, during this period we will begin work with biological scientists identifying promising areas for introduction of the potato crop and designing and evaluating appropriate technologies for these areas.

   d. Germplasm. By the year 2000 over 50% of CIP's research effort will be in the exploitation of genetic material in the World Collection. This presents a challenge to the Social Science Department. How should we become involved in a meaningful way? We hope to collaborate in (a) assessment of the adoption potential of new varieties and (b) guiding breeders toward the kinds of varieties needed for different ecological and socioeconomic environments.
2. **Social Science Research.** Our first priority in the coming year will be on synthesis and publication of our research results to date. We feel that CIP social scientists should be encouraged to publish their research findings in professional journals. In addition, a collection of our Peruvian-based studies and a collection of papers on the socioeconomics of world potato agriculture should be prepared for publication.

The major socioeconomic research involvements planned for the coming five years are the following:

a. **Potato Consumption and Marketing.** Studies of marketing and consumption are essential for developing basic information on the actual and potential use of potatoes as a food in developing areas, specially where new technologies may allow significant production increases in the near future.

b. **Farmer Acceptance and Impact of New Technology.** Evaluations will begin of the transfer and adoption process for low-cost seed storages. We feel that lessons from this highly successful case will be of value for research and transfer in other technological areas.

c. **Non-Andean Seed Systems.** Future work on seed systems will look beyond the Andes, to the more successful cases of, e.g., Chile, Mexico, Kenya, India, and South Korea. Understanding these cases should help CIP and national programs build viable seed production systems elsewhere.

d. **Potato Agriculture in the Developing World.** Information generated in our earlier bibliographic and statistical compilations, Country Studies and comparative work on farming systems will be updated and synthesized. Results should be of value for planning future research and transfer activities.

3. **Expanding Socioeconomic Work in the Regions.** In our regional work, top priority in the immediate future is on preparation of training materials on farm-level research with potatoes, based on the Mantaro Valley project. Our future work with regional and national programs will center on implementing interdisciplinary research projects and introducing social science perspectives to regional and national programs.

F. **Strategies for Implementing the Program**

Ideally, each social scientist should have two major research projects: one basically socioeconomic in nature within his/her respective discipline, and one of an interdisciplinary nature, involving the generation and/or transfer of new technology. Research projects should involve CIP's regional teams and national program workers, in order to ensure the relevance of the work and the regionalization of social science perspectives.
Over the course of the next five years, we plan to base social scientists with regional programs on special project funding. These individuals would work closely with the regional national scientist in developing social science research projects and interdisciplinary teamwork. They would also encourage use of local social scientists in country programs, in all phases of the problem identification-technology generation-diffusion-evaluation process. The major challenge in this area will be to identify areas of work which are of high priority to CIP and national programs and which are looked upon favorably by bilateral donors.

Table 1. Social Science Activities from 1973 to 1981.

<table>
<thead>
<tr>
<th>Role</th>
<th>Topic/Activity</th>
<th>Date Initiated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role 1.</td>
<td><strong>Interdisciplinary Teamwork in design/transfer of technology</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Post-harvest technology</td>
<td>1976</td>
</tr>
<tr>
<td></td>
<td>- Seed production in the Andes</td>
<td>1977</td>
</tr>
<tr>
<td></td>
<td>- Agronomic production constraints</td>
<td>1978</td>
</tr>
<tr>
<td></td>
<td>- True potato seed</td>
<td>1981</td>
</tr>
<tr>
<td>Role 2.</td>
<td><strong>Social Science Research</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Development of an information base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Bibliographies</td>
<td>1975</td>
</tr>
<tr>
<td></td>
<td>- International statistics</td>
<td>1975</td>
</tr>
<tr>
<td></td>
<td>- Farm-level research in the Mantaro Valley</td>
<td>1977</td>
</tr>
<tr>
<td></td>
<td>- Comparative studies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Farming systems</td>
<td>1979</td>
</tr>
<tr>
<td></td>
<td>- Marketing</td>
<td>1978</td>
</tr>
<tr>
<td></td>
<td>- Consumption/Nutrition</td>
<td>1979</td>
</tr>
<tr>
<td></td>
<td>- Trends in world potato production/use</td>
<td>1980</td>
</tr>
<tr>
<td>Role 3.</td>
<td><strong>Work with Regional and National Programs</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Backstopping CIP regional programs</td>
<td>1973</td>
</tr>
<tr>
<td></td>
<td>- Training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Natural scientists</td>
<td>1974</td>
</tr>
<tr>
<td></td>
<td>- Social scientists</td>
<td>1975</td>
</tr>
<tr>
<td></td>
<td>- Latin America (BID) special project</td>
<td>1975</td>
</tr>
<tr>
<td></td>
<td>- Ecuador/Colombia seed project</td>
<td>1977</td>
</tr>
<tr>
<td></td>
<td>- Optimizing Potato Productivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- OPP Philippines</td>
<td>1979</td>
</tr>
</tbody>
</table>
In response to the position paper, I would like to raise a series of issues or questions that might be addressed by this conference.

First, it appears that CIP social scientists focused a relatively large share of their effort on downstream research --technology transfer, post-harvest and demand-- as compared to upstream --the economic significance of the constraints that will have to be solved if production is to expand.

Second, I would like to be able to understand more clearly the implications of the stated policy that CIP social scientists have two major research involvements --one of an interdisciplinary nature and one with a more disciplinary orientation.

Third, to what extent are CIP social scientists going to be concerned with the policy and program constraints on potato production and use? And with the implication of advances in potato production technology for public policy?

Fourth, much of the emphasis in the conference papers was on interdisciplinary relations between CIP social scientists and biological scientists. However, I did not see very much about the linkages between CIP social scientists and the social scientists in national research institutions and universities in LDCs. When CIP biological scientists need assistance on basic areas they have used contracts with scientists in LDCs or DCs institutions. Has there been (or will there be) a similar pattern in Social Science research?
In the Position Paper the future role of social scientists at CIP is proposed to be:

Assist in focusing on factors limiting CIP from meeting its goals; to contribute to the development of appropriate solutions; and to observe the effectiveness of CIP's approaches.

Regarding interdisciplinary activities, I feel that instead of social scientists involvement in many projects, it may be more effective to embark on a merged TPS and lowland tropics effort, followed by concern for storage of the produce under hot conditions, and tapping the needed genes to fulfill these objectives.

The advantage would be to place the limited resources at the disposal of the new technology which most needs help and is not likely to succeed without it. Furthermore, traditional tuber seed carries latent diseases to the lowlands, a serious drawback that is bypassed by using TPS.

As to optimizing potato productivity (constraints), I feel that this approach must carry to farmers' fields a technological breakthrough that will result in significant increase in yield in addition to other advantages such as disease resistance, quality, etc.

Whatever is decided for the future, take on limited objectives that can be met considering that there are always many other activities at CIP we are all called upon to perform.
FARM-LEVEL RESEARCH ON AGRONOMIC CONSTRAINTS
TO POTATO PRODUCTION

Some Lessons from the Mantaro Valley

Douglas Horton

A. Introduction

From 1977 to 1980 the International Potato Center (CIP) and Peru's National Potato Program conducted a series of interdisciplinary studies in the Mantaro Valley of highland Peru. These studies were conducted under the umbrella of "The Mantaro Valley Project," which had as its two major objectives: (a) to better understand Andean potato agriculture, and (b) to develop and test survey and experimental procedures for identifying and solving production problems at the farm level.* Research activities included a review of literature on Andean agriculture, a baseline survey of ecology and agricultural land use, single and multiple-visit producer surveys, and in-depth farm-level research on three technological problem areas of particular concern to CIP and Peru's National Potato Program: agronomic constraints to potato production, post-harvest technology (storage and processing), and seed potato production and distribution. This paper presents results of our research on agronomic production constraints. Rhoades and Booth (1981) and Monares (1981) present additional results of research on post-harvest technology and seed systems.

A series of beliefs commonly held by potato researchers and extensionists served as the starting point for the Mantaro Valley studies. These beliefs can be summarized as follows:

First, production technology and yields are closely linked to farm size. Large farmers produce intensively, using tractors, high-yielding varieties and heavy doses of chemical fertilizer and pesticides. Small farmers, in contrast, employ traditional, low-input technologies.

Second, large farmers are well integrated into input and product markets, while small farmers remain subsistence-oriented.

* This research was made possible by a grant from the International Development Research Centre (IDRC), Canada.
Third, low-cost technology exists to greatly increase yields on small farms. If recommended practices were applied, small farmers could double or triple their yields.

Fourth, the most critical yield constraint is poor quality seed.

Fifth, small farmers do not adopt recommended practices because they lack information (problems of extension) and/or they resist change (problems of social integration and general education).

Our research confirmed that potato technology and yields are related to farm size, but not for the assumed reasons. The farm surveys showed that both large and small farmers were well integrated into the market system. Technology was found to be strongly influenced by ecological and socioeconomic factors often beyond the control of farmers. These factors had previously been ignored or little understood. The on-farm experiments indicated that not all recommended technology perform well under small farmers' conditions.

B. Survey Results*

1. Land Use, Agro-Ecological Zones, and Types of Producers

Land use in the valley reflects the interaction of two major variables: ecology and type of farming enterprise. Potatoes are grown in three agro-ecological zones: the relatively flat land of the Low Zone along the Mantaro River (3,200-3,450 meters above sea level); the sloping land of the Intermediate Zone (3,450-3,950 meters); and the more steeply sloping fields of the High Zone (3,950-4,200 meters). Within the Intermediate Zone two sub-zones can be identified: the humid Eastern Slopes and the drier Western Slopes of the Valley (Map).

A wide range of food crops is grown in the Low Zone along the Mantaro River, the most important of which is maize. As one ascends, fewer and fewer crops can be grown; maize is seldom found above 3,450 meters. Tubers (mainly potatoes) predominate on the eastern slopes of the Intermediate Zone; small grains (mainly barley) predominate on the western slopes. In the High Zone, where only the most hardy plants survive the cold and frost, potatoes are the dominant crop.

Cropping is most intensive in the Low Zone, particularly on irrigated fields. As one moves up into the Intermediate and High Zones land use intensity declines, fallow becomes important in rotation cycles,

* This section draws heavily on Mayer, 1979; Franco et.al., 1979; and Horton et.al., 1980.
MAP
AGRO-ECOLOGICAL ZONES
Mantaro Valley, Peru

Low Zone: 3,200-3,450 m
Intermediate Zone: 3,450-3,950 m
High Zone: Over 3,950 m
Mantaro River
and an increasingly large proportion of land is in permanent natural pasture.

Small farmers constitute the majority throughout the valley, occupying all possible ecological environments. In the Low Zone a fundamental difference is observed between large and small farmers. Large farmers tend to specialize in commercial potato production, while small farmers operate highly diversified, risk averting, part-time farming systems, growing potatoes mainly for home consumption. This distinction between large and small farmers is not so clear in the Intermediate and High Zones, where large commercial farmers are virtually absent. In the Intermediate Zone many small farmers market potatoes and barley, the crops which grow best in the area. In the High Zone, most farmers derive their cash income from livestock and produce potatoes mainly for home consumption.

Nearly every farmer in the Mantaro Valley produces potatoes. The average potato farm is quite small (under 1 ha), but potato production is highly concentrated on the few large farms. Ten percent of the valley's farmers produces over half the potatoes and an even higher percent of marketed output. Moreover, the yields of large growers are much higher than those of small and medium-size farms. In recent years the degree of concentration of potato production in large farms has increased, despite implementation of Peru's Land Reform. High production costs and risks have forced small farmers to reduce planting, while large growers with greater risk-taking ability and preferential financial and market arrangements have expanded acreage to supply the growing coastal markets for seed and consumption potatoes.

Both large and small farmers are well integrated into the cash economy. Large farmers purchase most of their inputs for potato production and sell most of their output. While small farmers keep a large share of their potatoes for home consumption, they purchase most inputs, including labor. The majority of small farmers also have non-farm sources of income -- primarily wage labor.

Nearly 90% of the valley's consumption potatoes are produced on the Valley Floor and the eastern slopes of the Intermediate Zone. These two agro-ecological zones, with 75% of the valley's potato producers and 80% of the land in potatoes, have significantly higher yields than the High Zone and the western slopes of the Intermediate Zone.

2. Input Use

a. Fertilizer and Pesticides. In contrast to the conventional view, use of chemical fertilizers and pesticides was found to be common, and application levels were surprisingly high -- often exceeding recommended levels. The major exception to this norm is the High Zone, where two-thirds of the potatoes are planted after fallow and, hence, require less fertilization and pest control (Table 1).
b. Modern and Native Varieties. Farmer's use of varieties provides an example of the complex rationality of Andean agriculture. Modern varieties occupy nearly every potato field in the Low Zone, half the fields in the Intermediate Zone, and only one-fifth of the fields in the High Zone. Native varieties and bitter potatoes,* which are found only occasionally in the Low Zone, occupy half the fields of the Intermediate Zone, and four-fifths in the High Zone.

Native and bitter potatoes are grown at high altitudes not because farmers lack information on modern varieties, but because native and bitter potatoes are well adapted to their ecological conditions and diet. With present technology, modern varieties have a considerable yield advantage over native and bitter potatoes in the Low Zone. But this is not the case in the high zones (Table 2). Traditional varieties are highly resistant to frost and hail, and they produce reasonably well with little application of chemical fertilizer and pesticides. Hence, they allow farmers to minimize financial risks in case of crop failure, which is frequent at high altitudes. In some areas native varieties outyield modern varieties, and allow farmers to derive a good income from their sale as a luxury commodity to urban markets.**

Potato farmers throughout the valley prefer to consume native potatoes rather than modern varieties. For this reason, many farmers in the Low Zone cultivate small parcels of native varieties for home consumption while they produce modern varieties for sale. Bitter potatoes, on the other hand, are generally considered to be of inferior quality (see again Table 2).

Potatoes play an important role in the diet of rural households in high areas, due to the limited cropping alternatives and absence of retail food markets in these scarcely populated areas.

Since native varieties store well, farmers can keep them for home consumption nearly year around. Night frost and sunny days after harvest are exploited in transforming inedible bitter potatoes into chuño—a freeze-dried product which is light in weight and non-perishable. Chuño plays a special role in the diet of the herding people of this zone. Since it is light-weight it can be easily carried along with herders in their seasonal migrations to high altitude pasturelands. And since it can be stored for years, it provides them with a degree of food security in this uncertain environment (Werge, 1979).

* Bitter potatoes with high levels of glycoalkaloids cannot be consumed fresh, and are used exclusively for production of chuño—a traditional freeze-dried potato product.

** This is the case on the humid eastern slopes of the Intermediate Zone.
c. **Seed Size and Quality.** Mantaro Valley farmers often consume or sell their largest potatoes and keep the small ones for seed. It is generally believed that this practice is most common among small farmers who do not realize that replanting small seed tubers reduces yields due to spread of virus diseases.*

Our surveys provided surprising new information on farmers' seed management practices. **First of all,** virus diseases were not observed in farmer's fields as frequently as expected. In the Low Zone, where virus transmitting insects are most prevalent, about 25% of plants had visible symptoms of virus infection, but in the Intermediate and High Zones virus infection was observed on less than 10% of plants (Table 3). **Second,** in the Low Zone, where virus infection is greatest, we observed that large farmers, not small farmers, planted their own seed most frequently. Small farmers generally consumed or sold their harvest and purchased seed the next year at planting time. **Third,** farmers were found to renew their seed stocks more often in the Low Zone than in the higher zones and farmers in lower areas usually obtained their seed from higher areas where they knew good quality seed could be obtained. **Fourth,** seed size was not as small as thought --averaging 47 g in the Low Zone and 43 g in the higher areas.** Fifth,** farmers planting the smallest size seed were growing native varieties which produce smaller tubers than do the modern varieties. **And finally,** many producers stated that they would like to plant larger seed but did not because of its high cost. These findings make it clear that farmers are by no means ignorant of the importance of seed size and quality. In fact, their seed management practices appear to be quite rational, given the varieties they grow and ecological and economic conditions beyond their control.

3. **Costs and Returns**

It is often assumed that "modern," mechanized production systems are inherently more profitable than "traditional" systems employing hand implements, native varieties, and organic fertilizers. Survey results indicate that this is not always true. In the Intermediate and High Zones, for example, the "ticpa" system, employing no tillage prior to planting, hand power for all cultivation and harvest operations, native varieties, and very little chemical fertilizer and pesticides, was

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* Virus infection increases the proportion of small tubers produced by a potato plant. Hence, in areas where viruses are common, planting small seed tubers can contribute to the spread of virus diseases which decrease yields. For more information on this subject see Monares, 1981 and the references cited therein.

** Recommended size is around 50 - 60 g.
found to be, on average, more profitable than the "barbecho" systems, employing tractor power, modern varieties, and high levels of chemical fertilizer and pesticides. Both yields and input costs associated with ticpa are about 20% less than those with barbecho. But net returns above direct input costs are higher in the ticpa systems because higher-value native varieties are produced (Table 4).

C. Results of On Farm Trials*

Experiments were conducted on farms in two crop seasons -- 1978/79 and 1979/80 -- to evaluate recommended practices under farmers' conditions. The first season's trials were planned by a working group consisting of the project team and local potato researchers and extensionists.

According to the surveys, farmers considered their most critical technological problems to be pests and diseases, drought, frost, and hail (Franco, et al., 1979). Based on their training and personal experience, potato researchers and extensionists believed that poor seed quality was the main yield constraint. They also suspected that the surveys had over-estimated fertilizer use, and felt that yields could be markedly improved through increasing and balancing fertilizer applications. They agreed that insects were a problem, and believed that control could be significantly improved through better management of currently used insecticides. They felt that at the present time adequate solutions to problems of hail and frost were not available.

Simple trials were designed to test recommended seed, fertilization, and insect control measures against current farmers' practices. These 3 inputs were combined in 3 technological packages: "low-cost," "medium-cost," and "high-cost" packages. In the 1978/79 crop season the individual elements of the packages were also tested in single-factor trials. In 1979/80 the single-factor trials were replaced with a factorial design which provided information on both the individual inputs and their combination. The experiments aimed to determine if the recommended technologies offered a significant potential for increasing farmers' potato yields and net returns.

In both years on the majority of farms the high-cost technological package increased yields substantially over the farmer's level. Average yields were increased by about 50%. But, as can be seen from Figure 1, the variation of experimental results was very high. Farmer's yields ranged from under 5 to nearly 30 t/ha. On average low cost package yielded the same as farmers' established technology, but in 5 of the 11 cases the low-cost package yielded less than the farmer's technology.

* This section draws heavily on Franco, et al., 1980 and 1981.
From the single-factor trials in 1978/79 and the factorial trials in 1979/80 we can see that the proposed insect control was the least costly of the recommended technologies, and it produced the highest net benefit/cost ratio, on average. While it had little effect on total yield, insect control improved the quality of potatoes harvested in fields infested with the "Andean tuber weevil" (Premnotrypes spp.). This improvement was reflected in an increased unit value of the output and increased total returns. The tuber weevil, which is prevalent throughout the Andean region, was effectively controlled at a low cost through improved management of insecticides currently applied by farmers.

Modified application and dose of chemical fertilizers also offered significant benefits at a somewhat higher cost.

Use of guaranteed seed and seed selection --the technologies considered by researchers and extensionists to be most promising-- were found to be the costliest of the proposed technologies and to have much lower benefit/cost ratios than the other technologies tested (Tables 5 and 6).

D. Conclusions

The Mantaro Valley research illustrates how surveys and on-farm experiments can be used to enrich understanding of farming systems and evaluate technological alternatives under actual farming conditions.

It is often assumed that agricultural researchers and extensionists have sufficient knowledge of production problems and technological alternatives to make economically viable recommendations to farmers in their area. This paper presents a case in which the recommended practice assigned highest priority by researchers and extensionists (seed improvement) was less economically viable than another which was assigned much lower priority (improved pest control).

Surveys were used to help identify farmers' production problems and establish priorities for on-farm experiments. The experiments, in turn, provided a means of evaluating --in both technical and socioeconomic terms-- proposed solutions to farmers' technological problems. We found that most farmers in the Mantaro Valley are familiar with modern inputs, including new varieties and seeds, chemical fertilizers, and pesticides. Some recommended inputs are not adopted, however, because they offer little or no economic advantage over farmers' conventional practices.

While our research focused on potato agriculture, we believe that the approach and methods could be beneficially applied to other crop and livestock production systems.
Table 1. Use of Chemical Fertilizers, Pesticides, and Fallow by Zone and Farm Size

<table>
<thead>
<tr>
<th></th>
<th>Low Zone</th>
<th>Intermediate Zone</th>
<th>High Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
<td>Medium</td>
<td>Small</td>
</tr>
<tr>
<td>Percent of potato fields with applications of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical fertilizer (N)</td>
<td>100</td>
<td>95</td>
<td>83</td>
</tr>
<tr>
<td>Soil pesticide</td>
<td>89</td>
<td>63</td>
<td>80</td>
</tr>
<tr>
<td>Ave. nitrogen application (Kg)</td>
<td>212</td>
<td>124</td>
<td>108</td>
</tr>
<tr>
<td>% fields planted after fallow</td>
<td>0</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 2. Average Yields and Producer Scores for Modern, Native and Bitter Varieties

<table>
<thead>
<tr>
<th></th>
<th>Low Zone</th>
<th>Intermediate Zone</th>
<th>High Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Modern</td>
<td>Native Varieties</td>
<td>Modern</td>
</tr>
<tr>
<td>Culinary quality</td>
<td>87</td>
<td>96</td>
<td>76</td>
</tr>
<tr>
<td>Market price</td>
<td>76</td>
<td>84</td>
<td>82</td>
</tr>
<tr>
<td>Yield</td>
<td>80</td>
<td>68</td>
<td>82</td>
</tr>
<tr>
<td>Pest resistance</td>
<td>59</td>
<td>46</td>
<td>66</td>
</tr>
<tr>
<td>Frost resistance</td>
<td>49</td>
<td>35</td>
<td>49</td>
</tr>
<tr>
<td>Storability</td>
<td>65</td>
<td>72</td>
<td>69</td>
</tr>
<tr>
<td>Average yield (t/ha)</td>
<td>5.7</td>
<td>3.7</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Scores range from 0 to 100. A score of zero signifies that all producers rated the variety "bad;" a score of 100 signifies that all producers rated the variety "good." Since fewer than 5 farmers interviewed produced bitter potatoes in the Low Zone, no scores for bitter potatoes are included for the Low Zone.
Table 3. Observed Symptoms of Virus Diseases, Farmers' Average Seed Size, and Percent Farmers Using Own Seed

<table>
<thead>
<tr>
<th>Percent using own seed</th>
<th>Low Zone, By Farm Size</th>
<th>Intermediate¹ and High Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large</td>
<td>Medium</td>
</tr>
<tr>
<td>Plants with virus Symptoms (%)²</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Ave. seed size (g)²</td>
<td>47</td>
<td>43</td>
</tr>
</tbody>
</table>

¹ Eastern slopes. ² Observations of virus symptoms and measurements of seed size were made in 12 fields in the Low Zone and 70 fields in the Intermediate and High Zones.

Table 4. Yields, Costs and Returns in Two Potato Production Systems in the Intermediate and High Zone

<table>
<thead>
<tr>
<th></th>
<th>Barbecho System¹</th>
<th>Ticpa System²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (t/ha)</td>
<td>9.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Gross return (US$)</td>
<td>1,102</td>
<td>1,030</td>
</tr>
<tr>
<td>Inputs (US$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed</td>
<td>278</td>
<td>235</td>
</tr>
<tr>
<td>Labor</td>
<td>186</td>
<td>218</td>
</tr>
<tr>
<td>Pesticides</td>
<td>67</td>
<td>14</td>
</tr>
<tr>
<td>Tractor/Oxen</td>
<td>64</td>
<td>0</td>
</tr>
<tr>
<td>Chemical Fertilizer</td>
<td>62</td>
<td>18</td>
</tr>
<tr>
<td>Manure</td>
<td>15</td>
<td>59</td>
</tr>
<tr>
<td>Total</td>
<td>672</td>
<td>544</td>
</tr>
<tr>
<td>Gross margin (US$)</td>
<td>430</td>
<td>486</td>
</tr>
<tr>
<td>Number of observations</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

¹ High-input system employing modern varieties and tractor for plowing after fallow. ² Low-input system used after fallow, employing native varieties, with no tillage before planting and all hand cultivation. Generally used in high areas on very steeply sloping land.

<table>
<thead>
<tr>
<th>Type of Trial</th>
<th>% Increase Yield</th>
<th>Increase in Cost (US$/ha)</th>
<th>Net Benefit/Cost Ratio&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect control (n=5)</td>
<td>16</td>
<td>48</td>
<td>7.1</td>
</tr>
<tr>
<td>Fertilization (n=4)</td>
<td>18</td>
<td>70</td>
<td>4.0</td>
</tr>
<tr>
<td>Improved seed (n=5)</td>
<td>51</td>
<td>223</td>
<td>-1.4&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Net benefit/cost ratio = (increase in returns - increase in cost)/ increase in cost.  
<sup>2</sup> Cost increased but return fell.

Table 6. Average Increase in Cost and Yield, and Net Benefit/Cost Ratio in Factorial Experiments, Intermediate Zone 1979/80 (n=12)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Increase in Yield</th>
<th>Increase in Cost (US$/ha)</th>
<th>Net Benefit/Cost Ratio&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect control (I)</td>
<td>-1</td>
<td>-2</td>
<td>-38.8&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fertilization (F)</td>
<td>8</td>
<td>20</td>
<td>12.8</td>
</tr>
<tr>
<td>Seed selection (S)</td>
<td>7</td>
<td>160</td>
<td>0.4</td>
</tr>
<tr>
<td>I + F + S</td>
<td>26</td>
<td>178</td>
<td>3.4</td>
</tr>
</tbody>
</table>

<sup>1</sup> Returns increased while cost fell.
Figure 1. FOOD CROPS IN THE MANTARO VALLEY (% CROPLAND)

LOW ZONE

INTERMEDIATE ZONE - WESTERN SLOPES

INTERMEDIATE ZONE - EASTERN SLOPES

HIGH ZONE
Figure 2. POTATO VARIETIES IN THE MANTARO VALLEY
(% Fields)

- Bitter Potatoes
- Native Varieties
- Modern Varieties
REFERENCES


COMMENTS

Carlos Samaniego

I should first like to congratulate the personnel of the Department of Social Science on the work they have carried out. The series of studies and the corresponding analysis they have realized have enabled them to obtain abundant knowledge and statistical information concerning the social-economic structure of potato production at the level of the producer.

I also consider the paper presented by D. Horton to be of great importance and recommend that, after appropriate review, it should be published because of its theoretical and practical relevance.
The paper expounded by D. Horton demonstrates the high quality of information collected during the series of surveys made at the level of potato producers, and the capacity for analysis which exists in the Department of Social Science. I am therefore glad that the analysis of information and its publication will continue. In relation to this I would suggest that the implementation of these analyses be realized together with personnel of the respective national institutions as a form of training of the latter in the use of socio-economic data in relation to production and their corresponding analysis.

I should like to make the following comments with respect to D. Horton's own paper.

1. I consider that the decision to realize the study in the Mantaro Valley was correct. In addition to the factors mentioned as deciding this choice, I would add that the Mantaro Valley at the present represents the peak of development possible in the interandean valleys in the Peruvian situation. Thus, the findings of the studies could also be considered as facts which could occur in the other Andean valleys if the actual development tendencies of the country are maintained.

2. I would have liked the given analysis to have taken into account, as a frame of reference, the marked social and economic transformation process in the Mantaro Valley. This could have a marked consequence for the future in the cultivation of potatoes, specially in the case of small producers for whom potatoes form the staple diet. This aspect is important since the CIP mandate considers as one of its important objectives the increase in potato production of small producers in the developing countries.

I will explain my point with an example. One of the important findings is that "in recent years the degree of concentration of potato production in large farms has increased, despite the effects of Peru's 1969 land reform law. High production costs and risks have forced small farmers to reduce plantings, while large growers, with preferential financial and market arrangements have expanded acreage to satisfy the coastal markets for seed and consumption potatoes." The question we must ask ourselves is whether the explanatory factor of the reduction in potato cultivation among small producers is really the high cost of production and the risks or whether they are simply the expression of more complex factors such as the change in the composition of the valley's rural population where a group of wage workers with a plot of land to produce part of their own food has become important in the valley present socioeconomic condition.

The problem I wish to suggest is whether the process of the reduction in potato cultivation in one sector of small farmers is
irreversible. To what point can the reduction in potato cultivation be explained by the reduction in land holdings of the small farmers' families because of population increase and because of unavailability of land in the valley. All these facts under an economic diversification allow the settlement of a larger population than the land alone could support. Similarly, I should consider up to what point the process is accelerated by the state policies of price control of the ware foods of high caloric content such as pasta, bread, sugar, rice and oils. In consideration of this, it would be of importance to determine the practicability of means of increasing the potato production and productivity in the sector of the small producer, who is losing land under potato cultivation. It should be pointed out that there is evidence to show that the process mentioned could be general in many interandean valleys and in the Altiplano of Puno, the latter being a traditional potato producer in Peru.

In general, I consider the results of the series of studies to be of marked relevance for the planning of increase in potato production. The findings are of great importance for the various research workers attempting to increase potato production and for the extensionists searching for methods and techniques for spreading the technology truly needed by the producers, above all certain small farmers.

Finally, I like to recommend the organization of a technical meeting between research workers, extensionists and policy makers of the Instituto Nacional de Promoción e Investigación Agraria del Perú, in order to interiorize the findings and their utilization, together with the methodology followed.
A. The Problem

Potato crops are conventionally vegetatively propagated, through planting of whole or cut tubers. This practice leads to a number of technical and socioeconomic problems, particularly in developing countries. Tuber seed is a major source of disease transmission, which often reduces yields. It is also an expensive input — often the costliest input in potato production. Due to perishability and bulkiness of seed tubers, careful storage and management are needed to minimize losses and ensure a viable crop.

Use of certified seed — common in developed countries — is often recommended in developing countries.* Successful programs for producing certified seed have been implemented in North America and Western Europe since the early 1900's. In the United States the seed potato certification program is older and more extensive than any other seed certification program; success with potatoes has provided impetus for certification of seed for other crops (Shepard and Claflin, 1975). In most developing countries, in contrast, seed potato certification programs have not been as successful as seed programs for other crops. In the Andean region of South America (Peru, Ecuador, Colombia, and Bolivia), for example, viable certification schemes are found for many crops, but not potatoes. In these countries, no seed potato certification program has ever met as much as 10% of the national seed requirements, nor has it operated continuously for more than five years on a commercial basis.

* Certified seed is defined here as seed produced by registered seed growers, inspected and approved by governmental agencies. To be certified, it must fulfill rigid standards for the kinds and maximum amounts of tuber transmitted diseases. In some developing countries this seed is termed "certified;" in others it may be termed "guaranteed" or "improved." In the present study these terms are used synonymously.
Potatoes, which were domesticated in the Andes, are a major food crop in densely populated highland areas, where few other crops can be grown. Tuber seed is the most expensive input for potato production in these areas, accounting, on average, for 20-30% of operating cost per hectare; among subsistence farmers seed costs may exceed 50% of total operating costs. The extremely high cost of seed potatoes is due partly to the low vegetative reproduction rate of the crops. Seed is a costly input even when it is kept from the previous harvest, rather than purchased, since potatoes used as seed could have been sold or consumed by the farm household.* Therefore, an improved technology which increases seed productivity or reduces its unit cost should generate a large demand from potato farmers.

Most potato researchers and production specialists believe that poor seed quality is a major factor limiting yields in the Andes (Gomez, 1975; Rodriguez, 1979). It has been stated that a regular supply of certified seed could rise yields up to 75 or 100 percent.

To date, little direct evidence from farm-level research has been presented in support of these claims. Instead, the reasoning is based on two assumptions: (a) that the experience of Europe and the U.S. is valid for the Andes, and (b) that results of research trials conducted on experimental stations can be extrapolated to farmers' field conditions.

The present study presents a theoretical framework and some empirical results which throw new light on the reasons for limited use of certified seed potatoes in the Andes. Many elements of the analysis are applicable to other areas of the world. However, it should be kept in mind that the empirical results apply only to the particular ecological and socioeconomic conditions of the selected Andean countries and their potato varieties.

B. Profitability of Using Certified Seed

Few Andean farmers use certified seed potatoes. This section presents an economic model to explain this phenomenon and to predict future adoption of this input under alternative technological and economic conditions.

* In the highland zones, most farmers save part of the tubers harvested to use them as planting material in the next planting season.
1. **The Basic Economic Model: Profitability of Using Certified Seed**

   It is assumed that a farmer's decision to use certified or non-certified seed* is determined on the basis of the relative profitability of these 2 input alternatives. A general production function is postulated:

   \[ Y = f(Sc, Sf, N, P, K, L, \ldots) \]

   where:

   \[ Y = \text{yield}, \]
   \[ Sc = \text{amount of certified seed used}, \]
   \[ Sf = \text{amount of farmer's own (non-certified) seed}, \]
   \[ N,P,K = \text{amounts of nitrogen, phosphorous, and potash, and} \]
   \[ L = \text{amount of labor}. \]

While the general production function may be of various types, it is assumed that the relationship between \( Sc \) and \( Sf \) is linear. That is, certified and farmer's seed are perfectly substitutable at a constant rate.

Holding all inputs but seed constant, the production function can be re-written:

\[ Yt = ScYc + SfYf \]

where:

\[ Yt = \text{total yield}, \]
\[ Yc = \text{average yield per unit of } Sc, \text{ and} \]
\[ Yf = \text{average yield per unit of } Sf. \]

The isoquant for this production function is illustrated in Figure 1. Note that production does not require use of both inputs, \( Sc \) and \( Sf \). Farmers generally do not use combinations, or mixes, of certified and non-certified seed in a given field; they use either one or the other.**

---

* In this paper the terms "non-certified seed" and "farmer's seed" are used interchangeably, to mean any seed the farmer uses which is not acquired from the certified seed system and its authorized producers and agents. Hence, the farmer's non-certified seed may be stored from his previous crop or it may be purchased through normal commercial channels.

** This observation has been confirmed in numerous farmer surveys in the Andes (Franco, et.al., 1979).
use of less certified seed (Sc₁) than of non-certified seed (Sf₁) reflecting the higher average yield potential of the former.

**Figure 1.** Optimum Combination of Improved and Non-Improved Potato Seed

Following standard economic reasoning, a farmer will decide to use Sc or Sf on the basis of the relative marginal productivities and prices of these inputs:

\[
\frac{MPSc}{MPSf} < \frac{Pc}{Pf} \tag{3}
\]

where:

- \( MPSc \) = marginal productivity of Sc,
- \( MPSf \) = marginal productivity of Sf,
- \( Pc \) = price of Sc, and
- \( Pf \) = price of Sf.

Given the postulated linear functional form, the marginal productivities are equal to the average productivities. Hence, equation (3) can be re-written:

\[
\frac{Yc}{Yf} > \frac{Pc}{Pf} \tag{4}
\]
If the ratio \( \frac{Y_c}{Y_f} \) is greater than \( \frac{P_c}{P_f} \) the farmer will purchase certified seed; if the ratio of average yields is less than the input price ratio the farmer will use his own seed.

2. **Empirical Results: Applying the Basic Model**

Farmer surveys and on-farm experiments were conducted in Colombia, Ecuador and Peru over the period 1977-1980. The on-farm trials provided data for calculating the yield ratio \( \frac{Y_c}{Y_f} \) in two locations in Colombia, one in Ecuador and two in Peru. Farmer surveys provided estimates of the price ratio \( \frac{P_c}{P_f} \) and of the percentage of farmers using certified and non-certified seed for the same five locations.

The experimental data came from 15 statistically replicated on-farm trials conducted jointly by CIP and the national potato programs of Colombia, Ecuador and Peru in 1978 and 1979. The specific objective of these experiments was to evaluate under farmers' field and management conditions the yield differential between the non-certified seed and the seed currently delivered by national potato programs. The statistical analysis, which was performed for each experiment separately, showed no significant yield differences between the non-certified seed and the certified seed in the highland areas of Colombia, Ecuador and Peru. In sharp contrast, in the lowland coastal valley of Cañete, Peru, a highly significant yield difference was found (Table 1).

Information on the use of improved seed was obtained through farm surveys. Table 1 gives the yield ratio, price ratio and percent area seeded with improved seed in each location. A close agreement between observed use and the expected levels generated by the theoretical model is observed. The results of this analysis cast serious doubt on the long-held assumption that use of available certified seed could significantly increase farmers' yields. The economic analysis indicated that only in the lowland coastal Peruvian area (Cañete) was use of certified seed more profitable than use of other non-certified seeds. In the highland trials improved seed currently produced and delivered by national potato programs did not yield more than seed from traditional sources in highland zones. Farmers in the highland areas are not buying, and cannot be expected to buy, improved seed unless the yield ratio increases relative to the price ratio.

3. **The Expanded Model: Maximum Allowable Level of Virus Infection in Certified Seed**

A question of great interest for national seed programs is the maximum allowable percent of virus diseases in their certified seed. There is a tradeoff between virus level and cost. In general, the
Table 1. Agro-Economic Characteristics of Experimental Sites, Yields, Prices, and Observed and Expected Use of Certified Seed

<table>
<thead>
<tr>
<th></th>
<th>Colombia</th>
<th>Ecuador</th>
<th>Peru</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paramo</td>
<td>Sabana</td>
<td>Machachi</td>
</tr>
<tr>
<td></td>
<td>Bogota</td>
<td></td>
<td>Mantaro</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Valley</td>
</tr>
<tr>
<td>Altitude (meters)</td>
<td>3,250</td>
<td>2,600</td>
<td>3,300</td>
</tr>
<tr>
<td>Irrigation</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Number of Trials</td>
<td>2</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Yield (kg/ha)a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified Seed (Yc)</td>
<td>34,100</td>
<td>16,400</td>
<td>25,300</td>
</tr>
<tr>
<td>Farmer Seed (Yf)</td>
<td>32,300</td>
<td>17,100</td>
<td>24,200</td>
</tr>
<tr>
<td>Seed Rate (kg/ha)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified Seed (Sc)</td>
<td>2,000</td>
<td>2,000</td>
<td>1,900</td>
</tr>
<tr>
<td>Farmer Seed (Sf)</td>
<td>2,000</td>
<td>2,000</td>
<td>1,900</td>
</tr>
<tr>
<td>Seed Price (US$/kg)b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified Seed (Pc)</td>
<td>.16</td>
<td>.16</td>
<td>.21</td>
</tr>
<tr>
<td>Farmer Seed (Pf)</td>
<td>.14</td>
<td>.12</td>
<td>.18</td>
</tr>
<tr>
<td>Yield Ratio (Yc/Yf)</td>
<td>1.06</td>
<td>.96</td>
<td>1.05</td>
</tr>
<tr>
<td>Price Ratio (Pc/Pf)</td>
<td>1.14</td>
<td>1.33</td>
<td>1.17</td>
</tr>
<tr>
<td>Percent Farmers Using Certified Seed</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Expectedc</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Observedd</td>
<td>2.0</td>
<td>6.7</td>
</tr>
</tbody>
</table>

---

**Notes:**

- Yields are based on the results of on-farm trials.
- Prices were provided by National Program leaders.
- Expected results based on the economic model developed in this study.
- Figures are taken from farm surveys conducted jointly by CIP and National Potato Programs.
healthier the seed the higher its production cost and, therefore, its market price. For simplicity, it is assumed that the production cost and selling price of the certified seed are equal.

There may be many differences between 2 lots of seed of a given variety -- e.g. size, physiological age and disease levels. But the distinctive feature of certified seed, as compared to non-certified, is its lower level of virus infection. Controlling for the other variables the yield difference between these two types of seed is due mainly to differences in levels of virus infection. A quantitative model explaining the yield effect of competition between healthy and potato leaf roll virus infected plants has been proposed by De Wit (1962) based in experimental results of Reestman (1946).* Van der Zaag (1972) has extended the work of De Wit by showing that the model can be used to estimate potato yield reductions as a function of the percentage of virus infected plants.

The Reestman-De Wit model expresses the average yield produced by a seed lot as a function of four variables: (a) the yield produced by a stand of 100% healthy plants, (b) the percentage of plants with virus disease, (c) the ratio of yields produced by stands of 100% healthy plants and 100% virus infected plants, and (d) the "crowding coefficient," which measures the compensation power of healthy plants in a field of healthy and diseased plants.

\[
Y_s = Y_h \left( \frac{K(1-Z) + gZ}{K(1-Z) + Z} \right)
\]

where:

- \(Y_s\) = average yield of a seed lot "s,"
- \(Y_h\) = average yield with 100% healthy plants,
- \(Z\) = percentage of plants with virus disease
- \(g\) = ratio between yield when all plants are virus diseased and yield when all plants are healthy, and
- \(K\) = the crowding coefficient.

The crowding coefficient, which depends mainly on variety and growing conditions, may range from 1.0 where no compensation occurs to about 2.5, for crops with abundant foliage growth.

The \(g\) coefficient varies from 0 to 1 depending on the type and severity of virus disease infecting the crop. The lower the value of \(g\), the greater the yield reductions due to virus infections.

* Potato leaf roll virus (PLRV) is one of the major viruses affecting potato crops in the world.
Assuming that the proportion of diseased plants is equal to the percentage level of virus infection in the seed source,* equation (2) can be re-written:

\[
Y_t = S_c Y_h \left[ \frac{K (1-Z_c) + g Z_c}{K (1-Z_c) + Z_c} \right] + S_f Y_h \left[ \frac{K (1-Z_f) + g Z_f}{K (1-Z_f) + Z_f} \right]
\]

where \(Z_c\) and \(Z_f\) percentage of virus infection in certified and farmer seed, respectively.

Using this formulation, equation (4) becomes:

\[
\frac{[K (1-Z_c) + g Z_c] [K (1-Z_f) + Z_f]}{[K (1-Z_f) + g Z_f] [K (1-Z_c) + Z_c]} > \frac{P_c}{P_f}
\]  \(\text{(7)}\)

Solving formula (7) for \(Z_c\) gives the maximum allowable percentage of virus infection that certified seed may carry to be purchased by a profit maximizing farmer.

\[
Z_c < \frac{K P_f \left[ K (1 - Z_f) + Z_f \right] - K P_c \left[ K (1 - Z_f) + g Z_f \right]}{(1 - K) P_c \left[ K (1 - Z_f) + g Z_f \right] - (g-K) P_f \left[ K (1 - Z_f) + Z_f \right]}
\]  \(\text{(8)}\)

This formula provides an approximate answer to the question "What level of virus disease will make a new seed program economically feasible or allow an existing one to expand?"

4. **Empirical Results**

The maximum allowable value for \(Z_c\) the level of virus infection in certified seed, was calculated for 2 highland area in Colombia, and 1 in Ecuador, given observed price ratios for certified and non-certified seed, observed percentages of virus in farmers' seed, and assumed \(K\) and \(g\) values.**

Results indicate that, given existing price ratios, use of certified seed would be less profitable than use of farmers' common seed in two of the three highland locations even if the levels of virus infection in certified seed were reduced to zero. In the third case a very low level of 2% virus infection was allowable (Table 2).

* A reasonable assumption for most situations.

** The \(K\) and \(g\) coefficients were assumed to be 1.5 and 0.5 respectively, on the basis of published estimates of Reestman(1970) and Van der Zaag (1972) for temperate zones and varieties. Estimation of these coefficients requires careful field experimentation, and this work has not been done for Andean varieties and agroecological conditions to date. (No estimates were made for Peru, because of the lack of reliable data on the % of virus diseases observed in the growers' fields).
Table 2. Theoretical Percent of Virus Diseased Plants That Would Make Profitable the Production of Improved Seed in Some Regions of Colombia and Ecuador

<table>
<thead>
<tr>
<th>Location</th>
<th>Observed % Virus Diseases</th>
<th>Theoretical % Virus Diseases</th>
<th>Observed Seed Price Ratio</th>
<th>Theoretical % Virus Diseases in the Improved Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-Improved Seed</td>
<td>Improved Seed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paramos</td>
<td>26</td>
<td>10</td>
<td>1.11</td>
<td>1.7</td>
</tr>
<tr>
<td>Sabana de Bogota</td>
<td>33</td>
<td>11</td>
<td>1.33</td>
<td>0 (1.14)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ecuador</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machachi</td>
<td>18</td>
<td>3</td>
<td>1.17</td>
<td>0 (1.07)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Figures in parenthesis indicate the theoretical seed price ratio consistent with the virus-free improved seed in each location.

Source: Data on observed percent of virus diseases in seed are taken from on-farm trials conducted jointly by CIP and the national potato programs (1978-79). Data on seed prices were provided by the national potato programs.

C. Characteristics of Present Users of Certified Seed

Results presented in Section B indicate that with present price ratios use of certified seed is less profitable than use of non-certified seed. Nevertheless it remains a fact that small numbers of farmers in each of the countries under study do use certified seed. In order to understand this apparent contradiction, characteristics of farmers currently using certified seed in the Mantaro Valley of highland of Peru were analyzed.
On the basis of past experience and farm-level surveys, it was hypothesized that in a given agroecological zone use of certified seed is positively related with use of irrigation, farm size, yield level, seed rate, seed size and level of fertilization. It was anticipated that use of certified seed would be inversely correlated with altitude, because of the slow spread of virus diseases at high altitudes.

a. The Model. A model was formulated to predict whether farmers would choose to use improved or non-improved seed. Probit and logit analysis have been used in previous research on adoption of new technologies (Schulter and Mellor, 1972; Gerhart, 1975). The latter was selected for the present study because of its computational tractability.

The following binomial logit model was specified:

\[
P_i = \frac{1}{1 + e^{-\sum a_j x_j}}
\]  

(9)

\[
1 - P_i = \frac{e^{-\sum a_j x_j}}{1 + e^{-\sum a_j x_j}}
\]  

(10)

where:

- \(P_i\) = probability that the individual \(i\) uses improved seed \(d_i = 1\)
- \(a_j\) = estimated parameters
- \(x_j\) = explanatory variables

An equation to be estimated can be obtained by re-writing the model as follows:

\[
\frac{P_i}{1 - P_i} = e^{\sum a_j x_j}
\]

so that:

\[
\ln \frac{P_i}{1 - P_i} = \sum a_j x_j
\]
A computer procedure "Multinomial Logit Program" was used to produce maximum likelihood estimates for the coefficients of each variable, standard errors, and t ratios.*

Fifteen independent variables were used.**

Data were taken from a 1977 single-visit survey conducted by CIP in the Mantaro Valley of highland Peru. This survey provides data on 493 potato fields (Franco et al., 1979).

b. Results. Results presented in Table 3 indicates that three factors have a significant influence on use of certified seed: irrigation, seed rate, and agroecological zone. The likelihood ratio, which tests the explanatory power of the 15 independent variables, taken as a group, was highly significant.

The estimated logit model was applied to predict the probability that potato producers will use certified or non-certified seed. Probability values were estimated for arithmetic means of the explanatory variables for each agroecological zone and within them, for irrigated and non-irrigated fields (Table 4).

From Tables 3 and 4 it can be inferred that agroecological zone is, by far, the main factor determining the probability of using improved seed in the Mantaro Valley. Irrigation emerges as the most important variable explaining differences in probability within a given agroecological zone. The probability that a farmer in the Low or Eastern Intermediate Zone will use certified seed is four times greater than that of a farmer in the High Zone. The probability that a farmer with irrigation will use certified seed is also 3-4 times greater than that of a farmer without irrigation. The combined effect of all other variables included in the model is very small.

* This computer program was developed by W. Green, Department of Economics, Cornell University.

** (1) altitude (in meters), (2) dummy variable representing availability of irrigation (0 = non-irrigated land; 1 = irrigated land), (3) potato plot area (hectares), (4) seed rate (kg/ha), (5) nitrogen (kg/ha), (6) phosphorous (kg/ha), (7) potato yield (kg/ha), (8) dummy variable representing the Low Zone, (9) dummy variable representing the Eastern Intermediate Zone, (10) dummy variable representing the Western Intermediate Zone, (11) dummy variable representing the High Zone, (12) dummy variable representing seed size over 80 grams, (13) dummy variable representing 60-80 gram seed, (14) dummy variable representing 40-60 gram seed, (15) dummy variable representing seed size under 40 grams.
### Table 3. Multivariate Logit Analysis of the Use of Improved Potato Seed, Mantaro Valley, Peru

<table>
<thead>
<tr>
<th></th>
<th>Equation 1</th>
<th></th>
<th>Equation 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>t-ratio</td>
<td>Coefficient</td>
<td>t-ratio</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.928976</td>
<td>-0.69</td>
<td>-10.760203</td>
<td>-1.80c</td>
</tr>
<tr>
<td>Altitude</td>
<td>-0.0000402</td>
<td>0.52</td>
<td>0.001382</td>
<td>0.96</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1.466867</td>
<td>4.01a</td>
<td>1.451536</td>
<td>3.82a</td>
</tr>
<tr>
<td>Plot Area</td>
<td>-0.040643</td>
<td>-0.73</td>
<td>-0.048812</td>
<td>-0.83</td>
</tr>
<tr>
<td>Seed Rate</td>
<td>0.000718</td>
<td>2.24b</td>
<td>0.000676</td>
<td>2.01b</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.001626</td>
<td>0.97</td>
<td>0.001523</td>
<td>0.89</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.003701</td>
<td>1.41d</td>
<td>0.003362</td>
<td>1.20</td>
</tr>
<tr>
<td>Yield</td>
<td>-0.000046</td>
<td>-0.21</td>
<td>-0.000046</td>
<td>-1.16</td>
</tr>
<tr>
<td>Low Zone</td>
<td>----</td>
<td>----</td>
<td>2.403380</td>
<td>1.64c</td>
</tr>
<tr>
<td>Eastern Intermediate Zone</td>
<td>----</td>
<td>----</td>
<td>2.031317</td>
<td>1.72c</td>
</tr>
<tr>
<td>Western Intermediate Zone</td>
<td>----</td>
<td>----</td>
<td>1.103880</td>
<td>0.78</td>
</tr>
<tr>
<td>Seed Size 1</td>
<td>----</td>
<td>----</td>
<td>0.657594</td>
<td>0.69</td>
</tr>
<tr>
<td>Seed Size 2</td>
<td>----</td>
<td>----</td>
<td>0.838034</td>
<td>1.07</td>
</tr>
<tr>
<td>Seed Size 3</td>
<td>----</td>
<td>----</td>
<td>0.424966</td>
<td>0.53</td>
</tr>
<tr>
<td>Likelihood Ratio Test</td>
<td>40.05a</td>
<td></td>
<td>49.24a</td>
<td></td>
</tr>
<tr>
<td>Degree of Freedom</td>
<td>7</td>
<td></td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

| a | Significant at 0.1% level. |
| b | Significant at 2.5% level. |
| c | Significant at 5.0% level. |
| d | Significant at 10% level. |
Table 4. Probability of Using Improved Potato Seed in Four Agro-climatic Zones, Mantaro Valley, Peru

<table>
<thead>
<tr>
<th>Agro-climatic Zones</th>
<th>Altitude (m)</th>
<th>Probability (%)</th>
<th>Number of Observations (plots)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Zone</td>
<td>3200-3450</td>
<td></td>
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<tr>
<td>Irrigated Areas</td>
<td>26.3</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Non-irrigated Areas</td>
<td>7.7</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td>Eastern Intermediate Zone</td>
<td>3450-3950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated Areas</td>
<td>27.8</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Non-irrigated Areas</td>
<td>8.3</td>
<td>172</td>
<td></td>
</tr>
<tr>
<td>Western Intermediate Zone</td>
<td>3450-3950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated Areas</td>
<td>10.9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Non-irrigated Areas</td>
<td>2.7</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>High Zone</td>
<td>Above 3950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-irrigated Areas(^a)</td>
<td>1.7</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Total number of Observations</td>
<td></td>
<td>493</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) In the High Zone no irrigation is available.
REFERENCES


I would like to congratulate the author for this interesting work. It has stimulated me to think about problems in this area and, I hope, to stimulate further discussion. Dr. Monares' research shows innovativeness and a combination of methods and tools which I find refreshing. However, I feel his approach and vision of the problem area is much too narrow. I want to encourage him to enlarge upon his research in this area. The hows, whys and impediments to the adoption of new technology in the less developed agricultural areas of the world are still very poorly understood. Over the past 20 years a vast literature has developed around the green revolution and around the wonders that the new high yielding varieties of corn, wheat and rice will produce.

There is a great amount of discussion devoted to the need for improved cultural practices, the difficulty of getting the majority of farmers in any area, product or country to adopt improved cultural practices and some lip service to the notion that the rate of adoption is related to the social, political and economic environment in which the farmer lives and works. Yet there is little information on the whole adoption process.

CIP's work, if it is to be relevant to a wide range or area, must face the decision involved in allocating scarce resources among alternative ways of doing things. For example, one way to encourage the adoption of output increasing technologies is by large increases in prices paid to farmer e.g. 50 or 100% or more. In contrast the same result might be obtained by a very small investment at the farm or community level. In between these two extremes one can conceive many possible combinations that could achieve a given level of increase in production. Currently we know very little about what these variables are and much less about their trade-offs. Even, socioeconomic research in specific areas on specific problems cannot ignore the larger context of the problem setting. For example, the author assumes that farmers are simple profit maximizers (Equation 3) and develops a complicated model that probably ignores many of the most critical variables.
In encouraging the author and CIP to expand their work in this area, there are several important factors that must be included in their research if their results are to be relevant to the problems they face.

First, there was much discussion in the 1977 CIP Planning Conference of identifying constraints to higher yields. Most of it assuming that one can identify the factors which might be constraining adoption of new technologies or achieving the results they promise in field trials. In reality we have a very poor understanding of this process. The farmer operates in an integrated environment. He is surrounded and influenced by forces which social scientists classify in boxes as sociological, political, psychological and economic. By training and tradition the social scientist sets up his research under a *ceteris paribus* assumption. This is part of the tradition of the scientific method which was developed primarily in the experimental sciences. In contrast, the social sciences are not experimental. We do not and cannot generate data, holding all but the experimental variables constant. We must take our data as generated by the realities of the situation in which it is encountered. Thus our data contains all the sources of variation that one can possibly imagine while our models have inherent in them a strong omitted relevant variable bias.

If our understanding of the spread of technology in a rural setting is to grow, we must develop models which include at least the major sources or variations that conceivably influence the dependent variable of research interest. We can then use statistical rather than experimental controls in our research. However, before we can develop such models we need to know what variables are important rather than assume them away. What I am saying is that models such as those in Dr. Monares' paper which assume adoption rates are a function of a very small subset of economic variables, are very limited in their usefulness.

The economist cannot ignore the noneconomic variables nor can the sociologist or the anthropologist ignore the economic structure in which the farmer operates. To do so is akin to the heart surgeon ignoring his patients immune reaction system in doing a heart transplant.

To be more specific, A. Monares postulates the following model:

(1) \[ I = f(Q_i, R_i, P_i), \text{ where,} \]

- \( I \) = Profit
- \( Q_i \) = Quantity of seed of type i,
- \( R_i \) = Yield of seed type i,
- \( P_i \) = Price of seed type i.
He proceeds to use real world data to quantify the model and to draw conclusions from it. Although he controls for some sources of variation, there is much room for improvement. Equation 2, below, is a much better conceptualization of what the data reflects.

\[ I = f(Q_i, R_i, P_i, M, E, G, S, e), \text{ where,} \]

- \( I, Q, R, \) and \( P \) are defined in equation 1, and
- \( M = \text{Management capabilities of the farmer}, \)
- \( E = \text{Set of economic variables influencing the farmer}, \)
- \( G = \text{Set of political variables influencing the farmer}, \)
- \( S = \text{Set of sociological factors influencing the farmer}, \) and
- \( e = \text{Random nonmeasurable occurrences and events}. \)

Comparing models 1 and 2, I conclude that A. Monares' profit maximizing model may have assumed away the most important source of variation in the Andean potato farmers' profits. Given the data sources he had to work with, he may not have had any choice. Nonetheless, looking at the available data set from the viewpoint of model 2 gives the researcher a much different perspective on the results.

My second point is a reemphasis of an earlier statement: if we are to make real progress in understanding how new methods, practices and ideas can best be introduced into traditional cultures, we first need to know what variables to include in our models before we attempt to specify how they affect our dependent variables. In my view, the most productive areas of research are likely to be through collaborative work across the disciplines.

I also expect the reliability of the results are very low, given the few observations upon which it is based. I would rather have seen the author develop a set of critical price ratios. This ratio would show the trade-off between yield and price for a given percentage adoption. The results could then be checked against actual field observation in other places.

Thirdly, we need much more replicative research. Why do economists feel that after one research project on the adoption of an innovation the profession is prepared to make generalizations and draw conclusions? We would question any agronomist who made recommendations on potato culture after one set of field trials. Yet, the agronomist has a much tighter control over his research data than his social science counterpart.

Fourthly, the assumption of a simple linear additive functional form is probably far from reality. For example, the linearity assumption in the logit model seems much too simplistic a view of real world data. I would expect that nitrogen, phosphorus and yield interact. The effect of
yield on adoption probabilities depends upon the level of nitrogen and phosphorus used by the farmer. Similarly the impact of seed rate (its coefficient) may be different in the low zone than in the high zone. Interactions are very common in the real world but they are almost always assumed away in the models we quantify. I also expect that the real world is non-linear. Given that our quantitative methods have difficulty in parameterizing non-linear models, introducing interaction terms into linear models can frequently approximate real world non-linearities.

Fifthly, economists tend to utilize a very limited set of quantitative techniques in their research. Ninety percent of the time it is regression or one of its derivatives. Other disciplines have developed and refined many other multivariate methods that often times are well suited to solving particular research problems. Unfortunately, our training in quantitative methods tends to be quite parochial. For example, discriminant analysis would be a much more appropriate technique for finding variables which discriminate between farmers who use improved seed and those who do not. I recommend using discriminant analysis to select the important variables that discriminate well between users and non-users and then use the logit model to get a better fix on the effect of each of those variables.

Finally, if one is to make policy inferences from research, then policy variables must be included in the analysis. In the logit model there are no variables that could be considered as policy variables. Thus the conclusion that "the limiting factors in growing potatoes ... are beyond the scope of government policies" grows out of the assumptions of the model not out of its results.

In summary, the fundamental hypothesis of the paper is a good one. We desperately need much more knowledge in this area. Unfortunately, the author was extremely narrow in his conceptualization of the problem. This is reflected in his models and how he operationalized them. Variables such as the management capabilities of the farmer, differentials in storage and marketing costs, the farmers perception of seed availability, the stability of market prices, and the marketability of his surplus production are a few examples that likely affect his decision to adopt or not adopt.

I note that, in session IV, there will be a discussion of future research areas including farmer acceptance of new technologies. I urge that at least some research projects in this area be devoted to a descriptive analysis of variables which farmers see as important to their decisions to use or not use a new technology. Such a study would have the most usefulness if it had cross-country comparability. It would provide a very useful framework within which further research hypothesis and economic analysis of new technologies can be developed.
AN INTERDISCIPLINARY TEAM APPROACH TO THE
DESIGN AND TRANSFER OF POST-HARVEST TECHNOLOGY

Robert E. Rhoades
Robert H. Booth

A. Introduction

Among the proliferation of strategies in the 1970s to improve food production in developing countries has been an emphasis on interdisciplinary teams in the identification, generation, and transfer to farmers of appropriate technology (Consultative Group on International Agricultural Research, 1978). These pleas are grounded in the realization that understanding agriculture requires the expertise of several disciplines. Farming is seen as more than ... 

... simply a collection of crops and animals to which one can apply this input or that and expect immediate results. Rather, it is complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences with the strands held and manipulated by a person called the farmer who, given his preferences and aspirations attempts to produce output from the inputs and technology available to him (CGIAR 1978:8).

With the accepted view that farming is not merely a technological endeavor but a socioeconomic one as well, social scientists are generally seen as indispensable to any team effort to improve production. However, a review of the literature shows that truly interdisciplinary teams with social scientists involved from the design to the transfer stage have rarely been constituted or, at least, the cases have never been documented (see Hildebrand n.d. for an exception).

A Technical Advisory Committee (TAC) Team of the International Agricultural Research Centers in reviewing Farming Systems Research at four international research centers points to a historical fact: "the most difficult role to integrate has been that of the social scientists"
The reasons for the difficulty of incorporating social scientists are not clear.

One possible explanation is that social scientists have been brought at the final farmer evaluation of a proposed technology. When farmers reject an innovation or the consequences of the technology is negative this may force the social scientist into the role of bearer of bad news. Thus social scientists have, rightly or wrongly, frequently been seen as after-the-fact critics who study and document cases where change agents or designers of technology have gone wrong in social, cultural, or economic terms. Many biological scientists are sensitive to the fact that new technology must be socially and economically relevant, but this 20-20 hindsight has generally left them skeptical of the social science contribution to improving the food production efficiency. In other cases, social scientists are often asked to do ex-ante feasibility studies but frequently this input does not carry through to other stages.

The same TAC review committee on farming systems, in commenting on the social sciences further comments that "production economics (is) essential at all stages of farming systems research" (CGIAR: 1978:64) while sociology or anthropology "should not be regarded as necessarily having an essential or permanent status" (CGIAR: 1978:64). These disciplines may nevertheless have consultative roles.

Since 1975, however, the International Potato Center (CIP) has made a strong push toward the use of anthropologists and sociologists, including their permanent incorporation into ongoing research teams dealing with the design, transfer, and evaluation of improved technology.

The objective of this paper is to describe the CIP team interaction in order to derive a suggested model and guiding principles for interdisciplinary research aimed at solving farm-level technological problems. Additionally, we will also briefly comment on the anthropological and sociological contribution to the team effort.

B. The Background

The International Potato Center with headquarters in Lima, Peru has as part of its mandate to rapidly develop and expand the research and technological base to solve problems limiting potato production in developing countries. CIP's source research is organized around nine technical "thrusts" which objectives ranging from collection and maintenance

* Farming System Research (FSR) is perhaps the most ambitious interdisciplinary Research effort yet undertaken by the various international centers.
of a world germplasm bank, control of diseases and pests, agronomy, seed production and distribution, and post-harvest technology. By establishing the latter, CIP recognized the importance not only of production but also of post-harvest constraints.

Realizing the design and transfer of improved potato technology needs socioeconomic input, a Social Science unit was established including not only economists but anthropologists and sociologists. The first anthropologist (Robert Werge) was assigned to CIP's post-harvest thrust led by a processing and storage specialist (Roy Shaw). In early 1978, the team was joined by a storage specialist (Robert Booth) and early 1979, after the departure from CIP of Robert Werge, another anthropologist (Robert Rhoades) joined the post-harvest group. A Peruvian sociologist (Maria Isabel Benavides) has worked part-time with the team since 1980.

C. Storage in the Andes: The Beginning of Understanding

To understand the anthropology/sociology contribution and role on CIP's post-harvest team, it is necessary to carefully study the interaction which occurred overtime between members. Initially, the anthropologist (Werge) set out in the Mantaro Valley of the Central Peruvian Andes to study post-harvest activities and problems facing highland potato farmers. The biological scientists at first restricted their activities to the experiment station located in the same region. However, from the beginning a dialogue between members was established and maintained.

Soon, however, social scientist and technologists found themselves engaged in an intra-team debate over the concept of "storage losses." The potato as a vegetable tuber, unlike the grains, is a highly perishable item. The storage specialists were logically concerned with how to design a storage system to reduce both pathological and physiological losses since these are major technological problems. Werge, however, based on his two month informal survey, argued that Central Andean farmers did not necessarily perceive small or shrivelled and spoiled potato as "losses" or "waste" (Werge, 1977). All potatoes were utilized by farm families in some form. Potatoes which could not be sold, used for seed on immediate home consumption were fed to animals, mainly pigs, or processed into dehydrated potatoes (chuño) which could be stored for as long as two or three years. In addition, wives informed him that in culinary quality the shrivelled, partially spoiled potatoes tasted "sweeter" and were often desired.

"Rob's observations," as one of the biological scientists put it, "was the beginning of understanding of a reality, mainly that we scientists often perceive technical problems through a different set of eyes than farmers. Losses to us were not necessarily losses to farmers."
Still, after further investigation and exchange of ideas the problem turned out to be more complex than either anthropologist or storage specialists had realized. Robert Booth in reflecting back on the experience explained:

I was not totally convinced of Rob's argument, although he certainly made me think about what I was doing. We (biological scientists) hadn't even really talked to a farmer about the problems we were working on. We were doing research about a problem from a distance not research to solve a problem. When I finally went with him to visit farmers I could see he was right, but only partially. We saw that farmers utilized surplus and waste potatoes to feed pigs and that there was something to the culinary aspect, but the problem still seemed more complex. As we talked and argued, things began to click. There has been a misinterpretation on both sides (anthropologist and specialist) but slowly we knitted things together.

It turned out that there were indeed "real losses" in storage perceived by many farmers. Since small farmers in the study area stored all potatoes together, whether for consumption, sale, or seed, they did not automatically offer information to the anthropologist on different requirements and activities related to potatoes destined for different purposes. While there may have not been losses perceived by farmers in consumption potatoes or those destined for animal feed, "losses" in seed potatoes emerged as a farmer identified problem.

Through interaction with the biological scientists on technical aspects of storage, Werge was able to sharpen his questions and ask them in a different way. He learned from scientists that potatoes stored in darkness produce long sprouts that are generally pulled off before planting. When he asked specifically about this activity farmers complained of the cost in time and labor associated with desprouting. Thus, farmer "losses" were not merely physiological problems but social and economic ones as well. The team now appeared on common ground with the farmer. By drawing knowledge from farmers and both disciplines, they jointly formulated a commonly agreed upon problem needing action: seed potato storage.

D. The Initiation of Action: The Case of Rustic Seed Stores

The biological scientists set up on-station experiments using known scientific information: that natural diffuse light reduces sprout growth and generally improves seed quality (Dinkel, 1963: 1047-48). This was a
principle developed long ago by European farmers (and elsewhere) but has largely been abandoned as a storage technique in Europe as a result of the introduction of refrigerated stores, although still used as a pre-planting practice. The on-station experiments were successful in terms of reducing sprout growth.

However, the engineering behind the stores was still developed from the biological scientists' point of view alone. Anthropologist Werge was concerned whether the design related to the farmer. Was it acceptable? He had been doing research on the architecture and uses of farm houses and buildings and was concerned with how the seed stores might fit. A storage facility separate from the house did not seem realistic (because of security problems and convenience), nor did it seem possible to introduce diffuse light into the dark, traditional stores. Diffuse light produces "greening" in potatoes which renders them inedible.

The anthropologist was anxious to begin on-farm trials to test acceptability of the design. The team inspected farm houses and talked the problem over with farmer cooperators. The inner court yard of many Andean houses have a veranda with a roof which lets in indirect light. It was decided to set up under the veranda conventional "seed trays" taken from the experiment station stores. These on-farm experiments yielded the same scientific results as on the experiment station. Farmers expressed interest, but concern over the unavailability and cost of seed trays. As a result of this feedback from farmers the technologists designed simple collapsible shelves constructed from locally available, unworked which they used in the second series of on-farm trials. Again, similar results in terms of seed tuber quality and increased yields were obtained. Farmers were now able to relate much more closely to the technology.

However, few of the farmers in the Mantaro Valley where the research was conducted have to date accepted the technology as originally demonstrated. Many have accepted the principle and are simply spreading seed tubers on the floor in thin layers but purposely exposed to diffused light penetrating the veranda area. It is clear that least initially farmers are reluctant to invest time or finances in building seed trays. Whether this wait-and-see experimentation with floor spreading will evolve into better but more costly store remains to be seen.

E. Processing: The Case of the Black Box

Another case of how anthropological input turned around the direction of a research project deals with CIP's processing research. Throughout the Andes, potatoes are dehydrated through solar drying for
long-term storage. Originally, project administrators and processing specialists thought the problem was solar drying, that farmers needed a more efficient and rapid way of dehydrating potatoes.

Roy Shaw, brought to CIP to work specifically on processing, first set out on a course independent from his anthropologist colleague. He designed a simple "Black Box" which made drying more efficient.* However, the anthropologist felt Shaw's on-station research needed on-farm testing. Werge actually took the black box to the villages to obtain opinions and evaluation of those that would be using the technology, mainly village women. Their conclusion: solar drying was not limiting (i.e., speed of drying was not important). It makes little difference to farmer if it takes one day or several days to dry potatoes. There was no hurry. Instead, farm families expressed interest in more labor efficient methods in cutting and peeling of potatoes. Shaw in thinking back on the experience noted:

We were again designing post-harvest technology from a distance. Since we were dealing with a dehydrated product, the problem seemed one of solar drying. We knew about peeling and cutting but since those were labor-intensive they were thought of as desirable and as problems.

As an anthropologist, Werge was suspicious of the widespread belief that rural people need and want labor-intensive technologies (Brush, 1977). This is specially true in the Andes where a rugged terrain, great distances between fields, and an enormous range of farm and off-farm activities put intense pressure on family labor. With this in mind, Shaw reoriented his efforts toward development of simple peeling and cutting equipment relevant to the total system, including a socioeconomic component, of producing dehydrated potatoes. On the socioeconomic side, two components were stressed:

1. technology design had to be economical and acceptable to the people,
2. equipment must be built in local workshops using locally available materials.

* The "Black Box" is simply a 1 by 2 meter and a half meter deep wooden box painted black. The sun—specially the Andean sun at high altitudes—shining through the slanted transparent box cover produced an atmosphere with the box to speed drying.
Shaw explained:

I first thought about having the equipment designed and manufactured abroad and shipped in. This would have been easier for me. But by this point we had been through the storage experience and we knew that we had to adapt our technology to the farmer's conditions.

Although the black box technology did not seem appropriate for small scale, private farmers, the team did not abandon the concept of solar drying. Instead, they looked for a socioeconomic context where it might fit. Since farm families in the Andes produced dehydrated potatoes for home consumption, very little was sold for commercial purposes. Only 5 of 52 families studied by Werge sold a part of their product (Werge, 1977). A sociological study of demand for dehydrated potatoes among migrants from the mountains now living in coastal cities suggested that a shift in scale seemed possible (Benavides and Horton, 1979). If economically realistic to produce dehydrated potatoes on a scale larger (village level, cooperatives, or commercial enterprises) than the family and a demand existed solar drying efficiency as part of a complete process seemed feasible. Based on these possibilities, a low cost processing plant was built using local expertise and equipment. This equipment was demonstrated to a variety of possible clients through fiedldays. The response was similar to the storage case. At least eight processing plants have been built.

F. Anthropological Impact on Training

Paralleling experiment station and field research activity was the need to train national potato workers in the principles of storage. However, as a result of the Mantaro Valley experience a new orientation to training, which had previously been primarily a technical exercise was developed. Robert Booth put it this way:

Rob was interested in training as a transfer mechanism but at first he was irritated with our overly technical approach. Roy and I were initially regurgitating "textbook" storage principles and spouting static technological design. However, as a result of four years in the Mantaro Valley we began to talk about technology and training in a social and cultural context and the need to design acceptable technology.

Therefore, in training courses they began to push an integrated approach. To a great degree, the technologists had by this point become
their own "back-pocket" anthropologists and the anthropologist a storage "expert." Perhaps more important for training was not the expertise they had gained in each other's areas, but the development of a common philosophy that agricultural research must begin with the farmer and end with the farmer. Courses were subsequently conducted in several world areas. Based on the Peruvian experience, the team argued with trainees and national potato program workers to first go to the farmer and find out what are his present practices, why he follows them, and how he perceives his problems. They related to trainees the Peruvian case in great detail, arguing that unless they also wanted to go through a similar long drawn out period of trial and error they should pay heed to the Peruvian case.

G. The Need for Continuation and Evaluation

The departure of Robert Werge from the team in 1979 left a break in the ongoing integration of the team. Another anthropologist (Rhoades) arrived about the same time but became involved in another research project. However, due to the biological scientists previous experience, a continual dialogue was maintained with the new anthropologist.

The need for continued, more substantial anthropological input into the storage effort became clear during a trip into the potato producing area of the northern Philippines. Booth and Rhoades observed the first tangible payoff of the post-harvest thrust's approach to the design and transfer of technology. In the previous year, Booth worked closely with national potato program workers to find out if the seed storage technology was relevant to the region. At that time, Booth was working as his own social scientist and carried out informal interviews using key informants. Under the guidance of national potato program workers, he met with farmers and talked over their storage problems. As a consequence, in 1978 the farmers in one community decided to erect a small demonstration seed store on their own. This was followed by 5 more demonstration stores built by the National Program. By 1979, a survey (Rhoades et. al. 1980) revealed at least 40 farmers in the area had made alteration in their seed storage practices, mainly by letting in diffuse light, and by 1980 this number increased to over 120 known adopters.

However, while positive response to rustic seed stores has been seen in Peru, Guatemala and the Philippines the idea has been moving slowly or not at all in other countries. The post-harvest thrust was looking for some gauge on where and under what conditions would it be most appropriate to apply their efforts. Thus a need was emerging to understand the acceptance and rejection of the innovation where it had been introduced by or with the help of trainees.

Technology should not be simply designed and introduced. Constant feedback is needed in order to continually improve the technology. Again,
these are not purely technical problems needing investigation. To understand innovation diffusion and consequences, and the evaluation of the technology under different environmental and institutional conditions, the technologists felt they lacked the necessary expertise to do the research alone. Thus, Rhoades joined the team to collaborate in this research effort. While the anthropological input into the team effort on seed storage had shifted the team considered evaluation just as crucial as the initial design stage, specially as more training in developing countries was conducted. Again at this stage, the social scientist worked closely in the field with technical scientists.

With rustic seed storage technology in a refinement and transfer stage, the team decided to tackle new storage problems, specially storage of consumption potatoes. This means, however, repeating —hopefully with fewer mistakes— the same steps followed in interdisciplinary research on seed storage and processing.

H. A Model for Interdisciplinary Team Research

In outlining how the team will proceed with future research and reflecting on past experience, certain guiding principles and stages emerged. These are diagramed in the attached circular figure.

1. **Research must involve a farmer-back-to-farmer process.** A guiding rule of the post-harvest team has been that agriculture research aimed toward improving technology must begin and end with the farmer. This is reflected in the diagram with farmer as both a starting and finishing point. It cannot begin in isolation on a research station with a planning committee out of touch with farm conditions. The top circle labeled "farmer" represents the totality of the farmer's practices and problems, in this case related to storage of potatoes. Appropriate technology must therefore address directly the farmer's problems, not what is presumed by outsiders to be his problems.

2. **Diagnosis: farmer, social scientist, and biological scientist.** The first research activity involves a diagnostic stage in which farmer, social scientist and technologists using their own backgrounds and skills interpret possible problem areas. Without a precise definition of the farmer's problems, applied laboratory or on-station research at this stage is possibly premature. Therefore, research must be "task-oriented."

Biological scientists at this stage will most likely be concerned with fairly narrowly defined technical problems, i.e., focussing on the technology, while social scientists will most likely focus more broadly on perceptions, beliefs, social conditions, and economic rationality.
Diagram 1.

An Approach to On-Farm Research

1. The Farmer
2. Diagnosis
3. Constructive Conflict
4. Common Definition
5. Team Research
6. Potential Solution
7. Farm Testing
8. Science Archives
9. Farm Evaluation

Acceptance or Rejection
that may bear on the problem area. Since the social scientist is specially trained to interpret the farmer's worldview and behavior, he will probably serve as a bridge between farmer and technologist at least regarding socioeconomic patterns.

3. **Constructive conflict and dialogue.** During the diagnostic stage it is probably inevitable that disagreements or questions over interpretation of the problem will arise. We have labelled this stage "constructive conflict" which corresponds in the case study to the disagreement over "losses" or the importance of time to Andean families in solar drying potatoes. Armed with information from the farmer, the scientists should engage in a process of debate to arrive at a more comprehensive problem definition and hypothetical solutions.

4. **Common definition of the problem.** The purpose of the diagnosis stage is to arrive at the widest possible consensus (farmer, social scientist, biological scientist) on a definition of the problem. In the case, the commonly defined problem centered on seed potato storage. In the Andean case, however, it does not appear that "losses" in consumer potatoes are perceived by farmers and scientists in the same way.

5. **Team research to amplify knowledge about the problem.** With the problem well-defined the team can now proceed forcefully with on-station research guided by farm-level information. In the case above, there was constant on-the-spot feedback between reaction and design of technology. This process should be ongoing throughout the design stage. Compromises and changes of direction may be required.

6. **Potential solution.** The purpose of the linked on-station and farm-level team research is to arrive at a potential solution, rustic, indirect diffuse light stores in the storage example. This is shown in circle following team research. Note that a portion of the farmer's problem is still undefined. Proposed solutions are rarely complete. Our feeling is that farm problems are immensely complex and interrelated and the thousands of variables a farmer faces can never be totally defined.

7. **Farm testing and evaluation of proposed solution.** This stage involves the actual use of the technology by the farmer, under his conditions and largely his management. Comparison with his traditional practices may be desirable. The point is to secure information on how the technology works under actual farm conditions.

If research results do not get back to the farmer in an acceptable form, unless the circle can be completed, then efforts may have been fruitless and research findings shelved in science archives. In our opinion, farmer participation from the beginning makes acceptance more
likely. If technology is rejected by the farmer, the research process can be repeated to determine the reasons and find ways to overcome them.

I. Other Considerations in Team Research

In addition to pursuing a farmer-back-to-farmer circular research methodology, the post-harvest case has pointed to a number of other guiding principles necessary for successful team research.

Based on our experience, we feel the team must work together through all the stages, from design to transfer. If it can be avoided, social scientists should not serve as simply part-time consultants but should feel they contribute to either the success or failure of the technology as much as the biological scientist. The tendency to view the social scientist simply as a service consultant to biological scientists must be avoided. The social scientist must be a fully integrated, participating, and responsible team member. If the anthropologist had been attached at the beginning to do only a survey (which the technologists claim they would have never read) or to do an evaluation after the fact, the chances of success will be greatly reduced.

Also, team members must develop a mutual respect and confidence in other disciplines as well as working knowledge of those disciplines. Technologist should appreciate the need to view the technology through the eyes of the farmer and recognize the importance of sociocultural factors. They should be open to the possible need to abandon or re-orient the technology. Similarly, anthropologists should not fall into the "social science syndrome" of cynicism toward technological change and avoid the philosophy that farmers are already perfectly adapted to the point that no improvements can be made. If a social scientist believes this, as is often the case he or she has no active place in planned, agricultural change. The question of whether one social science discipline is inherently more valuable than another (e.g., production economics versus anthropology) is in our opinion a bogus issue. Interdisciplinary research on agriculture research requires flexible, broadbased socioeconomic experience and expertise, at least in the post-harvest case. Economists can do this job as well as anthropologists, but anthropologists because of disciplinary label and association should not be automatically ruled out of an essential or permanent role.

Anthropology is perhaps specially relevant to the post-harvest team effort because of its methods and holistic theories which permit tracing the connections, specially in rural communities, between the mundane, bread and butter activities of farming and beliefs, religion, kinship, social institutions, material culture and even ecology or economy. Architecture, taste preferences, or cultural importance placed on time and
efficiency are typical areas that sociologists and anthropologists investigate but are not covered by sister social sciences. Although anthropologists do not reject and even use quantitative methods, the crux of their methods center around a total immersion (even during a short informal survey) in farming and social activities which can yield a special holistic understanding of farmer decision making.

Anthropology stresses the essential rationality of human adaptation to the wider social and physical environments. People (specifically farmers in this case) behave the way they do for very good reasons and for survival have through long-term adjustment and adaptation arrived at reasonable solutions. Farmers in particular carefully weigh "new" technologies in light of what they know already works, however imperfect that may be, and thus maintain a selective balance between the new and old. The anthropologist, in trying to see the world through the farmers' eyes, will always ask if the proposed technology can improve on those reasonable solutions and is it acceptable to farmers. Could the biological scientists have arrived at the same point without the anthropology input in the storage case? "Perhaps, we will never know, but it surely would have taken much more time at a great loss of energy and money," argued Roy Shaw.

Of course, one role of the anthropologists in this case study has been that of a link between technologists and farmers. Is this role important enough to justify maintaining or promoting the anthropological input into international centers and agricultural organizations dealing with designing and transferring new technology? The CIP post-harvest biological scientists feel it is. One biological science member of the team put it this way:

Getting us to see the farmers point of view is a necessary job. We don't get hung up on the fact that anthropologists help link us with our clients. There is nothing degrading about this role and if anthropologists think it is then that is their problem. Communication between scientists and farmers is an art requiring an expertise most biological scientists don't have.

J. Conclusion

In this paper, we have purposely limited ourselves to a case experience in interdisciplinary team research. We have not gone into detail on how each team member applied his expertise in working toward a common solution. We cannot state that our experience or proposed model is relevant to other problem areas. It is possible that post-harvest technology is a special case amendable to use of social science perspectives. However, we hope that by describing the case and offering our interpretation, that others will find relevance and suggestions for action in the implementation in their own research.
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COMMENTS

Sergio Ruano

Rhoades and Booth's paper describes how to carry out interdisciplin­ary research in a simple and effective way. In particular, it shows the relevance and importance of social science participation in generating and evaluating new technology.

Given the commercial orientation of many biological scientists, it is difficult for them to comprehend the arena where marginal, subsistence producers are working and living. Moreover, biological scientists may not understand macro-level political and socioeconomic structures if they have not been trained to do so. On the other, most social scientists are
prepared to analyze socioeconomic and cultural issues which are not related directly to agricultural technology. As a result, if social scientists do on-farm research on their own, they often come up with information that is irrelevant to the generation or adaptation of new agricultural technology. Biological scientists and social scientists doing research together --through all the stages of a given project-- is the most effective way to minimize a disciplinary bias. The methodology explained in the paper gives guidelines how we can go about this, not only in post-harvest but other areas of research as well.
ON-FARM RESEARCH TO OPTIMIZE POTATO PRODUCTIVITY
IN DEVELOPING COUNTRIES

Roger Cortbaoui

A. Introduction

CIP's present Optimizing Potato Productivity approach is the result of various research activities conducted during the past five years by regional and source scientists. These activities can be grouped as follows:

1. The Mantaro Valley Project (1977-1980) which constituted the "laboratory" where various on-farm research procedures were evaluated as to their adequacy for developing countries' conditions.

2. The Maximizing Potato Productivity Project, its Manual (January, 1978) and Planning Conference (December, 1978) which directed on-farm potato research towards the regional programs and motivated the adoption by CIP of on-farm research as part of a strategy for testing its technology in farmer's fields.

3. The implementation of the re-defined approach through several regional and country programs (1979-1982) and the continuous utilization of the experience gained to modify the research procedures. This aimed to make them more accessible to those for whom they were being developed: National Potato Programs. This emphasis on accessibility to national programs workers is the reason for the "simplicity" of CIP's on-farm research approach in comparison with that of some other International Agricultural Centers. We feel our approach is correct, because in the majority of cases on-farm research is being carried out by production agronomists with limited budgets and facilities.

After a general description of the OPP approach, this paper will review its implementation at the regional level and discuss the present and future roles played by the Social Science Department in this implementation.
B. The Optimizing Potato Productivity Approach

CIP has adopted an agroeconomic approach centered on farm-level evaluation of alternative production technologies, in order to improve the overall efficiency of generation and transfer of potato technology. This approach is termed "Optimizing Potato Productivity" (OPP). Its ultimate goal is to identify technological changes that farmers could make in their crop production system to improve their potato production or net returns derived from the crop. The basic assumption behind this approach is that to be potentially adoptable, a technology should be appropriate for the needs and resources of the farmer and bring an improvement in production* and returns** which covers the costs and risks associated with its adoption.

The procedures advocated are meant to be an intermediate step between the generation of technologies and their dissemination, which contribute to the efficiency of both research and extension by: (a) testing the relevance of research results for solving farmers' production problems, (b) allowing better selection of technologies to be disseminated, and (c) providing better information on farm-level production problems which stimulates additional research oriented towards solving specific production problems.

CIP's approach consists of three major phases respectively centered on the achievement of the following goals:

- Identification of alternatives to the present crop production system.
- On-farm testing of these alternatives in comparison with the farmer's current practice.
- Evaluation of the alternatives in terms of improvements in production and returns derived from the potato crop.

The three phases and their sub-phases are in the following sections.

1. Phase I: Identification of Technological Alternatives

The first phase of on-farm research aims at identifying possible ways in which the farmer could improve potato production and returns

* Production improvements do not always refer to quantitative increases in yield but might concern qualitative improvements of the product.

** Improvement in returns might come from, e.g., increased production, qualitative improvements of the harvest, cost reduction, better timing of harvest to meet better prices or to make land available for other crops, etc.
from the crop. This requires thorough study of the present crop production system in a given area and of the relevant alternative production technologies. Four steps must be taken:

a. **Zoning of the Area under Study.** The study area is delimited and divided into sub-areas or agroecological zones, on the basis of potato production conditions within the cropping system, climatic and topographical factors, land tenure and use, etc.

b. **Study of Crop Production Systems and Farm Types.** The production systems of each zone are studied and analyzed. For this purpose, an "informal survey" of the area is essential. This may be supplemented by a "formal, questionnaire survey" to quantify specific aspects of the crop production system. Distinct farm types may be identified, with different production systems and potentials for change.

c. **Diagnosis of Limiting Factors.** Components of the farming systems which are thought to be limiting the quality or quantity of production as well as returns from the potato crop are listed and ranked in order of importance.

d. **Identification of Technologies for Farm-Level Evaluation.** Knowledge of factors limiting production and returns, and of available technological alternatives is used to select technologies for evaluation in farm-level trials.

2. **Phase II: On-Farm Trials**

At this stage the researcher has developed hypotheses concerning one or more factors that could improve production and returns. On-farm trials are used to test these hypotheses. The following considerations are of special importance:

a. **Choice of Farmer Collaborators.** Farmer collaborators should be representative of important farm types in the area, and should be aware of the production problem under study. The number of collaborators chosen will depend largely on human and material facilities available for the research program, but should ensure several testing sites for each technology under study and a geographical distribution of the trial over the study area.

b. **Execution of On-Farm Trials.** The trials are meant to compare an alternative technology against the farmer's current practice. Thus, the "farmer's technology" should be an integral part of the trial (a treatment). Trials should be simple in design and layout, consisting of adjacent plots representing the "farmer's treatment" and the alternative technology.
c. **Follow-up of the Trials and Data Recording.** Regular follow-up visits are essential for: (a) executing the different cultural practices at the right time, (b) recording necessary agronomic and economic data, and (c) discussing performance of the proposed technology with the farmer collaborator. Data recording should be in accordance with the type of agroeconomic evaluation planned. In other words, the researcher should record data needed for the evaluation process. The necessary data relate mainly to agronomic and socioeconomic changes resulting from application of the proposed technology -- data on yield, quality of harvest, costs and returns, and compatibility of proposed changes with the farmer's goals and resources.

d. **Participation of the Farmer.** The farmer collaborator should play an active role in implementing the trials, not only because he lends his land and inputs, but because his personal evaluation of the proposed technological alternative is an important part of the research. Care should be taken to ensure that the farmer understands the trial and its results. Ideally, most inputs used in the trial should come from the farmer. The researchers may provide some inputs to compensate for extra costs and risks incurred by the farmer. But this compensation should be kept small, so as not to "buy" the collaboration of the farmer, regardless of the technical content of the trials.

3. **Phase III: Interpretation and Evaluation of Trial Result.**

By the end of the second phase the researcher should have accumulated a large amount of data concerning the agronomic and socioeconomic performance of the proposed technology in comparison with the farmer's practice. These data, gathered for all the farms where the alternative has been tested, consist of figures on production costs and returns for the prevailing farmer's practice and the alternative tested and qualitative information concerning the possibility of incorporating the proposed alternative into the farmer's production system. The third phase of the approach concentrates on utilizing these data in drawing conclusions about the potential of the proposed technology for improving potato production at the farm level. Two types of analysis are proposed:

a. **Micro-Analysis of the Trials.** For each of the experimental sites the following questions need to be answered: (a) Did the alternative technology produce better (quantitatively and/or qualitatively) than the farmer's present practice? If so, how much better? (b) Did the alternative increase net farm returns? If so, by how much? (c) How did the farmer evaluate the technology? Does adoption appear to be feasible and likely?

b. **Overall Interpretation of the Results and their Use.** Considering the agroeconomic performance of the proposed technology across several testing sites and farmers' opinions of the technology, the researcher
will judge its "adoption potential" within the present crop production system. Based on this judgement, he will decide what recommendations to pass on to extension agents, what questions to feed back to lab and experiment station researchers, what information to share with policy makers, and what technologies to test in the next cycle of on-farm research.

C. Implementation of OPP at the Regional Level in 1979-1980

During this period the OPP approach was implemented in several country programs. In addition three regional training activities were conducted: a Seminar was held in Costa Rica for the Central American countries (August, 1979); a Course was held in Peru for agronomists and economists from several Latin American countries (October, 1979); and a Seminar was held in Turkey for representatives of Middle Eastern and North African countries (August, 1980). These three activities brought to the participants CIP's views and experience in on-farm research and served the purpose of stimulating OPP work in different countries.

The various field activities conducted during this period by CIP regional scientists and their national counterparts can be summarized as follows:

1. Region I

Peru. Out of 21 OPP trials in the coastal Cañete Valley, 17 were conducted directly by CIP and 4 by national program personnel. Seed storage, biological control of root-knot nematodes, seed handling, irrigation and fertilization were evaluated. In storage trials seed stored in diffused light, compared with farmers own seed, increased yield from 7.5 to 14.5 t/ha, and was comparable to seed from cold storage. The costs of the diffused light store apportioned by tonnage and years, was economically more advantageous. In technical terms, biological control of root-knot nematodes was extremely effective, giving a control even better than nematicides. However, no economic benefit resulted from improved nematodes control, since the market price of both damaged and undamaged tubers was similar.

Ecuador. A late 1979 survey in northern Ecuador provided information for planning a series of trials to be conducted by INIAP's "Programa de Investigación en Producción." In July 1980, 10 trials were planted to test a balanced and more adequately timed fertilization and weed control.

2. Region III

Rwanda. On-farm research is a major focus of the Rwandan Potato Program (PNAP). In 1980 two series of on-farm trials were conducted,
totalling 31 trials. The first 7 (first crop) evaluated planting in rows, desprouting and mineral fertilization against the traditional system of planting in beds and using non-desprouted seed without fertilization. Although the proposed package of practices gave consistent increases in yields it had very low potential for farmer adoption since fertilizers are scarce and probably beyond the reach of the producers.

Twelve of the 24 trials of the second campaign investigated chemical control of late blight. Spraying fungicide every 14 days gave the most striking results with both the farmer's and improved varieties. However, scarcity of fungicide, high cost of sprayers and (for some locations) non-availability of clean water for spraying might limit adoption of this technology by small farmers. Organization of spraying cooperatives was seen as a possible solution to these problems.

The other 12 trials concerned improvement of farmer's seed quality by positive and negative selection. Performance of the seed produced using the two methods was compared to that of the farmer's traditional seed in a series of trials in 1981.

3. **Region IV**

**Tunisia.** During the past four years on-farm research has been instrumental in improving and reinforcing the national seed multiplication program. A series of 8 trials compared locally multiplied seed to imported seed during the early crop (Nov-Dec). The more physiologically mature "local seed" outyielded the imported seed in most cases. Profitability of using locally multiplied seed for the early crops was clearly demonstrated. Consequently, in future multiplication campaigns of the national seed program, emphasis will be placed on supplying seed for the early crop.

In the late crop 18 trials comparing seed provided by the national program against the farmer's own seed. As a result of these "demonstration trials" demand for local seed multiplied by the seed program is far higher than actual production.

**Turkey.** A total of 33 trials were planted in the Gundalan valley. The alternatives tested were: planting with a semiautomatic planter, presprouting, chemical control of Rhizoctonia and scab, and use of physiologically young seed. Each of these alternative improved production either by increasing yields or improving quality of the harvest. Economic analysis showed that use of a semi-automatic planter, presprouting and use of physiologically young seed had high benefit/cost ratios.

**Algeria.** Results of six package trials conducted in 1979 and 1980 were analyzed and used to plan a new series of simpler, one-factor trials
testing presprouting, planting in the middle of the ridge and pre-emergence irrigation. Despite great interest shown by the Algerian Research Institute, some logistic difficulties impaired the follow-up of the four trials planted during the last quarter of 1980.

4. **Region V**

A survey of two potato growing areas in the Punjab and north west frontier province of Pakistan provided information on the economics of farm practices and potato production. Results indicate that Punjab farmers see shortage of hand labor as the major problem and consider mechanization as a necessity. In contrast, shortage of good quality seed was considered to be the major production problem by the research staff. To complement the survey 10 agronomic trials on seed management and inputs were started and will be used as the basis for later on-farm trials.

5. **Region VII**

In the Philippines a CIP post-doctoral scientist collaborated with the national potato program in surveys which stressed the value of simple trials. Ten one-factor trials planted in 1980 included: elimination of expensive organic fertilization (chicken manure), use of larger seed pieces and minimum soil preparation. Six more complicated trials were conducted on larger farms. Elimination of chicken manure decreased yield by an average of 15%; this was largely compensated for by a cost saving due to the high cost of manure. Nevertheless considering that elimination of chicken manure could have long-term negative effect on soil fertility; researchers decided to seek means of increasing the efficiency of using chicken manure, rather than recommending elimination of its use.

Use of larger seed pieces gave a significant increase in yield but was not economically profitable. Minimum land preparation decreased yield and economic return and was consequently discarded from future trials. During the last quarter of 1980 planting of a series of 30 trials was initiated. These trials test changes in timing of fertilizer application, improved seed quality, a proposed control of thrips, and seed storage in indirect light.

Considerable time was devoted to training the team of extension agents who are implementing the on-farm activities of the Philippine Potato Program.

6. **General Comment**

This was a learning period for the majority of those involved in OPP at the regional level. In some cases the definition of variables included in the trials resulted from a technical diagnosis made by one or several potato scientists without taking into consideration the
socioeconomic characteristics of farmers. And in many cases the economic analysis did not receive the attention it merits. But in spite of these deficiencies the experience proved to be valuable in pointing out deficiencies in existing recommendations and revealing to the biological scientists the importance of socioeconomic aspects of farming and technological change. The on-farm trials in Tunisia confirmed the technical diagnosis made and proved the value of the solution proposed, hence giving more confidence to the seed program. In Rwanda the use of chemical fertilizers proved to be technically effective but beyond the economic reach of the producers. Hence it was dropped from recommendations. In the Philippines, on-farm research confirmed the diagnosis (high cost of the chicken manure) but proved that the solution suggested (suppression) needed to be reviewed.

D. Implementation of OPP at the Regional Level in 1981

In planning activities for 1981 participation of researchers and/or extensionists from the host country was considered as a basic condition of the work: CIP's personnel has to confine itself to a backstopping role leaving the lead to the national potato program. Thus in countries where this distribution of the roles was not possible, CIP's involvement was curtailed (Peru, Algeria) or greatly reduced (Turkey). In places where the national lead existed (e.g., Ecuador, Tunisia, Philippines, Korea, Rwanda, Cyprus) action was intensified. Special emphasis was placed on countries where a bilateral program exists and is receiving help from CIP (Nepal, Bangladesh, and potentially Pakistan).

In 1981 ten countries are involved in OPP research. Although a comprehensive description of the work cannot be presented (a big portion of the trials were not planted when this paper was written) the following remarks can be made:

1. In planning the trials all collaborators have insisted on the simplicity of the alternatives tested and the clarity of experimental design used. The data recording process was well planned and the amount of data to be recorded reduced to the strict necessary minimum. Interest in economic analysis of the trials is increasing, but it is not yet viewed as an integral part of the research and consequently is not properly planned and/or executed.

2. The importance of a better socioeconomic characterization of the farmers towards which the on-farm research is aimed, is being felt and understood by the collaborators. However, necessary "know-how" is very often missing, and only a limited amount of socioeconomic information is being gathered during implementation of the trials.

3. In the great majority of cases trials are now being looked at as tests for a proposed alternative in comparison with the farmer's
current practice. Hence, more attention is being paid to the "farmer's treatment" in the trial.

Three special activities were conducted in 1981, a seminar in January reviewed the experience accumulated in the Mantaro Valley project and its adequacy for the implementation of OPP at the regional level; a training seminar was organized in April in Pakistan, where the potato program is working on a proposal to obtain international funding for a 5-year project centered on on-farm research; a training course was held in Rwanda for 10 potato scientists from 4 African countries. This course showed that together with the scientists from Rwanda (who have been involved in OPP for the last two years) CIP has reached the stage where it can share its on-farm research experience with developing countries and offer procedures for them to implement on-farm potato research with the limited facilities of their national potato programs.

E. Present and Future Role of the Social Science Department

Ever since the initiation of on-farm research in the Mantaro Valley the Social Science Department has played a leading role in integrating on-farm research within CIP's list of priorities, sharing the responsibilities originally with two of CIP's Thrusts (VII and VIII) and subsequently with the regional scientists. From late 1979 until the end of 1981 one member of the department is responsible for coordinating OPP throughout the regions, and another staff member is assigned to OPP research in Region VII (1979-1982).

Because of these various types of involvement, the department is playing the role of a "think tank" for on-farm research at CIP, providing advice for CIP's regional scientists and their national counterpart, participating in various training activities, and in some cases being directly involved in implementing the research. The experience gained through these activities is being used for preparation of a series of training documents covering different aspects of on-farm research.

Besides coordinating and updating CIP's know-how in on-farm research, the department is providing the social science expertise that the great majority of collaborators (biological scientists) are lacking. This expertise concerns mainly the socioeconomic aspects of the research (e.g., survey techniques to describe and understand the areas under study and their crop production systems, economic analysis of the trials, and monitoring of farmer's reactions to technology tested). Past experience indicates that many deficiencies in implementing OPP at the regional and national levels are result from lack of socioeconomic expertise within regional and national potato programs. Hence, the Social Science Department should not limit itself to a critical role -- not
these deficiencies—but should help avoid them. Hopefully, this Planning Conference will help us find ways for providing socioeconomic expertise to regional and national programs without transforming the department into a "service agency."
REFLECTIONS ON ON-FARM POTATO RESEARCH
IN THE PHILIPPINES

Michael J. Potts

A. Background

In the Philippines the potato is regarded as a luxury food limited to the catering trade, wealthier classes and perhaps festive occasions.

Agronomic yields have been thought generally to be low, circa 6.6 tonnes per hectare (Anon., 1979a); but production costs are high.

In an effort to improve yields whilst maintaining or lowering production costs, thereby making the potato more widely available, the Philippine Potato Programme (PPP) has actively experimented since late 1979 with the International Potato Center's (CIP'S) strategy of "Optimizing Potato Productivity" (OPP).

The following paper summarizes the major philosophical, organizational and practical features experienced in the field by the author since he joined the PPP project of OPP in February, 1980. Many of the points raised are likely to be encountered in other countries when similar projects are initiated. The steps taken to overcome difficulties and a few personal comments are forwarded for discussion.

B. Initial Approach

The initial scheme was to develop a package of technology incorporating the best technology available. This package was to be tested on farms and evaluated agronomically and economically before being promoted by the Extension Services. As new technology became available it would be incorporated into the package, tested on farms and, if successful, a revised package would be promoted. (Anon., 1979b).

Organization of the project and the field practices were as follows:

1. The PPP set up a sub-committee of field co-ordinators comprising a senior extension worker, a socioeconomist, an agronomist and a post-harvest specialist.
2. The sub-committee drew up a detailed agroeconomic survey questionnaire aimed at identifying current practices and problems.

3. The sub-committee formulated a low cost, high-income package of production technology which consisted of 22 steps.

4. Field extension technicians conducted the agroeconomic survey and identified farmer co-operators.

5. Two packages were tested December 1979 to April 1980 and a further six, March 1980 to July 1980. Each trial was the responsibility of one technician, covered an area of approximately one hectare but had no direct comparison with the farmers' own practice; reliance being placed on farmers' estimates of yield in previous seasons, as gathered from the agroeconomic survey.

6. All material and labour costs were borne by the farmer co-operator, although assistance was offered in negotiating a loan.

C. Evaluation

At the end of each trial series an evaluation meeting was held comprising of members of the Management Committee of the PPP, the field coordinators and the extension technicians. These meetings were valuable in that they allowed for the free flow of information, particularly from the technicians to the Programme leaders. Many useful discussions took place, problems elucidated and solutions aired. The more notable points were:

1. Philosophy
   a. The trials were complex and difficult to carry out in the field. Farmers did not appear to appreciate the philosophy and principles involved and all farmers selected those technologies which they considered most appropriate to their situation, thus forming their "own package." Comparison between trials was therefore not possible.

   b. Reliance on survey data to estimate farmers' inputs and yields was not practical. Both vary considerably from season to season, e.g. according to the incidence of pests and diseases.

   c. The complete package was considered by many farmers to involve considerable financial risk, specially when the areas involved are taken into account. Trials were thus limited to the larger, financially-secure farmers, which were unrepresentative of the Provinces as a whole.
The offer of help to negotiate a bank loan was generally not accepted by farmers: firstly, many farmers were squatters or tenants and had no collateral in terms of land rights; secondly, farmers considered the risks too high; thirdly, many farmers have their own source of finance, e.g. a neighbor or merchant, and they did not want to disrupt this often long-standing relationship by borrowing from another source for one season only.

d. The economic costing was difficult, many estimates being necessary.

2. Administration
   a. The extension technicians were scattered geographically with no transport of their own; thus it was difficult to co-ordinate activities and make rapid decisions.

   b. The field technicians carried out the trials in addition to their normal duties and they were unable to give the trials the close attention required. This insufficient contact and supervision was partially responsible for the lack of understanding and involvement by the farmers.

3. Data Collection
   a. The execution of the preliminary survey was complex and beyond the scope of most extension workers since considerable knowledge of survey practices was required.

   b. Interpretation of the mass of data collected was difficult. Also, only those farmers were surveyed who had already been located as co-operators. Thus the sample was biased and the numbers too small to draw any general conclusions.

   c. The field technicians had not chosen the farmer co-operators at random, preferring to visit those that were readily accessible and with whom they were acquainted. These farmers tended to be the larger, more progressive farmers and were not representative. They were, furthermore, the subject of many surveys and demonstrations and the continuing use of these farmers is probably the source of several misunderstandings and fallacies concerning production practices.

   d. Farmers' estimates of previous yield were often unreliable. Reliance could not, therefore, be placed on comparisons between farmers' estimates of yield and those yields obtained from trials.

   e. Whilst regularly travelling through the area it became apparent to the author that many of the responses in the initial survey were inaccurate; e.g. visual estimates indicated that yields were in fact considerably more than 6.6 tonnes per hectare.

- 93 -
4. **Field Practice**
   a. Each trial was one hectare. This effectivity restricted trials to large farms; the average holding being only 0.5 ha.
   
   b. All field work was carried out by Ministry Extension technicians: a group which should have close contact with the farmers.

5. **Training and Extension**
   a. Some extension technicians had little experience with the potato crop, due in part to a reorganization of the Ministry of Agriculture.
   
   B. None of the technicians had any practical experience in conducting field trials.

D. **Remedies and Comments**

In order to overcome the problems several steps were taken:

1. **Philosophy**
   a. Demonstrations were carried out at ten locations, March to July 1980, of CIP's "OPP" approach in which only one, or several interrelated, variables are compared directly in the field with the farmers' own practice; thus allowing a true comparison between the current farmer technology and the improved practice (Cortbaoui and Potts, 1980). A change to this approach was made beginning October 1980.
   
   b. The simplified approach allowed for the size of each trial to be reduced to 500 m$^2$, thus the average and small farmer could be included.
   
   c. The reduction in trial size reduced the financial risks incurred by the farmer, aiding the incorporation of smaller farmers into the project. For the season, October 1980 to March 1981, a small financial subsidy was offered to farmers participating in trials involving certified seed because a considerable increase in input costs was envisioned. Whether such subsidies were of much practical value in aiding the trial program is not known at this point; but several technicians have suggested that if a cash inducement is needed to encourage a farmer then he will have little interest in the trial and will probably not look after it as well as a fully committed co-operator.
   
   d. A simplified approach to the economic costing was used in which a partial budget analysis was used in place of the full economic costing (Horton, 1980).

2. **Administration**
   a. A senior Filipino field technician was appointed as a counter-part to the author and they were empowered to take all day-to-day
decisions. Transport, an essential for any co-ordinator, was also available thus frequent visits could be made to all trial sites and decisions made rapidly. Errors in the field have been greatly reduced. Unfortunately, the counterpart, like the field technicians, is involved in the project in addition to his normal duties, thus co-ordination of activities is difficult. A full-time field "leader" would be the ideal goal for the project if it is to continue at its present size and form.

b. To limit the workload for any one technician, a ceiling of two trials each was set. This resulted in the involvement of many technicians with little experience with the potato crop.

3. Data Collection
   a. The technicians were thoroughly briefed on basic survey principles and on the information required from this questionnaire, the questionnaire was radically simplified and the survey carried out prior to identification of the farmer co-operators. However, the existing workload of the technicians still restricted the number of farms that could be surveyed and reliance had to be placed on field experience in order to obtain a representative sample.

   b. Briefing of the technicians and simplification of the questionnaire allowed for the more important points to be identified, but much basic information was missed still. For instance, this small survey allowed for the identification of those groups of farmers requiring assistance and gave valuable information about their geographical distribution, economic status and the overall production pattern; but some essential information, in particular relating to social factors and the quality of the field practices, was lacking. This problem is likely to be encountered by any quick survey of naturally cautious farmers, whether it is formal or informal and the sample large or small; particularly when it is carried out by non-trained personnel.

   The only practical way to gain such information is for a non-biased, trained scientist, conversant with the local dialects and with interests in agronomy, economics and anthropology to spend the full cropping season in the field observing and talking to farmers: the quality of the field practices, the real problems as the farmer sees them and his reasons for acting as he does should then become apparent.

   c. In addition to the preliminary survey supplementary yield data were obtained through a yield survey in which sample yields were taken in the field, from a total of 184 randomly distributed farmers during the harvest, July to August 1980. The average yield per hectare was computed at 28.2 tonnees per hectare: a figure which was not disputed by the farmers concerned and which agreed with their own private estimates of "more than 20 tonnees." Obtaining such basic information is essential and
further similar supplementary surveys may be necessary if a meaningful project is to develop.

4. Field Practice
   a. For the first series of trials, beginning October 1980, four main variables were selected. Selection was based partly on the preliminary survey but also on the observations and experience of the author during the previous six months. For example, the use of chicken manure was selected as a variable because the initial survey showed it accounted for 25% of the input costs but, more importantly, observations showed that for the dry season at least it was often undecomposed at harvest and thus of little benefit to that crop.

   Each selected variable was compared with the farmers' current practice and was considered to be most likely to be accepted by the farmers and to increase their monetary returns. They also acted as examples of the general classes of variables that may be expected.

   - The elimination of expensive organic manure: a reduction in input costs.
   - A change in the timing of phosphate fertilizer application: no change in input costs, merely a minor change in husbandry practices.
   - The use of improved (certified) seed: an increase in input costs.
   - The use of improved seed storage techniques: a change in capital costs. (This series of trials was carried out jointly with Dr. R. Booth, CIP, Lima and Mr. W.V.D. Albert, CIP storage apprentice).

   b. The use of only one variable enabled the farmer to understand and more readily identify himself with the trial. Farmer participation and regular visits by extension workers allowed a rapport to be built up and much traditional information gained.

   c. Farmer selection was critical to success since it is the farmer who finally bore the financial risks and the brunt of the day-to-day cultural practices. Thus, whilst ensuring that farmers were selected from within the designated group, preference was given to those most likely to actively participate as one of the team.

   Once again, a thorough season-long initial survey would have been most likely to identify suitable co-operators; since the opportunity should have arisen to strike a personal relationship and also to discover who was responsible for the daily decisions and management of the farm, since this will be the person in most frequent contact with the technicians and who must be encouraged.

- 96 -
Other personal information regarding the candidate co-operator also affected his suitability; in particular, his relationship with his creditors. For example, several trials were lost in this project because the creditor visited the farm and insisted that, due to market prices, the crop, although very immature, be harvested immediately, leaving no time for the field technicians to be notified. Such possible situations must be identified at an early stage.

d. To reduce error to a minimum and to ensure that all the necessary information was gathered, a very simple step-by-step guide was made up for each experiment together with the necessary data recording sheets. This approach plus regular visits maintained uniformity across the trials and few errors in either the field techniques or data recording appear to have occurred.

e. To spread the trials geographically and within the target groups, two trials were located in each of the 13 municipalities. Increasing the number of trials, target: fifteen per variable, reduced the risk of a series being invalidated due to the loss of too many trials. Experience to date would seem to indicate that under Philippine conditions approximately 15% of trials may be lost through unavoidable circumstances including weather.

5. Training and Extension

a. The inexperienced technicians attended a National Course on "Potato Production Technology" in which considerable time was devoted to "Technology Transfer." In future it is intended to invite leading farmers to this course, thus further expounding the philosophy. More important, however, was the practice of the author and his counterpart of regularly visiting each trial in the presence of the technician concerned. This enabled enthusiasm to be maintained and, indeed, technicians and farmers are now requesting help with their own additional trials, aimed at local or farm-specific problems. Also, it served as an ideal form of "in-service" training thus the project is also enhancing the competence of the field technicians.

b. Whilst no formal program has been set up in which the trials are used as demonstration sites, they are always a focus of interest amongst neighbouring farmers. Thus, the more enterprising field technicians have encouraged neighbouring farmers to visit the sites and discuss the trials and they have gained much supplementary information whilst serving a useful extension function.

6. Motivation

a. Motivation of the technicians is of primer importance to the success of the project since much depends upon their diligent execution of the field work. The problems are not inconsiderable, particularly
as the technicians are very busy. The creation of a "feeling of involvement" by means of a careful explanation of the philosophy behind the project; regular meetings, in which senior members of the Program enthusiastically participate; group participation in such activities as planting and harvesting; and finally constant contact and encouragement in the field appear to have overcome most of these difficulties.

Unenthusiastic technicians, who have not adequately supervised their trials, have been dropped from the project since they contribute little to the project or to the farming community at large and cause a considerable drain on time and resources that could be better allocated elsewhere.

b. Enthusiasm and co-operation on the part of the farmer is also of paramount importance since it is he who is bearing the financial risks and the brunt of the day-to-day field practices. Through their regular visits and patience, the technicians have built up an enviable rapport with the farmers and maintained considerable enthusiasm.

c. Finally, the enthusiasm and encouragement of the Program hierarchy should not be forgotten; since unless leadership is given by these administrators the people in the field will feel that their efforts are held only in low esteem. The regular meetings and visits to the field by senior members of the Philippine Potato Program have avoided this pitfall.

E. Interpretation of Results

Fifty-two trials have been laid down and 43 have been harvested or are still "in situ": nine have been lost, mainly to adverse weather.

Interpretation of the results, using the procedure outlined by Horton (1980), has been relatively easy for those trials involving a simple change in variable costs or merely in agronomic practices. Some considerable difficulty, however, has been experienced in obtaining accurate data on the manhours required for an operation and its subsequent computation to a meaningful "per hectare" basis, since relatively small areas have been used for the trials. Fortunately, since the yield differences and economic returns have been so marked, slight errors in this particular computation have little effect on the overall picture.

A problem of far greater importance with respect to the economic analysis has been estimating the capital costs involved in constructing diffuse-light seed stores. The degree of complexity involved ranged from very minor modification to existing structures to the erection of very complex stores. Further, many stores were built from unused
materials already on the holding and constructed during hours when labour would not otherwise have been usefully employed. Thus, there is a conflict between the true economic cost of adopting the technology and the farmers' perception of the cost: and probably neither reflect the optimum cost of producing good quality seed. Such a conflict may be envisioned for the adoption of other technologies involving capital investments.

F. Dissemination of Results

Having shown that a technology is agronomically and economically sound, a problem still arises in disseminating the findings to other farmers in the area.

The path chosen by any program will obviously depend very much on the ability of the Extension Services and their usual practices. However, consideration should be given by planners to this problem at the outset, particularly if the extension services are known to be weak: a situation likely to arise as CIP moves from leader countries to less developed countries. Success or failure of the whole project will ultimately depend on the ability of the extension services to get the message across.

G. Summary/General Observations

1. Optimizing Potato Productivity is a logical, stepwise approach to the problems of technology transfer. It is not, however, a mechanical process. It should be a dynamic approach which is constantly changing as new technologies arise, and not bound by a fixed set of rules. It is, therefore, a long-term approach and this should be borne in mind by planners and administrators.

2. All people involved, from farmer to administrator, are human and have personal reasons for acting in a certain manner. Attempts must be made to fully understand those reasons and to bear them in mind at each step if the right decision is to be made for the next stage.

Success at each stage depends upon thorough completion of the previous step. Omission of a step is very likely to result in failure.

3. OPP requires scientists of many disciplines and often different institutions to work together. Motivation at all levels is thus of prime importance and time must be allowed for the scientists to get to know each other and gain confidence in each other.
4. Before embarking on an OPP project a thorough "survey" must be made of the area to pinpoint those groups of farmers that require assistance and which can be helped. The stationing of a trained scientist in the area for a full cropping season is more likely to produce a true picture of the current situation and practices than any survey; formal or informal.

5. Trials should be kept very simple as these are more likely to be understood by all people participating, to require a small plot area and a low financial risk on the part of the co-operator, thus being suited to average and below average farmers.

6. Consideration should be given to the costing and analysis of technologies involving capital inputs.

7. Consideration must also be given throughout to methods of disseminating the accumulated information particularly where the extension services are weak, if OPP is to be of lasting benefit and not simply an end itself.

REFERENCES


Both papers, On-farm Research to Optimize Potato Productivity in Developing Countries and Reflections on On-Farm Potato Research in the Philippines, are an important contribution to our understanding of the processes of how research is carried out in practice rather than in theory. Only too often polished manuals of research methods are published, sometimes with examples of how it was thought that those methods were the key determinants in giving successful results. However, the mistakes, failures and, what might be seen in hindsight—or by outsiders as foolish errors—are not described.

Often key factors, which made the research relevant and feasible and established a research capability, are omitted from the analysis. For example, the trials in the Philippines in the first year might be described by a harsh critic as irrelevant to farmers' problems, too large, badly executed, and only go to show why that kind of on-farm research is a waste of scarce research resources which would be more usefully spent on experiment station research. However, as we have seen, the Philippine Potato Program drew out other implications from their mistakes and made critical and selective changes which were relevant to the establishment of their own on-farm research program for potatoes. The fact that the local potato program saw the usefulness of this type of work and could see ways to release its own resources and to develop its own dynamic and evolving research capability is very important.

In general terms, I fully support CIP's Social Science Department in using its international status to help legitimize the development of integrated on-farm and experiment station research programs. The development of these systems is a difficult process where, in the application of sound scientific principles, mistakes are always being made, as each country develops its own capability for the organization and management of agricultural research. By working directly with national potato programs, CIP's Social Science Department is making a significant contribution to what I feel is CIP's most important objective, namely the development of national R & D capabilities as regards agricultural research.

From a broader perspective, a nagging question at the back of my mind as I read the papers was a lack of reference to the justification for why potato research and production was in the national interest. For example, who are going to be the main consumers and why should the government support potatoes rather than another crop? If there had been some national research policy analysis, then one of the questions
which would have been addressed would have been which groups of farmers and in which parts of the country were to be the main beneficiaries of the potato research and production programs. Without this explicit reference to the circumstances of a specific group of clients there is no way to focus applied research on relatively important problems for a large number of farmers or consumers and have criteria to assess and steer the research programs as circumstances and information change. The Philippine case study illustrates well the costs involved when the circumstances of clients are not defined before the program starts.

Another issue concerns the integration of on-farm and experiment station research. The fact that the Philippine Program was working with extension personnel might indicate that their on-farm approach was orientated more to extension issues than to research issues. Little mention was made in Cortbaou's general paper about the involvement of potato plant breeders, pathologists, etc., and little was said about the relationship with experiment station research activities. If this is correct it is unfortunate, as I see an on-farm research program as critical for (a) directing experiment station research priorities, (b) technology development in the field and (c) extension training purposes. Thus, I would like to see CIP strengthen the role of on-farm research as a critical input to the priority setting and planning of experiment station activities.

Another question comes up in both papers: What is the role of social scientists? I think as social scientists we play three roles. First, we play a role as a scientist --irrespective of whether we are social or applied natural scientists. Consequently, in research situations we apply certain principles to the collection and analysis of data, etc. In some interdisciplinary situations, we act merely as scientific researchers. Second, the role of the social scientist is to be involved in planning, executing and analyzing the results of trials and surveys in the way described in the CIP papers. Third, the role of the social scientist also involves an analysis of the research system, e.g. looking at such issues as the flows of information and the importance of scientific reward systems. In this regard I have found that field workshops for national and international scientists, policy makers and production administrators centered around a set of on-farm trials and surveys, facilitate dialogue and exchange which result in a significant change in the perceptions and priorities of the research program. I would maintain that a meeting of the same people, held in a conference room, and not looking at the crop (and alternatives) on farmers' fields would not produce the same outcome. As social scientists, I think we should give more attention to these organization and management issues, such as effective communication methods, linkages, etc., in research and extension systems.

I would encourage CIP to see collaborating farmers as research colleagues. From experience of working with national scientists on the
Gangetic plain and in the Himalayan hills we found that some farmers become very interested in the on-farm research and in conducting trials. In fact, some on-farm trials have been better managed than some experiment station trials. It seems we may be missing an important opportunity by not shifting some research work to farmers. Some farmers are always experimenting in one way or another and there may be high pay offs to supporting and encouraging this type of activities.

The authors feel that more efforts should be given to ways and means of promoting technology from research programs. My own feeling is that first and foremost we have to have technology which is relevant and feasible to the circumstances of a target group of farmers. Consequently the on-farm research program must have research staff from experiment stations fully participating. Research must be the primary role of the program. However, I also feel that a dynamic on-farm research program of special purpose surveys and trials can be the most appropriate location for training extension staff. Extension people who have interviewed farmers for a specific purpose, carried out crops cuts in farmers' fields, looked after crops in field trials over the full season, seen how and why technology "packages" are put together in an environment not isolated from the practical observations and participation of farmers would be very well trained. All of these components are in on-farm research program and therefore make it an ideal extension training laboratory. This type of training would also result in extension agents who are confident of what they are promoting because they have helped develop the technologies. Finally, this approach would strengthen the currently very weak linkages in many developing countries of feed-back from farmers and extension staff to researchers.

In his concluding paragraph, Cortbaoui asks us for suggestions of where to find social scientists to work in national on-farm research programs. A good question, because our professions have not traditionally trained us to produce graduates who would be rewarded by their professional colleagues for being involved in this type of difficult applied interdisciplinary research. However, I think this is changing and institutions such as CIP, with their international status, are already helping to change the values of our professions. For example, your pragmatic manual for Optimizing Potato Productivity, which was a stencilled rather than a polished "definitive" textbook gives the impression you are interested in the "principles" rather than the "polish" and that you have taken a decision to allocate your resources in this way. You should continue to publish similar materials. You can also continue to help change professional reward structures by continuing to have conferences such as this one which, as far I can see, are a method by which you outline an indicative plan and ask for comments before you proceed. This is a very different approach from traditional social science conferences which discuss the results of research which has already taken place.
As regards finding social scientists, I have three suggestions. CIP could place resources and time into actively searching out:

1. In developing countries those people in universities, social science and other research institutes who would be interested in working in this type of technology-based research program. This takes time and perseverance, however, it is the only long-term answer to establishing agricultural R & D capabilities in developing countries.

2. In developing countries social scientists who could visit and work with colleagues in other developing countries.

3. In developed countries, specific social scientists who have the skills to complement the work of CIP's Social Science Department by short term visits to integrated on-farm and on-station research programs in developing countries. People exist who share CIP's philosophy, who have either experience in this type of work, or experience in the countries involved, who could visit for periods of one month or so, once or twice a year, depending on the circumstances, and work as a colleague with local interdisciplinary groups of scientists. The fact that the outside colleague repeatedly goes away helps ensure that there is an effective local commitment to the program, and that no one gets the impression that it is not a local project.
PERUVIAN POTATO AGRICULTURE IN
COMPARATIVE PERSPECTIVE

Robert E. Rhoades

A. Introduction

As the potato's geographical center of genetic diversity, Peru offers the International Potato Center a superb natural laboratory for biological and agronomic research under drastically different agroecological conditions. In the relatively confined distance of 300 air-kilometers eastward from Lima, one finds a major arid zone (desert coast), tropical mountain chain (Andes), mid-elevation premontane jungle (Ceja de selva) and humid, tropical lowlands (Amazon Basin). In each ecological zone, CIP tests germplasm material and conducts experimental research: Cañete and La Molina on the arid coast, Mantaro Valley in the highlands, San Ramon in the premontane jungle, and at Yurimaguas in the Amazon Basin (see Diagram 1).

This ecological landscape, among the most diverse in the world, also offers social scientists an excellent opportunity to understand farming systems in different environments in order to examine the role or potential role of the potato within each. Until 1979, social science research at CIP concentrated on the highlands with some specialized agroeconomic research on seed potatoes along the coast. To broaden our experience, a comparative study of farming systems in all four zones was launched. The research objectives can be briefly summarized:

1. Conduct general descriptive studies of farming systems in Cañete, San Ramon, and Yurimaguas, comparing these systems with each other and existing information on the Mantaro Valley in the highlands.

2. Cast the findings from the Peruvian cases into a worldwide framework to determine in general terms if the agroeconomic research conducted by CIP in each area has possibility for extrapolation to other similar areas; and

3. Develop, as a result of these studies, practical, inexpensive methods for conducting informal agricultural surveys of value to regional and national programs facing shortages of funds, personnel, and time.
Diagram 1.
In this paper, I will highlight the findings related to the first and second objective. Since less is known at the present time about potential potato production in hot, humid areas, more emphasis will be placed on San Ramon and Yurimaguas, utilizing the desert and mountain cases as points of comparison.

B. Cañete: Arid, Irrigated Farming

Arid regions are often defined as environments which receive less than 250 mm of rainfall per year. Irrigation is generally required for crop production. Arid zones cover around one-third of the earth's surface and support about 135 million people.

The Peruvian coast is a narrow strip 25 to 40 miles wide and constitutes one of the world's driest deserts. Rivers originating in the highland have given rise to 52 coastal valleys characterized by commercial, irrigated production. Still today, these valleys support Peru's major cash crops such as cotton, rice, maize and potatoes. In this zone potatoes are monocropped, cultivated by traction (draft animals and tractors) rotated with other crops (mainly cotton), and intensively fertilized. Main production problems, in addition to costs and marketing, faced by potato farmers at the farm-level are lack of an excellent seed supply, irrigation constraints, salinity, as well as a number of insect and disease problems.

The coast supports both large scale producers (cooperatives and haciendas) and small farmers. Potatoes enter their production schemes as a commercial cash crop linked to urban markets, mainly Lima. Farmers receive relatively high potato yields (over 20 tons per hectare) and face high costs of production due to costly highland seed and pesticides. Only improved varieties are grown.

C. The Mantaro Valley: Mountain Agriculture

Highlands (above 1,000 m) cover more than one-fifth of the earth surface and harbor at least 500 million people. Mountainous areas vary in population density, ranging from sparsely populated high mountains to some of the the most densely populated regions of the world (e.g., Nepal, Guatemalan Highlands, Central Andes). More importantly, mountains are situated in close proximity to at least half of the world's population, and frequently lowland cities increase in size by the influx of mountain migrants. For example, although only 40 million people live in the Greater Himalayas, more than 350 million people live in adjacent lowlands.

The potato has a comparative advantage over many crops in mountainous areas. Not only do such regions need improved nutrition, specially
highlands where the potato has not made inroads, but the importance of mountain potatoes as an export crop to the world's urban populations should not be forgotten (e.g., Philippine's mountain provinces to Manila, Kenya Highlands to Nairobi, Guatemalan Highlands to Guatemala City, Mexican Highlands to Mexico City, Andes to Lima). Analogous highland regions are the Mexican and Central American Highlands, East Africa, the Himalaya, the Zagros-Tauros Arc, and the mountainous belts of Southeast Asia. Also, hilly regions are frequently important as seed suppliers to lowland producers, specially those of arid, irrigated areas and the subtropical zones of South Asia.

In contrast to the commercial arid coast, potato farming in the Mantaro Valley is more traditional except among a few sophisticated seed growers. Indeed, the Mantaro is historically a section of the geographical center of potato domestication and still today in the higher zones of the valley native, bitter varieties are extensively cultivated. Potatoes in the high zones are processed into chuño or dehydrated products. The region is also characterized by dispersed, small landholdings typically cultivated by age-old practices. On the valley floor and gentle slopes, tillage is by machine or animal traction while on higher, steep slopes, hand cultivation with hoes or Andean footplow is practiced. In the highest zones, potatoes are monocropped and rotated with Andean grains and tubers and produced largely for household use. However, virtually all farmers market potatoes. Although a traditional potato area, production is similar in some ways to temperate areas of the world because of climatic factors. In this region farmers complain of climate problems (frost, hail, drought) in addition to lack of capital, poor soil, insects and disease.

D. San Ramon: Tropical Plantation Estates

As one drops from Peruvian Highlands down the eastern slopes of the Andes, potato production takes different form. As conditions become warmer and wetter, monocropping gives way to multicropping and relay planting wherein planting dates of several crops in the same field are staggered. By 2,000 meters potatoes are rarely found in pure stands but mixed with corn, cassava, squash, beans, and tropical fruit trees. As many as 15 crops can be intercropped in the same field. The elevations between 2,000 to 1,000 meters represents a transition zone in which crops from the highlands overlap with crops from the lowlands.

The upper reaches of the Chanchamayo valley, where San Ramon is located, is a zone of colonization wherein migrants from the Peruvian highlands have settled. The objectives of these migrants is to ultimately set up commercial, tropical plantation farms emphasizing coffee, citrus, bananas, and a variety of export tropical crops.
However, since most tree crops take a number of years to reach a profitable productive level, farmers begin by intercropping in their plantation maize and cassava which are used for both local sale and subsistence. Since highland migrants find potatoes a preferred food, but locally expensive, they attempt to plant small patches of potatoes on their high jungle farms. Below 1,000 m., however, farmers have difficulty in growing potatoes although many have experimented extensively with varieties brought from the highlands. They generally abandon their experimentation after one or two tries.

On the higher, forested slopes these farmers practice a form of semi-permanent slash-and-burn agriculture. The trees and bush are cut, allowed to dry, burned, and crops are planted among the ashes. The soil is not turned, and potatoes in the upper altitudes of the Chanchamayo Valley are planted in hoe-dug holes and among the remaining burned tree roots much in the fashion that cassava is planted.

Farmers complain that highland seed (brought down from their highland farms a few weeks before planting) does not tuberize or the plants are attacked by "la rancha" (probably late blight) and a host of insect pests. Although these farmers are excellent potato growers under highland conditions, at lower elevations they complain that highland varieties are not adapted.

Although higher, marginal lands of the Chanchamayo are inhabited by recently arrived colonists from the highlands, the valley floor and adjacent slopes are characterized by large, well-developed plantation estates now in the form of cooperatives or haciendas. The major crops grown here are: coffee, citrus fruit, bananas, papaya, mango, palta, corn, yuca, and coconuts. Typical of such mid-elevation humid areas around the world, these agricultural systems are diverse, characterized by stratification of plants, use of shading and intercropping. Other characteristics of plantation estates on a worldwide basis are:

1. They are replacing shifting cultivation systems in hot, humid tropics,
2. Can be small-holder or large-scale production systems,
3. Higher intensive use of chemical fertilizer compared to other hot, humid farming systems,
4. Geared toward export, and
5. Subject to "bust and boom" price cycles.

If potatoes could be economically grown in these farming systems, they might help to smooth out the "bust" side of the cycle by providing a locally marketed crop as well as food for farmers and the generally large populations of seasonal laborers. Also, the natural shade provided by tree crops might help overcome some of the heat stress problems.
if agronomic practices for intercropping are developed. In the San Ramon area, CIP agronomists have demonstrated that potatoes can be successfully grown under coconut trees.

E. Yurimaguas: Slash-and-Burn Cultivation

From CIP's mid-elevation experimental site it is only a short-distance to the Amazon Basin, the true, hot-humid tropics. This is Peru's famous "Green Hell" a rain catching jungle which supports only 15% of Peru's population. Most of this region is a dense tropical rain forest characterized by ecosystem complexity. The predominant form of agriculture is called slash-and-burn shifting cultivation and is practiced by at least 250 million people worldwide. This system contains the following characteristics:

1. Clearing by fire
2. No tillage
3. Use of dibble stick or hoe
4. Absence of manuring or chemical fertilizers
5. Rotate fields then crops
6. Short period of soil occupancy altered with long fallow period
7. Use of shading, intercropping, and relay planting
8. Use of human labor only

Agriculture in the secondary and primary tropical forest areas around Yurimaguas closely follows the classical slash-and-burn system. Farmers generally prefer to clear secondary forest instead of the primary forest because the farmer requires much less labor. A typical production system in the secondary forest areas roughly involves the following steps:

1. Cutting with axes and machetes of secondary forest growth
2. Burning
3. Planting upland rice with digging sticks
4. Weeding rice by hand or herbicide
5. Rice harvest
6. Planting of plantains and cassava to be harvested over two or more years
7. Fallow period of four to seven years
8. Cycle repeated
As in the case of San Ramon, intercropping and relay planting is widespread. Rice is the major commercial crop and except for a herbicide in rice no chemical controls or fertilizers are used. Agriculture is extremely low input (except cost of labor) and low cost.

In a system of no tillage it is difficult to see how the potato might be introduced, and indeed no farmers to our knowledge have even experimented with potatoes in this region. However, experiments by CIP scientists have demonstrated that potatoes can be successfully grown although the economic feasibility of doing so on farms has yet to be demonstrated. For on-farm trials in rain forest areas, it may be advisable to seek out specialized econiches where water and lower temperatures are found. In Yurimaguas, it appears potatoes can be grown most successfully during the dry season (May–October), but this is also frequently the period of severe drought. However, the river level is low at this time and farmers cultivate fields and gardens along the banks where water is available and temperatures are probably lower. This may be a potential area for trying to grow potatoes, rather than in higher fields where vegetational covering is heavy and tillage is difficult.

Another possibility might be in intensively cultivated gardens located near the household. The backyard or kitchen garden holds potential for making a greater contribution to the nutrition of the rural populations in hot, humid areas. In temperate zones, backyard gardens generally have the following general characteristics:

1. Geared for family consumption
2. Small plots which are generally fenced
3. Close proximity to permanent family household
4. Mixed and dense planting of a great variety of crops
5. High intensity of land-use
6. Typically cared for by women and children
7. Extensive use of natural fertilizers and compost
8. Vegetables and fruits cultivated are generally not found in family's commercial field
9. Cultivated with hand implements

In the Yurimaguas area, however, backyard gardens as presently utilized differ from highland, coastal, or temperate zone gardens. Yurimaguas gardens consist of dispersed tropical fruit trees and scattered single yard plants around the household where well over 20 edible plant species can be identified. If the potato is to be cultivated in backyard gardens in the Yurimaguas area, more intensive cultivation methods may well have to be introduced. Fencing or raised beds may be necessary
due to the large number of freely roaming barnyard animals as well as ground crawling insects.

F. Conclusions

The characteristics of farming systems in the four Peruvian zones are summarized in Table 1. It is immediately obvious that farming systems reflect ecological conditions and that substantial variation occurs between zones. Potatoes enter or potentially fit into each zone in markedly different ways. While this appears on the surface to be an obvious fact, it is sometimes forgotten in the promotion of technology related to a single crop.

For example, it is well-known that agricultural techniques and methods developed in temperate or highland zones have frequently failed when applied to hot, humid areas such as the Amazon Basin (or, for that matter, when lowland techniques are applied to highland areas). Existing tropical farming systems have naturally evolved to the present state because of ecological and socioeconomic forces. These systems are essentially rational and basic farmer practices (such as multicropping, use of shading, risk aversion through intercropping and relay planting) make sense under the circumstances. Thus when introducing new crops, such as the potato in the lowland tropics, it seems appropriate to begin where the farmers are at present and build upon their current approaches. It can be argued that fitting the crop to the system is easier than changing a system to fit a single crop.

Another reason for carefully monitoring the farming system and environment is the need to determine if agricultural research results can be extrapolated to other world areas. Although most agricultural research is site-specific it would be of great advantage if research has wider applicability. Agricultural experimentation is too costly and time-consuming to be repeated in every locality, although it is logical that all technology must be ultimately adapted to local conditions. Therefore, if a test region can be shown to be roughly similar in agro-ecological and socioeconomic terms to other regions then it is possible that research results can be extrapolated. For example, if agriculture in hot, humid areas in Peru generally involves intercropping, studies of intercropping potatoes may be of value to researchers in similar regions of Africa and Asia.

Map 1 shows the four Peruvian zones in world context. Our review of the literature combined with short, informal studies in the Philippines and Nepal show that striking similarities are evident in other zones of similar ecological conditions. Table 2 summarizes some of these similarities. With careful qualification we can say that potato farming in Cañete is structurally similar to potato farming in North
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cañete</th>
<th>Mantaro</th>
<th>San Ramon</th>
<th>Yurimaguas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological zone</td>
<td>Arid coast</td>
<td>Tropical highland</td>
<td>Mid-elevation, humid tropics</td>
<td>Lowland, humid tropics</td>
</tr>
<tr>
<td>Principal crops or crops types</td>
<td>Cotton, potatoes, maize</td>
<td>Andean tubers, grains, vegetables</td>
<td>Coffee, tropical fruit, cassava, maize</td>
<td>Rice, cassava, plantains</td>
</tr>
<tr>
<td>Method of land preparation</td>
<td>Plow cultivation</td>
<td>Plow cultivation</td>
<td>Clearing by fire, no tillage, plow cultivation on estates</td>
<td>Clearing by fire, no tillage, digging stick</td>
</tr>
<tr>
<td>Manuring or use of chemicals</td>
<td>Intensive</td>
<td>Intensive</td>
<td>Limited on small farms, widely used on estates</td>
<td>Extremely rare</td>
</tr>
<tr>
<td>Cropping pattern</td>
<td>Monocrop</td>
<td>Monocrop</td>
<td>Intercropping, relay planting</td>
<td>Intercropping, relay planting</td>
</tr>
<tr>
<td>Backyard garden</td>
<td>Well-defined frequently fenced</td>
<td>Well-defined</td>
<td>Dispersed tropical fruit trees and yard plants, no fencing</td>
<td>Dispersed tropical fruit trees and yard plants, no fencing</td>
</tr>
<tr>
<td>Agricultural calendar: sociocultural factors</td>
<td>Fixed dates, government regulated</td>
<td>Fixed dates, community and individual decision</td>
<td>Dates highly variable, individual decision</td>
<td>Dates highly variable, Individual decision</td>
</tr>
<tr>
<td>Social unit of production</td>
<td>Cooperatives, individual households</td>
<td>Individual households</td>
<td>Cooperatives individual households</td>
<td>Individual households</td>
</tr>
<tr>
<td>Present status of potato production on farms</td>
<td>Modernized; geared for export to urban areas</td>
<td>- traditional technology - advanced seed production</td>
<td>- Experiments by farmers at elevations over 1000 m for home consumption as supplemental vegetable</td>
<td>Non-existent</td>
</tr>
</tbody>
</table>
Map I.

Mexico, Caribbean, and Central America

Tropical and Subtropical lowlands
(less than 400 m)

Tropical highlands
(above 1000 m)

Tropical hills and tablelands
(400-1000 m)

Arid lands
(less than 250 mm precipitation)
<table>
<thead>
<tr>
<th>Peruvian case</th>
<th>Analogous world areas</th>
<th>Ecological zone</th>
<th>Potato Technology level</th>
<th>Farming system</th>
<th>Present role of the potato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cañete</td>
<td>North Africa, Punjab, India</td>
<td>Arid tropics</td>
<td>Highly commercial; modernized</td>
<td>Arid, irrigated</td>
<td>Export to urban areas; limited subsistence dependence on potatoes</td>
</tr>
<tr>
<td>Mantaro Valley</td>
<td>Nepal, Himalaya, E. African highlands</td>
<td>High, cool tropics</td>
<td>Traditional production; tendency toward small scale subsistence</td>
<td>Mountain agriculture</td>
<td>Staple or exchange item; seed production, export lowlands</td>
</tr>
<tr>
<td>San Ramon</td>
<td>Central American, African, and Asian hill zones</td>
<td>Mid-elevation, humid tropics</td>
<td>Incipient introduction</td>
<td>Plantation estates, shifting cultivation</td>
<td>Restricted consumption, kitchen gardens, experimental stage, supplemental vegetable</td>
</tr>
<tr>
<td>Yurimaguas</td>
<td>Lowland Asia, Central Africa, Amazon Basin, Lowland Central America and Caribbean</td>
<td>Lowland, humid tropics</td>
<td>Potential introduction</td>
<td>Shifting cultivation</td>
<td>Little or no consumption, import food, supplemental or luxury vegetable</td>
</tr>
</tbody>
</table>
Africa and the Punjab of India. In arid zones, potatoes are commercial export crops and major production problems center around irrigation constraints, seed supply, and salinity. Although Peru's highlands are unique in that they are the center of great diversity in varieties and potato cultivation follows age-old practices, many other aspects (land use, poor soils, erosion, dispersed land, holdings, frost) are similar to the East Africa highlands and the Himalayas. Likewise, mid-elevation and lowland tropics characterized by plantation estates and slash-and-burn cultivation parallel conditions found around San Ramon and Yurimaguas. However, the close proximity of San Ramon (and other ceja de selva communities) to major potato producing zones may render this site unique in an economic sense in reference to farmer interest in potato as a cash or subsistence crop. Finally, Peru does not contain extensive areas of wet rice cultivation nor is paddy cultivation found in any regions where CIP conducts experimental research. The major thrust of understanding how the potato might fit into this important farming system will no doubt come from experimentation in Asia.

COMMENTS

Carlos E. Aramburu

Robert Rhoades' paper looks at "farming systems in different environments in order to examine the role or potential role of potato within each." To do so, he states as research objectives the following:

- Descriptive studies of farming systems in Peruvian high and low tropical rain forest areas comparing them to Andean farm systems which CIP has been studying for some time.

- Extrapolate these findings into a worldwide framework.

- Develop practical and inexpensive methods for conducting informal agricultural surveys.

The paper focus mainly in the first two research objectives, which I find of great interest and useful both for methodological research and applied programs.

Comments

1. Our first general remark stresses the need to deal in more detail, and with an adequate theoretical framework, with the economic and institutional factors associated with the four farming systems studied. It
seems to me that for a sound comparative study, ecological factors are necessary but not sufficient to explain observed variations in such systems. Economic factors such as type of economic unit (cooperative, modern farmer, or peasant household), access to labor force, market, and credit (among others) certainly influence the role of potato in the agricultural systems analyzed.

It is a well established fact since Chayanov's studies at the beginning of the century, that peasant agricultural units face a different cost pattern, specially in relation to family labor, than capitalist farms. This will certainly determine both the feasibility of certain technical innovations (such as fertilizer vs. mechanization) as well as other crop alternatives. Access to improved seed, and credit, will probably influence the destiny of production. It is unclear what are the causes behind household consumption vs. market sales in the Mantaro Valley. This kind of economic data seems important for comparative analysis of farming systems.

2. Institutional factors are also, to my mind, neglected in the paper. Potato production in the San Ramon area has been introduced by immigrants of Andean origin, because this is a preferred food for them. But generalizing from that fact, the potential role of potato as a staple food for the tropical regions is disputable. The staple for Amazonian populations is cassava (yuca) and the introduction of potato as a food for local consumption (since as an export crop it could not compete with the coastal and Andean potato) would require major changes in consumption habits.

Other institutional factors that would warrant examination are related to production organization (services coops, peasant communities) and marketing systems and accessibility. Being potatoes a fairly bulky, heavy and low profit crop, these factors will certainly influence its importance (in terms of area cultivated) and economic use (sale vs. consumption).

3. Regarding potato production in tropical rainforest areas Rhoades argues that "If potatoes could be economically grown in these farming systems, they might help to smooth out the "bust" of the cycle by providing a locally marketed crop as well as food for farmers ...." That is a very big "if." The first problem would be the high cost of tuber seed supply. The second, the conditions in which the seed is transported. Thirdly, it would be important to study the crops would it displace, specially if the best "varzea" land is used for potatoes. Fourthly, problems of marketing should be considered (as pointed out before), specially because potatoes would compete for the best land with the main Amazonian cash crop: rice. If farm consumption is the objective (based on it's higher nutritional value vs. Cassava), cost considerations may make this impossible. Lastly, it seems worth looking at innovations attitudes and the risk factor in introducing a completely new crop to this area.
4. A final comment I would like to present, deals with methodological issues that the paper does not present in full detail. How were the case studies selected? Are they based on samples and, if so, what criteria were used to construct sample frames? What are the main variables explored in the questionnaires, if they are used? If, on the contrary (or complementary) case studies are used, how is their representativeness determined? Are these cases studied in depth to evaluate production practices, are economic magnitudes derived from them?

All these queries point to what I think could be a major contribution of CIP Social Science researchers to farming systems studies, that is a survey and case research methodology that could establish the relevant variables to determine types of producing units. This in relation not only to potato production, but in general pertaining to the economic and social rationale of different farms systems, specially small family units characterized by multicropping agriculture, reliance on unpaid family labor, and facing severe resource, technical and capital constraints.

It seems to me that ecological location is a necessary but not sufficient selective criterion. In fact, it would be most illuminating to compare potato (and others) agricultural practices of different types of farm units located in a similar ecological zone (e.g., Cañete is ideally a zone for this purpose).

Extrapolations of results could then be based not only on ecological similarities, but also on socioeconomic terms and conditions. I would like to finish by stressing the importance of comparative studies of farming systems, and hoping that CIP and Dr. Rhoades' effort can be pursued both in Peru and elsewhere.
POTATO CONSUMPTION IN DEVELOPING COUNTRIES

Susan V. Poats

A. Introduction

At the 1977 CIP Social Science Planning Conference three research areas were endorsed:

- Farm-level production constraints,
- Post-harvest technology, distribution and utilization,
- Seed production and distribution.

The Potato Consumption Project, initiated in August 1979, is part of the second of these topics. The original consumption project proposal listed three major goals:

- To determine the current role of the potato in local diets,
- To determine whether greater potato availability could improve the diet,
- To define the obstacles confronting increased potato consumption and propose appropriate methods to overcome these.

In order to include the cultural factors surrounding potato consumption, a case study approach emphasizing qualitative measures was adopted as the methodological framework, rather than a broad-based quantitative approach. A typology of potato consumption was constructed and countries selected for case studies to exemplify each of the hypothesized roles. It was felt that a careful indepth treatment of well-selected cases would provide information of greater applicability to the problems confronting national potato program in the area of consumption, demand and marketing, than would the superficial examination of a large sample of countries. The typology was based on preliminary investigation in Peru where each of the proposed roles is represented by a different agroecological zone. Analogous zones in other countries were then identified using secondary sources. (See Table 1).
<table>
<thead>
<tr>
<th>Role</th>
<th>Peruvian cases</th>
<th>Analogous examples in developing world</th>
<th>Tentative price relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato as a dietary staple</td>
<td>Mantaro valley (Highlands above 1,000 m.)</td>
<td>N. Nepal Rwanda</td>
<td>Inexpensive</td>
</tr>
<tr>
<td>Potato as an exchange item for dietary staples</td>
<td>Cañete (Irrigated coastal valleys)</td>
<td>Benguet Province of Philippines Guatemala</td>
<td>Expensive</td>
</tr>
<tr>
<td>Potato as a supplementary vegetable</td>
<td>San Ramon (mid-elevation humid tropics 400-1,000 m.)</td>
<td>India Nepal (Terai) Bangladesh</td>
<td>Moderately expensive</td>
</tr>
<tr>
<td>Potato as a high status import item</td>
<td>Yurimaguas Iquitos</td>
<td>Major urban centers of developing world (Manila, Lagos, Manaus, Calcutta)</td>
<td>Extremely expensive</td>
</tr>
</tbody>
</table>

Each dietary role was defined as follows:

**Dietary staple:** When potatoes are the primary source of calories and consumed in large quantities at least once a day most of the week.

**Exchange item:** Potatoes are produced and sold to buy other dietary staples of lower cost or greater preference.

**Staple vegetable:** When potatoes complement staple food items and appear regularly in the diet through in small quantities at any one time.

**Luxury vegetable:** Where potatoes are extremely expensive in comparison to other available staple foods, have a high status position due to high cost or associated cultural factors, and are consumed in quantity only by the wealthy or on special occasions.

It was tentatively suggested that the existence of one or more of these patterns in a country was due to an interaction of ecological (altitude, temperature and humidity), economic (price of potatoes and income levels of consumers), historical (length of time cultivated and/or manner of introduction), and cultural (food habits and preferences) factors. The proposed roles were not intended to be mutually exclusive and more than one could be exhibited within a country, such as was the case with Peru.
Peru, Rwanda, Philippines, Guatemala and Bangladesh were initially selected as case studies. To date, research has been conducted in the first four. Currently (May-November, 1981) a case study is being conducted in Indonesia, which will serve to expand and complement work conducted in the Philippines. For 1982, field work is tentatively scheduled for Bangladesh and Bhutan.

B. Methods and Procedures

There are two phases in each case study:

- Utilization of secondary information and statistics, and
- Primary data collection during on-site field work.

The steps taken in each phase differ from country to country depending on available information, local socioeconomic and cultural patterns, the amount of logistical and personnel support, the type of local counterpart organization, language barriers and the amount of time available. The need to maintain a high degree of flexibility in the project methodology has been of great importance. Certain approaches that were successful in one site were impractical in another. Each of the research phases is briefly outlined below.

Secondary Data Collection

This phase often can be initiated prior to study initiation, and complemented with additional information as the study progresses. Potential sources of secondary information include:

a. Food Balance Sheets (FBS). These serve as the starting point for each case study. They report the total estimated area under potato production, average yield, and availability per capita. Experience thus far indicates that both the area under potato production as well as the yields per hectare are grossly underestimated, resulting in low per capita consumption. It is important, however, to utilize the figures and commit them to memory, because they are universally used to justify development programs or to rationalize the relative unimportance of secondary or tertiary crops, like potatoes. Any new figures obtained from field observations must be compared to them. A major difficulty with FBS is that they do not report any regional differences in socioeconomic, or cultural patterns in potato consumption. In FBS all ethnic groups, religious groups, rich and poor are considered equal, which at least insofar as potato consumption is concerned, they are not. Sole use of this information source makes it difficult to make predictions or estimations of the potential for change in consumption rates.
b. National Production Statistics. These are used to locate production areas, identify producer and non-producer population groups, and aid in mapping routes of supply to markets.

c. Marketing Studies. Market and highway checkpoint studies are useful for determining the amount and frequency of potato supply to market populations. These are compared to calculations from urban consumption studies. Marketing studies are also useful for backtracking the supply network to determine the reliability of the reported potato production.

d. Nutrition Surveys. These are conducted at national, regional and local levels. They are useful for determining potato consumption on a daily basis, and, depending on the quality of the survey, to distinguish patterns of consumption according to regional classifications, socioeconomic status, price fluctuations, or seasonal availability. Such surveys measure total consumption of a large sample of people for a period of time (24 hours, 3 days, or a week) in order to calculate daily intake averages and annual consumption rates for the area under study. Surveys conducted in rounds during a year can indicate seasonal consumption. Though nutrition surveys supply a wealth of information on potato consumption, there are three problems which limit their usefulness in determining potato consumption. First, their goal is to measure caloric and protein levels in the subject population to determine dietary adequacy. Often foods are grouped together and their nutritional contribution is considered as a unit, for example: "root and tuber crops." Depending upon the level where the grouping took place, it may or may not be possible to separate potato consumption from that of other foods. Second, if a recall method is used, and the potato plays only a nominal role in total intake, the informant may simply forget any potatoes consumed. This is specially true if the recall period is longer than 24 hours. Finally, these methods cannot adequately measure potatoes consumed only on ritual or special occasions since nutrition surveys normally take place on working days and not on Sundays, holidays, Holy days or festival days. Food consumed only at these times could very well never appear in consumption tallies. It is true that consumption of luxury or special foods may not have high nutritional significance, but estimating their periodic demand so as to plan for production, marketing and storage is quite important.

2. Primary Data Collection

To obtain information on why people do or do not consume potatoes, responses to potato prices, sizes, qualities and origins, and the inclinations of individuals to alter their potato consumption, primary data collection methods and first-hand observations are necessary. The procedure begins in potato production areas, traces routes of potatoes

- 122 -
through rural and urban markets, and leads finally to clients who purchase them. Interviews and observations take place at each point in the chain. The objective is to identify homogeneous groups with regards to potato consumption, estimate consumption level and frequency, and determine constraints which control the potential for increased consumption. Examples of some such groups and certain common characteristics are presented below.

a. **Potato producers.** Farm size, land tenency, economic status and the number of potato crops planted per year distinguish sub-groups within this group. Some potato producers are well-known as high consumers of potatoes, but others consider potatoes as their cash crop and consume very little. It is rare to find potato producers who do not consume any of their produce.

b. **Non-potato farmers in potato production zones.** This group has greater access to potatoes than rural non-producers living in non-production areas, since they can harvest potatoes and receive a portion of their payment in kind, exchange their production for potatoes, or purchase directly from neighbors at low prices.

c. **Non-potato farmers outside potato production zones.** These people theoretically have the least access to potatoes, the highest potato prices and perhaps the least familiarity with potato consumption, especially when distant from the influences of urban dietary habits. Price and availability can limit consumption in this group but other consumption constraints, such as socioeconomic status or food taboos, can be even more important determinants.

d. **Potato marketing people.** Other than potato producers, potato wholesalers, retailers and small vendors have the greatest and most regular access to potatoes at the lowest cost. This group is the best indicator for the potential consumption of a non-producing population if constraints of price and availability are removed. Additionally, market people are often the best informants on buying habits and preferences of the larger population.

e. **Urban residents in potato production zones.** Potato prices and seasonal availability patterns can differ here from urban areas in non-producers zones. Market centers in production zones usually have lower potato prices than other cities specially at harvest times, and more familiarity with the use of potato in the diet. It is important to separate this group from the other, because their consumption levels can also indicate the overall potential urban consumption if prices are low.

f. **Urban residents in non-potato production zones.** It is necessary to consider separately those persons living in small urban settings from those in regional or national capitals, since the latter normally
receives larger proportions of the potatoes marketed. Capital city populations, specially in S. and S.E. Asia also receive greater potato consumption motivation from the influence of western expatriate residents. Stratification by urban socioeconomic levels will also usually result different consumption levels.

g. Special groups. In the course of each case study, special groups had to be singled out because certain economic or social factors caused their consumption patterns to be quite different from the rest of the population. Western expatriates living in the tropics bring a set of food habits which are accommodated to the new environment, but nevertheless, not radically altered. Potato eaters removed from potato areas will still maintain high potato consumption levels even when potatoes prices are high. Because potato producers, sellers and many agricultural planners often unjustly claim that expatriates are the biggest clients for potatoes, and because their influence on native food habits, specially in colonial situations, is so great, they must be considered as a separate consumer group.

Certain elite groups are also separate consumer units. For example, in Rwanda, military personnel are granted special lands and inputs to produce potatoes for their own consumption and sale. Their consumption levels are much higher than economically equivalent civilian groups. There are differences among ethnic groups also. In Indonesia, interview protocols separate ethnic Chinese from other groups such as Sundanese, Javanese, Batok or Minangkabau.

Pre-school children deserve special attention. Ages children are fed potatoes, how they are prepared, taboos, and the frequency of consumption should be determined. As potatoes are an excellent source of food for infants and pre-school children from six months on, it is important to understand current consumption in order to determine potential utilization.

Institutional food services (schools, hospitals), restaurants and hotels comprise another special group. Since this group often constitutes the major bulk consumer of potatoes, it is necessary to determine their tendency to increase quantities currently utilized.

Nutritional and agricultural professionals can also be considered separately since they have greatest access to accurate information about the use of the potato. Considered separately, it is possible to obtain an idea as to the effects of education and exposure on potato consumption.
3. Specific Case Study Procedures

Each case study presented individual problems or opportunities which necessitated changes or additions to the general methodological format. Some of these are presented below.

a. Peru. (August 1979 - March 1980). The first three months were spent in Peru at CIP headquarters designing the project objectives and typology, and doing background research. Methodological procedures were refined during informal surveys conducted in each of Peru's four major agroecological zones. No assistants were hired, although CIP Social Science Department staff members often collaborated during certain phases.

Considerable time was spent collecting materials on the nutritional value of the potato for use in training and information materials. Investigations on potato variety or quality preferences were also conducted. Several simple potato testing trials were carried out among a group of low-income Lima residents to determine the acceptability of potatoes produced in novel environments such as the mid-elevation tropical zone where CIP's San Ramon station is located. Results showed that though tasters found San Ramon potatoes to be inferior to those from traditional highland areas, several of the varieties tested were quite acceptable for consumption, specially in mixed preparations. Based on this experience, close attention in other case studies was paid to local potato preferences.

b. Rwanda. (April-November 1980). Language difficulties, rough terrain for traveling, a lack of secondary information sources and an unusual social taboo restricting the discussion of eating habits, prompted hiring of two full-time assistants to conduct interviews. Half-time assistants, students from the women's agricultural technical school, were selected from areas representing rural and urban consumer groups. Following a training session, they returned to their homes and worked in their communities. Periodic supervisory visits were made. The full-time assistants worked in the major potato production zone. All assistants conducted a series of household potato consumption interviews and followed this weekly visits to observe consumption over a ten-week period comprising pre and post-harvest seasons. They recorded weekly retail and wholesale market prices, interviewed at local nutrition centers, described potato farming systems and wrote histories of potato cultivation and consumption. The National Potato Improvement Program (PNAP) collaborated extensively with the study.

c. Guatemala. (January-March 1981). Less than three months were available for this study, but the lack of time was compensated by the existence of numerous secondary sources of information provided by the Instituto de Ciencia y Tecnología Agrícolas (ICTA) and the Institute
of Nutrition for Central America and Panama (INCAP). In rural areas, this was complemented with a series of informal interviews among potato producers and non-producers in collaboration with existing ICTA and INCAP survey projects. In the capital city, where most of the potatoes produced are marketed, two former INCAP interviewers conducted interviews among four types of urban residents: wealthy suburbanites, middle-class or civil servant families, residents of several city slum areas and market wholesalers and retailers.

d. Philippines. (April-May 1981). A complete case study was not carried out in the Philippines. Instead, an informal consumption survey was conducted in collaboration with the Philippine Potato Program (PPP) and CIP Region VII staff, in order to determine areas of future research activity. Together with production scientists, interviews were conducted in major and minor production sites, non-production areas and in a variety of market places.

e. Indonesia. (May-November 1981). This case study was conducted in affiliation with the Indonesian Vegetable Crops Research Program (BPTP), Lembang, West Java and the International Agricultural Development Service (IADS - Indonesia). The intention was to hire a number of assistants to work in several locations and proceed much as with the Rwanda study. However, difficulties in obtaining official permission to conduct even informal surveys precluded this and a decision was made to focus on West Java. An assistant (a former CIP tissue culture trainee) was hired to obtain the requisite permissions (a process which took nearly a month) and conduct informal interviews among the following population groups:

- small and large potato producers in the Lembang highland vegetable zone,
- non-potato farmers in the same zone,
- wealthy, middle-income and low-income residents of Bandung, the capital of West Java,
- staff and laborers at the BPTP-Lembang research station,
- rural and urban residents of Karawang, a lowland rice growing area.

It is unwise to generalize about all of Indonesia from data collected only in West Java, so visits were made to a number of other previous including East and Central Java, Bali, South Sulawesi, North and West Sumatera. Although inconclusive, these visits to markets and production sites helped to broaden and clarify the potato consumption picture. In Jakarta, a series of market interviews were conducted, and a potato breeder was hired to interview low-income residents of Jakarta,
to see if the general opinion than only the rich can afford to eat potatoes was true. Finally, an expatriate was hired to interview other expatriate families in Bandung to determine whether their consumption is higher than national consumption levels, as the general consensus claims. The size and complexity of Indonesia makes it a difficult case study, yet its position as the largest producer and consumer of potatoes in S.E. Asia justifies the effort and indicates the need for future research.

4. The Informal Interview

In all case studies, no matter how procedures differed, the informal interview was the key research tool. In essence, it is a conversation between an interviewer and an informant covering a set of pre-determined topics. The goal is to obtain qualitative and quantitative data. Not only is it important to know how many potatoes are consumed and with what frequency, but why potatoes are consumed and if people would like to consume more. Even when a questionnaire was used to record information, a conversational style was used to elicit information and to encourage free responses. Generally, an interview covers the following topics:

- quality and frequency of consumption
- where and how potatoes are obtained
- how they are consumed (preparation) and by whom
- would they like to consume more (why or why not)
- how potatoes compare to other foodstuffs
- potato preferences concerning variety, color, consistency, taste
- beliefs, taboos or medicinal uses.

With market people, questions concerning prices, supply, seasonal demands and amounts purchased by clients are included.

C. Preliminary Results

The experiences gained from the case studies have provided three significant results: (1) alterations in the potato consumption typology, (2) clarification of factors influencing potato consumption, (3) construction of the relationship between potato price, role in the diet and consumption levels both current and potential.

1. Revised Potato Typology

In the revised typology (Table 2) a number of changes have been made. In column (1) the role as an exchange item has been replaced
Table 2: Revised Potato Typology

<table>
<thead>
<tr>
<th>(1) Role</th>
<th>(2) Frequency of consumption</th>
<th>(3) Rate of consumption</th>
<th>(4) Common beliefs</th>
<th>(5) Retail price relationship</th>
<th>(6) Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato as a staple food item</td>
<td>Five or more meals per week</td>
<td>0.25-0.5 Kg. or more/person/meal or 60-200 Kg./person/year</td>
<td>Potato = food, potato provides energy. It is not a meal unless there are potatoes</td>
<td>Low when compared to other caloric sources</td>
<td>Andes, Nepal, Rwanda and E. African highlands. Andean countries urban centers. Some Central American and Asian producers at harvest time.</td>
</tr>
<tr>
<td>Potato as a staple vegetable item</td>
<td>.5-5 meals/week</td>
<td>0.25-0.5 Kg./person/week, or 15-52 Kg./person/year</td>
<td>Potato ≠ food, potato = vegetable, is a compliment to food staples. Potato harmful when consumed frequently. Potato energy ≠ to energy needs for day's work</td>
<td>Moderate compared to other vegetables, but often more expensive than other tubers.</td>
<td>S.E. Asian, C. American, E. African urban upper class and urban middle income class. S.E. Asian, C. America, some African potato producers.</td>
</tr>
<tr>
<td>Potato as a luxury vegetable item</td>
<td>Consumed at one meal or less per month, or consumed 1-5 times/year</td>
<td>≤ 1-10 Kg./person/year</td>
<td>Potato = vegetable Potato = special food Potato = rich people's food Potato harmful if consumed frequently</td>
<td>Excessive when compared to other foods, vegetables, tubers or grains</td>
<td>S.E. Asian lowland rural rice producers Lower class S.E. and some middle income urban S.E. Asian populations</td>
</tr>
<tr>
<td>Potato is not consumed</td>
<td>Never consumed</td>
<td>0.0 Kg./person/year</td>
<td>Potato is food for other people. Potato is unknown</td>
<td>Extremely expensive when compared to local dietar, staple foods</td>
<td>Rural poor of lowland humid or dry tropics. Urban poor of S.E. Asia</td>
</tr>
</tbody>
</table>


with the non-consumption role. This resulted from the fact that no potato farmers were found who did not consume at least some of their production. They may exchange potatoes for other foods, but their own consumption of potatoes fits one of the first three roles, and not the fourth. Columns (2) and (3) quantify the frequency and rates of consumption that typify each role. Column (4) summarizes the most important beliefs about potatoes which aid in governing the role it plays in the diet. Beliefs concerning the upper or maximum limits of healthy potato consumption were quite common among the second and third roles and could be more significant in limiting consumption or desire for consumption than price. The price relationship (5) was not altered significantly. The only change has been that the items compared to potatoes differ from role to role. The examples in column (6) represent disaggregated groups rather than countries and points out the great variation within countries as well as the inherent problems in generalizing consumption levels for an entire country. Even within countries, such as those of S.E. Asia where consumption levels are said to be miniscule, there are many groups who regularly consume significant quantities of potatoes. This indicates a potential for increasing consumption if the constraints prohibiting the consumption for low- or non-consumers are removed.

2. Factors Influencing Potato Consumption

Figure 1 shows factors which can influence the role of the potato in the diet, expressed here in the central box as the quantity and frequency of potato consumption. Price is placed closest to the central block because it is often the most obvious factor, the easiest to measure and one often thought to be most important. Equal weight, however, in terms of intensity (thickness of the indicator arrows), is given to the other factors which appear to determine the role or pattern of the consumption response to price. Some examples of how this works are given below.

a. Food beliefs. Among Filipino producers, potatoes are consumed but not regarded as food. Only rice is food. It is said that if rice is eaten in the morning, one can work all day, but if potatoes are eaten the person will be hungry by ten o'clock. This belief encourages potato farmers to consume only a small portion of their crop and sell the remainder in order to buy rice or sweet potatoes.

b. Historical events. When introduced in Rwanda, potatoes were considered taboo items and not consumed. If eaten, one's cows could become sick and die, or the milk could go bad. Tribal leaders, seeing that potatoes caused no harm and had good production potential, convinced local headmen to consume them and proved no harm occurred to
Figure 1. Factors Influencing Potato Consumption

ROLE OF THE POTATO IN THE DIET

- Food beliefs
- Historical events
- Rural or urban residence
- Agroecological setting
- Type and quality of potatoes
- Potato producer, non-producer or merchant
- Seasonality or availability
- Foreign influence
- Income level
- Social status
- Famine
- Food classification system

Quantity and frequency of consumption

Price
people or cattle. Forced labor migrations of people from consuming communities promoted the spread of potato cultivation and consumption.

c. Famine. In both highland Rwanda and Nepal, periodic famine in pre-potato times encouraged a rapid acceptance of potatoes once they were introduced. In these areas little else could produce as well at higher altitudes and potatoes were rapidly incorporated into the diet as a staple food.

d. Social status. Potatoes in Southeast Asia are expensive relative to staple foods or native vegetables, therefore, it is assumed that if one can eat them, one must be wealthy.

Potatoes are also symbolic of Western expatriates who normally enjoy high status positions. Thus, conspicuous consumption of potatoes at special occasions is a way of demonstrating that a high social status level has been achieved. In Singapore the younger generation is reported to be changing from eating only rice to eating potatoes as well. Potato consumption is viewed as symbolic of modern ideas. For young people, "status is to walk down Orchard Road while eating from a package of McDonald's french fries."

e. Income level. In every case study outside of the Andean countries higher potato consumption is recorded for wealthier groups. This can be from two times as much in Guatemala to over ten times as much in parts of the Philippines.

f. Foreign influence. Potato-consuming colonizers of tropical countries have influenced local consumption habits. Colonial administrators often introduced potato cultivations. In Rwanda, Belgians influenced consumption as did the English in India and the Dutch in Indonesia. Potato production and consumption grew in the Philippines only after the American occupation even though the Spanish had introduced potatoes over a century earlier.

g. Food classification system. Among many native rural peoples of highland western Guatemala, "hot-cold" food classification systems which refer not to temperature but to intrinsic qualities of foods are common. Potatoes are "cold" food since they grow underground. They are "cold" even if consumed while the physical temperature is hot. People believe that excessive consumption of "cold" foods can do damage to the "warm" body. To avoid harm from potatoes they are not eaten at more than three consecutive meals and are always the supplement to "hot" foods such as grains or legumes.

h. Seasonability or availability. For Filipino producers, consumption occurs only at harvest. They practically never buy potatoes.

* From an interview with Ms. Hazel Ong, Commercial Officer, British High Commission, Singapore.
Though annual consumption is high compared to other Filipinos, it is concentrated into one, two or three short periods.

i. Potato producers, non-producers or merchants. Potato producers consume the greater amounts that non-producers among rural populations. But potato merchants will often have even higher rates and greater frequency of consumption, due to more constant supply throughout the year.

j. Type and quality of potatoes. Among Filipinos, marked preferences exist for red-skinned or white-skinned potatoes. In Luzon, red-skinned ones are used for cold salads while white-skinned ones are for cooking with meat or vegetables. In Mindanao, white-skinned potatoes are eaten. Red ones are said to spoil quickly and are often avoided. In Indonesia, red or purple-skinned potatoes are produced in a few isolated areas but they have little market value. Consumers think they look like sweet potatoes, a low-status food, and they will not buy them. Santa Rosa used to be a leading potato producing area in Guatemala. Potatoes from this area, referred to as "Papa Santa Rosa," were highly esteemed by urban consumers. Today Santa Rosa no longer produces many potatoes, but merchants, desiring better prices for their potatoes, hawk them as Santa Rosa potatoes, no matter what their variety or production location, and consumers will pay higher prices for them.

k. Agroecological setting. People in highland production zones naturally have greater access to potatoes than others and their consumption is higher. People in zones adjacent to these have greater access to potatoes by proximity than lowland neighbors at great distances from these zones.

l. Rural or urban residence. Outside production zones, urban residents have greater access to potatoes at cheaper prices than rural residents due to the fact that city markets are more abundantly supplied than village or rural community markets.

The above factors combine to form the accepted role of the potato in the diet of a population group. They form a framework of potential consumption within which price acts as the modifier of actual consumption rates.

3. Relationship Between Price, Role and Rates of Consumption

Potato consumption patterns fluctuate within each consumption role in response to price changes as shown in Figure 2. Though tentative evidence thus far seems to support this relationship. When the potato plays the role of staple food in the diet, consumption can
Figure 2. Relationship of Potato Prices, and Consumption Role

- Staples
- Complementary vegetable
- Luxury food

Price Fluctuations

kg/person/year
go much higher than 100 Kg/person/year. In fact, some Andean populations are reported to consume over 200 kilos per person. In this role, consumption, irrespective of price, does not go below a certain level, proposed here at roughly 60 kilos. To people with this consumption pattern, potatoes are a basic necessity, so even when expensive, they are still consumed.

When potatoes are consumed as staple or complimentary vegetable consumption fluctuations are highly responsive to price fluctuations but maximum and minimum limits of 60 kilos and 10 kilos are proposed. If potatoes are cheap and available, they will be consumed more frequently; if expensive, less frequently, but the intake at a given meal remains fairly stable. Consumers in this role with average annual intakes in the upper ranges (35-50 kg/yr) will commonly state that they do not want or need to consume any more potatoes even if they became very cheap.

The most interesting pattern displayed is that of the luxury vegetable role. When potatoes are considered as luxuries, they are consumed only at special times, usually holidays or religious celebration. In the Philippines, potato consumption is highest during the pre-Christmas season and during May fiestas. The primary Indonesian potato consumption time is Lebaran, the holiday period following Ramadan, the annual Moslem month of feasting. In both countries, people buy large quantities of potatoes of these times to prepare special foods. Vendors know that potatoes are status symbols and must be obtained, so they increase their prices to their highest annual levels because they are confident they will be able to sell all. To meet this increased periodic demand, farmers practice delayed harvesting and merchants hoard potatoes in order to bring prices up. After these times, prices drop again but so does demand. This results in the "blip pattern" shown on the chart.

D. Conclusion

Reviewing the typology, the factors influencing consumption, and the price/role relationship, it is proposed that there is greater potential for luxury potato consumer to become staple vegetable consumers, than for the latter to incorporate the potato as a staple food. As a luxury vegetable, the potato has a high status position in the diet. People would likely include it in ordinary meals, as a vegetable, if it were more readily available or cheaper. There is a little difference between these two groups in terms of beliefs. It is much more difficult to change potatoes from a staple vegetable position to that of staple food. Strong belief systems hold the potato to one or
the other position. Usually in the vegetable role, other foods such as grains, legumes or other tubers are considered staples and are more readily available. This does not mean that changes cannot occur, but that rather when they do, the potato comes to fill a staple food role that was either previously unoccupied or poorly occupied by local foodstuffs.

E. Recommendations for Future Research and Application

The results of the project thus far indicate current trends and potentials of potato consumption in the tropics. Looking beyond the objectives central to completion of this project, future objective should focus on how to apply the results and hypotheses determined here. The following suggestions are considered here.

1. Project hypotheses and results should be tested in other countries to determine whether they do indeed describe potato consumption patterns of the tropics.

2. Efforts should be made to improve existing information regarding potato consumption specially countries where CIP works. Reliance solely on food balance sheet statistics for consumption should be avoided.

3. Efforts to determine potato consumption should involve agricultural researchers, nutrition workers, and extension personnel in order to stimulate collaborative work between these often separate entities.

4. Disaggregated consumption groups should be defined for each country in order to determine the areas of greatest potential for potato consumption when limiting constraints can be removed.

5. Potatoes are currently used by many Central American and Southeast Asian producer and merchant mothers as baby food, since for them potatoes are relatively cheap and available. However, when the child is old enough to eat adult food potato consumption often drops off to be replaced by local staples. Among many Filipino producer families, potatoes are only rarely given to children; instead costly items are purchased for baby food, and potatoes, a very nutritious food for children, overlooked. Educational materials and pilot projects are needed to teach mothers why and how to better use the potatoes they produce or market to feed their children. If potatoes are to be more widely consumed among these regions of the tropics, then efforts must begin with those persons for whom price structures are not constraints to consumption.

- 135 -
6. The large numbers of people living in agroecological zones adjacent to but lower than traditional potato producing areas usually consume potatoes and would consume more if they could grow them. These people are usually familiar with potato production, often viewing it on hillsides above their own croplands, and may have already tried to grow potatoes. They represent the rural group of greatest potential increase in consumption, if potatoes were more available. Attention should focus production efforts on these mid-elevation areas, rather than on lower, humid elevations where other root crops form stable parts of the diet and potatoes do not.

7. Peru has the unusual distinction of being the home of the potato, but one of the few countries where production is not increasing, and where per capita consumption is reported to be decreasing. Efforts should be made to determine what factors are causing this, what foods are taking the place of potatoes, and the implications this has for other countries in the developing world.

8. Finally, it must be re-emphasized that for a large part of the tropical world, the potato is considered as a vegetable. This classification places potatoes in a category considered much less important than rice or secondary grain and tuber crops. Within such a system, it is difficult for governments to justify specific programs dealing only with potatoes, and even more difficult to allocate personnel to work solely on potatoes. Instead, potato research and extension must be combined with that of other vegetable crops such as tomatoes and cabbages. CIP must also orient its thinking in Southeast Asia towards promoting potato improvement within a vegetable farming system. We must not only be concerned with improving potatoes themselves, but with improving potato production within the highly intensive vegetable cropping systems common to this part of the world.

COMMENTS

Frank Cancian

Dr. Poats employs diverse methodologies. She uses the "lurking about" method where it is appropriate, interviews people where that is useful, analyzes government statistics and other people's survey results where they yield needed information, and conducts her own surveys when that is the only way to get needed information. This methodological flexibility contributes greatly to her substantive results.
The use of disaggregation is particularly impressive in the Rwanda case. The national consumption average is shown to be made up of diverse components; and a disaggregated analysis reveals differences suggestive of groups that should receive special attention in future research.

Treated as a research hypothesis the concrete recommendation that where potatoes are established as luxury items, prospects are enhanced for expanded consumption because local people already have a cultural place for potatoes. Does previous knowledge encourage or constrain expanded use?

While the potato is often a high status food where it is little used, and although it is tempting to use this status bonus to promote expanded consumption, I suggest that prospects for introduction of the potato as a lower status, inexpensive food should also be considered. Perhaps it would be useful to explore the parallels available in the history of the spread of potatoes and maize in Europe, for they are staples and low status foods in many areas.
ESTIMATING THE DEMAND FOR POTATOES IN DEVELOPING COUNTRIES
AND THE ROLE OF ECONOMIC RESEARCH AT CIP

Gregory Scott

A. Introduction

To insure fruitfull cooperation between CIP and its national program clients, CIP must have accurate and up-to-date information about the demand for potatoes in each of these countries. CIP needs this information to anticipate requests for improved technology. The national programs need this information to plan future research efforts and to advise policy makers about domestic potato production needs. Working with national programs, CIP social scientists can make a crucial contribution to CIP's international effort by helping to provide this basic data and to develop a future capacity to carry out research in this area in the countries themselves.

The need for research on the demand for potatoes in developing countries appears especially important to CIP because recent papers by Bennett, 1975 and Horton, 1980 have noted that the potential role of the potato as a food crop in the developing countries may have been seriously underestimated. Among the reasons cited for this miscalculation were "ancient prejudices, misinterpreted economic principles, and political interests."* This paper focuses on the economic reasons for this miscalculation. The first part of the paper explains briefly the economic concepts involved. The second part assesses the use of these concepts in light of the available evidence. The final part outlines a program for future research in this area.

B. The Basic Components of Demand Projections for Potatoes

From the economist's perspective, the potential role of the potato as a food crop in developing countries depends on the future demand for this commodity. A decision by the government of Country X to allocate

more resources to potato production should depend in part on (1) whether available estimates show potato consumption increasing or decreasing in the years ahead; and (2) whether these estimates have been reasonably accurate in the past. The estimates referred to are demand projections. They consist of calculations concerning changes in population and in per capita income, plus certain assumptions about the price of potatoes as well as substitutes and of complements. Before turning to the numbers themselves, it may be useful to discuss briefly the principal components of most potato demand projections: (1) population growth; and (2) real income changes.

1. Population Growth

FAO agricultural commodity projections estimate that roughly 70% of the increase in the demand for food in the developing countries would come from population increases.* Population growth quite simply means more mouths to feed. Yet, the potential impact of population changes on the demand for food crops like potatoes can be easily overlooked. A simple, hypothetical example may help illustrate this point.

In the imaginary developing country, Santa Clara, prospects for per capita real income growth over the next decade are nil. Although real incomes are increasing at 3% a year, the population is growing at the same rate. Thus, considering per capita real income changes alone, the demand for potatoes in Santa Clara is projected to remain the same in 1990 as in 1980.

Still, Santa Clara does have a growing population. Thus, the demand for potatoes in Santa Clara will increase over the next 10 years because of the increasing number of consumers in the country.

Information about the future demand for potatoes is also crucial if CIP and Santa Clara's national program are to try and estimate how fast new technology must be adopted for potato prices to fall and/or per capita potato consumption to increase. Without this information, cooperative research plans run the risk of seriously under- or over-estimating the local demand for additional potatoes. Consequently, for effective cooperation with national programs, CIP must have a capacity to investigate solutions to both supply i.e. production and demand problems.

2. Income Elasticities of Demand

The impact of real income changes on the future demand for potatoes is calculated using estimates of the income elasticity of demand. The income elasticity of demand is a "measure of the responsiveness of quantity to changes in income other factors held constant."* Since the relationship between income and the quantity of a particular good demanded is considered to be continuous, income elasticities can vary at different income levels. For example, at a particular income level, if \( Y \) represents income and \( X \) the quantity of potatoes demanded, then the definition of an income elasticity of demand for potatoes, \( E_{YP} \), would be:

\[
E_{YP} = \frac{\Delta Y}{AY} = \frac{\Delta X}{AX} \times \frac{Y}{X}
\]

The value of \( E_{YP} \) is interpreted as the percentage change in the quantity demanded of potatoes, given a 1 percent change in income, all other factors held constant.

As a consumer's income increases, he or she generally buys more of a particular product. Consequently, the income elasticity of demand is positive in most instances. However, there are exceptions to this general tendency.

The income elasticities of demand for a food item like potatoes are generally lower in the developed countries --where per capita incomes are high and food needs relatively satiated-- than in the developing countries --where per capita incomes are low and base food needs are still to be satisfied.

With their growing populations and strong aspirations for higher real incomes, many developing countries would thus appear to have an increasing demand for potatoes in the decades ahead. The following section examines the availability of demand projections for potatoes, what they indicate about potato consumption trends, and assesses their usefulness as a guide to policy makers.

C. Research on the Demand for Potatoes in Developing Countries

While much has been written about the projected trends in food grain consumption in developing countries (see IFPRI, 1977, World Bank, 1976, and the Asian Development Bank, 1978) there are few demand projections available for potatoes. A computer based bibliographic search

turned up over 15,000 citations on potatoes, but not one on the demand for potatoes in developing countries.* Moreover, a review of a recently completed bibliography on the socioeconomic aspects of potato production and utilization in developing and developed countries also had meager results. Of over 1,100 articles, books, and dissertations cited, less than 10 entries were studies of the demand for potatoes in developing countries.**

Columns B and C in Table 1 list the estimated percentage increases in demand for potatoes proposed by FAO for 30 developing countries. The data indicate that there was a projected increase in potato consumption in every one of the countries—both for 1975 and 1980. In fact, for many countries, the projected increase in demand for potatoes was higher in average percentage terms per year for 1975 to 1980 (Columns B and C) than from 1965 to 1975 (Columns A and B). This tendency suggests that in these countries the demand for potatoes was projected to rise at an increasing rate over the 15 year period.

In Column D of Table 1, the projected increases in actual demand are compared with the estimated actual increases in actual demand in these same countries.*** In 26 of the 30 countries, there was an increase in potato consumption over the 10 year period. While in many cases these increases were not as high as projected, in 19 countries, potato consumption increased by an estimated 20 percent or more.

For half of the countries, however, the difference between total projected demand and estimated actual demand was 25 percent or more. There are a variety of possible explanations for these inaccurate projections, e.g., poor data, mistaken assumptions, etc.

* The computerized data search was done with DIALOG for the years 1970 to May 1981.


*** The term total "actual" demand is used by economists to refer to the net quantity of potatoes available for human consumption. This quantity is to be distinguished from total "apparent" demand which equals domestic production, plus imports, minus exports. Total "actual" demand represents total "apparent" demand less (a) the quantities used for seed, feed, and manufacturing, and (b) the estimated losses from commercial activity.

The estimated actual increase in total actual demand for potatoes was derived from averaging total apparent demand for 1974, 1975, and 1976 and multiplying this figure by the estimated percentage for total actual demand. This estimated percentage was based on the percentage that total actual demand constituted of total apparent demand in 1964-66. A more recent percentage was not available.
Table 1. Total Actual Demand for Potatoes in 1965, Projected Percent Increase in Demand for 1975, and Estimated Percent Increase in Demand for 1975 in Selected Developing Countries

<table>
<thead>
<tr>
<th>Region</th>
<th>A. Total Actual Demand(^1/) (1965 base year)</th>
<th>B. Projected Increase in Demand for 1975(^2/) (1,000 m.t.)</th>
<th>C. Projected Increase in Demand for 1980(^3/) (1,000 m.t.)</th>
<th>D. Est. Actual Increase in Demand for 1975(^3/)</th>
<th>E. Difference Between Projected and Actual Increase in Demand for 1975(^3/)</th>
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<tbody>
<tr>
<td>North and Central America</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Costa Rica</td>
<td>19</td>
<td>53%</td>
<td>89%</td>
<td>1%</td>
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</tr>
<tr>
<td>Guatemala</td>
<td>7</td>
<td>43%</td>
<td>57%</td>
<td>96%</td>
<td>Low</td>
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<tr>
<td>Mexico</td>
<td>271</td>
<td>58%</td>
<td>96%</td>
<td>99%</td>
<td>Low</td>
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<td></td>
<td></td>
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<td>56%</td>
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<tr>
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<td>China (Mainland)</td>
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<tr>
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<td>2288</td>
<td>35%</td>
<td>55%</td>
<td>95%</td>
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<tr>
<td>Indonesia</td>
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<td>33%</td>
<td>53%</td>
<td>329%</td>
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<td>Iran</td>
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<td>100%</td>
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<td>Iraq</td>
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<tr>
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<td>72%</td>
<td>-9%</td>
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<tr>
<td>Korea (Rep.)</td>
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<tr>
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<td>21%</td>
<td>34%</td>
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<td>Equal</td>
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<tr>
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<tr>
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<tr>
<td>Turkey</td>
<td>1281</td>
<td>42%</td>
<td>66%</td>
<td>47%</td>
<td>Low</td>
</tr>
</tbody>
</table>

Sources: 
3/ Food Production Yearbooks, FAO, Rome, various years.
The precise contribution of each factor in each country is not possible to determine because, among other things, the procedures used by FAO are not made explicit in the publication.

From this brief review of the available research on potatoes, the following points should be emphasized. First, there has been little research on the demand characteristics of potatoes in developing countries. Second, actual increases in the demand for potatoes have almost always been positive, but the rate of increase has varied considerably from country-to-country. Third, past demand projections have not been particularly accurate.

D. An Outline for Future Research on the Demand for Potatoes in Developing Countries

To anticipate the requests for technical assistance and to cooperate more effectively with national programs, CIP needs basic information on the demand characteristics for potatoes in its client countries. Given the limited research in this area of fundamental importance, CIP social scientists can make a crucial contribution by working with national programs to generate this information. It is proposed that this research be carried out using secondary data for approximately 20 countries. For the purposes of generating a series of generalizable conclusions from this research, it is hypothesized that countries can be organized into a typology to reflect two variables: (a) per capita income and (b) the role of the potato in the diet.

This project proposes to use time-series data to estimate income and price elasticities of demand for potatoes. In this way, it represents a prepared departure from past reliance on household consumer surveys in many countries. On the one hand, the information on the price for potatoes and the price of substitutes and complements is now available in many countries for a relatively long historical series. This was not the case 20-25 years ago when these projections were first being considered by FAO. On the other hand, the advantage of estimates based on time series analysis is that they reflect consumer's behavior over a number of years rather than at a single point in time.

The project also proposes to estimate these elasticities using simple linear models. The time and resources necessary to produce results based on more sophisticated models is not appropriate for this type of first approximation being proposed. Moreover, the data themselves are not sufficiently refined to merit more advanced models.

The practical results of the project are anticipated to be as follows:
1. A knowledge of the demand characteristics for potatoes that would facilitate better demand projections for potatoes on a regional and individual country basis;

2. Country specific estimates of the price elasticity of demand for potatoes that would help assess the feasibility of alternative marketing and storage programs (in cooperation with Thrust VIII).

3. A methodological framework that would be transferable to national programs for future work in this area;

4. A complement to the on-going anthropological research on the tastes and preferences of potato consumers in developing countries carried out by Dr. Susan Poats.

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COMMENTS

Kenneth J. Brown

Regional Research and Training frequently influence national priorities intentionally or unintentionally. There was a question the other day on how we chose target countries. The truth is that we have little or no basic data on which to make our judgements. In many cases we react to a technical approach which eventually turns itself into a policy intervention.

Scott's paper shows the paucity of information and the great need for an improved study of demand to provide us with a sound base for our judgements, particularly where a major financial investment by national or bilateral funds is required.

Having said that we need such information, I find the paper leaves me unsatisfied on how the project is going to set about getting it. Of the 7 pages only the last briefly refers to the research process and a lot is left unsaid.

Are the proposed parameters the best? Can we get better data than FAO's and if so for how many countries? I wonder whether there are so many imponderables influencing a parameter like CDP that, without looking at a very large multifactor equation, we will be unable to come up with estimates better than those already available.

Perhaps we do not need quite the usual accuracy that a national planning office requires. For our purposes some value for demand with acceptable confidence limits e.g. ±15% might be adequate. At least it will allow us to pick out those countries which a reasonable potential for expansion and perhaps eliminate those where future demand will be falling.

In showing up the erroneous nature of the currently available data, it brings up the point of how useful are derived judgements such as inferred income elasticity of demand. Those given in the paper do not seem in any way to tie in with the detailed knowledge turned up by Susan Poats' studies.

In summary, the study is needed but it should be made clearer how it is going to take place.
FARMER ACCEPTANCE OF NEW TECHNOLOGY:
A PROPOSED RESEARCH PROJECT

Robert E. Rhoades

A. Statement of Problem

One of the great paradoxes in agricultural development is that the farmer is often the last person to be consulted in the identification, design, and promotion of technology aimed toward farmer use. Invariably, the multitude of beautiful, detailed flow charts on agricultural research and transfer show a direct arrow leading from a research institution through extension to the immediate client, the farmer, and then a feedback loop to continuing research.

This, however, is an ideal rarely followed. A diagram of reality would show separate, disjointed circles of activity with no or extremely weak links between research, extension, and farmers.

I am proposing a research project which will analyze farmer responses to specific recommended potato technologies in light of the total process from identification of a technology to attempted or actual transfer to the farmer. The purpose of this broader focus is to avoid the pitfall of assuming that a farmer fails to adopt because of "constraints" he faces (i.e. lack of capital, low educational level, poor understanding of technology, etc.) It is conceivable that farmers often do not adopt because of faulty identification, design, and communication of appropriate technology at the research or transfer level. In other words, this proposed study would not only concentrate at the farmer's end but consider the full research-transfer context from "Laboratory to Land," so to speak.

B. Purpose of Research

Four broad purposes for conducting this research can be identified.

1. Obtain information to better understand farmer response to recommended technology in order to improve the technology's design, appropriateness, or even to reorient research;
2. Explore ways to reduce the communication gap between researchers and farmers and seek possibilities to reduce the time between availability of appropriate new potato technology and actual use by farmers;

3. Identify types of producers and contexts where a given technology has a high chance of success and where it may not be appropriate at all; and

4. Contribute to the general social science knowledge about adoption behavior, especially in relation to potato technology diffusion about which little is presently known.

C. Research Strategy

Although this project is presently being formalized, some research has already been conducted on rustic seed stores in the Philippines and Peru in coordination with CIP's post-harvest thrust. The task now is to better conceptualize the problem, methodology, and select cases to be researched in the coming years.

The following steps are suggested to accomplish the objectives outlined in part B.

1. Review the important literature on agricultural technology transfer and diffusion. A vast literature presently exists on this topic and the classical theories and cases will be examined to guide research.

2. Select particular technologies introduced by national programs or CIP-related institutions, preferably in several agroecological contexts. Overtime, different types of technologies will be selected for study. These may include such diverse cases as new varieties, or germplasm material, agronomic practices, post-harvest technology, or even certified seed programs.

3. Document for each case the background leading up to introduction of the technology to farmers. This involves an in-country history of the case up to exposure to farmers, including the institutional framework through which the idea or technology moved.

Three broad questions will be entertained at this stage for each technology:

- How was a need for the technology identified for a given set of farmers in target regions?
- How was the technology adapted to local conditions, if at all?
- How was it presented to farmers (demonstration, training, etc.)?
4. In each locality where the technology was introduced, study farmers' responses to the new technology. Who were adopters and non-adopters? What are their characteristics (socioeconomic) or farming circumstances (agroecological)? A combination of informal and formal survey techniques will be used, although in general anthropological survey methods will be emphasized.

The purpose will be to determine selective flow, if any, of the technology through a community or region. This research stage will probably be modelled along the lines of traditional sociological diffusion of innovation studies.

5. A final analysis will aim to explain why the technology was accepted, rejected or --in some cases-- even failed to reach farmers. At this stage, the analysis will reach beyond description and correlation. If methodologically possible, comparison of several cases where the same technology was introduced into different countries or regions with varying degrees of success will hopefully yield a more generalizable understanding of the factors underlying success or failure.

D. Collaborative Project with Thrusts VIII: The Case of Rustic Seed Stores

Through the efforts of post-harvest technologists, rustic stores have been introduced to a large number of countries by former CIP trainees and other potato workers. The technology and transfer methodology used by thrust VIII is essentially the same (at least the basic principles) but the circumstances (environment, institutions, methods of communication, etc.) vary substantially. The rustic seed store case offers the best case to begin CIP research on farmer acceptance of technology.

Initially, we are considering the following countries selected on the basis of geography and past storage activity.

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Some research has already been conducted in the Philippines (see Rhoades, et.al. 1980), although this should be considered preliminary. Research is now underway in Peru. Colombia will be visited in September. General secondary information has been gathered on Guatemala, Kenya and Nepal.

We plan to conduct a follow-up survey of trainees and analysis of national program efforts. In addition to studying farm-level research,
it is necessary to study the processes by which the technology was extended to farmers. In this regard, we feel the opinions and experiences of trainees in post-harvest courses will be invaluable.

We have already mailed a questionnaire to some 70 former trainees in South America, Central America, and Asia, asking them to document their experiences and offer opinions on the institutional framework in which they work. It is possible, for example, that when a national program places low priority on storage that this is as constraining to the transfer of rustic store technology as identifiable constraints at the farm-level.

The rustic storage case is considered only a beginning. In time this type of analysis should be extended to other cases, tracing events from the earliest design stage to the transfer stage. In this way, the post-harvest approach can be evaluated to determine if it is applicable to other types of technology. I would suggest for future research technologies which are substantially different in nature than rustic seed stores (i.e., improved varieties, agronomic practice such as a fertilizer input, and certified seed program).

COMMENTS

Frank Cancian

The proposal emphasizes broad multifaceted study of farmer responses to specific recommended potato technologies. It narrows the object of research to specific technologies (such as seed storage) and thereby gains the advantages of a fairly open-ended, informal, "blanker" approach that anthropologists favor.

Given the limited research available on the spread of potato-related technology, it seems wise to keep the approach broad for some time. Rhoades and Booth's previous paper on interdisciplinary research illustrates very well the need to attend to the farmer's situation, and the virtues of providing technological alternatives in terms of general principles --so that farmers can adapt them to their circumstances. Given potatoes and the people who grow them in the third world, flexibility is crucial.

My suggestions for possible modification of the proposed research are as follows:

1. Rhoades points out that the literature on technology transfer and diffusion is vast. Fortunately he proposes to review only the important
parts. For those not familiar with the rural sociology research tradition, I note that roughly between 1940 and 1960 about 400 diffusion studies were done, and that by the mid-1970s more than 2,000 had been done. Few of these studies are on potatoes.

It would be of special use to, at the outset, think through the properties of potatoes which make them similar to and different from the other crops (technologies) so that something general might be learned about the diffusion process and something about potatoes might be learned from what is known about other crops. For example, potatoes have a low yield to seed ratio in comparison with cereals. You seed a lot of food. Does that make them comparable to beans? What do we know about beans that helps us think about potatoes?

The model for this kind of comparative thinking in terms of agroenvironment is already in Rhoades' comparative paper which we heard this morning. I am suggesting that comparing potatoes with other crops will allow us to use knowledge acquired about other crops and stimulate useful thinking about the properties of the potato.

2. The methodology section of the proposal is brief and suggests that informal interviewing of key informants will be the main method. This method is crucial to the exploratory stage of the research, but it is not adequate to accomplish the goals set out for the study of farmer responses. Rhoades suggests that his work will be modeled after traditional sociological diffusion of innovation studies. These demand very ambitious surveys.

3. The diffusion of innovation research, CIP research in general, and Rhoades' proposal in particular, pay great attention to the farmer as an individual decision maker. While this is an important approach that underlays the vast majority of previous studies and a continuing stream of contemporary research, it has become fashionable to criticize the lack of attention to a variety of larger system factors of two kinds: (a) ones stemming from the fact that the farmer's life goals as a whole are more important than the specific technology studied; they are in effect the dog that should wag the potato as a tail; (b) ones stemming from the larger political and social system.

I agree with the fashion for the following reasons:

1. Many indicators show that CIP social scientists are considering more and more the complexities of dealing with a decision maker who is not a primarily potato producing firm. These factors have been briefly covered or added in discussion of papers. An example is the role of off-farm income in the farmer's decisions. The reality is that vast proportions of the world farmers are part-time. So the development of potatoes adapted to this fact is important.

- 151 -
2. Farmers' relative positions within their communities will influence their reactions to new technology since production and the technology itself is in the end of an instrument in their social lives.

I am particularly concerned about social stratification and its implications for spread of technology, but there are a number of characteristics of community structure that will influence the appropriateness and the adoption of new technologies. The general point is that not all farmers will adopt, and that those who will adopt will often do so in terms of community position. This must be studied.

The larger political economy and the positions held in it must be of concern. There is no doubt that the introduction of varieties that are relatively capital intensive or varieties that present significant economies of scale will lead to increased income differentiation and often to an increase in landless laborers. CIP is not responsible for the ills of the world, but its limited powers are not simply neutral. The socioeconomic implication of technical alternative must be studied more fully.
SOCIOECONOMIC ANALYSIS IN THE GENERATION OF A NEW TECHNOLOGY: TRUE POTATO SEED

Anibal Monares

A. The Problem

European-style potato certification programs have been advocated to provide disease-free tuber seed to developing country farmers. In most developing countries, however, these programs have not been successful. A host of technical, economic and institutional problems often hampers their operation, and after a few years they tend to collapse (Whyte, 1977; Monares, 1981).

A new approach --the use of true, or botanical, seed (TPS) is being investigated by the International Potato Center (CIP) as an alternative to traditional potato propagation methods in areas where they present problems. Planting with TPS instead of tubers could offer several advantages:

1. It could reduce the cost of producing, storing, transporting and handling tuber seed. Only around 100 grs. of TPS are needed to plant one hectare while 2 tons of tuber seed may be required for the same area.

2. Problems associated with tuber-transmitted diseases could be minimized, as TPS carries fewer pathogens, especially viruses, from season to season.

3. TPS could be stored from one planting season to another, or for several years, conveniently and inexpensively.

4. Use of TPS could help extend potato cultivation to subsistence farmers in warm, humid areas with no source of low-cost, high quality tuber seed.

Use of TPS for producing potatoes is not new. Potato scientists have used TPS for years in breeding new varieties. But, once obtained, varieties have been multiplied vegetatively through a certification scheme to maintain their varietal purity and to supply disease-free tuber seed. Current seed certification programs are so stringent that an entire seed field may be rejected if it has a few atypical plants (Page, 1979).
In spite of the potential value of TPS, commercial potato crops are nearly always grown from seed tubers. In the past decade, a few countries, such as China, have been successfully growing potatoes from TPS. In the People's Republic of China TPS technology mainly substitutes for basic or foundation seed and is not used by farmers for direct production of consumer potatoes (Sawyer, 1980).

According to Rowe (1974), cultural problems that will have to be solved if botanical seed is to be used on a commercial scale are longer growing period, smaller yield per plant, and less adaptation to environmental stress. A plant grown from TPS has little potential for recovery after frost, drought and insect or disease attack. In addition, seedlings require careful planting, maintaining, and transplanting which in turn, require increased labor. Farmer use of TPS will also require development of a special seed production and distribution system.

B. Agro-Economic Background

The potential role of a new technology should be examined in connection with the nature and relevance of the farmer problems it is intended to solve. Since the use of TPS is not something entirely new pertinent questions are "What role has this technology played in the past?" and "Under what circumstances may its use be extended in the future?" We will examine briefly these questions in the light of three possible functions of TPS in the farming system: (a) creating new varieties, (b) rejuvenating old varieties, and (c) serving as a source of low-cost, high quality planting material.

1. Creating New Varieties

At the present time only potato scientists use true seed for breeding. But according to Ochoa* true seed must have been frequently used by native farmers in the Andean Region of South America to produce new varieties. In his view this use of TPS explains, in part, the great variability of native varieties still found in the Andes. The Incas practiced an advanced agricultural technology, knew how to transplant, and probably learned how to use TPS through curiosity. Salaman (1970) accepts that native South American cultivators occasionally raised new varieties from TPS, but thinks that the vast majority of such seedlings were the outcome of natural self-fertilization. He adds that the first conscious effort to create new potato varieties arose in Western Europe around the middle of the eighteenth century to overcome the depressing effect of virus disease, then known as "curl"**

* Personal communication from Carlos Ochoa, CIP breeder and taxonomist.

** Curl is what today is know as virus disease, particularly leaf roll and potato virus "Y". The incidence of curl was so serious that the logical solution was to raise new varieties from seed to regenerate the parental stock.

- 154 -
2. **Rejuvenating Old Varieties**

Several cases of Andean farmers using TPS to eliminate viruses from existing diseases have been reported. According to Hawkes* TPS is planted in northern Ecuador (Pichincha) and southern Colombia (Pasto) to produce tubers which are in turn, replanted the next season for production of consumption potatoes. Ochoa** has observed farmers using TPS in the central and southern highlands of Peru (Mantaro Valley, Abancay and Cusco) also to produce seed free from tuber-transmitted diseases. Franco (1981) also presents a case of farmers in Chincheros (Cuzco, Peru) who use TPS in response to the problem of varietal degeneration. The process of seed degeneration refers to the gradual yield losses, off type tubers and abnormal foliage color resulting from the continued use of infected seed. Jones*** points out that native varieties have much higher levels of resistance to virus infection than do modern ones which would account, at least in part, for the need to sustain the latter with seed programs involving the taking of active control measures against virus spread. From the above it can be concluded that Andean farmers have used, and continue to use, TPS as partial alternative to certification programs.

3. **Source of Low-Cost, High Quality Seed**

The most important potential role of TPS is as a source of low-cost high quality seed for small farmers in subsistence agricultural areas. Use of TPS could reduce cultivation costs in areas where it is not possible to produce seed tubers and where healthy seed tubers are very expensive (Accatino, 1981). In the past TPS was not used on a large scale for production of either consumption or seed tubers for the following reasons: (a) superior TPS progenies with high yield, tuber uniformity, earliness and resistance to major pests and diseases were not available, (b) TPS technological requirements were higher than those of seed tubers (for example, careful planting, transplanting, fertilizing and irrigation practices are required), and (c) using TPS reduced direct seed cost but increased labor inputs.

If these constraints to use of TPS at a farmer level could be removed, the need for a sophisticated tuber seed certification program would be eliminated and potato cultivation could be extended to subsistence farmers who at present cannot afford high quality seed tubers.

** Personal communication.
*** Personal communication. Dr. R.A.C. Jones, former CIP virologist, now is working at Harpenden Laboratory, Ministry of Agriculture, Fisheries and Food, England.
C. Research Strategy

Present knowledge on TPS is limited and mostly related to its use under experimental conditions. Information on socioeconomic aspects of production and use of TPS is almost non-existent. Socioeconomic analysis can help evaluate the potential role of this technology in different potato production systems in order to help realize its usefulness under developing country conditions. The case of TPS offers a unique opportunity for social scientists to be involved in ex ante research in the design and generation of new technology. The main objectives of this research project are:

1. Gain knowledge and experience which will help develop TPS technology suitable for farmer conditions.
2. Evaluate TPS technology under different agroecological conditions, beginning in Peru (Coast, Central Highlands and High Jungle).
3. Identify target areas for potential farmer adoption of TPS.

This project will be conducted jointly by the Social Science Department and Th. it VII: Physiologic and Agronomic Management.

The research plan includes as a first step, the development of an economic framework to record and analyze costs and returns for producing potatoes from TPS and seed tubers. To gather relevant information on agronomic practices and inputs for producing potatoes from TPS and seed tubers comparative trials will be installed at CIP experimental facilities in Lima and San Ramon. These trials will help identify elements of the technology with potential for reducing costs or increasing benefits.

A few on-farm trials will be installed on Peru's Coast, Central Highlands and High Jungle, in order to evaluate major agroeconomic constraints associated with using TPS under farmers conditions.

Farm surveys will be taken in the areas where experiments are conducted to improve our understanding of farming systems and conditions that favor, or limit, use of TPS. Both on-farm trials and farm surveys will provide information on socioeconomic characteristics of potential users of TPS.

D. Preliminary Economic Framework

Two economic questions of central interest in the generation of TPS are: "At what yield level will the new technology cover its average cost (break even point)?," and "At what yield level are the benefit/cost ratios of the new and prevailing technologies equal?" The first question defines the lower limit of economic feasibility of the new technology;
the second, the level that makes use of the new technology competitive in areas where the potato crop is already grown with seed tuber. These questions will be examined briefly.

1. **Break even Point**

   Knowledge of true seed's break even point, under diverse agroecological and socioeconomic conditions, can be used by researchers to improve costly practices and inputs or select superior progenies. A reasonable assumption is that farmers will only adopt new technology which at least cover their average cost.

2. **Competitive Profitability**

   TPS technology is not being designed necessarily to compete with the seed tuber technology. It could be used in warm, humid areas where it is not feasible to use seed tubers or where subsistence farmers lack a cheap source of quality tuber seed. These farmers could adopt TPS, regardless of the profitability level, if it is consistent with their farming system and provides them a useful source of food.

   Where the new technology plays a competitive role, two factors must be examined carefully: costs and yields. Available experimental results indicate that use of TPS results in lower yield and lower variable costs than use of seed tubers.

   Future research may result in higher TPS yields with lowered cost. In any case, these evaluations of cost versus yield is crucial to the decision making process of whether or not farmers will adopt TPS technology.

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**REFERENCES**


COMMENTS

Robert Booth

As co-artist with Bob Rhoades of the farmer-back-to-farmer circles I hope you will excuse me if I comment upon this future social science research activity on the use of TPS, at least in part, through the eyes of those circles.

I believe the storage and TPS projects to be much more similar than the majority of either biological or social scientists involved in the TPS work admit. Once we identified seed storage as the problem, we were left to research how the known scientific information on the effect of light on sprout growth could be applied to providing a practical and potentially acceptable solution to the problem. In the case of TPS, the problem has been identified as the availability and cost of quality seed tubers and biological research has started on how to use true seed which, like diffused light, is not entirely new to potato research.

While I will be the first to agree that the biological research requirements in the TPS work are much more complex and likely to require a longer phase than did the seed storage project to come up with potentially acceptable solutions, I do also think that the cases are similar enough that the TPS project should benefit from the experiences gained in the storage case and the development of the farmer-back-to-farmer approach. In particular the benefit which result from the continuous involvement of social scientists in the storage project should be noted.

Thus, while I very much agree with Anibal that the true seed case offers an opportunity for social scientists to be involved in ex ante research in the design and generation of new technology, I was disappointed when he came to specifics. Major attention in his presentation was given to after-the-fact economic analysis of biological research findings and farm-level testing.
I don't think, however, that this narrow approach is entirely the fault of the Social Science Department since some biological scientists involved continue to believe that this is the major role of social scientists although they commonly dislike the results of this approach which only serve to broaden the divide between social and biological scientists. Also, within CIP and possibly because of the major effort put into the Mantaro Valley and OPP projects by the Social Science Department, social science has become partially synonymous with on-farm trials.

To overcome this limited approach to the use of the social scientists in the TPS work I believe that what is required is greater "constructive conflict" between the social and biological scientists involved. This never-easy and sometimes outright unpleasant phase is essential in the development of a fully interdisciplinary team. Without this phase I do not think a commonly agreed-upon definition of goals and objectives are arrived at and so there is a real danger that the team simply remains multidisciplinary with each member setting his or her individual disciplinary objectives.

Once a common definition of the goals have been agreed upon, I believe that social scientists can play an important role in the research and design stages as well as the testing phase of this project. This, however, requires a more aggressive and positive input than is achieved by simply "lurking" (a role which has been attributed to social scientists during this meeting) but which is still unfortunately regarded as interference by some biological scientists. Again I think that these attitudes are broken down in the important "constructive conflict" phase.

Looking for specific possibilities for social science inputs into the TPS work in addition to after-the-fact economic analysis and on-farm trials, I think the scope is enormous. For example, the different possible technical ways of using TPS could beneficially be more closely examined to evaluate if their potential adoption might be associated with specific farming systems or other socioeconomic factors. In turn, there is a need to determine what biological or technical requirements those associated factors place on the technology and which need to be considered in biological research activities. Thus, many of the specific problems such as seed germination and vigour, nursery technology, uniformity, etc., which biological scientists have identified and are researching could benefit from a social scientist input. For example, Susan has clearly illustrated how the scientists', farmers' and consumers' view of uniformity and market acceptability differ and how these factors differ from region to region and season to season. Such information raises the question of need for a common and useful definition of "uniformity" so as to help guide the use of resources in this research activity. I think that the general lack of credibility which social scientists have among biological scientists for undertaking this sort of
research guiding and planning activities is because in the past social scientists, perhaps particularly economists, have undertaken this work in isolation from and not jointly with the biological scientists.

In the storage case, the time I spent as a biological scientist on such activities with my anthropologist colleagues more than paid for itself. And I recall that by doing more than just "lurking," anthropologists helped us steer our research in the direction that gave us the greatest chance of our findings being adoptable and acceptable to farmers.

Thus as occurred in the storage case I would hope that from a broader integration of the social sciences in the TPS work that the most effective use could be made of the limited biological research resources and so speed up the accomplishment of the overall objectives.

Having said all this I do however believe that much more of this type of activity is on-going than is actually reflected in this paper.

Similarly, I think the social scientists should already be integrating into the germplasm utilization field.
FUTURE INVOLVEMENT OF THE DEPARTMENT
IN OPTIMIZING POTATO PRODUCTIVITY

Douglas Horton

As outlined in the Planning Conference paper by Roger Cortaboui, the Optimizing Potato Productivity approach consists of a set of procedures for (a) testing the relevance of research results for solving farmer's production problems, (b) selecting among new technologies those which should enter into the extension process, and (c) feeding back information on farm-level production problems to biological scientists to stimulate additional research needed to solve these problems. Hence, this approach represents an intermediate step between the generation of technologies and their dissemination (Cortbaoui).

Ideally, this type of on-farm research involving both technical and socioeconomic evaluations should be conducted within each national agricultural research/extension system, as a routine step in screening new technologies and formulating extension recommendations not only for potatoes but for all commodities.

In recent years, progress has been made in this direction within a few national institutions, such as ICTA in Guatemala and INIAP in Ecuador. In ICTA, a novel farming systems approach has been adopted which initiates the research process in each region of the country with a diagnosis of technical and socioeconomic production problems (Gostyla and Whyte, 1980; Hildebrand and Ruano, 1978). In INIAP, farm-level research is conducted by a special new "Production Research Program," in association with the already existing commodity and support-discipline programs, (Ampuero, 1981). These cases have 2 important similarities. First, on-farm research has been embraced as an institutional approach for all commodities. Second, both these institutes received substantial external support for the social sciences and farming systems research from the Rockefeller Foundation and others in the case of ICTA and the University of Florida and CIMMYT in the case of INIAP.
As documented in the papers by Cortbaoui and Potts, several other national institutions have begun on-farm potato research with varying degrees of encouragement and support from CIP, or from regional programs such as PRECODEPA in Central America.* In the special case of Rwanda, with support from a bilateral donor, the recently established Potato Program relies heavily on farm-level research in establishing and refining its research priorities and screening proposed technological solutions to production problems prior to extension. In these cases with potatoes, the social science research input has been quite limited to date. Hence, in selecting variables for farm-level evaluation, there has been a tendency to minimize survey work and to heavily rely on the assumptions and casual observations of natural scientists. These are subject to professional biases: e.g., entomologists and pathologists stress pests and diseases and soil specialists stress fertilization. In addition, on-farm trials have tended to drift away from comparisons between the farmers and alternative technology toward either standard research trials or demonstrations.

What should be the future role of the Social Science Department in encouraging and assisting national programs to conduct on-farm research with potatoes?

First of all, I think we should discourage on-farm research for its own sake, or merely as an extension or technology transfer mechanism. Second, I think we should discourage the "packing" of technologies and the establishment of optimal input levels, such as fertilizer levels, seed size, and planting densities. The optimal levels and combinations of such inputs are site-specific, and farmers probably have an advantage over researchers in arriving at them.** Instead, I believe that we should encourage the evaluation of qualitatively new technologies --new inputs, such as varieties, seed sources, storage methods, or techniques for controlling pests and diseases. Unless we have something truly new to offer the farmer, we cannot expect much of an impact on production. Some improvements may be identified initially but after a very few years the on-farm testing work will become redundant unless it is fed by a steady stream of new technologies.

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* PRECODEPA is a Swiss-funded project for 6 Central American countries which have pooled their resources for potato research.

** In this respect, I believe we should consider changing the title "Optimizing Potato Productivity," which implies to many people that we are striving to identify economically optimal input levels.
We should also encourage evaluation of farmer acceptance and use of new practices, to generate evidence on the benefits or returns to the resources committed to this work. Experiences with this approach and its results to date have not been documented in a comprehensive way. This is understandable since the field work began only in 1979. But we should now begin to pull together the existing elements for evaluation of the OPP approach.

Finally I think we should become involved in the work only where the National Program's priorities and institutional framework are conducive to interdisciplinary research involving social and biological scientists. This means several things: first, a commitment is necessary from biologists to incorporate results of farm-level research into their laboratory and experimental station work. Second, research and extension need to be linked in a well coordinated fashion to allow information to flow freely between farmers, researchers and extensionists. Third, active, continuing involvement of social scientists is needed, for several years. Unless these conditions are met, I believe that on-farm research particularly the trials, will be of little practical benefit to the research system.

Operating from our Lima base, we cannot be directly and significantly involved in on-farm research around the world. What we can offer is training, guidance in the areas of theory and procedures, and moral support. If CIP is to provide more direct support to national programs, it will be necessary to base social scientists with our regional programs. This would allow (a) continuing interaction with regional and national production specialists, (b) more intensive training, and (c) backstopping of the national teams implementing farm-level work. Ideally, these "regional social scientists" would work closely with staff members of other International Agricultural Research Center, encouraging social science research with other commodities within a farming systems framework.

Given the above, I feel that the Social Science Department's future involvement in Optimizing Potato Productivity should consist of the following:

1. Document experiences with OPP to date, in terms of objectives, institutional arrangements, procedures, and results.

2. Continue to produce training materials on farming systems research, which could be put together in a manual. Such a manual should outline CIP's philosophy of technology generation and transfer, the role of interdisciplinary farm-level research within the research transfer system, and alternative steps and procedures for conducting on-farm research.
3. Encourage, through example, training, and support, National Program workers to engage in interdisciplinary teamwork aimed at generating appropriate technologies.

4. Continue and strengthen our own teamwork with CIP biological scientists to ensure the production of relevant technology at CIP.

5. Continually update our knowledge of farming system research, particularly in the areas of problem identification, economic analysis and evaluation of the adoption and social impact of new technologies.

In closing, let me state that, in my view, on-farm research can be extremely productive within a broader interdisciplinary research process geared to generate and disseminate new agricultural technologies. To date OPP has been associated with a relatively late stage in the research process -- on-farm evaluations. In the future we should attempt to introduce social science perspectives into CIP's key research thrusts at a much earlier phase. The post-harvest work provides an excellent example of the potential benefits of such an integrated approach to technology development and transfer. No methodology is a substitute for technology. Without a strong flow of the appropriate new technologies, the on-farm trials and OPP, may well run out of steam.

REFERENCES


In previous papers presented in this Planning Conference, it has been noted that the OPP approach was originally formulated as a strategy for increasing the utilization of CIP's technology by farmers in the developing world. This strategy was to help national scientists identify potato production problems and appropriate technology for solving them. Once established and institutionalized in regional and national programs this approach would help CIP's newly generated technology reach farmers in the shortest possible time.

As a strategy, OPP seems to have evolved to the point where many of its original methodological deficiencies have been overcome. This is extremely important, since CIP's direct involvement must be reduced in the future as national programs take on greater responsibility for implementing this work.

The quite innovative technology being developed by our Source Research Program is coming closer to the final evaluation phase. My personal belief is that the OPP approach should be implemented in key areas of the developing world where CIP is focusing its regional research and training efforts, to facilitate the transfer of this technology for final adoption by farmers.

The backstopping role of the Social Science Department proposed in Horton's paper, will be most effective if it concentrates in a few key areas of the world. In this way, the most appropriate technological components can be selected to ensure greatest potential adoption.
"PURE" SOCIAL SCIENCE RESEARCH VS. INTERDISCIPLINARY RESEARCH WITH BIOLOGISTS

Susan V. Poats

I would like to begin by rejecting the proposed dichotomy of "Pure Social Science Research vs. Interdisciplinary Research with Biologists." Our mere presence here at CIP indicates that we are no longer "pure economists" or "pure anthropologists." Not only are we contaminated by potatoes, but we have cross pollinated with our colleagues, whether we want to admit it or not. We are, instead, "applied social scientists" applying ourselves to the issues and problems of improving potatoes. The question concerning our research role at CIP seems to me to lie more in a choice between conducting applied social science research on potatoes alone and amongst ourselves or joining interdisciplinary teams at CIP to conduct joint research. Some positive and negative aspects to both are presented here for discussion.

<table>
<thead>
<tr>
<th>Social Science Research (as a group or as individuals)</th>
<th>Interdisciplinary Research (with Biological Scientists)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not always viewed as essential, realistic or worthwhile by biological scientists.</td>
<td>1. Encourages greatest relevance of social science research to biological problems.</td>
</tr>
<tr>
<td>2. Relieves social scientists of the need to constantly justify their existence or methods.</td>
<td>2. Inherent dangers in biological scientists calling all the shots and controlling the technology.</td>
</tr>
<tr>
<td>3. Easier to maintain professional disciplinary connections via traditional routes of publication.</td>
<td>3. Tendency to become &quot;service scientists,&quot; accountants, interpreters, welfare agents or publications editors in projects.</td>
</tr>
<tr>
<td>4. Potential for conducting long-term research which encourages development of methodologies and theories.</td>
<td>4. Often brought in before the fact without intent to continue joint efforts, or after the fact to determine reasons for failure.</td>
</tr>
</tbody>
</table>
5. Provides opportunity to pursue avenues of research in which the scientist is most qualified.

5. Must produce quick answers in a variety of unfamiliar areas lumped into "Social Science."

6. Increases the likelihood of acceptance of technology.

COMMENTS

Jacqueline A. Ashby

Susan has laid out the importance of interdisciplinary research and the major pros and cons from a social science point of view.

The issue on which we ought to focus is now the question of how to institutionalize effective interdisciplinary team work while allowing scope for specialist social science contributions.

Implicit in this question are three issues:

1. How to define collaborative roles in relation to the research process from problem definition to transfer;
2. How to determine appropriate allocation of time to specialized research;
3. What interdisciplinary research means in terms of research methodologies.

How Collaborative Roles are Defined?

Social science normally tended to enter into the research process in the transfer stage so Susan's point 4 is especially worthy of emphasis here. However, effective contribution from specialized research requires both biological and social science involvement in the technology design stage to enhance probabilities of adoption.

Time for Specialized Research by Social Scientists

The important point here is that interdisciplinary research means bringing a variety of disciplines to bear on a common problem, which often requires specialized research by individual team members into quite widely divergent areas of investigation.
The appropriate allocator of time-specialized research is identified from a common problem focus. We do this informally through creative conflict. However, we need to formalize key questions to be asked in an interdisciplinary framework about the biological and socioeconomic variables that interact to define what is a technologically feasible solution to a specific problem. This is necessary so that national program scientists can replicate this process of defining a common focus for research efforts and the appropriate specialized research in the light of local conditions.

Methodologies

Regarding Susan's point about the tendency to become "service" scientists, I have the following observations:

a. No substitute for exposure to field conditions for all disciplines in applied research to identify gaps in knowledge and formulate hypotheses. Of course, anyone can talk to farmers. But talking to a farmer is the tip of the methodological iceberg in social science.

b. Social scientist as "broker" or interpreter is an important role. Social scientists bring methodologies to bear in interpreting farmer conditions to help develop uniformed assumptions into informed judgments about a technology's potential to encourage more than ad hoc use of social science in national programs by creating opportunities for national social scientists.

In summary, if the research process is to be reproduced and self-sustaining at a national level a model of how to combine interdisciplinary and specialized research is as important in terms of transfer as the actual technology components.

COMMENTS

Orville Page

In many ways the presentations during the past 2 days --including that by Dr. Poats-- have shown a concern about how the social scientists bridge between the biological scientists and farmers. This involves a people to people connect to interpret and transfer the technology developed by the biological scientists to farmer clients. This is a difficult role for the social scientist, particularly if not involved in the development of the technology and sometimes providing uncomplementary feedback to the biologist. The biologist may be shown to have developed a less than successful technology. The biologist then tends to blame failure on
the weather, poor field experimentation by the social scientist, wrong choice of farmers or some other shortcoming by social scientists.

This is not all unnatural since the biologist probably conceives himself as being a practicing agriculturist—a farmer-oriented scientist. Then, too, he is also a professional—a virologist, geneticist, nematologist, mycologist, physiologist—who is called upon to give on-the-job training to a social scientist. He has to present in understandable terms some of the secrets of his profession. Such attitudes place the social scientist in an uncomfortable position—the biologist calls the shots, controls technology, may blame failure on the social scientist. Social scientists wonder whether they are merely interpreters, service staff, accountants, or quick answer specialists.

The solution seems to me to lie in the social scientists being full members in interdisciplinary projects. It must be pointed out, however, that feelings of alienation are not unique to the social scientist. The virologists often feel that they are no more than service persons for the breeder, the physiologist a problem solver for the agronomist or the seed specialist a bountiful provider of clean seed of 50 different varieties for the "ologists" who never think ahead to the next planting.

Social scientists are essential in the transfer of technology and providing analysis and feedback information to the biologist. There is wisdom in having social scientists in a separate department—between source and regional research—a foot in both camps. Most biologists at CIP have their hands and minds fully occupied with research to understand how to control this or that fact or disease or how to develop a high yielding resistant potato. Somewhere along the line as a practical solution unfolds, as the research evolved a hopefully useful technology, the expertise of the social scientist must come into play. There must be an integration of effort by both the biologist and the social scientist to ensure that delivery of the wonderful new concept to the farmer client will be appropriate to his need.
WHAT SHOULD OUR ROLES BE IN WORKING WITH NATIONAL PROGRAMS

Michael Potts

National Programs are generally set up to increase potato production, with the intention of improving the nutrition of a nation or group and also to improve the income of its farmers. The Programs vary considerably in their structure and capabilities but tend to be production orientated. Participation by social scientists is limited usually to a small input by economists; little or no input is made by the other social science disciplines such as anthropologists, social scientists and political scientists. Reasons for this lack of participation are many, but arise essentially from the fact that in most developing countries these other disciplines receive a low priority, are weak and are academically orientated; with little or no field experience. Thus, it is probable that there is a need for assistance by National Programs in many areas embraced by the Social Sciences.

CIP's Social Science Department is possibly in a unique position to help fulfill this role of helping National Programs in that it is made up of personnel representing a very wide range of disciplines and who are familiar with interdisciplinary work's particularly with the biological sciences. Areas of assistance can, however, be considered conveniently under three headings: administration, training and local participation. But, in each of these cases any co-operation will have to be tailored to suit the requirements of both parties if the department and the individuals within it are not merely to become a "service agency" with no direction of its own.

1. **Administration.** At the highest level it can advise the authorities responsible for the formation of a program and guide the program in its early stages. This aspect of early guidance is essential if programs are to identify realistic goals and the groups most likely to need and to be able to respond to assistance; thus utilizing limited resources to full advantage.

2. **Training.** The Department can play a major role in training national personnel. Here, two aspects are of particular importance. Firstly, personnel must be identified; and this is always a difficult procedure
when we do not have an intimate knowledge of the country. Secondly, personnel must be given an "all-round" training. Many scientists in developing countries have a very specific and academic training: if they are to grasp the overall problems facing the crop and interact with other disciplines then their horizons must be broadened. This aspect is likely to be particularly difficult to overcome since so many scientists fear losing their identity as an economist, nutritionist, etc; also, few persons have a sufficiently rounded education and general interest to take-on such a role.

3. Local Participation. The Department can also help programs through participating in specific research projects in a country, by the stationing of personnel for a set time-phase. Such projects should not be to the exclusion of the National Program and CIP personnel should be seconded as members of the program, with a national counterpart always appointed. Such projects would greatly assist in the training of local personnel whilst at the same time probably greatly speeding-up a particular piece of research. Such short or medium duration projects are to be vastly preferred to frequent short stays by CIP scientists, which often do not allow sufficient rapport and understanding to be built-up with local scientists. Other specific projects may entail contracting out to third parties; but again, wherever possible, local personnel should be involved.

CIP's Social Science Department has, therefore, a major guiding and supporting role to play in National Programs, particularly in the early stages of their development, until such time as the national personnel are trained and can confidently provide the necessary input.

COMMENTS

Sergio Ruano

Two types of agriculture are widespread in the majority of third world countries: (a) commercial or entreprenurial agriculture, and (b) traditional or subsistence agriculture. Commercial agriculture normally has the resources needed to obtain high levels of productivity. Subsistence agriculture, however, as practiced by large numbers of peasants has several constraints which limit productivity and income generated.

In the majority of developing countries, agricultural research programs spend most of their resources solving problems of commercial agriculture, under the assumption that technology developed for this subsector may easily be extended to the subsistence subsector. After
years of failure, a few national programs have begun experimenting with a new approach focused on the needs of subsistence farmers. Developing improved technology appropriate to existing small farm conditions is a major objective of this approach. Economic, social and political aspects are recognized as important, and social scientists are integrated into technology generating teams. Many of the strategies used are interdisciplinary in perspective.

Because this new approach is from the "bottom-up," the sequence of "scientific" work starts in the field with the farmers. The initial work aims to understand what farmers are doing, how they are doing it, and why they are doing it that way.

While there already exists a general theoretical framework for this work, few scientists have been trained for interdisciplinary teamwork. Most biological scientists are still educated in the classical approach, adapted to the conditions of commercial agriculture (capital intensive inputs). Working under subsistence conditions their tendency is to look the crucial differences between the two types of agriculture. While social scientists have a greater knowledge of political and socioeconomic factors influencing subsistence farmers, most lack basic technical principles of agricultural production.

Multidisciplinary teamwork has many problems. Because of the traditional education of scientists, there is a strong tendency for them to utilize methods and techniques which are, in fact, obstacles in achieving the new paradigm. In my view, interdisciplinary research should be cooperative work to solve an identified problem. The social and biological scientists should not do their work alone, assembling their parts at the end. The clue is to participate jointly in all the activities related to the problem solving process. At the beginning, since the subject of the research is the farmer, the social scientist may become in some sense the guide helping to sensitize the biological scientist to socioeconomic aspects of the problem and possible solutions. After the diagnosis phase, however, the agronomist may carry the greater responsibility, getting the social scientist involved as much as possible in relevant technical aspects of the production process. All activities in generating and evaluating technology should be conducted as a team, with varying degrees of leadership and responsibility depending upon the phase of research and the specific situation.

The strategy CIP should follow with national programs should distinguish two situations. A few programs are working under the new paradigm, but most of them still work using basically traditional methodologies and techniques. When a national program still works under the traditional approach, it is necessary to encourage the incorporation of social sciences into this program. The most important task in this case is to encourage use of the new interdisciplinary farming systems approach, unless the program adopts this approach, the role of social
scientists will be marginal or irrelevant. On the other hand, when a national program is beginning to use or is already using the new paradigm, social scientist could be important.

Michael Potts' paper mentioned three important and crucial aspects of working with national programs: administration, training and local participation. I would say that interdisciplinary training seems to offer the highest payoff. CIP's social scientists already have gained much experience that could orient technicians from national programs. Training should be designed to balance a combination of theory and practice. Peru may be a good location for such a training program. On the administrative side, I think that being an international organization, CIP is in advantageous position to encourage interdisciplinary work among national institutions still working under the classical approach. Regarding local participation and the consequence need for training, there is a shortage of CIP scientists to cover the possible demand for training. Short-term advisories could help meet the need.

COMMENTS
Haile Kidane-Mariam

The social scientist can play a very significant role at all stages of development of the National Programs. It is at the national level that we have so many and complex problems, specially at an initial stage of organizing a research and extension program. For example, when we started a potato project in Ethiopia about 6 years ago with the assistance of CIP, we were faced with a number of problems; each one of those problems appeared to be as important as the other ones. At that stage, the presence and involvement of a social scientist would have been useful in properly orienting priorities and our approach to the problems.

I believe that there is a definite appreciation of social scientist in the National Programs. However, there is a shortage of trained man power in this area. And since potato is only one of the many important food crops, it faces strong competition for the allocation of meager local funds and personnel. Therefore, many National Programs have to depend on CIP's Social Science Department for a social science input for their programs.

The types of involvement of social scientists in the National Programs may include (a) determining the existing status of the crop (production and consumption patterns, major problems, economic and food potential of the crop, existing technologies, etc.), (b) establishment of priorities, (c) generation and adaptation of new technologies, and (d) measurement of impact and feedback of information.
In accomplishing these tasks I do not envisage the direct involve-
ment of CIP's core social scientists in all National Programs. The Re-
gional Programs should serve as a bridge between the Lima-based social
scientists and the National Programs. Under the guidance of the core
staff, regional scientists can stimulate National Programs to undertake
social science research on problems affecting potato production and use.

Michael Potts has mentioned three aspects of working with National
Programs: administration, training, and local participation in contract
projects. In my view, training is the most important aspect and should
include both national personnel and the regional scientists. In most
national programs it would be very difficult to justify employing a high-
ly trained social scientist whose only role would be research on the po-
tato. Hence, I would advocate development of an ad hoc type of trained
personnel in the area of social sciences. A technical assistant from the
national programs or other institutions could receive social science ex-
posure and work under the guidance of the national program leader and the
regional scientist in surveys and collecting data in specific projects.
The results of this fieldwork could be analyzed and evaluated by Lima-
based scientists and/or regional scientists. As much as possible, the
venue for such training should be in the regions. Regional scientists,
as well as the national program leaders, should also receive more expo-
sure to the social sciences.

I believe that it is a good idea for CIP to provide contract pro-
jects to local social scientists who may be located in institutions oth-
er than the national agricultural research program. Such contracts may
be to conduct specific projects in collaboration with the national pro-
gram, regional scientists, and the ad hoc staff. In many cases these
contract projects may involve the same type of research activities un-
dertaken by the Lima staff. This can provide a mechanism for (a) test-
ing the relevance and applicability of the core research projects and
(b) generating information which may be more directly useful to the co-
operating institutions of that region.

In the areas of administration that Dr. Potts suggests, I am doubt-
ful of the feasibility of the SSD's playing a direct advisory role to
national program authorities. In this respect, the SSD's role should be
limited to providing facts and figures which may be used in the internal
decision-making process of the countries concerned.
SOCIAL SCIENCE DEPARTMENT PUBLICATION POLICY*

A. Purpose of Publications

The challenge of expanding production and use of the potato as a food crop in developing countries involves important socioeconomic as well as biological factors. However, a social science understanding of potato agriculture remains largely in its infancy. As part of CIP's Social Science Department's (SSD) efforts to increase our knowledge about this important areas, several publication series have been instituted. The purpose is twofold:

1. Disseminate to potato scientists, policy makers and scholars significant research results of the SSD and collaborators.

2. Stimulate the development of a social science of potato agriculture, production and utilization by encouraging the exchange of ideas among people concerned with the potato's role in agriculture development.

The CIP Board of Trustees recognized the importance and validity of SSD publications in the 1980 Report of the Program Committee:

"(The Committee) commends the series of publications on the socioeconomic aspects of potato cultivation in developing countries, an area in which documentation is sparse."

B. Types of Publications


Considered a pre-publication format, the objective of the Working Paper Series is to rapidly disseminate major findings of SSD research projects. Authors are encouraged to revise Working Papers for publication in journals or by outside publishers. A few high-quality papers will be issued each year. The frequency of issue will vary over time as significant research results are obtained.

* This policy statement, prepared by the members of the Social Science Department, does not replace and is subject to the normal procedures established by the CIP Publications and Audio Visual Committee.
2. **Training Documents (T.D.)**

These publications are designed to be used in CIP, regional or national training courses where a social science perspective on potato agriculture is included. As the Working Papers, they are issued in a pre-publication format. Training Documents are intended as guides to potato scientists, extension workers or collaborating social scientists interested in using social science perspectives and methodologies. Topical priorities will be determined on the basis of CIP course requirements. Where possible, Training Documents will be revised and issued as chapters of broader CIP manuals.

3. **Special Publications**

Occasionally, the SSD will issue Special Publications which do not fall into the Working Paper or Training Document categories. Examples include: (1) monographs deserving special attention, too lengthy for the Working Paper series and in a more final form; (2) potato-related bibliographies and statistical publications; and (3) country studies of potato agriculture. It should be noted that few Special Publications will be considered. Authors are encouraged to first seek other publishing outlets.

4. **Student Thesis**

Quality social science thesis conducted under department supervision and in conjunction with CIP projects will be distributed by the Social Science Department.

Extraordinarily high quality student thesis or chapters, may be considered for issue in the Working Paper, Training Document or Special Publications series.

5. **Reprints**

The SSD will make available for distribution selected reprints of journal publications by CIP Social Scientists and collaborators.

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C. **Guidelines and Procedures for Submission of Manuscripts**

1. **Priorities**

Priority will be given to manuscripts reporting on the major findings of CIP Social Science research projects. Manuscripts dealing with relatively minor elements within projects or service tasks will normally not be considered. In order to maintain high publication standards, and because of limited funding and publications capacity, the SSD will not consider its series an outlet for reports on spur-of-the moment projects. Hastily prepared manuscripts submitted simply "to get out publications" will not be considered.
2. **The Role of Editor**

The Editor of SSD publications will be in charge of receiving manuscripts, coordinating procedures and policies with the Training and Communications (T&C) Department, executing the review process, corresponding with authors, and delivery of manuscripts for final disposal to T&C Department. The Editor's position will be for one year and will rotate among SSD core staff. If the editor does not have native fluency in one of the publication languages, he or she may call upon complete editing services from appropriate staff members.

3. **Submission and Review Procedures**

**Submission.** Manuscripts should be submitted to the Editor in as final and polished form as possible. Poorly written papers will not be accepted. Authors should circulate their own preliminary manuscript for comments and go through several revisions before submission to the editor. Prospective contributors should examine prior SSD publications for style and format. Manuscripts must contain a brief abstract.

**Review Procedure.** Manuscripts will be reviewed by all full-time staff, unless travel or distance prevents speedy evaluation. Manuscripts will also be reviewed by one reviewer outside the SSD and one representative of the Training and Communications Department. These persons will be chosen by the Editor.

A majority positive vote by reviewers is required for publication. In case of equal positive and negative evaluations, the Editor will make final decision. Authors may be asked to revise their manuscript based on reviewer's comment.

Publication of manuscripts accepted by the SSD review committee must also be approved by the CIP publications committee. Because of the international character of CIP and long periods of time required for corresponding, up to 3 months may be required for a decision.

D. **Distribution of Publications**

1. The SSD will distribute publications using three separate mailing lists:

   a. **The Priority List** will have around 50 individuals, to whom publications will be airmailed. These include CIP regional staff, the Board of Trustees, CGIAR, and others for whom speedy receipt of publications is sought.

   b. **The General List** will have up to 500 names of individuals, libraries and other institutions requesting our publications. Surface mail will be used for this list.
c. **The Training Document List** will have around 100 names of individuals and institutions using our training documents.

2. Working Papers, Training Documents and Theses will be free of charge. Single copies of Special Publications will be made available to individuals and institutions in developing countries free of charge. We will charge for bulk-ordered Special Publications, and those distributed to developed countries.

**COMMENTS**

Dana Dalrymple

A publication policy is an important matter for social scientists because the products of their research generally take a written form.

As background for our discussion of this matter, I have prepared a note on "Publications Policies and Activities at the International Agricultural Research Centers: A Social Science Perspective" (reproduced here as an annex). I will not comment on this document in detail here because it says little directly about CIP. But I would like to briefly mention two points, one of philosophy and one of fact. My view is that the major purpose of a publications policy should be to encourage and facilitate publication. It should also give order and cohesion to the process and maintain or improve the communication effectiveness of the product. I do not think that such a policy should be designed as a method of bureaucratic control. My other point is that at most centers two basic types of publications exist: (a) informal working papers, and (b) more formal center publications. Different goals, purposes, and procedures are involved with each.

Now to turn to CIP, I would like to start out by stating my view—and that of my colleagues participating in this conference—that the Social Science Department has done a lot of very good work that now needs to be more completely written up and given wider circulation. In short, the Department needs to step up its rate of publication. And some of the material presently available in Departmental Working Papers needs to appear in a more formal form.

In this context, the draft departmental publication policy paper appears to be basically satisfactory. However, I would like to suggest consideration of a few modifications. In general, and in line with my earlier comments, I suggest that it be revised to express a more positive view to publication; the present document reads more like a set of regulations. Also it needs to sort department publications out more clearly from center-wide publications.
To elaborate on the latter point, I would suggest that the statement needs to be broader in scope than just Department Publications, which to me suggests merely working papers and other products of that sort. This is because some publications by Department members should be of a more formal, center-wide nature. Moreover, some of the research work is broader in nature than the Social Science Department. The policies of other departments, and indeed of CIP as a whole, need to be considered.

This is, I think, particularly relevant to the category of Special Publications. Many/most of these would be considered center/institute publications at other centers. They would be edited and published (often in quite finished form) by the central publications office. No center department that I know of presently publishes reports of this nature on their own.

Assuming that the special publications are shifted out of the department series, the proposed review procedure for the remaining departmental reports seems a bit overdone. I am particularly concerned with the suggestion in paragraph 3 that "publications of manuscripts accepted by the SSD review committee must also be approved by the CIP publications committee." Departmental publications should, I think, remain just that. Subjecting such manuscripts to an external committee is not appropriate. Further it could be repressive and time consuming. I suggest simplification/streamlining of these procedures.

CIP may have a special problem in handling publications done by contractors. This is a vexing problem in the U.S. government, and attempts to solve it have led to some fairly complex regulating procedures which have, in turn, been a real nuisance to the regular publications. I have no special advice on this matter except to try not to tie yourself in knots.

In any case, one existing in-house publication outlet may have been relatively overlooked by the Department. This is the monthly CIP Circular which takes a thematic approach. As I recall, little has been said of social science work, except for the storage project, in the newsletter. It could be used to summarize on-going work as well as to provide summaries (abstracts) of major CIP social science publications. To date surprisingly little reference has been made to CIP publications in the circular.

One related matter that is outside the scope of a publications policy, but can be of significance to social science publications, relates to library resources. The value of CIP social science research and publications will be enhanced if they build on and make reference to a broader field of knowledge. This may be difficult to do at CIP in view of the relatively limited library facilities which seem to be available.
This situation can be offset to some extent by other resources and study opportunities with which I am not fully familiar. But it does seem to me that some additions to the social science holdings in the library may be desirable in the future.

Let me close by simply suggesting that some fairly modest modifications in the proposed publications policy may be desirable. These modifications might better organize and facilitate the publications policy. In addition, the authors of social science publications might well benefit from a selective strengthening of CIP's library holdings in the social sciences.

COMMENTS

Hernan Rincon

I would like to start by saying that for an editor it is helpful to follow an institutional publication policy. It reminds you where to concentrate efforts to help the organization achieve its objectives. In fact, I tend to prefer a general institutional communications policy because it includes other forms of communication, and gives you more alternatives to be creative and effective in processing the message. Department or Thrust guidelines for publication and audiovisuals should then follow the general common policy.

The purpose of the Social Science Department publication policy statement seems to be very broad and department-centered rather than audience-oriented. Helping to develop a social science of potato agriculture is a big job. Thinking of it, with messages, media, time, and audiences in mind, I drew this cube where the SSD publications are in a theoretical relationship with the other factors.

Please note the horizontal "media" axis where I placed SSD publications in an arbitrary position. The vertical axis shows three classes of audience and in the third axis the messages (only potato is shown). An area in the cube represents the receiver's allotted reading time. If a SSD publication, for example, on the socioeconomic of the potato in the
torrid zone captures the attention of all donors, they will devoted a tiny part of the top layer to the text and hopefully will learn something about the social science of the potato.

Second, Social Science Department publications have to compete with other media, and the potato has to fight with other topics to get the attention of potential readers. I would love to see a developing, and developed, social science of potato production and utilization. To help develop it we will need to learn who are potential audiences and what kind of potato information they want and need. Then we have to extract this information from the SSD information bank, devise content and form for the messages, communicate them, and monitor the responses.

Third, Dr. Dalrymple already dealt with a crucial aspect of the policy: audience identification. Any early effort in this direction is worthwhile. A suggested naming of CIP's key audiences, in random order is: (a) donors, (b) policy makers, and (c) scientists and technicians (IARC's and national programs). Audience identification can help the administrator, scientist, writer and editor decide what kind of people to have in mind while working on messages.

It seems to me that the five kinds of publications listed in the SSD publication policy statement are more fitting to audience category. Policy makers and donors may need another kind of summarized presentation.

Finally, I suggest that a feedback procedure be added in the document. This is to obtain comments, ideas and facts from the audiences. The procedure may be informal at the start but could evolve into a communication research activity to find out what the communications needs are, what comparative advantages CIP has in fulfilling them, and what the audiences expectations of CIP are.
According to CIP's mandate, a major goal of social science training is "to train competent research and production specialists to be able to receive CIP technology and to adapt it to local conditions, overcoming the obstacles between the research scientists and the farmers." Within this role, training can have three objectives:

1. Create awareness about the socioeconomic characteristics of farmers towards whom transfer of technology is being directed. This awareness includes developing understanding about farm-level conditions and analysis of the capability of the farmers to adopt technology.

2. Impart social science skills among non-social scientists for developing sensitivity to the farmers' problems. The Center may like to examine the issue of including a social science component in training being conducted for biological scientists at the regional and national level. The purpose would not be to create social scientists out of biological scientists, but to acquaint them with social science perspectives, skills and information which they could employ in their research and/or extension work.

3. Increase social science skills among social scientists who will participate in specific projects. This type of training may not be of a general nature but related to the specific requirements of projects. Many research methods developed and used in CIP work would be of value to regional and national scientists. In this regard the research approaches of the anthropologists need to be looked at more closely for purposes of training. In any case, training materials for a diversity of research methods need to be prepared for such training programs. These may also turn out to be useful for biological scientists who may require strengthening of the ability to observe and perceive the socioeconomic scene.

The training activities mentioned are directed at biological scientists in regional and national programs in the first instance. This
needs special emphasis because social scientists are generally not in these programs to support work of the biologists. Therefore, there is a great need to develop social science skills among biological scientists. This will not only help in their own work, but will become a useful source of feedback information to CIP-based scientists.

The second group of people whose training needs ought to be strengthened is the national program staff involved in taking the technology to the farmers. The skills of this group need to be considerably strengthened and reoriented, because it is usually only production-oriented. Skills of social analysis that will help in local adaptation and redesign of new technologies would be extremely important. Training in evaluation of adoption and impact of new technology would also help strengthen the work of extensionists and the feedback of information to experimental station-based researchers.

COMMENTS

Garry Robertson

In keeping with the training activities outlined in CIP's profile, the 1980s will see the Center engaged in specialized training, having passed through a phase of production-oriented training. Training in the social sciences obviously falls within the realm of specialized training.

The Social Science Department's involvement in training during the next decade has been outlined in two distinct spheres: (a) the training of CIP regional staff and national program staff in farm-level research approaches and methods, (b) helping national programs develop the capacity to conduct their own socioeconomic research on potatoes.

There is a definite need to train CIP regional scientists in the social sciences so that they can ensure that new technology is appropriate to the agricultural system in the country where it is to be introduced. It is also necessary to prepare them to advise national programs with decision-making on research topics to ensure that research is designed and geared to answer farmers' questions.

In most national programs, scientists are responsible for undertaking research on experimental stations. If this work is to be meaningful and research is to be taken to the farm-level, then national biological and social scientists have to be trained. So far, little has been done in this respect. For example, in five storage courses, no anthropologists, sociologists or economists have participated in their capacity as social scientists.
There are two reasons for the fact that there are very few social scientists actively involved in agricultural research and technology transfer in developing countries. Firstly, because until recently research has been mainly conducted within the confines of research stations. Secondly, because few agricultural leaders in developing countries see the need to have social scientists involved in agricultural research. Policy makers must be sensitized to the necessity of having social scientists in agriculture. This has far-reaching implications right through education at university level.

When social scientists are not directly employed in agricultural research, I agree with using social scientists from other government departments, institutes or universities but, unfortunately, this does not help build an infrastructure within the national program. If the linkage between a research institute and university can be made very strong, then this method has some merit. However, in nearly all countries we are a long way from being able to effectively utilize local social scientists, because they are still not integrated into the agricultural research and technology transfer system. Hence, CIP's role in training national social scientists should remain limited because it will be impossible to keep these trained staff within potato programs. There is a very good chance that, once trained, they would work with other crops or problems of greater national importance.

In order to institutionalize CIP's regional activities at the national program level, in such areas as OPP, the best approach is to train production agronomists or biologists to understand the implications of their research.

One possible training mechanism would be for Lima-based social scientists to train national social scientists, who, in turn, could train local agriculturists.
GENERAL COMMENTS ON
PLANNING FOR CIP'S SOCIAL SCIENCE PROGRAM

Ralph K. Davidson

CIP's mandate is to expand production and use of the potato as a food crop in developing countries, giving special attention to the technology needs of resource-poor farmers. The CGIAR statement puts the objective in terms of developing improved technology which will increase food production and improve the welfare of poor people in developing countries.

The CGIAR statement of objectives (World Bank, 1980) is broader than CIP's in that it includes the welfare of poor people who are not food producers. CIP appears to have focused on technologies which will help farmers (resource-poor farmers?) produce more potatoes. The question is raised, "Who benefits in the short run and in the longer run?"

The division of benefits among producers and between producers and consumers depends on conditions in food markets, entry into potato production, supply conditions in input markets, and off-farm employment opportunities. The introduction of a new technology in production has the effect of reducing production costs which increases the quantity supplied by the producers at any given price and reduces the price in the market in order to absorb the increased production. On the producer side, if a cut in production costs makes potato growing more profitable, even with a lower price, more potatoes will be produced. Part-time farmers will shift more labor into potato production. Farmers will purchase more inputs and shift more land into potato production. Production will expand and prices will fall further. As prices fall, potato consumers benefit. Who are the consumers in the particular locations? To which income bracket do they belong? How does new technology fit into the production system and meet the needs of resource-poor farmers? What are the returns to potato production in multi-crop systems? What are the returns to labor (male, female)? What are the returns to land and capital?

As an example of development of a new technology, let us look at potential use of true potato seed (TPS) and trace through the implications of the technology.
1. What is the impact on use of family labor (male, female, children) in the production process for, e.g., planting seed, transplanting and taking care of seedlings?

2. How will TPS fit into the production system of a multi-crop, resource-poor farmer?

3. What will be the seasonal impact on non-farm employment of members of the household?

4. What are the implications for cash production costs?

5. How will demand for potato-growing land be effected (returns to land)?

6. What will be the impact of increased production on, e.g., storage and marketing?

7. What will be the short and long run impact on potato prices?

8. What will be the longer-run impact on numbers of potato producers and their incomes?

9. What will be the effect on returns to tuber seed producers (large, medium or small-scale producers) and on existing seed certification systems?

10. How does national food policy affect the development and adoption of new technology?

To date, national potato programs appear to be focusing largely or exclusively on technical production issues, with little or no concern for the national policy framework. I believe the Social Science Department needs to be involved in analysis of the short and long-run issues related to potatoes both on a disciplinary and on interdisciplinary basis in order to provide answers to questions like the above.

The impact of the introduction of new technology has the immediate effect of reducing costs of production for the producers, and whether or not this will result in a substantial increase in the quantity produced depends both on the conditions in the market for potatoes and the conditions in the market for the inputs, labor, land and the other chemicals that are used in the production of potatoes. If the conditions in the input markets are such that the farmers can expand production quickly and easily, then there will be a substantial shift to the right of the supply curve. If conditions in the input markets are such that it is not easy to acquire additional inputs, the change in technology will
result in a much smaller shift in the supply curve. On the market side, a great deal will depend upon the demand conditions. If the market is relatively elastic, i.e., if the market can absorb a substantial increase in the quantity of potatoes produced with a relatively small fall in price, then there will be a substantial increase in production. If the demand for potatoes is relatively inelastic, then the market will absorb only a relatively small quantity of potatoes without a substantial fall in the price.

The gains from the new technology, which increases productivity of all the resources, will be distributed between the consumers, the producers (depending upon the conditions in the various markets) - and may or may not benefit the resource-poor farmer, depending upon alternative opportunities for the use of his land and labor. The adjustment to a change in technology takes time and the more time it takes, the greater will be the amount of short-run gains retained by the producers. It would appear, however, that the substantial gains will be to the consumers, who are able to purchase greater quantities of potatoes at a lower price.

Figure 1 illustrates the position with a relatively elastic demand and Figure 2 illustrates the implications of a relatively inelastic demand.
A. Introduction

Publication policy may be of particular interest to social scientists at the international research centers (principally agricultural economists and a few anthropologists) because their major product usually appears in written form. Biologists can produce new biological products such as new varieties; physical scientists often produce new machinery or processes. These scientists can partially substitute products for words, though they too generally must publish some. But the social scientist mainly produces words and numbers, and hopefully thoughts. There is seldom a non-verbal escape mechanism for the social scientist --although some fairly successfully substitute numbers for words, or the spoken word for the written word.

B. Purpose of Publication and Policy

The purpose of publications is obviously to communicate, to convey information from the author to others. Here we are concerned with the communication of the results of social science research at IARC's. Just who this information is to be conveyed to is more of a mixed bag and is a source of some complexity in establishing a publications policy. The potential audience may range from other scientists at the center, to scientists, technicians, policy makers, and donors in the outside world. It is a maxim among information officers that it is vital for an author to identify his or her potential audience early on. But I know from experience that this is often difficult to do because of the need and desirability for a single publication to reach a range of readers. We are seldom in a position to do much specific tailoring, specially when our potential audience is rather broad and publication resources limited.
Another dimension of the communications process and one that is seldom discussed but which is nevertheless important, is the desire of the researcher to gain professional recognition and appreciation of his or her work. This is important in securing advancement within his or her own organization and in securing subsequent employment in the outside world. This dimension may slightly modify the publication process which would otherwise be followed. Specifically, usually it means some orientation to professional journals. Often this just represents a tailoring or extension of work reported in other ways. The only problem comes when this orientation is followed to the exclusion of other activities; this is far from the case at the IARC's to this point.

Given the diversity of purposes of publication, how can an overall policy be established that is of any particular value or improvement? The answer is, I think, to make policies rather general at first and then refine them over time. In this vein I start by suggesting that the general purpose of a policy should be to facilitate, and to organize or order the publication process. Too often, however, policies are established with regulation or control of the publications process. The latter is increasingly the case in the U.S. Government and is, I think, most unfortunate. It is usually hard work to prepare a good publication, and many scientists do not have the inclination or skills to even try. Others are more inclined or talented in this direction, but can be frustrated by the policies imposed. Both groups need help and encouragement, and that should be the purpose of a publication policy.

Having said this, I should immediately acknowledge that different IARC's have quite different attitudes toward publication. Some, such as IRRI, are extremely active. Others such as CIMMYT, do much less in the way of publishing. It is difficult to specify precisely why these differences exist, but in many instances reflect the attitude of the center leadership, both administrative and scientific, and the subsequent emphasis and resources devoted to the process. In turn, those scientists who are inclined to publish may be attracted to a center that emphasizes publication; the reverse may also be true. Also, as suggested earlier, some lines of work lend themselves more to publication than do others.

C. Types of Publications

The current range of center publications or publications by center scientists is very wide and defies easy summarization. Let me, however, try to suggest a classification and some examples from the social science realm (the latter are cited more fully in the Appendix).
1. **Center Publications**

Most centers issue a wide array of reports for several different audiences.

a. **Center-Wide Publications.** Here I have in mind publications issued by the central information office: annual reports, newsletters, book-length publications, research monographs, and a research report series.

Social science usually emerges as a section in the annual report, though some of the work of social scientists may be included elsewhere in the report. Similarly, it may be mentioned in brief form in the center newsletter. CIP's thematic monthly circulars provide more than usual opportunity to report social science work. A recent CIMMYT TODAY report reviewed the work of the economics program (Appendix, Section A/3).

More detailed reports are, of course, provided in book-length publications and research monographs. Both are usually soft-covered. The former are usually proceedings of conferences (see the examples listed in the Appendix, Section A/1). The latter are probably the main channel of publication (examples are listed in the Appendix, Section A/2). They often differ in style and format, even within a given IARC over time. The International Food Policy Research Institute (IFPRI) has taken this process a step further and established standardized Research Report Series, which is its main publications outlet; to date some 24 reports have been issued. An abstract leaflet is also prepared for each report and sent to a much wider mailing list.

At a different level, one IARC-IRRI- has established a center-wide Research Paper Series. Relatively brief reports, generally somewhat longer than articles, appear in a standardized format. Some 57 have been published to date, but only a relatively few have been prepared by social scientists.

b. **Department Publications/Reports.** Most social science (read economic) departments at the IARC's also have their own less formal methods of getting their materials out in written form. Generally this takes the form of some sort of reproduction of typed copy (formerly mimeographed, now anyone of several reproduction processes) on 8-1/2" x 11" paper and usually stapled together. These actually are not part of any special series and are not numbered. A wide range of materials may be covered and they may include early drafts of materials to subsequently be published elsewhere.

From time to time, attempts have been made to slightly upgrade and systematize these reports. For a while the agricultural economics...
department at IRRI had a standardized cover and an annual series number, but subsequently came under some pressure from central administration to abandon the idea in favor of the center-wide Research Paper Series noted above. It still issues working papers, but without a cover and with an unobtrusive series number in a footnote. IITA had, and perhaps still has, a Discussion Paper Series. I note that CIP has a Working Paper Series as well as a Training Document Series. The Economics Program at ICRISAT has variously issued Occasional Papers and Discussion Papers; in June 1980 these were consolidated into a numbered Progress Report Series (currently up to number 22).

In all these cases, the departmental reports were not considered formal centers publications. As a statement in the ICRISAT publication notes:

Progress Reports are informal communications about ongoing research, or thoughts of ICRISAT staff members, which are designed to stimulate thinking and comments of professional colleagues within and outside the Institute. These reports are not to be considered as formal publications bearing the endorsement of the Institute.

My own view is that departments should be allowed to upgrade their reports to the ICRISAT level, without getting them involved in the more general center review and publication process.

2. External Publications

This is a somewhat smaller category, but can be important in reaching the outside world. The center may sometimes be involved in partly subsidizing the activity, generally by buying copies of books.

Social scientists at the IARC's have authored or edited a few books (see the Appendix, B/2), but more commonly have prepared chapters for inclusion in books edited by others. This outlet may increase somewhat in importance as the amount of knowledge builds up at each center. A former and current IRRI economist are, for instance, currently preparing a book on rice in Asia. Sabbatical leaves have proven useful for starting or finishing such efforts.

Journal articles are a fairly common outlet (see examples in Appendix, B/2). One problem has been that some of the early articles submitted by the economists were not considered fancy or theoretical enough by the journal editors. This problem may lessen over time as the center economists seem to tailor their articles to journal requirements, as they reach out to a wider range of journals, and as the significance of the center work becomes better known. Two articles by
center economists (Hayami and Herdt, 1977; and Pinstrup Anderson, et al., 1976) were selected as the best articles published in the American Journal of Agricultural Economics. Reprints of journal articles are sometimes distributed by centers under their own cover; IFPRI in particular makes use of this device to broaden the reach of articles by its staff.

Magazines have perhaps been less frequently utilized but offer some promise—particularly international professional magazines such as CERES which have a very wide distribution. Douglas Horton of CIP had a fine article on potatoes in the January-February 1981 issues of CERES.

D. Some Current Issues

Despite the diversity of publications, there are a few general issues that are relatively common to all centers. Some which have occurred to me will be noted here; others could undoubtedly be listed.

Perhaps the key initial question is the degree of support that the center is going to give to publications and how this support will be manifested. On one hand, there is the question of the amount of psychological encouragement the center is willing to give to individual scientists to write. On the other hand, is the question of how much the center is willing to invest in the publication process in terms of funding and staffing for publications staff. There is a resource trade-off. Still, the marginal cost of publication is relatively modest and the marginal returns in terms of center recognition are apt to be great. My own inclination, considering that the centers are supported by voluntary public funds, would be to be quite positive with respect to publications, both with respect to encouragement and funding.

Just how the resources might be best allocated among various publishing alternatives is more difficult to say. From my point of view as a donor representative, a well-done and colorful annual highlights report is of first priority. But beyond that I do not have many convictions as yet—except to note that a departmental publications series can be very low cost and undemanding of central information staff. Just what the most appropriate array and blend of publications might be would vary by the individual center.

The answer in part may depend on the degree of centralized control the central administration wants to exert. If the center director feels that everything that goes out under the center's name should go across his desk and through the central office of information, then a different publication pattern may emerge than if the publication process is more decentralized with each department having a substantial say in the course it wishes to pursue.
The review process can become a central issue. Perceptions of what comprises an appropriate review process differ sharply and the importance of the issue depends on the type of publication. Most scientists would probably be satisfied with an informal technical review by a few other scientists who knew the subject, plus perhaps review by a competent editor. The administration, on the other hand, may be much more taken with the idea of a high level and formal process; it wants to feel safe.

I do not know much about how the review process is handled at the various centers, with two exceptions. IRRI has established a review committee for its Research Paper Series. And IFPRI has two internal reviewers and two external reviewers for each research report; the external reviewers are paid. This strikes me as a good idea for major technical reports.

In any case, time and productivity must be considered. Elaborate, administratively-satisfying review processes can take up considerable time, and may not produce much in the way of improvement. The cost, in terms of frustration on the part of the author and loss of timeliness, must be considered. And the productivity of the review process -- in terms of actual improvement in the manuscripts -- should be evaluated.

Once cleared, the actual publication process always seems to take too long for centrally-issued publications. But if the process entails good editing and design, it can be well worth it. Translation into another language may be involved. There is not a great deal of this outside of Latin America, but there may be more in the future. IITA, for example, expects to issue more publications in French as well as English. This means extra time and expense. It can be difficult to secure translators who can handle technical agriculture.

The next step involves distribution of the product. This can be a big bother and many authors, exhausted by the publication process, probably do not give the matter the attention it deserves. (I know I don't). The difficulties involved vary, of course, with the type of publication, the intended audience, and the degree to which the publications process is systemized. IRRI has developed a rather elaborate computerized mailing list system (which is described in IRRI's Research Paper Series, No. 51, August 1980, 37 pp.) for its centralized publications. Other centers may have similar but less elaborate systems. Department-level distribution procedures may be considerably less sophisticated. Several departments issue an annual list of publications. In any case, the problem is to keep mailing lists complete and up to date.

Several distribution devices have been used for the larger research reports and book-length publications. One is to send them to various periodicals for coverage in their book review sections. IRRI has done
quite well on this score. I have been asked to write reviews of several of their publications for some American journals. Another device, which (as previously noted) has been utilized by IFPRI, is to prepare a summary leaflet for each bulletin which is given wide circulation. This technique, however, may be less useful for centers with a wider range of research activities and publications.

As center budgets tighten, there may be increased attention in providing the larger reports on a sale basis. Once again, IRRI has been particularly active on this front and has recently established a North American distributor. This can be a significant source of revenue and can substantially offset publication costs to the center. But it is a complex business to establish and run. Still, we may see more of it in the future.

More of these issues could be raised, but many of them are more in the province or the center information office than the center social scientist. Still, they effect the social scientist and perhaps he should be more aware of them.

E. Conclusion

I end my comments not far from where I started, by returning to a few general needs and concerns. The major purpose of a publication policy should, it seems to me, be to encourage and facilitate publication. It may also give more order and cohesion to the process and should maintain or improve the communication effectiveness of the product. It should not be an instrument of bureaucratic control.

APPENDIX

EXAMPLES OF PUBLICATIONS BY IARC SOCIAL SCIENTISTS

A. Published by IARC's


2. Research Monographs


Enrique Mayer, Land Use in the Andes; Ecology and Agriculture in the Mantaro Valley of Peru with Special Reference to Potatoes, CIP, Social Science Unit, 1979, 115 pp.


3. Other

B. Published by Others

1. Books


2. Journal Articles


Richard Perrin and Don Winkelmann, "Impediments to Technical Progress on Small Versus Large Farms," American Journal of Agricultural Economics, December 1976 (Vol, 58, No. 5), pp. 888-894.


3. Magazine Article