PN-ABF-083
66035

Report of a Workshop

AGRICULTURAL RESEARCH POLICY AND ORGANIZATION IN SMALL COUNTRIES

Wageningen
The Netherlands
11 to 14 September 1984

Directorate for Agricultural Research, Netherlands Ministry of Agriculture & Fisheries
Agricultural University Wageningen
Technical Centre for Agricultural and Rural Cooperation
International Service for National Agricultural Research

Citation:

Agricultural University Wageningen – Technical Centre for Agricultural and Rural Cooperation – Directorate for Agricultural Research, Netherlands Ministry of Agriculture & Fisheries – International Service for National Agricultural Research.
Workshop on Agricultural Research Policy and Organization in Small Countries. 1985. The Hague, Netherlands.

Report of a Workshop

AGRICULTURAL RESEARCH POLICY AND ORGANIZATION IN SMALL COUNTRIES

June 1985

Directorate for Agricultural Research, Netherlands Ministry of Agriculture & Fisheries
Agricultural University Wageningen
Technical Centre for Agricultural and Rural Cooperation
International Service for National Agricultural Research

Foreword

In the course of the last 20 or 25 years, many developing countries have made significant progress toward strenghtening their national agricultural research capacities. It is well known, however, that the research problems confronting individual countries differ widely. Small countries represent a category apart which has been given little attention. The conflict between research needs and available resources, ever-present in all developing countries, is particularly acute in small countries.

Discussions in recent years on agricultural research organization and policy issues have given little consideration to the problems which specifically confront small countries, and to their solutions. Out of concern for this situation, the International Service for National Agricultural Research (ISNAR), the Agricultural University of Wageningen, the Directorate for Agricultural Research (DLO, Netherlands Ministry of Agriculture and Fisheries), and the Technical Centre for Agriculture and Rural Cooperation (CTA), decided to convene a workshop. The purpose was not to develop solutions to these complex problems; that would have been presumptuous. Rather, it was to identify priority aspects for consideration, and to propose an agenda of work leading to a better understanding of the issues involved, so contributing toward the identification of realistic alternatives.

This volume contains the proceedings of the workshop, which was held at the Agricultural University of Wageningen, in Wageningen, The Netherlands, 11 to 14 September 1984.

William K. Gamble
Director General
ISNAR

Table of Contents

Page No.

7. Program

9. List of Participants and Guests

13. Agricultural Research Policy and Organization in Small Countries: Towards a Research Agenda

19. Toward a Global Agricultural Research System

36. Establishing Agricultural Research Policy: Problems and Alternatives for Small Countries

53. Research Policy Linkages: a Case in Developed Countries

58. Research Policy Linkages: a Case in Developing Countries

62. Agricultural Research Policy and Organization in Small Countries: Scientific Linkages in a Developing Country

Page No.

65. Scientific Linkages of Agricultural Research Systems for Small Countries

70. Researcher-Farmer Linkage for Technology and Agricultural Development

76. Organization of Agricultural Research in The Netherlands with Special Reference to Potato Research and Farmers' Participation

83. Relationships Between Research, Extension and Farmers in a Small Developing Country: the Case of Rice in the Dominican Republic

94. Working Group 1: Research Policy Linkages

96. Working Group 2: Scientific Linkages

98. Working Group 3: Researcher-Farmer Linkages

100. Agricultural Research Policy and Organization in Small Countries: Summary of Researchable Topics

Program

Tuesday 11 September	1700	Cocktail Party
	1900	Cold Buffet
Wednesday 12 September	0900 - 0920	Opening of the workshop Dr. de la Rive Box
	0920 - 0950	Further acquaintance with participants (short introduction)
	0950 - 1050	Keynote address: "Towards a global Agricultural Research System" (Session 1) Prof. Ruttan
	1050 - 1110	Coffee
Chairman: E. Trigo	1110 - 1130	Introduction CTA-Center. "Relevance of the Workshop for ACP-Countries" Dr. Treitz
	1130 - 1230	Day Topic on Research Policy Making "Establishing Agricultural Research Policy: Problems and Alternatives for Small Countries" (Session 2) Dr. Gamble
	1230 - 1400	Lunch
	1400 - 1500	Case on Research Policy Making in the Netherlands (Session 3) Prof. de Zeeuw
	1500 - 1530	Tea
	1530 - 1630	"Research Policy Linkages: Case on Developing Countries" (Session 3) Dr. Subhi Qasem
	1630 - 1700	Closing remarks and conclusions by Chairman
	Evening Free	
Thursday 13 September *Chairman: M. Flach*	0900 - 0910	Brief introduction on morning program
	0910 - 1000	Day Topic on Scientific Linkages (Session 4)
	1000 - 1030	Coffee

	1030 - 11.15	Case on Scientific Linkages (Session 5) Dr. Panabokke
	1115 - 1215	"Scientific Linkages of Agricultural Research Systems for Small Countries" (Session 5) Prof. Boynton
	1215 - 1230	Closing remarks and conclusions Chairman
	1230 - 1330	Lunch
Chairman: L. de la Rive Box	1330 - 1430	Day Topic on Researcher-Farmer Linkages (Session 6) Prof. Hildebrand
	1430 - 1530	"Organization of Agricultural Research in the Netherlands with Special Reference to Potato Research and its Farmer Participation" (Session 7) Dr. van der Zaag
	1530 - 1600	Tea
	1600 - 1700	"Farmers and Researchers: Two Cases on Farmer-Researcher Linkages from the Dominican Republic" (Session 7) Dr. Cuevas, Ir. Doorman
	1700 - 1730	Closing remarks and conclusions Chairman
	1800	Dinner
	Evening	Meet the Dutch Informal meetings
Friday 14 September	0900 - 1130	Working Groups on a) Research Policy Making b) Scientific Linkages c) Researcher-Farmer Linkages
	1130 - 1230	General Session
	1230 - 1400	Lunch
	1400 - 1730	Open afternoon session in cooperation with the Study Group for Development Issues (Studiekring voor Ontwikkelingsvraag-stukken) - Summary of day topics - Results of working groups - Discussion
	1730	Official closing of the workshop Dr. de la Rive Box

List of participants and guests

1. Prof. Dr. G. Allen
   West Woodlands
   Newton Tracey
   Barnstaple EX31 3PP
   England

2. Dr. D. Boynton
   Department of Pomology
   Plant Science Building
   Cornell University
   Ithaca, NY 14853
   USA

3. Ir. N.B.M. Brüll
   Directorate of Agricultural Research
   Ministry of Agriculture and Fisheries
   PO Box 5A
   6700 AB Wageningen
   The Netherlands

4. Dr. J. Casas
   INRA
   Place P. Viala
   34060 Montpellier Cedex
   France

5. Dr. N.R. Collins
   Program Officer
   The Ford Foundation
   320 East 43rd Street
   New York, NY 10017
   USA

6. Dr. T. Cuevas
   Department of Plant Breeding
   Instituto Superior de Agricultura
   La Herradura
   Santiago de los Caballeros
   Dominican Republic

7. Dr. Ir. G. van Dijk
   Department of Agricultural Economics
   and Policy
   Agricultural University
   PO Box 8130
   6700 EW Wageningen
   The Netherlands

8. Ir. F.J. Doorman
   Assistant Researcher
   Adaptive Agricultural Research
   Instituto Superior de Agricultura
   La Herradura
   Santiago de los Caballeros
   Dominican Republic

9. Dr. Ir. D.W.B.M. van Dusseldorp
   Department of Rural Sociology of
   the Tropics and Subtropics
   Agricultural University
   PO Box 8130
   6700 EW Wageningen
   The Netherlands

10. Dr. Ir. M. Flach
    Department of Tropical Agriculture
    Agricultural University
    PO Box 341
    6700 AH Wageningen
    The Netherlands

11. Dr. W.K. Gamble
    Director General
    ISNAR
    PO Box 93375
    2509 AJ The Hague
    The Netherlands

12. Dr. Ir. J.J. Hardon
    Directorate for Agricultural Research
    Ministry of Agriculture and Fisheries
    PO Box 59
    6700 AB Wageningen
    The Netherlands

13. Dr. P.E. Hildebrand
    Department of Food and Resource Economics
    University of Florida
    Gainesville, Florida 32611
    USA

14. Prof. Dr. F.P. Jansen
Director
International Agricultural Center
PO Box 88
6700 AB Wageningen
The Netherlands

15. Ir. J. Leeuwangh
Directorate of Agricultural Research
Ministry of Agriculture and Fisheries
PO Box 59
6700 AB Wageningen
The Netherlands

16. Dr. F. Meijndert
DGIS, Bureau DPO/OT
Ministry of Foreign Affairs
PO Box 20061
2500 EB The Hague
The Netherlands

17. Ir. W. Oosterberg
Adj. Director
International Agricultural Center
PO Box 88
6700 AB
Wageningen
The Netherlands

18. Dr. C.R. Pannabokke
Agrarian Reserch and Training Institute
PO Box 1522
Colombo 7
Sri Lanka

19. Dr. L.R. Przekop
Head of Training
ICARDA
PO Box 5466
Aleppo Syria

20. Dr. Subhi Qasem
Dean
Graduate Studies
University of Jordan
Amman
Jordan

21. Dr. L. de la Rive Box
Department of Rural Sociology of
the Tropics and Subtropics
Agricultural University
PO Box 8130
6700 EW Wageningen
The Netherlands

22. Dr. Ir. N.G. Röling
Department of Extension Education
Agricultural University
PO Box 8130
6700 EW Wageningen
The Netherlands

23. Ir. J. van Ruiten
Department of Rural Sociology of
the Tropics and Subtropics
Agricultural University
PO Box 8130
6700 EW Wageningen
The Netherlands

24. Dr. V.W. Ruttan
Department of Agricultural and Applied
Economics
332C Classroom Office Building
1994 Buford Avenue
University of Minnesota
St. Paul, Minnesota 55108
USA

25. Dr. P. Saint-Clair
Visiting Scientist
ISNAR
PO Box 93375
2509 AJ The Hague
The Netherlands

26. Dr. R. Tarte
Director General
CATIE
Turrialba
Costa Rica

27. Dr. W.N. Treitz
Deputy Director
Technical Centre for Agricultural and
Rural Cooperation
PO Box 380
6700 AJ Wageningen
The Netherlands

28. Dr. E. Trigo
ISNAR
PO Box 93375
2509 AJ The Hague
The Netherlands

29. Dr. Ir. H. Vermeulen
Department of Phytopathology
Agricultural University
PO Box 8025
6700 EE Wageningen
The Netherlands

30. Ir. W. van Vuure
Directorate of Agricultural Reseach
Ministry of Agriculture and Fisheries
PO Box 59
6700 AB Wageningen
The Netherlands

31. Ir. G. Wansink
Secretary
National Council for Agricultural
Research
PO Box 297
2501 BD The Hague
The Netherlands

32. Dr. Ir. M. Wessel
Director
ICRA
c/o International Agricultural Center
PO Box 88
6700 AB Wageningen
The Netherlands

33. Dr. Ir. D.E. van der Zaag
Research Coordinator
PO Box 20
6700 AA Wageningen
The Netherlands

34. Dr. Ir. D. de Zeeuw
Director of Agricultural Research
Ministry of Agriculture and Fisheries
PO Box 20401
2500 EK The Hague
The Netherlands

35. Dr. P.J. Zuurbier
Department of Industrial Management
Agricultural University
PO Box 8130
6700 EW Wageningen
The Netherlands

AGRICULTURAL RESEARCH POLICY AND ORGANIZATION IN SMALL COUNTRIES: TOWARDS A RESEARCH AGENDA

L. de la Rive Box

Agricultural University
Wageningen, The Netherlands

ABSTRACT

In the near future the majority of the world's agricultural scientists may be working in developing countries. Yet, little is known about policies and organizations governing research programs in many of these. Since small countries have not been studied as a group, it is good to pay extra attention to them. Considering the high degree of integration in the world of international agricultural research, and considering that small countries cannot solve all problems by themselves, they will have to find ways of feeding into research programs other than their own.

THE PROBLEM

Over the last 20-25 years agricultural research has developed rapidly, especially in the developing countries with some spectacular successes. Several instances can be cited in support of this statement.

Today, a little less than half (42%) of the world's agricultural scientists work in developing countries (V. Ruttan, Table 3) and the predictions of massive food deficits in some of the most over-populated regions in the world seem to be fears of the past. This is true throughout Asia, and even India, which not so long ago was considered a hopeless case, is now self-sufficient in food grains. Agricultural research, however, is under pressure.

In a number of industrialized nations such as the United States, existing models of agricultural research organization are under serious review (1). The same tendency can be identified in the developing world where large and small countries are undertaking major efforts to overhaul their research systems; the search for more productive arrangements being always the main justification. Colombia, Argentina, Dominican Republic, Sri Lanka, Indonesia are all examples of this trend. This is an intriguing observation. Even the most closely monitored research system of them all is under review: a major study is being done on the impact of the research system linking developing and developed countries, coordinated through the CGIAR. Agricultural research policy, organization, and management have become issues of ever increasing importance and to day it is not evident at all that the models governing the current research effort will still be operative at the end of the decade.

Why these changes? Why is it that the sheer sacrosanctity of the Land Grant College System could be called into question? Why is it that the heralded Dutch conception of the triptych (or "drieluik") of research, extension and education is not as evident as it was a decade ago? Why was it that the Consultative Group on International Agricultural Research dedicated a million dollars to an evaluative activity, when budget pressure on the Centers is already so high?

There are several lines of explanation. One is that agricultural research may be suffering from its own success. The success stories and particularly those associated with the IARCs and the CGIAR have drawn attention to the potential of research as an agricultural development tool, leading to an increased interest in maximizing their potential contribution. Secondly, the last 15-20 years have seen dramatic scientific and organizational changes: biotechnology and the emerging role of the private sector call for new approaches to agricultural research organization. Finally, and maybe most important of all, is the fact that despite the successes achieved in advancing agricultural production and productivity, the world still faces a tremendous challenge if the future food requirements are to be met. It is true that Asian countries have achieved a certain balance between demand and supply, but population growth in this region is still very large in absolute numbers, and there are no significant areas of new land that can be brought into production. In Africa, the food situation has deteriorated in the past decade, and the causes go beyond the climatic

(1) KENNY, MARTIN, and Jack KLOPPENBURG, *The American Agricultural Research System: An Obsolete Structure?* Agricultural Administration, 14: pp 1-10.

Previous Page Blank

disasters that the region underwent. In Latin America, production has increased substantially, but today the region is more dependent than ever on food imports.

Furthermore, there is increasing concern over a widening gap between countries, particularly between large and small developing countries, and the inability of this latter group to put together self-sustainable research systems. It is in the light of this context that a workshop was organized. The objective was not to develop answers to the above-mentioned problems and concerns: it would be presumptuous to think that problems of such magnitude could be resolved in three days of discussions. The objective was to bring attention to the problems and pose the proper questions, so that we can start working on the development of a workable strategy for strengthening the research systems of the developing world in general, and of the small developing countries in particular. It is with this intention that the papers included in this volume were commissioned. Their value does not lie in the answers they provide, but, hopefully, in the questions they raise.

The objectives for which the papers were written were twofold:

1. to generate researchable topics in the field of agricultural research policy and organization;
2. to suggest ways of institutional collaboration while working on these questions.

The reasons why the workshop focussed on research systems in small countries have been given above. Little is known about the specific problems of these countries. Larger countries have been the subject of many studies. Ruttan's recent book on agricultural research policy (1982), refers to countries like India and Brazil. But what of the smaller ones, like Costa Rica, Sri Lanka or the Dominican Republic? Or, for that matter, Denmark, Finland or The Netherlands? Obviously, resources in the latter three are far larger than in the former. But how are agricultural research activities affected by the smaller scale of these countries? Does their size have anything to do with the types of interaction and communication operative between different parties in the research and development enterprise?

It is for this reason that this report is called Agricultural Research Policy and Organization in Small Countries. We stress "Policy and Organization" to emphasize that the research questions cannot be limited to notions of good management and efficiency or effectiveness. Policy is a key element. And we concentrate ourselves on small countries because we think that this may be an area where research is most needed and where it is feasible as well. The scope, however, is comparative; the analyses are not limited to these countries by themselves. Neither are they limited to developing countries.

THE PAPERS

The general scene: small countries, great needs.

The tone for the different papers in this volume is set by Ruttan's "Toward a global agricultural research system."

He formulates three generalizations, which could be restated as follows:

1. small research systems have higher research investments per hectare than large ones, to achieve an equal level of effectiveness;
2. small countries, with great agroclimatic variations will face higher costs to develop productive farming systems than more homogenous countries;
3. small countries cannot avoid being dependent on others for much of their agricultural technology.

Ruttan distinguishes between different types of small countries. For those in the four to ten million population range, with access to resources, he considers the development of agricultural research and educational institutions within this century.

For the fifty or so smallest low-income countries this is not in the offing. He therefore warns development agencies that they should not plan in 5 or 10 year project cycles, but rather in terms of a generation. These smaller systems should also dedicate their resources qualitatively in a different way, namely to the direct support of agricultural production and rural development programs. They may not be able to support the costs of a minimal research program aimed at the principal commodities, estimated by Trigo and Piñeiro at US$12 to US$15 million.

Ruttan therefore suggests an approach for those countries which is based on:

- the emergence of organized producer groups;
- a funding model in which the size of the donor contribution is tied to the growth of domestic support;
- national research assistance support and implementation groups;
- effective linkage with non-national research and development agencies, be they public or private, and based on multilateral or bilateral arrangements.

Gamble and Trigo in their paper on "Establishing agricultural research policy," conclude that research needs in small countries are not linked to their size, whereas resources usually are. If adequate resources are not provided, useful results are unlikely, and resources are wasted. They base their analyses on the Minimum Research Module (MRM) proposed by Trigo and Piñeiro. It is applied to seven prime crops in 38 small countries in Central America, the Caribbean, and Africa. Only in 14 out of 207 country-crop combinations, is the economic base large enough to support a minimum research effort. Rice research, for example, can only be supported in Cuba, the Dominican Republic, Guyana, Costa Rica, Panama, Liberia, and Sierra Leone. Cassava research only in Benin and Burundi. Even if research allocations would be doubled, the authors conclude that the picture remains approximately the same.

Gamble and Trigo therefore make the following recommendations:

1. to concentrate research efforts to maximize impact of available resources;
2. to coordinate donor assistance through a national research support group (analogous to Ruttan's proposal);
3. to decide what research needs to be done locally, and what can be done through regional or international collaboration (by means of international agricultural research centers).

Coordination should take place on the international level as well, as Treitz argues. Many of the countries covered by Gamble and Trigo in their analysis, belong to the so-called group of African-Caribbean- Pacific (ACP) states, linked to the European Communities (EC) through the Lome Conventions.

Donor countries can join efforts to support agricultural research and development by actively participating in agencies like the recently created Technical Center for Agricultural and Rural Cooperation of the EC. It could become a clearing-house for information on agricultural research, thereby stimulating the types of research policies as suggested by Ruttan, or Gamble and Trigo.

RESEARCH AND POLICY

Two papers deal with the research-policy linkage. Qasem defines "linkage" and "policy" and goes on to specify the parties involved in the respective relationships. Dealing with developing countries, he mentions a number of their specific problems. First, the relation to the ministry of agriculture and the desire of autonomy on the part of the researchers. Researchers may wish to generate support from outside agencies, such as farmers' groups or foreign financing institutions.

A second issue deals with the relation to other policy makers, such as in the ministry of planning. Researchers have to make their case, to show that their work is in line with prevailing priorities in food policies. They also need to convince agribusiness leaders of their work's value.

Relations with clients form a third issue, in particular the relations with farmers. Since they are generally poorly organized and do not have real power, they do not participate in research priority setting.

A number of these issues are taken up by De Zeeuw, who describes the case of a developed country, The Netherlands. He starts his paper unequivocally: "The Netherlands never had an independent agricultural research policy, and it is my sincere hope that my country will stay in this state of blessing as long as the sea level allows us to exist." What does exist is a Government agricultural policy of which research is a part. Rephrasing De Zeeuw's argument, I derived the following propositions:

1. Good agricultural research can do without an explicit research policy.
2. Only take up a subject if it is not, or cannot be researched by others (like private enterprise).
3. Only take those subjects which can be expected to pay off at the farm level within a period of 10 to 15 years.
4. Pick subjects through consensus between main parties involved, through informal and cooperative arrangements.
5. Formalize only what needs to be absolutely formalized, so that researchers can respond quickly to emerging needs among farmers.

Quite evidently these propositions hold under certain conditions. De Zeeuw presses the point that Dutch agricultural entrepreneurs are well-educated, well-read, well-organized, and that agriculture is still profitable (even though average farm income is, according to him, still below standard). Comparing his analysis with Qasem's, it is clear that on these points, the differences between rich and poor countries are vast. This makes for essential differences in the embedding of agricultural research in the general field of agricultural development.

LINKAGES AMONG SCIENTISTS

One of De Zeeuw's propositions referred to the way in which subjects are selected for study. In the Netherlands an

elaborate structure was established, based on decentralized problem formulation. In this National Council for Agricultural Research, researchers meet the users of their work, as well as their colleagues.

Boynton has described in his "Scientific linkages of agricultural research systems for small countries," the case of five Central American states. Costa Rica, Guatemala, Honduras, Nicaragua, and El Salvador all are small, face globally the same political and economic consequence of their size, and share a number of institutions.

The author points out that the development of agricultural research follows the same pattern in most of the countries concerned. Research generally starts on export-crops produced in enclave economies. Gradually it is complemented by national research on particular export crops such as coffee. After World War II, interest starts in food crops and it is believed that what is needed is good extension to transmit research results from foreign institutes. But that approach fails.

What is needed is research oriented to the particular production conditions, to generate technologies which are well enough adapted. One of the institutes which has done this is ICTA, the Guatemalan Institute of Agricultural Science and Technology, created in 1972. ICTA functions as a mediating institution between local researchers with international institutes, national extension services, and local farmers or their groups.

Boynton calls for more study on these types of national coordinating agencies and on the possibilities of centralized (regional) data banks providing information on ecological and socioeconomic factors influencing agricultural development in these small countries.

Both the Dutch and the Guatemalan case point to the importance of effective linkage among scientists. At the same time, both models are based on ways to balance this relationship with effective linkage to farmer interest groups.

LINKAGES WITH FARMER INTERESTS

Peter Hildebrand discusses researcher-farmer linkages in the paper with the same title. To him, the prime factor in this relation is confidence. In rich, as well as in poor countries, farmers distrust government officials for a variety of reasons. Researchers may be perceived as part of this lot. He pleads, therefore, for a partnership between researcher and farmer and indicates how this is done in the Farming Systems approach, which he has helped to develop.

This approach calls for a clear identification of the target group of farmers (the "recommendation domain"), technology development, and testing at the farm level ("on-farm research") based on multidisciplinary data gathered through rapid reconnaissance surveys ("sondeos") or other methods.

Like Boynton, Hildebrand has worked at ICTA when developing this method. In the decade of its existence, ICTA has attempted to generate technology to achieve Guatemalan self-sufficiency in food grains. During this 10-year period, yield increases are notable: in rice (78%), beans (55%), sorghum (53%), and maize (39%). Hildebrand cannot indicate to what extent ICTA is responsible for these increases. He argues, however, that the strong researcher-farmer linkage has been important in generating the changes.

But the linkage may also be created in different ways which do not use a Farming Systems approach. This is shown by Doorman and Cuevas in their contribution on relationships between research, extension, and rice-farmers in the Dominican Republic. Doorman, a sociologist, worked there with an Adaptive Agricultural Research Project. Dominican rice breeder Cuevas had noted years ago that rice cultivators in his country had developed a fairly efficient system of ratoon cropping. The system might well compete with some of the new technological packages, which are based on double cropping. He translated this into a research design and could prove indeed that farmers were right to stay with their system, and government officials were at least simplistic in supposing that double cropping would pay under all conditions. In fact he shows how farmer interest (in benefits per hectare) is opposed to state interest (in reaching self-sufficiency through gross production gains).

Doorman has followed another approach, but arrives at comparable conclusions. He has formalized reconnaissance and the subsequent surveys, which Cuevas did intuitively. He was interested in finding out which adaptations small rice growers make under different production conditions. In another area than where Cuevas worked, he could show that farmers under good conditions could (and did) adopt the technological package (although some farmers also ratooned). But cultivators who were less well off, adapted their cultivation system in a variety of ways. Some of these adaptations are quite fascinating. Even though these adaptations are described in the literature, many researchers and rice-extension officials did not know about them. When they were confronted with an adaptation, they would deny its value.

Researchers tend to find solutions for areas where "quick results in raising production levels were most likely," the authors argue. But this "has led to the exclusion of other topics which are of interest to farmers." Only through dialogue between farmers and researchers can topics be selected which will ultimately have the highest payoff in terms of the farmers' and the national interest.

This is no news to Dutch potato farmers. They have been entertaining the dialogue with researchers in a variety of ways, as Van der Zaag argues in his paper on "Organization of agricultural research in the Netherlands with special reference to potato research and farmers' participation in it." The success of the Dutch effort in potato research is largely due to a well-balanced research program, involving the participation of growers, breeders, merchants, and processors.

Within the framework of the Dutch National Council for Agricultural Research, subcommittees are formed where research producers and consumers meet. Van der Zaag suggests that the success of these committees depends on the capacity of key officials to mediate between the worlds of science and farming. If researchers are interested in solving practical problems, chances of success increase.

And the success of Dutch potato production has been quite remarkable. Through the coordinated effort of all parties involved, the crop is currently the country's most important. Fifty per cent of the income of farmers with arable land is derived from it. Two-thirds of total production is exported, making The Netherlands, for example, the world's largest exporter of seed potatoes.

The last three papers are written from different perspectives and deal with different production conditions. But they agree on the point that successful agricultural research cannot do without close linkage to farmers' interest groups. It is this subtle, and oftentimes informal linkage, which warrants more study.

RESEARCH AGENDA

During the Workshop where these papers were discussed, a tally was kept of suggestions for further research. The number and variety was startling. This is a good sign for an emerging field.

Three "working groups" met at the end of the plenary sessions, each of which undertook one main area of discussion:

* Research Policy-making;
* Scientific Linkages;
* Researcher-farmer Linkages.

The main objective was to move from the general suggestions to a feasible agenda, that is, one with a sense of priorities and resource limitations. The attempt was made to capitalize in as much as possible on the experience and expertise of the participants. After the organizing committee worked with the original list of suggestions and the reports of the working groups to develop a list of about 12 topics, which are now reported as the suggested research agenda. A full discussion of each topic is in the paper by Box and Van Ruiten, included as Annex 3 to this volume. In reaching this list, which includes topics dealing with general as well as specific issues of agricultural research in small countries, several workshop participants were consulted.

GENERAL ISSUES

1. Research organization in market versus planned economies: contrast and convergence.
2. The organization of private versus public agricultural research: competition or cooperation.
3. Farmer participation in agricultural research policy formulation and execution: possibilities and limits.
4. The management of rapidly changing budgets for agricultural research: country experiences compared.
5. The biography of specific technologies: from problem formulation to technology testing.
6. Extension systems in developing countries: their conversion into more effective agents of knowledge transmission between consumers and producers of agricultural research.
7. Social science contributions to agricultural research: emerging patterns of multidisciplinary collaboration.

ISSUES FOR SMALL COUNTRIES

1. Minimum scale requirements for agricultural research: the diversity of demands versus the paucity of resources.
2. Bilateral arrangements in agricultural research and training: strengths and weaknesses from the small country perspective.
3. Regional networks in agricultural research: lessons from experience.
4. The role of small countries in International Agricultural Research Center networks: need for mutual adjustment.

5. Agroclimatic zoning: making research results comparable and available to small country systems.

This list is a first attempt . ordering the issues. We have no other objective as to start discussion on the priorities of research. We have not included in this volume a listing of all the specific suggestions for research; these can be requested by writing to ISNAR.

WHERE TO GO FROM HERE? CONCLUSION

The Wageningen Workshop brought people and papers together. The meetings were kept small, to allow for as much exchange as possible. The main conclusion of the Workshop was that it had proved a valuable meeting ground for defining the general issues. Research on agricultural research has been done in the United States by people like Ruttan for a number of years. In Europe it has recently come to the level of research programs and university courses.

It is exactly at this point in time that coordination might prove beneficial to all involved. If some international division of labor can be generated, if contacts between researchers can be maintained and information exchanged, all are to benefit.

To this effect a coordinating group was proposed, with participants from rich and poor countries. ISNAR has offered hospitality for the secretariat of this group. In this way, the initiative of ISNAR, Wageningen Agricultural University, The Technical Center for Agricultural and Rural Cooperation (CTA), the Director of Agricultural Research of the Dutch Ministry of Agriculture and Fisheries, and the National Council for Agricultural Research can be continued.

NOTES

I thank Ir. John van Ruiten and Dr. Eduardo Trigo for their continuous help in the organization of the Workshop and their helpful comments on an earlier version of this text.

TOWARD A GLOBAL AGRICULTURAL RESEARCH SYSTEM

V. W. Ruttan

University of Minnesota
Saint Paul, USA

We are, during the closing decades of the 20th century, approaching the end of one of the most remarkable transitions in the history of agriculture. Prior to the beginning of this century, almost all increases in agricultural production occurred as a result of increases in the area cultivated. There were only a few exceptions to this generalization. One exception was the wet rice cultivation areas of East Asia. A second major exception was the areas in Western Europe that contributed to the agricultural revolution of the 18th and 19th centuries.

By the end of this century, there will be few significant areas where agricultural production can be expanded by simply adding more land to production. Expansion of agricultural output will have to be obtained almost entirely from more intensive cultivation in areas already used for agricultural production. Increases in food and fibre production will depend to a great extent on continuous advances in agricultural technology. It is imperative that over the next several decades we complete the establishment of agricultural research capacity for each commodity of economic significance in each agroclimatic region of the world.

In this paper I address the task that remains: to design and implement the global agricultural research system that will need to be in place by, at the very latest, the first decade of the 21st century. I will pay particular attention to the special problems of the smaller countries in the emerging global system.

THE INTERNATIONAL AGRICULTURAL RESEARCH SYSTEM

Let me first recall what has been accomplished over the last several decades. The architects of the post-World War II system of global institutions included the problem of meeting world food needs and reducing poverty in rural areas as essential elements in their vision of a world community that could assure all people of freedom from want and insecurity. They sought to achieve this vision by the creation of a set of global bureaucracies, the UN specialized agencies. The establishment of the UN Food and Agriculture Organization was the initial institutional response to this concern (Hambridge).

It was not until the late 1950s and early 1960s that a combination of concern about meeting world food needs, experience in advancing technology in food grain production in the tropics, a more adequate analysis of the role of agriculture, and of advances in agricultural technology in the development process, converged to provide the impetus, on the part of several bilateral and multilateral assistance agencies and national governments, for a major effort to build the research capacity needed to sustain agricultural production in the poor countries of the tropics.

Organization and Impact

One of the most remarkable advancements that emerged out of the efforts of the last two decades has been the establishment of a new system of international agricultural research institutes (Table 1). The first four institutes in the system were the product of the joint efforts of the Ford and Rockefeller Foundations. The system now operates under the aegis of the Consultative Group for International Agricultural Research, and is funded by a consortium of private foundations and bilateral and multilateral assistance agencies. An important innovation in the management of the system is that each institute is governed by an independent board of directors and operates as an autonomous institution. This structure, which combines decentralized decision-making with respect to scientific program, with centralized supervision regarding funding and program direction, is fundamental in accounting for the efficiency of the system. Scientific judgments about programs are made in a decentralized manner, while system design and strategy can be made centrally.

Evidence regarding the productivity of the system is fragmentary and incomplete. Yet there is little doubt that the rate of return to the investment in the system has been high, even by comparison with the more productive developed countries national systems (Table 2). As early as the mid-1970s, evidence developed by Robert Evenson and colleagues, at the University of the Philippines and the International Rice Research Institute, indicated that the supply of rice in all developing countries was approximately 12 per cent higher than it would have been if the same total resources had been devoted to the production of rice using only the varieties that were available prior to the mid-1960s (Evenson, Flores, and Hayami). A recent study by Joseph Nagy suggests that the gains to Pakistan alone, from the wheat research conducted by CIMMYT, would have been more than enough to cover the cost of the entire CIMMYT wheat program from its inception to 1980. Another way of making the same point is that Pakistan could then have afforded to invest in a wheat research program of its own, comparable in extent and cost to the CIMMYT program.

Support for Small Country Systems

The international system is particularly important for enhancing and sustaining the productivity of the smaller national agricultural research systems. I recall in the late 1970s visiting the rice research station at Mopti in Mali. The scientific staff at the station consisted of four young men: a rice breeder, an entomologist, a plant pathologist, and an agronomist who had recently returned from completion of master's level (or equivalent) training abroad. They had access, through the West African Rice Development Authority (WARDA), to the IRRI germplasm collections. Their professional isolation was relieved and their productivity enhanced through participation in WARDA and IRRI workshops and seminars. A decade earlier, they would have had little access to either the genetic resources or the intellectual contact that enabled them, in the late 1970s, to initiate a modest but yet productive research program.

Let me refer to a second example. At the 1984 Agricultural Research Policy Seminar held at the University of Minnesota, a research director from one of the smaller Latin American countries commented to the effect that: "It is very well for those from Mexico or Brazil to talk about the strength of your national systems and how little you gain from the international centers. But without the international centers we would not get anything from you. The international centers are there working with us to make sure we have access to the available technology. The primary factor that limits what we get through the centers is our own capacity to use it."

A Continuing Need for International Support

When the system of international centers was being established by the Ford and Rockefeller Foundations in the early and mid-1960s, there was a general consensus that over a period of several decades the foundations would withdraw and transfer the management and support of the institutes to the host countries. The two foundations have now withdrawn from anything more than token support of the system. But responsibility for supervision and support has been assumed, as noted earlier, by the CGIAR and its member institutions. Yet one still hears comments from both staff members of the developed countries donors and the developing countries national research system that, at some time in the future, the responsibility for the system can be transferred to the developing countries or that the major units of the system (excepting the International Board for Plant Genetic Resources) will eventually be phased out.

I find such discussion unrealistic. The system should be viewed as a permanent component of the global agricultural support system. This should not mean that every unit in the present system should be regarded as permanent. It is not difficult to visualize circumstances that could lead to the de-emphasis of some programs and the initiation of new programs. But the international system should be regarded as permanent. And the funding for the system should become part of the permanent commitment of the more developed countries to the agricultural development of the poorer and smaller countries in the system. In this respect, there is a similarity between the national funding of a system of regional research centers in larger countries such as Brazil, India and the United States, even though the individual states also support state experiment stations.

An Incomplete System

While arguing for a permanent commitment to the support of the international systems, I would like to suggest that the system remains incomplete. I do not, however, argue for any significant expansion of the system of international commodity research institutes. But there is a need to rationalize the management and supervision of a number of international agricultural research centers that have grown outside the CGIAR system (Table 3). And I do see the need for greater capacity to conduct research on some of the difficult resource problems that continue to inhibit the development of agriculture in tropical environments. And it also seems apparent that lack of basic scientific knowledge represents a serious constraint in the

Table 1: Centers Supported by the CGIAR, 1984

Acronym (Year Established)	*Center*	*Location*	*Research Programs*	*Geographic Focus*	*1984 Budget** ($ million)
IRRI (1960)	International Rice Research Institute	Los Baños, Phillippines	Rice Rice based	Global Asia	22.5
CIMMYT (1966)	Centro Internacional de Mejoramiento de Maíz y Trigo	Mexico City, Mexico	Maize Bread wheat Durum wheat Barley Triticale	Global Global Global Global Global	21.0
IITA (1967)	International Institute of Tropical Agriculture	Ibadan, Nigeria	Farming systems Maize Rice Sweet potato, yams Cassava, Cowpea, Lima bean, Soybean	Tropical Africa Global Tropical Africa	21.2
CIAT (1968)	Centro Internacional de Agricultura Tropical	Cali, Colombia	Cassava Field beans Rice Tropical pastures	Global Global Latin America Latin America	23.1
CIP (1971)	Centro Internacional de la Papa	Lima, Peru	Potato	Global	10.9
WARDA (1971)	West African Rice Development Association	Monrovia, Liberia	Rice	West Africa	8.9
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics	Hyderabad, India	Chickpea Pigeonpea Pearl millet Sorghum Groundnut Farming systems tropics	Global Global Global Global Global Semi-arid	22.1
ILRAD (1973)	International Laboratory for Research on Animal Diseases	Nairobi, Kenya	Trypanosomiasis Theileriosis	Global Global	9.7
IBPGR (1974)	International Board for Plant Genetic Resources	Rome, Italy	Plant genetic resources	Global	3.7
ILCA (1974)	International Livestock Center for Africa	Addis Ababa, Ethiopia	Livestock production systems	Tropical Africa	12.7
IFPRI (1975)	International Food Policy Research Institute	Wash. D.C., U.S.A.	Food policy	Global	4.2
ICARDA (1976)	International Center for Agricultural Research in the Dry Areas	Aleppo, Syria	Farming systems Wheat, Barley, Triticale, Broad bean, Lentil, Chickpea, Forage crops	Dry areas of West Asia and North Africa	20.4
ISNAR (1980)	International Service for National Agricultural Research	The Hague, Netherlands	National agricultural research	Global	3.5

* CGIAR supported core budget, net of capital, at the bottom of the bracket (from 1983 Integrative Report.)

development of viable and sustainable technologies in some areas.

The establishment of an International Fertilizer Development Center at Muscle Shoals, Alabama, USA, in 1974 represented an initial step in the development of an international capacity for research on resource development and management problems. The decision, this past year, by a group of donors to establish an International Irrigation Management Institute (IIMI) in Sri Lanka represented a second significant initiative. There is widespread discussion in forestry circles of the need for greater capacity in the tropics for reseach on the development, management, and utilization of fast growing trees, to sustain the demand for biomass for fuel and other uses.

We have also seen the beginnings of international support for the development of capacity to work on some of the problems where lack of basic knowledge acts as a constraint in technology development. Within the CGIAR system, the International Laboratory for Research on Animal Diseases (ILRAD) has been forced to direct much of its research to basic investigations. The International Centre for Insect Physiology and Ecology (ICIPE), initially established in 1970, has gradually evolved into an institution with very substantial research capacity. The United Nations Industrial Development Organization (UNIDO) has sponsored exploratory studies that are leading to the establishment of an International Centre for Genetic Engineering and Bio-Technology (ICGER). It is doubtful, however, that the ICGER will devote adequate attention to the work in molecular biology that will be most relevant for animal and plant protection in developing countries. There is also, in my judgment, a very strong need for capacity to conduct research to overcome the lack of knowledge about problems of fertility maintenance and enhancement of tropical soils. In many parts of Africa, lack of knowledge about soil fertility represents a serious constraint on the ability to design viable short rotation systems, to replace the more extensive slash-and-burn or other long rotation systems now in use. Finally, there are serious deficiencies in the knowledge needed to develop economically viable technologies for the control of the parasitic diseases that inhibit the development of more intensive systems of agricultural production. In many cases, the relationship between disease and development appears to be symbiotic.

Intensification of agricultural production enhances the environment for parasite disease. And parasite disease reduces the capacity of rural people to pursue more intensive systems of cultivation.

It is not too difficult to obtain agreement, at least in principle, for greater international support for research on problems of resource development and management. But there is considerable scepticism about the need for international support for a series of basic research institutes in the tropics. The argument is frequently made that the basic research can be done in developed countries institutes, particularly in countries such as France, the United Kingdom, and the Netherlands, that have a tradition of tropical research and are now seeing that capacity erode as support adjusts to the disappearance of colonial responsibilities and to budgetary constraints. Part of my answer is that intellectual commitment to the solution of scientific problems is enhanced when scientists working on these problems are located in the environment in which the problems exist. Basic research capacity in the tropics will also facilitate more effective dialogue with the research community of the developed countries.

Considerable thought will also have to be given to the appropriate governance of the emerging system of natural resource and basic science research centers. The present CGIAR system is already approaching the limits of its financial and managerial capacity. Yet it would be a serious mistake if new natural resources and basic science institutes were to continue to emerge on an ad hoc basis. One of the great strengths of the present CGIAR system is its planning and supervising role in welding the set of autonomous institutes into an international research system. It may be necessary to consider the establishment of new supervising bodies, such as a Consultative Group for Natural Resources Research (CGNRR) to govern the new natural resource-based institutes. And it will certainly be necessary to establish a separate governance system for any new system of basic research institutes - a Consultative Group of Biological Sciences for Tropical Agriculture (CGBSTA).

As new internationally supported basic research units are established in the tropics, more attention should be given to their training role, particularly advanced training at the Ph.D. and post-doctoral levels, than was the case when the present international commodity institutes were established.

A Global System

Finally, I would argue that an effort should be made to ensure that the international system becomes a truly global system. The new international system has been effective in building communication among developing countries national research systems. The linkages of the international centers with developed countries research institutions are, however, generally filtered through the bilateral

Table 2: Summary Studies of Agricultural Research Productivity

Study	Country	Commodity	Time Period	Annual Internal Rate of Return (%)
Index Number:				
Griliches, 1958	USA	Hybrid corn	1940-1955	35-40
Griliches, 1958	USA	Hybrid sorghum	1940-1957	20
Peterson, 1967	USA	Poultry	1915-1960	21-25
Evenson, 1969	South Africa	Sugarcane	1945-1962	40
Barletta, 1970	Mexico	Wheat	1943-1963	90
Barletta, 1970	Mexico	Maize	1943-1963	35
Ayer, 1970	Brazil	Cotton	1924-1967	77
Schmitz and Seckler, 1970	USA	Tomato harvester,	1958-1969	
		Tomato harvester, to displaced workers		37-46
		Tomato harvesters, with compensation of displaced workers for 50% of earnings loss		
Ayer and Schuh, 1972	Brazil	Cotton	1924-1967	77-110
Hines, 1972	Peru	Maize	1954-1967	35-40 (a)
				50-55 (b)
Hayami and Akino, 1977	Japan	Rice	1915-1950	25-27
Hayami and Akino, 1977	Japan	Rice	1930-1961	73-75
Hertford, Ardila, Rocha, and Trujillo 1977	Colombia	Rice	1957-1972	60-82
	USA	Soybeans	1960-1971	79-96
		Wheat	1953-1973	11-12
		Cotton	1953-1972	none
Pee, 1977	Malaysia	Rubber	1932-1973	24
Peterson and Fitzharris, 1977	USA	Aggregate	1937-1942	50
			1947-1952	51
			1957-1962	49
			1957-1972	34
Wennergren and Whitaker, 1977	Bolivia	Sheep	1966-1975	44
		Wheat	1966-1975	48
Pray, 1978	Punjab (India)	Agricultural research and extension	1906-1956	34-44
	Punjab (Pakistan)	Agricultural research and extension	1948-1963	23-37
Scobie and Posada, 1978	Bolivia	Rice	1957-1964	79-96
Pray, 1980	Bangladesh	Wheat and rice	1961-1977	30-35
Regression Analysis:				
Tang, 1963	Japan	Aggregate	1880-1938	35
Griliches, 1964	USA	Aggregate	1949-1959	35-40
Latimer, 1964	USA	Aggregate	1949-1959	not significant
Peterson, 1967	USA	Poultry	1915-1960	21
Evenson, 1968	USA	Aggregate	1949-1959	47
Evenson, 1969	South Africa	Sugarcane	1945-1958	40
Barletta, 1970	Mexico	Crops	1943-1963	45-93
Duncan, 1972	Australia	Pasture improvement	1948-1969	58-68
Evenson and Jha, 1973	India	Aggregate	1953-1971	40
Cline, 1975 (revised by Knutson and Tweeten, 1979)	USA	Aggregate	1939-1948	41-50 (c)
		Research and extension	1949-1958	39-47 (c)
			1959-1968	32-39 (c)
			1969-1972	28-35 (c)
Bredahl and Peterson, 1976	USA	Cash grains	1969	36 (d)
		Poultry	1969	37 (d)
		Dairy	1969	43 (d)
		Livestock	1969	47 (d)
Kahlon, Bal, Saxena, and Jha, 1977	India	Aggregate	1960-1961	63
Evenson and Flores, 1977	Asia - national	Rice	1950-1965	32-39
			1966-1975	73-78
	Asia International	Rice	1966-1975	74-102
Flores, Evenson and Hayami, 1978	Tropics	Rice	1966-1975	46-71
	Philippines	Rice	1966-1975	75
Nagy and Furtan, 1978	Canada	Rapeseed	1960-1975	95-110
Davis, 1979	USA	Aggregate	1949-1959	66-100
			1964-1974	37
Evenson, 1979	USA	Aggregate	1868-1926	65
	USA	Technology oriented	1927-1950	95
	USA	Science oriented	1927-1950	110
	USA	Science oriented	1948-1971	45
	Southern USA	Technology oriented	1948-1971	130
	Northern USA	Technology oriented	1948-1971	93
	Western USA	Technology oriented	1948-1971	95
	USA	Farm management research and agricultural extension	1948-1971	110

Appendix to Table 2

Evenson Robert E., Paul E. Waggoner, and Vernon W. Ruttan, *Economic Benefits from Research: An Example from Agriculture*, Science, 205 (September 14, 1979), pp. 1101-7. Copyright 1979 by the American Association for the Advancement of Science.

Notes:

(a) Returns to maize research only.
(b) Returns to maize research plus cultivation "package".
(c) Lower estimate for 13-, and higher for 16-year time lag between beginning and end of output impact.
(d) Lagged marginal product of 1969 research on output discounted for poultry and dairy, and 7 years for livestock.

Sources for Table 2: The results of many of the studies reported in this table have previously been summarized in the following works:

Arndt Thomas M., Dana G. Dalrymple, and Vernon W. Ruttan, eds., *Resource Allocation and Productivity in National and International Agricultural Research* (Minneapolis: University of Minnesota Press, 1977) p. 6, 7.

Boyce James K. and Robert E. Evenson, *Agricultural Research and Extension Systems* (New York, Agricultural Development Council, 1975), p. 104.

Evenson Robert, Paul E. Waggoner, and Vernon W. Ruttan, *Economic Benefits from Research: An Example from Agriculture*, Science, 205 (September 14, 1979), pp. 1101-7.

Sim Robert J. R. and Richard Gardner, *A Review of Research and Extension Evaluation in Agriculture*, (Moscow, Idaho: University of Idaho, Department of Agricultural Economics Research Series 214, May 1978), pp. 42, 42.

The sources for individual studies are:

Ayer H., *The Costs, Returns and Effects of Agricultural Research in Sao Paulo, Brazil* (Ph.D. dissertation, Purdue University, 1970).

Ayer H. W. and G. E. Schuh, *Social Rates of Return and Other Aspects of Agricultural Research: The Case of Cotton Research in Sao Paulo, Brazil*, American Journal of Agricultural Economics, 54 (November 1972), pp. 557-69.

Barletta Ardito N., *Costs and Social Benefits of Agricultural Research in Mexico* (Ph.D. dissertation, University of Chicago, 1970).

Bredahl M. and W. Peterson, *The Productivity and Allocation of Research: U.S. Agricultural Experiment Stations*, American Journal of Agricultural Economics, 58 (November 1976), pp. 684-92.

Cline Phillip L., *Sources of Productivity Change in United States Agriculture*, (Ph.D. dissertation, Oklahoma State University, 1970).

Davis Jeffrey S., *Stability of the Research Production Coefficient for U.S. Agriculture*, (Ph.D. dissertation, University of Minnesota, 1979)

Duncan R. C., *Evaluating Returns to Research in Pasture Improvement*, Australian Journal of Agricultural Economics, 16 (December 1972), pp. 153-68.

Evenson R., *The Contribution of Agricultural Research and Extension to Agricultural Production*, (Ph.D. dissertation, University of Chicago, 1968).

Evenson R., *International Transmission of Technology in Sugarcane Production*, (New Haven, Conn: Yale University, Mimeographed paper, 1969).

Evenson R. E. and P. Flores, *Economic Consequences of New Rice Technology in Asia*, Los Banos, Laguna, Philippines: International Rice Research Institute, 1978.

Evenson R. E. and D. Jha, *The Contribution of Agricultural Research Systems to Agricultural Production in India*, Indian Journal of Agricultural Economics, 28 (1973), pp. 212-30.

Flores P., R. E. Evenson, Y. Hayami, *Social Returns to Rice Research in the Phillipines: Domestic Benefits and Foreign Spillover*, Economic Development and Cultural Change, 26 (April 1978), pp. 591-607.

Griliches Z., *Research Costs and Social Returns: Hybrid Corn and Related* Journal of Political Economy, 66 (1958), pp. 419-31

Griliches S., *Research Expenditures, Education and the Aggregate Agricultural Production Function*, American Economic Review, 54 (December 1964), pp. 961-74.

Hayami Y. and M. Akino, *Organization and Productivity of Agricultural Research Systems in Japan*, in Resource Allocation And Productivity in National and International Agricultural Research, Thomas M. Arndt, Dana G. Dalrymple, and Vernon W. Ruttan, eds. (Minneapolis: University of Minnesota Press, 1977), pp. 29-59.

Hertford R., J. Ardila, A. Rocha, and G. Trujillo,

Productivity of Agricultural Research in Colombia, in Resource Allocation and Productivity in National and International Agricultural Research, Thomas M. Arndt, Dana G. Dalrymple, and Vernon W. Ruttan, eds. (Minneapolis: University of Minnesota Press, 1977), pp. 86–123.

Hines J., *The Utilization of Research for Development: Two Case Studies in Rural Modernization and Agriculture in Peru (PhD. dissertation, Princeton University, 1972).*

Kahlon A. S., H. K. Bal, P. N. Saxena, and D. Jha, Returns to Investment in Research in India, in Resource Allocation and Productivity in National and International Agricultural Research, University of Minnesota Press, 1977), pp. 124-47.

Knutson M. and Luther G. Tweeten, *Toward an Optimal Rate of Growth in Agricultural Production Research and Extension*, American Journal of Agricultural Economics, 61 (February 1979), pp. 70-76.

Latimer R., *Some Economic Aspects of Agricultural Research and Extension in the U.S.* (PhD. dissertation, Purdue University, 1964)

Nagy J. G. and W. H. Furtan, *Economic Costs and Returns from Crop Development Research: The Case of Rapeseed Breeding in Canada*, Canadian Journal of Agricultural Economics 26 (February 1978), pp. 1 - 14

Pee T. Y., *Social Returns from Rubber Research on Peninsular Malaysia* (PhD. dissertation, Michigan State University, 1977).

Peterson W. L., *Return to Poultry Research in the United States*, Journal of Farm Economics, 49 (August 1967), pp. 656-69.

Peterson W. L. and J. C. Fitzharris, *The Organization and Productivity of the Federal State Research System in the United States* in Resource Allocation and Productivity in National and International Agricultural Research, Thomas M. Arndt, Dana G. Dalrymple, and Vernon W. Ruttan, eds. (Minneapolis, University of Minnesota Press, 1977), pp. 60-68.

Pray C. E., *The Economics of Agricultural Research in Bangladesh*, Bangladesh Journal of Agricultural Economics, 2 (December 1978)F, pp. 1-36.

Pray C. E., *The Economics of Agricultural Research in British Punjab and Pakistani Punjab, 1905-1975, (PhD. dissertation, University of Pennsylvania, 1978).*

Schmitz A. and D. Seckler, Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester, American Journal of Agricultural Economics, 52 (November 1970), pp. 569-77.

Scobie G. M. and R. Posada T., *The Impact of Technical Change on Income Distribution: The Case of Rice in Colombia*, American Journal of Agricultural Economics, 60 (February 1978), pp. 85-92.

Tang A., *Research and Education in Japanese Agricultural Development*, Economic Studies Quarterly, 13 (February-May 1963), pp. 27-41 and 91 - 99.

Wennergen E. B. and M. D. Whitaker, *Social Return to U.S. Technical Assistance in Bolivian Agriculture: The Case of Sheep and Wheat*. American Journal of Agricultural Economics, 59 (August 1977), pp. 565-69.

In addition to the studies listed in the table, there have been several other important research impact studies in which results are reported in a cost-benefit rather than an internal rate of return format.

Bauer L. L. and C. R. Hancock, *The Productivity of Agricultural Research and Extension Expenditures in the Southeast*, Southern Journal of Agricultural Economics, (7 December 1975), pp. 177-72.

Marsden J. S., G. E. Martin, D. J. Parham, T. J. Risdill, and B. G. Johnston, *Returns on Australian Agricultural Research: The Joint Industries Assistance Commission-CSIRO and Benefit-Cost Study of the CSIRO Division of Entomology*, (Canberra: Commonwealth Scientific and Industrial Research Organization, 1980.

Purchase H. Graham, *The Etiology and Control of Marek's Disease of Chickens and the Economic Impact of a Successful Research Program*, in Virology in Agriculture: Beltsville Symposium in Agricultural Research-1, John A. Romberger, ed. (Montclair, N.J.: Allanheid, USMUN, 1977), pp. 63-81.

Table 3: Some International Agricultural Research Activities Outside the CGIAR*

Center	Primary Focus	Location	Year initial operation	Budget US$m	(Year)	No. Senior Staff	Programs
ICIPE	insect physiology and ecology	Nairobi, Kenya	1970	4.77	(1982)	46	Crop borers Livestock ticks Tsetse fly Plant resistance Medical vectors Insect pathology and pest management
AVRDC	tropical vegetables	Shanhua, Taiwan China	1972	3.60	(1983)	32	Tomato Chinese cabbage Sweet potato Soybean, Mungbean
ICLARM	living aquatic resources	Manila, Philippines	1973	1.70	(1983)	14	Aquaculture Traditional fisheries Resources development and management Information services
INTSOY	soybeans	Urbana, Illinois,	1973	0.95	(1983)	8	Soybeans
IFDC	fertilizer	Muscle Shoals, Alabama	1974	6.70	(1982)	60	Nitrogen research Nutrient interaction Phosphate research Sulfur research Potassium research Economics research National programs Technical assistance Training
ICRAF	agroforestry	Nairobi, Kenya	1978	2.20	(1983)	18	Agroforestry systems Agroforestry technology Information Training Collaborative research
IIMI	irrigation management	Kandy, Sri Lanka	1984	5.00	(when operational)	10-12 in HQ 3-4 unit	Collaborative research Training Information dissemination
IBSRAM	soils	not fixed	1985	4.54	(when operating)	5-10	Headquarters Soil management networks
INIBAP	banana and plantains improvement	not fixed	1985	1.75	(initially)	small	Headquarters Regional networks

* Activities currently using CGIAR meetings or in some other way related to CGIAR activities in 1984 (Total approximately $30 million).

development assistance agencies. Direct linkages with the national research systems of the developed countries remain underdeveloped. The linkages among the national research systems of the developed countries are even more rudimentary. It is my impression, for example, that there has not yet emerged any institutional capacity to rationalize or coordinate agricultural research among EEC member countries. There is a modest program of information exchange among OECD countries, but its activities appear to be more ceremonial than substantive. And we have not yet begun to build effective linkages between the international systems, or with agricultural research systems of the socialist countries.

NATIONAL RESEARCH SYSTEMS

The last several decades have witnessed a remarkable expansion in agricultural research capacity in a number of important developing countries. The number of agricultural scientists in the developing countries of Latin America, Africa, and Asia rose from approximately 14,000 in 1959 to 63,000 in 1980 (Table 4).

When one examines individual countries in detail, however, it is clear that most of this growth has occurred in a relatively few countries such as Brazil, the Philippines, India, China, and Nigeria. In 1980, there were only

Table 4: Trends in Numbers of Research Scientists and Extension Workers, 1959 - 1980

	Research Scientists[1]			Extension Workers			Ratio of Extension to Research Scientists		
REGION/SUBREGION	1959	1970[2]	1980	1959	1970[2]	1980[3]	1959	1970	1980
Western Europe	6,251	12,547	19,540	15,988	24,388	27,881	2.56	1.94	1.43
Northern Europe	1,818	4,409	8,027	4,793	5,638	6,241	2.64	1.23	0.78
Central Europe	2,888	5,721	8,827	7,865	13,046	14,421	2.62	2.28	1.63
Southern Europe	1,545	2,417	2,686	3,330	5,704	7,219	2.16	2.36	2.69
Eastern Europe and USSR[4]	17,701	43,709	51,614	29,000	43,000	55,000	1.64	0.98	1.07
Eastern Europe	5,701	16,009	20,220	9,340	15,749	21,546	1.64	0.98	1.07
USSR	12,000	27,700	31,394	19,660	27,251	33,454	1.64	0.98	1.07
North America and Oceania	8,449	11,688	13,607	13,580	15,113	14,966	1.61	1.29	1.10
North America	6,690	8,575	10,305	11,500	12,550	12,235	1.72	1.46	1.19
Oceania	1,759	3,113	3,302	2,080	2,563	2,731	1.18	0.82	0.83
Latin America	1,425	4,880	8,534	3,353	10,782	2,835	2.35	2.21	2.68
Temperate South America	364	1,022	1,527	205	1,056	1,292	0.56	1.03	0.85
Tropical South America	570	2,698	4,840	2,369	7,591	16,038	4.16	2.81	3.32
Caribbean and Central America	470	1,160	2,167	779	2,135	5,505	1.59	1.84	2.54
Asia[4]	11,418	31,837	46,656	86,900	142,500	148,780	8.55[5]	7.28[5]	5.06[5]
West Asia	457	1,606	2,329	7,000	18,800	16,535	15.31	11.71	7.10
South Asia	1,433	2,569	5,691	57,000	74,000	80,958	39.80	28.80	14.23
Southeast Asia	441	1,692	4,102	9,500	30,500	33,987	21.54	18.03	8.29
East Asia	7,837	13,720	17,262	13,400	19,200	17,300	1.71	1.40	1.00
China	1,250	12,250	17,272						
Africa[4]	1,919	3,849	8,088	28,700	58,700	79,875	14.96	15.25	9.88
North Africa	590	1,122	2,340	7,500	14,750	22,453	12.71	13.15	9.60
[illegible] Africa	412	952	2,466	9,000	22,000	29,478	21.80	23.11	11.95
[illegible]rica	221	684	1,632	9,000	18,750	24,211	40.72	27.41	14.84
Southern Africa	696	1,091	1,650	3,200	3,200	3,733	4.60	2.93	2.26
World Total	47,163	108,510	148,039	177,521	294,483	349,337	3.87[5]	3.06[5]	2.67[5]

Source

M. Ann Judd, James K. Boyce, and Robert E. Evenson, *Investing in Agricultural Supply*. Paper presented at Workshop on Agricultural Growth, Economic Growth Center, Yale University, 20-21 June, 1983.

Notes:

(1) Research scientists estimates include only workers with advanced degrees. An attempt has been made to include only research workers engaged in production-related agricultural research. Research on post-harvest technology is, for example, not included in these estimates.

(2) 1970 data are an average of 1968 and 1971.

(3) 1974 data are used when more recent data are not available. In other cases, the 1980 data are averages for 1974-1980.

(4) Data for Extension Workers in Eastern Europe, USSR, Africa, and Asia are estimated.

(5) Excludes China, for which data on extension workers were not reported.

slightly more agricultural research scientists in all of Latin America and Africa combined than in the US federal and state system, and fewer than in the Japanese national and prefectural system. Even in those countries that have made substantial progress, the ratio of research expenditures to the value of production remains low, and it remains lowest for those commodities produced and/or consumed primarily by the poorest farmers and consumers.

During the last several years, I have been involved in a series of studies of agricultural research systems in Asia (Ruttan, 1981). The concerns about the development of national agricultural research systems that have emerged out of my own research and experience have been reinforced by the series of very useful reviews conducted by the World Bank (1983), the US Agency for International Development (1983) and by the UNDP-FAO (1984). Let me list some of these concerns.

1. *I have become concerned about what appears to be excessive investment in research facility development relative to development of scientific staff.* There are too many facilities without programs. Many of the premature facility

Table 5: Estimated Cost of a Minimum Research Module for One Product (in thousands of current US dollars) (1)

I.	**Direct Research Costs** (60% of total budget)	306
A.	Personnel	245
	1. 4 chief researchers, MS or PhD, 3 persons/year in plant breeding, agronomy and pest and disease control and 1 person/year equivalent in socioeconomics and other specializations, according to requirements (soils, physiology, etc). Total cost per person/year US $30,000(2)	120
	2. 8 specialists, university graduates. Total cost per person/year US $12,500	100
	3. Training Calculated on the basis of 2 x 1 rate of retention; total rotation every 15 years; cost of US $100,000 per PhD (MS 60%). Total annual cost for a permanent team of 3 PhD and 1 MS (approximately)	25
B.	Services and materials Calculated as 12.5% of direct costs.	38
C.	Equipment Calculated as 7.5% of direct costs.	23
II.	**General Costs and Administration** (40% of total budget) Includes direction, support and services (administration, laboratories, library, communication, field, etc.)	204
A.	Personnel Calculated as 60% of general and administrative costs	122
B.	Services and materials 25% of general and administrative costs.	51
C.	Investments and equipment 15% of general and administrative costs.	31
	Total Budget	510

Percent summary by broad budgetary items (approximate)

A.	Personnel	72.5%
B.	Services and materials	17.5%
C.	Equipment	10.0%

Source

Eduardo J. Trigo and Martin E. Piñeiro, "Funding Agricultural Research" in *Selected Issues in Agricultural Research in Latin America*, eds. Barry Nestel and Eduardo J. Trigo. (International Service for National Agricultural Research, March 1984, The Hague, Netherlands, p. 85).

Notes

(1) The estimates were made using the budgetary structure of the international agricultural research centers as a guideline for determining the percent of each item of expenditure.

(2) US $30,000 was used as an average of the case for the different countries of the region. The sum includes salaries plus benefits. A variation of US $1,000 above or below this average figure implies an increase or decrease of US $4,250 in the total budget.

developments are the direct result of the multilateral and bilateral assistance agency programs that find it easier to invest in facility development than in human capital development or program support. Premature facility investment represents a burden on the research system rather than a source of productivity.

2. *I have become concerned about the excessive administrative burden that stifles both routine investigations and research entrepreneurship.* A major challenge to any national research system is how to achieve consistency between the personal and professional objectives of individual researchers, research teams, research managers and the social objectives of the research system. In many respects, the individual scientist can appropriately be viewed as an independent contractor who makes his or her services available in return for professional and economic incentives. Bureaucratic efforts to achieve consistency between the objectives of the individual and of the system, or simply fiscal responsibility, is often carried to the point where it becomes an excessive burden on research productivity.

3. *I have become concerned that location decisions for major research facilities, often made with the advice of assistance agency consultants have frequently failed to give adequate weight to the factors that contribute to a productive research location.* These factors include: location in a community that includes related educational and professional infrastructure; location in an agro-climatic environment that is representative of an important part of the area in which the particular commodity is grown, or which is representative of a major resource (soil, water) problem area; and selection of a site with appropriate resource (soil, water) and infrastructure (electricity, transport, amenity) characteristics.

4. *I have become concerned about the lack of congruence between research budgets and the economic importance of major commodities or commodity groupings.* If new knowledge and new technology were equally easy (or difficult) to come by in each commodity area, a good rule of thumb would be to allocate research resources roughly in proportion to the value (or value added) of commodity output or resource input. It is easy to think of good reasons for departure from such a rule. In a small research system, critical mass (i.e. scale economies) implies the desirability of focusing resources or areas that account for a large share of output (i.e. rice) or on a commodity where very large gains can be made in a short time (i.e. lowland irrigated rice in the 1960s). But extreme lack of congruence often suggests that little careful thought has been given to research resource allocation or that particular interest groups have biased research allocation to their own benefit.

5. *I have become concerned about the lack of information and analysis that goes into establishment of research priorities and thrusts.* In the research planning staffs that have successfully struggled with the research resource allocation problem, it has become increasingly obvious that effective reseach planning requires close collaboration between natural and social scientists and among agronomists, engineers, and planners. This is because any research resource allocation system, regardless of how intuitive or formal the methodology employed, cannot avoid making judgments about two major questions. *One is: what the possibilities are of advancing knowledge or technology if resources are allocated to a particular commodity problem or discipline.* Such questions can only be answered with any degree of authority by scientists who are on the leading edge of the research discipline or problem being considered. The intuitive judgments of research administrators and planners are rarely adequate to answer such questions.

A second question is: what the value would be to society of the new knowledge or the new technology if the research effort is successful. The intuitive insights of research scientists and administrators are no more reliable in answering questions of value than are the intuitive insights of research planners in evaluating scientific or technical potential. Many of the arguments about research resource allocation founder on the failure of the participants to clearly recognize the distinction between these two questions, and the differences in expertise and judgment that must be brought to bear in responding to them (Ruttan, 1982, pp 262-264).

6. *I have become concerned by the apparent presumption in some national systems that agricultural science is possible without scientists.* In too many national research systems, commodity program leaders often have neither the training nor capacity to direct either scientific research or technology development. Salary structures and non-economic incentives are frequently so unattractive, relative to other national and international alternatives, that potential leadership is eroded, research programs become routine, and returns to research investment are low.

7. *I have become concerned about the cycles of development and erosion of capacity that have characterized a number of national agricultural research systems.* There is a disturbing tendency among the systems that have had the longest history of development with substantial external assistance. Periods of rapid development have often been followed by the erosion or collapse of research capacity, when external support has declined. Martin Piñeiro, Eduardo Trigo and their colleagues have documented this pattern most thoroughly in a number of Latin American countries such as Argentina, Peru, and Colombia (Ardila, Trigo and Piñeiro, 1980; Piñeiro and Trigo, 1983). But those of us who have worked in other parts of the world can each find examples familiar to us.

I do not wish to be misinterpreted in suggesting that the perspectives and concerns that I have expressed about agricultural research in developing countries are the exclusive problems of new and growing research systems. Don Hadwiger has provided evidence that in the United States, the "pork barrel" approach to the location of agricultural research facilities resulted in 44 percent of all USDA research facility construction between 1958 and 1977 occurring in states represented by members of the Sub-committee on Agriculture of the Senate Appropriations Committee. He noted that this practice has forced "the federal Agricultural Research Service to operate a 'traveling circus' opening up new locations in current Senate constituencies, while closing some locations in states whose senators are no longer members of the sub-committee."

SMALL COUNTRY AGRICULTURAL RESEARCH SYSTEMS

The concerns I have outlined above, impinge most severely on the development and management of small country agricultural research systems. We are confronted with a remarkable paucity of data and analysis on the relationship between scale (or size) and productivity in agricultural research. And what evidence there is, even in the way of casual observation, often lacks precision as to whether the size-output relationship being referred to relates to the size of the individual research unit (team, laboratory, department), the individual research institution (center, institute, faculty), or the national or international research system. The view that small is better has often been advanced with considerable heat, but with relatively little precision in concept or definition and with even less empirical evidence. The issues that I discuss in this

section represent an important opportunity for research to bring better theory, method, and data to bear in order to advance our understanding.

Size and Productivity in Research

What little knowledge we do have suggests that the optimum scale of the research is affected by factors both external and internal to the research process. The optimum level of resources devoted to a commodity research program, as demonstrated rigorously by Binswanger, is positively related to the area planted to a commodity in a particular agroclimatic region. Determining the optimum scale of a research unit or program involves, therefore, balancing the increasing returns associated with the area devoted to the commodity (or problem) on which the research is being conducted, against the possible internal diseconomies of scale of the research process or system.

The data we do have suggests that industrial research and development productivity, measured in terms of patents per engineering or scientific work, is lower in the large laboratories of the largest firms than in the smaller firms in the same industry (Schmookler, Kamien and Schwartz). There is similar evidence for agricultural research by G. S. Pound and P. E. Waggoner. There are also a number of case studies that suggest very high rates of return to individual public, philanthropic, and private research units, often with fewer than 20 scientific or technical staff members per unit (Evenson, 1977; Sehgel, 1977). Many of the smaller "freestanding" agricultural research units are, however, engaged primarily on technology screening, adaptation, and transfer activities that depend only minimally on in-house capacity in such supporting areas as physiology, pathology, chemistry, and even modern genetics.

Evenson also noted that, during the early stages in the development of national research systems, experiment stations tend to be widely diffused, to utilize primarily technical and engineering skills, and to be characterized by a strong commodity orientation. He also pointed to a trend towards hierarchical organization and consolidation into a smaller number of larger units at later stages in the development of agricultural research systems. These centralizing trends are apparently motivated in part to take advantage of economies resulting from research activities in the basic and supporting sciences, and to use economically the laboratory, field, communications, and logistical facilities.

The urge for consolidation can, however, easily be overdone. In the United States, for example, there is now rather strong evidence supporting the value of decentralization even within individual states. For a given level of expenditures, a state system that includes a strong network of branch stations gets more for its research dollar than a state system that is more concentrated. What decentralization gives up in terms of lower costs seems to be compensated for by the relevance of the research and the more rapid diffusion of results. There are, of course, limits to the gains from decentralization. The gains vary among commodities and are influenced by the diversity of agroclimatic conditions and the area devoted to the crop in each agroclimatic region.

A Minimum National System

One of the most difficult issues related to size and productivity in agricultural research is the problem faced by the smaller countries in the development of their agricultural research systems. Most of the smaller countries (those in the 4 to 10 million population range) do have the resources, or access to donors' resources, that would permit them to develop, over a ten to twenty year period, an agricultural research and training capacity capable of staffing the nation's public and private sector agricultural research, education, planning and service institutions. The fifty or so smallest low-income countries must, however, think of research systems that will often be little larger than a strong branch station in a country such as the Netherlands or Denmark, or in a state such as Texas or Minnesota.

But how can the government of a small country decide on the appropriate size and organization of its national agricultural research system? For countries like Sierra Leone or Nepal, even the financial and professional agricultural resources of a small American state or a Japanese prefecture are probably at least a generation ahead. The time required to achieve viable research systems for many of the smaller national systems must realistically be calculated in terms of a generation rather than the five to ten year project cycles used by most development assistance agencies.

One major focus of the research effort in these smaller research systems must be the direct support of agricultural production and rural development programs. This means a primary focus in applied fields such as agronomy, plant breeding, animal production, crop production, farming systems, and agricultural planning and policy. Trigo and Piñeiro have estimated that a minimum research module for one product requires a team consisting of four researchers trained at the MSc. and PhD. levels, complemented by eight specialists with graduate level training, plus a complement of support personnel. They estimate that the total cost of such a program would run in

the range of 500,000 US dollars (1984) (see Table 5). For a small country with 6-10 major commodities and several important agro-climatic regions, this implies a research budget of 5.0 - 8.0 million US dollars. When this effort is complemented by the non-commodity oriented research in areas such as soil and water, pest management, cropping systems, and socio-economic aspects of agricultural production marketing and policy, the implications run into the $12 to $15 million range.

The viability of even a small nation's agricultural production also requires capacity for higher education in agriculture, at least up to the master's level, to support national programs of technology in transfer, rural development, and regulatory and service activities. When these activities are aggregated, it is not difficult to arrive at a minimum level of professional capacity, with training at the MSc. and PhD. levels, of around 250, and with budget support somewhere in the $20-$30 million range for even the smaller (but not the smallest) countries. For the very smallest countries, even this investment is not feasible in the foreseeable future. For one of the more serious attempts to suggest a solution to the smallest countries' problems, I refer you to a recent paper by Lawrence A. Wilson, Dean of the Faculty of Agriculture, University of West Indies.

Interdependent Systems

The idea of reducing or eliminating technological dependency generates strong emotional appeal. Yet, even larger countries with advanced agricultural research systems (United States, Soviet Union, Japan, India, and Brazil, for example) are not able to be self-sufficient in agricultural science and technology. An effective national agricultural research system must have the capacity to borrow both knowledge and materials from the entire world. The problem of how to link effectively with an increasingly integrated, and interdependent, global agricultural research system is difficult for the state and provincial research units in the larger national systems. It is even more difficult for the national agricultural research systems in the smaller countries.

One approach to this problem has been to attempt to establish cooperative regional research programs; for example, the West African Rice Development Association (WARDA) and the international crop research networks that are linked to the international agricultural research institutes. Other regional institutions not directly linked to the international (CGIAR) system include the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), the Caribbean Agricultural Research and Development Institute (CARDI), and the Southeast Asian Fisheries Development Center (SEAFDEC). It is hard, however, to find many outstanding success stories amongst these efforts. Program activities and cooperative efforts often appear stronger in the glossy pamphlets issued by the organizations than they do in practice (Venezian, 1984). To my mind, such regional programs can succeed only with the commitment of long-term external support and with the participation of external donors in the governance of such centers. Some of the most effective collaborative regional efforts have been organized around the research programs of the international research centers (Plucknett and Smith, 1984).

The international crop research networks, centered around the international institutes have not, however, been without problems. When the institutes have had confident and effective leadership, they have often played an exceedingly useful role in creating opportunities for productive professional interaction and collaboration. But the institute research networks tend to be selective. At times, they have found it hard to bend institutes priorities to meet national priorities. Collaborative efforts tend to involve the strongest institutions and the leading scientists rather than those who have the greatest need.

A richer institutional infrastructure is necessary to strengthen and sustain the capacity of the smaller national agricultural research systems. In spite of ideological considerations, many small countries have found it advantageous to encourage the transfer and adaptation of technology by the private sector seed supply industry or by the multinational firms engaged in commodity production, processing, and trade. Firms engaged in the production of crops grown under plantation systems, and independent growers producing under contract arrangements with processors, have at times provided their own research and development facilities. In other cases, associations of producers have been willing to tax themselves to support commodity research stations. Such arrangements have often been associated with discredited systems of colonial governance. A strong case can be made for re-examining and strengthening the incentives for private sector research, development and technology dissemination.

The perspectives outlined in this section are highly tentative. Although they are drawn from considerable experience, they should be treated as hypotheses to be tested by further research, rather than as conclusions. Institutions such as the IADs, ISNAR, and CTA should devote a reasonable amount of analytical effort to attempts to understand the problem of developing and sustaining effective agricultural research in the smaller national research systems.

Some Generalizations

In spite of the limited knowledge available, there are a few generalizations about smaller agricultural research systems that can hardly be avoided. One is that the research investment per acre or per hectare will have to be higher in a small system than in a larger system, in order to achieve an equal level of effectiveness. This is because of the cost of developing, for example, a new millet variety that will be grown on a million acres is unlikely to be substantially greater than one that will be grown on half a million acres.

A second generalization is that the cost of developing productive farming systems for a small country with great agroclimatic variations will be greater than for a small country that is more homogeneous. For example, the cost per hectare of developing an effective agricultural research system for Sri Lanka is likely to be much larger than developing one for Uruguay. The issue of guns versus butter in national budgets is also likely to cut more sharply into a small country than in a large country.

Finally, there is no way that a small country can avoid being dependent on others - on the international agricultural research system, on the research systems of large countries in the same region, and on multinational firms - for much of its agricultural technology. Furthermore, a small nation with a strong research program but a limited agricultural or industrial base cannot capture as high a proportion of the benefits from its investment in basic research as can a large nation with a diversified economic base. Much of the benefit will spill over to other countries. If it has a weak agricultural research system, it will lack the knowledge needed to capture the benefits of research in other countries or to choose technological paths consistent with its own resource and cultural endowments. Even a strong agricultural research system cannot assure autonomy. But small countries do need to develop sufficient agricultural science capacity to enable them to draw selectively on an interdependent global agricultural research system. They need to be able to discern what is useful to borrow from other national systems and from the international system.

TOWARDS A REFORM OF AGRICULTURAL RESEARCH SUPPORT

What can be done to alleviate the deficiencies that charaterize assistance for the support of agricultural research, extension, and rural development programs in poor countries? A solution to the problems of "aid effectiveness" in support of research is particularly important at this time. I anticipate that in the next decade there will be a decline in the real flow of aid resources and increasing competition among the several claimants on aid resources.

In my opinion, the basic thrust of the reform that is needed is to move away from primary reliance on narrow project approaches. In supporting agricultural research, the project system should be largely replaced by a "formula funding" or "revenue sharing" approach (Ruttan, 1984). There have been many criticisms of the project approach followed by the major bilateral and multilateral development assistance agencies. The criticism most frequently heard is that the assistance agencies exert undue influence on the content of the national development programs (Faaland, 1982; Salmon, 1983). This criticism is partly correct. It is not too difficult to identify cases where close patron-client bonds have been established between particular officers in the aid agencies and the leadership of favored national program agencies. Such relationships have often appeared to give particular national programs a degree of stability and continuity that would be difficult to achieve in the unstable political environments that characterize many developing countries.

Cycles of development and erosion are inherent in the traditional project approach. The reason for this inherent contradiction is that external assistance provides an alternative to the development of internal political support. National research system directors have frequently found that the generation of external support requires less intensive entrepreneurial effort than the cultivation of domestic political support. Domestic budget support required by donors is often achieved by creative manipulation of budget categories rather than by increments in real program support, particularly when donor representatives are under pressure from assistance agency management to "move resources". Most existing project systems thus have built-in incentives for national research system leadership to direct entrepreneurial effort toward the donor community rather than toward the domestic political system.

Any effective alternative should attempt to reverse the perverse incentives characteristic of the existing development assistance instruments. The system should be reformed to provide incentives for national research system directors to redirect their entrepreneurial efforts toward building domestic political and economic support for agricultural development.

I am increasingly convinced that the long-term viability of agricultural research systems depends on the emergence of organized producer groups who are effective in bringing their interests to bear on legislative and executive budgetary processes. The support of finance and planning

ministries for agricultural research is undependable. Their support tends to fluctuate with perceived severity of food crises and foreign exchange demands.

A Formula Funding Model

What alternatives to the existing system are there? I do not want to be interpreted as completely negative with respect to traditional development assistance instruments. Project aid is often quite appropriate for physical infrastructure development projects. Program aid can be an effective way to provide macroeconomic assistance for structural adjustment or for sector development in a country with substantial capacity for macroeconomic policy analysis and program management. But neither the traditional program aid nor project aid instruments are fully effective in countries that have little financial or professional capacity for providing support for long-term institution building efforts. New methods of combining the flexibility of program support, effective technical assistance, and sustained financial support for long-term development efforts must be sought. One innovation that might be effectively used is for the donor community to move towards an approach in which the amount of external support is linked to growth in domestic support (Table 6). This implies the development of a "formula" approach in which the size of donor contribution would be tied to the growth of domestic support. The formula should include a factor that adjusts the ratio of external to domestic support to take into account differences in domestic fiscal capacity.

Country Level Research Support Group

A second alternative might take its lead from the experience now accumulated with the CGIAR model and the various donor consortia that have been organized to coordinate assistance to some of the larger aid recipients. What I am suggesting here is country level Research Assistance Support and Implementation Groups (RASIGs), chaired by the chairman of the National Agricultural Research Council or the director of Agricultural Research. The Support Group will need to have at its disposal relatively long-term program plans for the development and operation of the national agricultural research system. To produce and continuously update this program, the national research system may require external assistance, but in general the program should be the product of indigenous experts in agricultural science and development. Its focus, to help protect the program from the vagaries of political change, would be on long-term agricultural research needs and goals and on the incremental steps required for implementation.

It is expected that the long-term program development and the priority setting would be done through an interactive process with the Support Group. Once the program has been accepted, it is hoped that donor members of the Support Group would collectively agree with the host country to help provide the components essential to the execution of the program as a whole. The host country, in turn, would assume the responsibility for moving its national research program along the agreed-upon development path. Initial commitments might be for three to five years, subject to annual review and course corrections suggested by the analysis and feedback from actual experience.

Use of an institution such as a Support Group has the potential of helping the country involved avoid many of the pitfalls of the project mode whilst retaining several of its desired attributes. Donor identity could be retained by relating grants to components of the agreed-upon overall program. These could even be called projects if, for administrative purposes, it were so desired. The Support Group, like the CGIAR, would likely involve bilateral grants developed in the framework provided by the forum of multiple donors and the host country. The impersonal process of contributing to a common fund is not envisaged. However, this would not preclude "incentive funding" of a formula type. At the same time, this would minimize the danger of a single donor dominating the priority-setting process, or of essential program components being ignored.

The RSG also has several other potential advantages. It would contribute to building a national constituency by focusing from the outset on this essential ingredient for viability. The donors, for example, might agree to increase their contributions by some fraction of the rise that occurred in the real support provided by the nation involved. Or other matching provisions might be agreed upon to provide incentives for nurturing and cultivating national constituencies. It would provide reasonable continuity in support (commitments would be fairly long-term and subject to review and extension well in advance of termination dates) with less risk of the excessive program fragmentation frequently associated with narrowly defined project funding. It would reduce the administrative and management load on the host country through the planning and review process the RSG would follow. Furthermore, it would place donors in a position of genuinely complementing and supplementing one another and the national program, rather than endlessly competing for "good investment opportunities".

The fact that such a support mode is often discussed but little used is evidence that implementation is not a simple, trouble-free task. The method is, however, being used

Table 6: Illustration of a Funding Model for Agricultural Research Support

	Program Support and Assistance Level (in millions of US $)					
	Low		Medium		High	
Nation Fiscal Capacity	National Support	Donor Assistance	National Support	Donor Assistance	National Support	Donor Assistance
Low (40% Assistance)	20	8	50	20	100	40
Medium (20% Assistance)	20	4	50	10	100	20
High (10% Assistance)	20	2	50	5	100	10

successfully in Bangladesh and, somewhat more informally, in several other countries. An important element in its success in Bangladesh is that the Support Group meetings are chaired by the director of the Bangladesh Agricultural Research Council, rather than by a donor representative.

A dialogue on donor assistance to national agricultural research programs was initiated by the World Bank in 1981. The dialogue has been continued by ISNAR in a series of meetings with directors of agricultural research systems. It is imperative that these dialogues be continued. The issue of reform of agricultural assistance should be recognized as one of the most urgent items on the agenda.

BIBLIOGRAPHY

Ardila Jorge, Eduardo Trigo and Martin Piñeiro, "Human Resources In Agricultural Research: Three Cases in Latin America", Instituto Interamericano de Cooperación para la Agricultura, San Jose, Costa Rica, March 1981.

Evenson Robert E. , "Comparative Evidence on Returns to Investment in National and International Research in Institutes," in *Resource Allocation and Productivity in National and International Agricultural Research*, Thomas M. Arndt, Dana G. Dalrymple and Vernon W. Ruttan, eds. (Minneapolis: University of Minnesota Press, 1977), pp. 237-64.

Evenson Robert E., Piedad M. Flores and Yujiro Hayami, "Costs and Returns to Rice Research", *Economic Consequences of New Rice Technology* (Los Banos, Laguna, Philippines: International Rice Research Institute, 1978).

Hadwiger Don, *The Politics of Agricultural Research* (Lincoln: University of Nebraska Press, 1982).

Hambridge Gove, *The Story of FAO* (New York: Van Nostrand, 1955).

Kamien Morton I. and Nancy L. Schwartz, "Market Structure and Innovation: A Survey," *Journal of Economic Literature* 13 March 1975, pp 1-37.

Nagy Joseph, "The Pakistan Agricultural Development Model: An Economic Evaluation of Agricultural Research and Extension Expenditures," PhD Thesis, University of Minnesota, March 1984.

Piñeiro Martin and Eduardo Trigo, *Technical Change and Social Conflict in Agriculture: Latin American Perspectives* (Boulder, Colorado: Westview Press, 1983).

Plucknett Donald L. and Nigel J. H. Smith, "Reworking in International Agricultural Research," *Science* 225 (7 September 1984); pp. 989-993.

Pound G. S. and P. E. Waggoner, "Comparative Efficiency, as Measured by Publication Performance of USDA and SAES Entomologists and Plant Pathologists" in *Report of the Committee Advisory to the US Department of Agriculture*, G. S. Pound, Chairman (Washington, DC: National Academy of Sciences, 1972) pp 145-70.

Ruttan Vernon W., *The Asia Bureau Agricultural Research Review* (University of Minnesota Economic Development Center Bulletin 81-2, St Paul, March 1981).

Ruttan Vernon W., *Agricultural Research Policy*, (Minneapolis: University of Minnesota Press 1982).

Ruttan Vernon W., "Reforming the Global Agricultural Research Support System' in Kenneth C. Nobe and Rajan K. Sampath, *Issues in Third World Development* (Boulder, Colorado: Westview Press, 1983), pp 405-417.

Sehgal S. M., "Private Sector International Agricultural Research: The Genetic Supply Industry" in *Resource Allocation and Productivity in National and International Agricultural Research*, Thomas M Arndt, Dana G. Dalrymple and Vernon W. Ruttan, eds (Minneapolis: University of Minnesota Press, 1977), pp 405-15.

Schmookler Jacob, *Intervention and Economic Growth*, (Cambridge, Mass: Harvard University Press, 1966).

US Agency for International Development, "Strengthening the Agricultural Research Capacity of the Less Developed Countries: Lessons from AID Experience". (Washington DC: AID Program Evaluation Report No 10, September 1983).

United Nations Development Programme and the Food and Agricultural Organization of the United Nations, *National Agricultural Research: Report of an Evaluation Study in Selected Countries* (Rome: FAO, 1984).

Venezian Eduardo L., "International Cooperation in Agricultural Research" in *Selected Issues in Agricultural Research in Latin America*, eds Barry Nestel and Eduardo J Trigo (The Hague, Netherlands: International Service for National Agricultural Research, March 1984), pp 99–124.

Wilson Lawrence A., *Toward the Future: An Alternative Framework for Agricultural Research, Training and Development in the Caribbean*. (St Augustine: The University of the West Indies, February 1984).

World Bank, *Strengthening Agricultural Research and Extension: The World Bank Experience (Washington DC: 1 September 1983)*.

ESTABLISHING AGRICULTURAL RESEARCH POLICY: PROBLEMS AND ALTERNATIVES FOR SMALL COUNTRIES

W. K. Gamble and E. J. Trigo

International Service for National Agricultural Research
The Hague, Netherlands

I. INTRODUCTION

Agricultural policy guidance is a very important issue for most nations and is of crucial importance to the agricultural research systems of the developing countries. ISNAR's experience in working with more than 25 highly diverse countries reveals inappropriate policy interactions as one of the major impediments to developing an effective research system. In many countries, we find frequent statements and discussions about the importance of agriculture and agricultural research; but in most cases, this is not followed by a coherent set of policy decisions that can serve as a basis for system development and program orientation. It is our view that identifying the relevant policy linkages affecting the performance of a national agricultural research system is an effective way of initiating a constructive dialogue between national agricultural research leaders and policy-makers.

In this paper our interest is focused on the relevant policy dimensions and alternatives for small developing countries (1). However, it is important to note that policy deficiencies affect countries small and large, highly developed and less developed; and there is strong evidence that the nature of the relevant linkages and agricultural research policy issues are quite similar, irrespective of country size and level of development. What varies is the nature and range of the alternatives open to each. Before focusing on this theme, we will first introduce a general discussion of the objectives and components of a national agricultural research policy and then move to take a closer look at the small country case.

(1) There is no standard definition of what can be considered to be a "small country". Smallness is a relative concept. A country may be large or small, depending on the indicator chosen and the standard against which it is measured. Countries may also be large in some aspects (population, total size) or contexts (regions of the world, country groupings such as high income, growth rate) and small in others. For the purpose of this paper we define smallness in terms of their agricultural resources. Taking the bottom half of a ranking based on this variable for the different regions of the world, the countries in Central America and the Caribbean will be considered small in the Latin American context, and countries such as Benin, Guinea-Bissau, Liberia, Sierra Leone, Togo, Somalia, Burundi, Gabon, Congo, Rwanda, Botswana, Namibia, Lesotho, and Swaziland would be small in the African context.

II. THE MAJOR COMPONENTS OF A NATIONAL AGRICULTURAL RESEARCH POLICY

A national agricultural research policy should be concerned with the development and implementation of an agricultural research system which reflects the country's characteristics and development objectives, and present and future available resources. It requires the setting of objectives and goals (which must mesh with other national and regional objectives and goals), the establishment of the principles and criteria for program scope and orientation, and the development of the institutional, human, and financial resources required for program implementation.

Within these general lines, we can identify several major questions that a research policy must address or provide guidelines for; each of these questions is associated with a specific set of instruments and a specific decision-making level. They include the setting of the system's overall objectives (research for what), the resources to be invested in research (how much research), the allocation of responsibilities among the different components of the research system, and the mechanisms and criteria for deciding among program alternatives (who should do what and how much). These questions and decision areas are clearly interrelated, and determinations with respect to any of them affect the others: mandates and objectives cannot be discussed independently of resources, the amounts to invest depend on the nature of the system mandate and objectives, and planning and resource allocation mechanisms vary with the patterns of distribution of responsibilities among different research units.

Decisions with respect to every instrument are interrelated with the nature of the country's problems and policies in other areas. For instance, investment patterns will be limited by national budget allocation policies. Human resource levels will be affected by educational policies. The general pattern of political and administrative organization will influence how research responsibilities are allocated among different bureaus. And the planning and resource allocation mechanisms will inevitably reflect the overall resource allocation mechanisms.

Research for What: The Key to an Effective Agricultural Research Policy

A clearly defined set of goals linking agricultural research activities to society's problems and development objectives is the cornerstone of an effective agricultural research policy. The statement of the objectives to which the research effort should contribute is the starting point in the process of building an agricultural research system. Only after the question "research for what?" has been answered can the discussion of the level of investments and the allocation of responsibilities be effectively initiated. In answering this question, research will be placed within the context of the country's development policy, and the basis for a stable and continued allocation of resources will be established.

Objectives, however, must be defined in accordance with the type of contribution research can be reasonably expected to make. Research is an extremely powerful tool, but not all problems can be solved through research. At any particular moment, what research can accomplish is conditioned by past investments and experiences, not only in the research system but also in other areas, such as education. For a set of objectives to be useful, they must reflect these limitations and must focus on areas for which research can reasonably be expected to develop solutions.

A brief review of the objective-setting in the developing world reveals two serious shortcomings. On the one hand, objectives may cover problem areas or societal goals to which research can make little contribution. Typical are objectives like "reducing rural-to-urban migration" or "changing the distribution of income". On the other hand, national objectives seldom recognize what is achievable with available resources. The typical situation is one of broad mandates that cover nearly every possible clientele and extend well beyond the system's scientific and logistical capabilities. Both shortcomings have resulted in frustration and disenchantment with the power of research as a development tool and subsequent loss of the needed support.

How can a relevant and realistic set of objectives for a nation's agricultural research effort be developed? Only through an effective linkage between the research system and the country's political establishment. The crucial issues at this level are the nature of the information necessary for the decision-making process and the role of the research system itself in generating it.

National objectives to which agricultural research is expected to contribute are likely to be defined in broad terms such as "to develop the nation's natural resources", "achieving food self-sufficiency", "generating foreign exchange", "increasing the incomes of small farmers", "improving the living conditions of the rural population". For some of these typical objectives, research is at best a weak tool. For others, true impact will be possible only if complementary actions beyond the scope of the research system are undertaken. Defined in this way, national objectives are not of much use for guiding the development and implementation of the research effort. If they are to serve a purpose, they must be made much more specific and realistic. Setting clear boundaries – what resources are to be developed, which export crops, what groups of farmers or regions – will facilitate the integration of research into the national development effort.

At the same time, clear, specific, and realistic objectives are the basis for the allocation of responsibilities and resources, and become the basis for eventual evaluation of the system's performance. This kind of precision of objectives is possible only if there is an active interaction and flow of information between the research system leadership and the higher echelons of the policy-making system. It is the research system's responsibility to inform the policy-making level of the potentials of different alternatives. It must also define the limits of science's ability to achieve prescribed goals. Scientific feasibilities and time lags are essential components of a dialogue crucial not only to the articulation of an effective research system, but also further up to the selection of realistic global development goals.

How Much Should a Country Invest in Agricultural Research?

The level of investment in agricultural research is a key element in a research policy, since the quality of the product is usually directly related to the amount of resources a country is willing to devote to research activities. It is also the most clear-cut indicator of the level of commitment.

Ideally, investment should reflect policy objectives and result from simultaneous decisions as if they were variables in a simultaneous equations system. Unfortunately, in reality these processes differ considerably from the ideal. Decisions on objectives and levels of investment are taken at different places within the government structure: federal, state, and local governments; universities; etc. This emphasizes the importance of having a set of criteria for determining the optimum investment level and guiding the decentralized decision-making process.

In principle, given that research is an investment activity, the criteria should be oriented toward setting resources for research at the level where marginal benefits equal marginal costs and the rate of return to expenditures on agricultural research equals those for alternative uses of funds. But for two reasons it is difficult to propose such an analysis as the standard criterion for arriving at the nation's optimum level of investment on agricultural research activities. First there are conceptual and methodological problems: Whose benefits should be considered? Should benefits to all potential beneficiaries be weighted the same? Can overall benefits be estimated without considering actual allocations to specific research alternatives? Second, there are the empirical considerations: the costs and information requirements of conducting such an analysis at the system level.

In contrast with the setting of investment levels, the minimum requirements for any given set of overall objectives may be considered. This should provide a basis for judging whether or not the system is receiving adequate resources and should focus the discussion on the question of how much can be achieved with different levels of investment. This approach is useful for most developing countries, where the consideration is seldom of having an optimal system, but rather a realistic one that can be expected to produce results with the available resources.

Another alternative is the use of broadly defined rules of thumb, such as the proposal by the World Bank that developing countries devote 2% of their agricultural GDP to research. This approach, unfortunately, does not recognize country differences in level of development and in the complexities of their agricultural problems. Both differences are important.

On the one hand, the more highly developed countries can be expected to spend more on research. They should have a better understanding of how investments in science are linked to economic and social growth. And their agriculture will already likely be more science-based.

On the other hand, factors like the diversity of climate and soil conditions, the number of economically important crops and animals, and the possibility of utilizing research developed for other environments will undoubtedly influence a country's research needs and, therefore, the optimal or desired level of investment. In recognizing these factors, an effective use of the World Bank guideline concept would require considering countries in groups or by types. An initial step in this direction would be the setting of targets on the basis of the actual or historical averages of countries of comparable environmental situations and income levels.

Who Should Do What Within the Research System?

The allocation of responsibilities among potential providers of research is another crucial component of an effective agricultural research policy. The organizational structure that will be in charge of implementing the system's mandate and objectives must be defined. This involves two related sets of issues. One relates to the organizations that will carry out the different components of the research effort. It is the institutional setting of the system. The second relates to the procedures, methodologies, and decision criteria that will guide the allocation of resources between those different components and bring them together into a coherent program. It is the system's planning mechanism.

In discussing the institutional setting, the focus is on how many organizations should be given research responsibilities and what the mandate of each should be. Should all public research responsibilities be given to one organization? To several? Should there be national, state, and local responsibilities? Should research and extension be together in a common organization? Should agricultural research be placed within the university system? Should research responsibilities be cut along commodity lines? Should basic and applied research be placed together? What role, if any, should the private sector play within the agricultural research system? These are some of the questions that must be answered.

There is no standard answer for these questions, but there are several general considerations.

The institutional organization must reflect the country's characteristics and overall politico-administrative style. Acceptable degrees of centralization and autonomy must be considered. The size of the country and the characteristics of its agricultural sector are important factors, as large countries tend to require more diversified and decentralized research systems, while in smaller countries, centralized structures would appear more feasible on a priori basis. It is not always a straightforward

question of size, however, as we observe relatively small countries like Sri Lanka evolving a relatively decentralized organizational setting for its agricultural research system and a relatively large country like Argentina having a highly centralized research structure. In both cases, elements in their styles of politico- administrative organization explain their pattern of organization.

A system's efficiency in the use of its resources must also be considered. Institutional settings that concentrate responsibilities in one or a few organizations appear to be more effective in avoiding duplication of research effort. At the same time, centralized systems tend to better reflect the overall policy objectives in the actual research program development process. They also tend to facilitate a more direct contact with the clients of research, thereby making it more likely that research will reflect real farming problems. How research responsibilities are allocated has an impact on the ability to do multidisciplinary and farming systems research and on the relationships between research and other agricultural services, extension in particular.

The relationship between research and the university system is also an essential consideration for an effective agricultural research policy. Research and higher education have many complementarities and mutually reinforcing common elements and interests. An effort must be made to bring both of them together in pursuit of the system's overall objectives and to assure an effective and complementary use of the training and research capacities of both.

Finally, the role of the private sector within the agricultural research system must be considered. Private participation usually takes place at the more applied end of the research chain at the technology development level: seeds, herbicides, pesticides, fertilizers, machinery. The private sector can be a natural complement to the public effort and an essential tool for the diffusion of the new knowledge developed in the public sector. The experience of the developed countries and some developing countries in the development of the seed industry clearly indicates the importance of close public-private collaboration in efficiently moving research results into production.

Flexibility and problem-solving orientation are two important dimensions of the research system that private participation can help to improve. Unfortunately, in many developing countries, market size is not large enough to attract private-sector participation. Under these circumstances, defining an appropriate pattern for this participation and creating incentives to attract private interest in technology development activities are important policy dimensions for increasing the research system's effectiveness.

The planning and resource allocation mechanism identifies the broad problem areas on which to target the research effort, within the system's mandate, the overall research policy objectives, and the available resources. This decision level is the link between the research system's leadership and the country's planning and policy-making bodies. It is essentially an outward looking activity oriented towar ' ...king explicit to what the research effort should contribut... a given planning period. Political considerations and the integration of research with other policy instruments are essential factors in this process.

The specific characteristics of the operational mechanisms and criteria to be used in deciding among program alternatives will vary in response to the system's general objectives and in connection with its institutional setting, as has been discussed above. However, several aspects must be considered irrespective of the system's individual characteristics.

An effective planning and resource allocation mechanism must bring together the political dimension and the system's clients. No resource allocation system can be independent of the political process. It must be recognized that political considerations will affect not only the overall allocation of funds to research, but it will also play an important role in determining which programs receive funds. Priorities at this level should be determined by the same process that allocates funds among the other major objectives and components of the country's rural development policies. This influence is inevitable, but positive, since it will contribute to facilitating the full integration of research and the other agricultural policy instruments being used to achieve the country's development objectives. It is essential, however, that political influence be kept out of those decision levels where it has no competence: program orientation and the selection of specific research topics.

The research system must also have reliable information about the problems facing the clients of research and the scientific feasibility of each research alternative. When making reference to the clients of research, we include the farming community, other agricultural services (with extension occupying a prominent place), consumers, and the policy-makers. To move from the broad objectives resulting from overall allocation decisions to a relevant program, it is necessary to identify which are feasible and relevant to client needs. This can only be done if the

research system is in direct contact with the clients themselves so to assure a permanent flow and analysis of the different clienteles' problems and potentials, and if this information is in turn confronted with the system's capacity in terms of its human resources – level of training and areas of expertise – and the state of the art in the disciplines involved.

III. THE SMALL-COUNTRY PROBLEM: CONFLICT BETWEEN RESOURCES AND NEEDS

The main problem facing the development of an effective agricultural research system in a small country is the potential conflict between research needs and the amount of resources available to meet those needs.

A country's research needs are related to the country's size, but the relationship is not a direct one. Given the characteristics and location specificity of agricultural production, some research capacity is essential in support of agricultural development, no matter how small the country may be. Smaller countries do not necessarily have a smaller variety of crops in their agricultural production mix than larger countries. Quantities produced will of course be less, but not necessarily the number of production alternatives that should be included in the agricultural research mix.

This problem can be confirmed by a cursory look at the situation in a few countries of widely different size, such as the Dominican Republic, Costa Rica, and Colombia in Latin America, and Sri Lanka, Bangladesh, and India in Asia. There may be differences in the total numbers of products they include in their research mix but there is not much variation in the major components of their research programs other than that coming from agroecological differences. Even when going into the smallest size category, that of the island states, such as Fiji in the South Pacific and Jamaica or Barbados in the Caribbean, we find that the number of crops for which research is required is likely to be 10 or more.

Another important consideration is the relative indivisibility of research below a certain minimum critical mass effort. This is a difficult issue to discuss in general terms, but, it can be safely stated that there is a minimum size research effort below which no relevant results can be expected. This effort, which can be equated to a fixed-cost concept, will be approximately the same throughout a wide range of variation in the area planted to any particular crop. The work and costs required to develop a new variety or a new cultural practice would be about the same, whether a crop is planted on 10,000 or 100,000 hectares. In both cases, the basic core of activities and expertise required will be the same, and includes information on the country's natural resources – soil and water surveys, etc. – plus some capacity on a minimum number of areas such as agronomy, plant breeding, pest and disease control, physiology, soils and socioeconomics.

The size of a country's core research effort is also influenced by its climate and other environmental characteristics. Tropical agriculture tends to be more diversified than temperate agriculture, and as diversity increases, research needs will also increase, if for no other reason than the need to replicate experiments and to test results in a greater number of different production environments. So environment exacerbates the conflict between research needs and available resources; most small countries in the developing world are located in the tropics.

Consumer demands also have an important impact on research needs, and they are not directly related to country size. Income and climatic factors will affect diets, but whether a country is large or small will have little bearing on the numbers and types of products included in its diet. The need to reduce balance-of-payment deficits and the political importance of food self-sufficiency have made meeting food demand through local production high priority in many, if not most, developing countries. This increases the pressure on the number of products a national research system must include in its program whether a country is large or small.

Quite apart from research needs, the amount of resources a nation can devote to agricultural research *is* determined by its size and the importance of agricultural production within its economy. The profitability of investments in agricultural research are clearly related to the actual or potential area planted to a crop. Consequently, the larger the area over which the new technologies resulting from research can be diffused, the larger the economic returns and the larger the economic base to support the research effort.

The quantitative dimension of the small-country conflict between resources and needs is difficult to assess in general terms, because each country is unique. The required minimum capacity will vary depending on both institutional and technical issues. The type of problems in need of research and the possibility of using information generated for other purposes or available internationally will be important factors to consider. This level of analysis is well beyond the scope of this paper. However, a broad estimate of the magnitude of the conflict between research

Table 1 – Central America and the Caribbean: Country-Product Combinations Generating Enough Economic Value to Support a Minimum Research Module

Subregion/ Country	Maize				Rice				Cassava				Cotton				Beans				Potatoes			
	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%
Caribbean																								
Barbados																								
Cuba				X	X	X	X	X			X									X				X
Dominican Republic					X	X	X	X												X				
Grenada																								
Guadeloupe																								
Guyana					X	X	X	X																
Haiti				X		X	X	X				X								X				
Jamaica																								
Martinique																								
Trinidad & Tobago																								
Central America																								
Belize																								
Costa Rica					X	X	X	X								X								
El Salvador	X	X	X	X				X					X	X	X	X				X				
Guatemala	X	X	X	X				X					X	X	X	X		X	X	X				
Honduras		X	X	X										X	X	X				X				
Nicaragua				X				X					X	X	X	X			X	X				
Panama					X	X	X	X																

Where "x" denotes if value greater than U.S. $ 309,000.

Table 2 - Africa: Country-Product Combinations Generating Enough Economic Value to Support a Minimum Research Module

Subregion Country	Maize				Rice				Cassava				Cotton				Sorghum			
	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%	0.5%	0.75%	1%	2%
West Africa																				
Benin		X	X	X					X	X	X	X		X	X	X				
Bissau (Guin.)																				
Equatorial Guinea																				
Gambia																				
Liberia					X	X	X	X			X	X								
Sierra Leone					X	X	X	X												
Togo				X						X	X	X			X	X				
Comoros																				
Cape Verde																				
Reunion																				
East Africa																				
Mauritius																				
Somalia																				
Central Africa																				X
Burundi				X					X	X	X	X								
Gabon																				
Rep. Congo										X	X	X								
Rwanda										X	X	X								
Sao Tome																				X
South Africa																				
Botswana																				
Namibia																				
Swaziland														X	X	X				
Lesotho																				

Where "x" denotes if value greater than U.S.$ 309,000.

needs and potential resources is possible. This is through comparing the costs of a hypothetical research module for one product against the actual value of production of major food crops in a number of developing countries.

Tables 1 and 2 present the results of this comparison on the basis of cost estimated on the basis of a minimum module of four scientist man-years, and support and other expenses for major food crops in a number of "small countries" in Central America, the Caribbean and Africa, and for three different percentages of value of production being allocated to agricultural research: 0.5%, 0.75%, and 1.0%. The details of the cost structure of the minimum research module and the actual values of production are included in Annexes 1 and 2.

According to this analysis in Latin America and the Caribbean, of 102 country-product production combinations for maize, rice, cassava, cotton, beans, and potatoes, in only 10 cases is the economic base large enough to support a minumum research effort if 0.5% of the value of production is spent on research. If expenditures are increased by 50% to 0.75%, 14 cases would be viable, and if 1.0% (double the actual expenditures for 1980) is spent, the minimum research module could be supported in 16 cases. The magnitude of the gap implicit in the table is important. At the present levels of expenditure, research on crucial food crops such as rice and maize can be supported only in a few situations – rice in the Dominican Republic, Cuba, Guyana, Costa Rica, and Panama, and maize only in El Salvador and Guatemala. And no country can support a minimum module for beans, another product of widespread consumption in the region. Potato is another case where the value of production is not large enough to generate the resources needed to support a minimum module. When the potential resources available for research are estimated at 0.75% and 1.0% of the value of production figures that, at 50% and 100% above today's average values, seem to be reasonable targets, the picture remains approximately the same, with only a few new cases becoming viable – maize in Honduras, rice in Haiti, cassava in Cuba, cotton in Honduras, and beans in Guatemala and Nicaragua. Research on potato remains a non-viable effort even at these levels.

The African situation is not much different. Out of 105 cases covering five products (maize, rice, cassava, cotton, and sorghum), four combinations are feasible at the 0.5% level, 10 at 0.75%, and 11 at 1.0%. According to these figures, not one of the countries listed could support sorghum research at the defined minimum level, only one could support maize research, and in two cases a minimum effort in rice would be viable. In cassava, there is a better situation, especially at the 0.5% and 1.0% level, where six and seven cases respectively are viable.

These results are similar to those of Oram (1977), who analyzed national capabilities for funding research programs of different sizes, on the basis of area of production under different crops rather than on the basis of value of production.

IV. SOME POLICY ALTERNATIVES

Even though there may be no adequate solution to the conflict between resources and research needs, there are a number of policy alternatives that can reduce its impact substantially. Through them, a country can effectively increase the resources available for its research effort and can affect the nature of the research needs it must attend to.

Before turning to the discussion of some of these alternatives, it is important to emphasize that none of them will be relevant in all cases. Although small countries share a number of very important common characteristics, they cannot be considered to be homogeneous. Many factors, such as level of economic development, climate, geographical location, and historical and cultural factors will differentiate one country from another and in turn the relevancy of any particular policy option. A number of important general considerations can be made however.

Concentration of Efforts to Maximize the Impact of Available Resources

Program dispersion, duplication, and research projects not addressing relevant production constraints are the most frequent causes of resource wastage. These problems are present in both small and large countries, but their impact is much more severe in the smaller ones. Any research alternative requires a certain minimum critical mass of resources if it is to produce results. With fewer total resources to invest in research, priority-setting becomes the cornerstone of a small-country research policy. Program coordination mechanisms and research problem identification in close contact with the clients of research are two other important elements for maximizing the impact of available resources.

At the priority-setting level, the issue is concentration of effort, recognizing that with limited resources only a limited number of needs can be addressed effectively. Which alternatives to include should be selected following

the country's overall national and agricultural development policy objectives. This, however, is not a simple decision-making process, as frequently the appropriate organizational framework is lacking and the criteria for setting priorities are unclear. Under these circumstances, it is important for the research system to take the initiative and present the policy decision-making levels with program alternatives for the use of presently available resources, including clear indication of what is being left out and what projects will be brought into program implementation if extra resources become available.

This approach can be an effective tool for improving the links of agricultural research policy-making to economic development planning and budget determination. At the same time, it can generate important information for program monitoring and evaluation and can put the research system in a much stronger position to seek additional resources from both domestic and external sources.

Together with the concentration of effort, the coordination of all potential providers of research and a close relationship between research and technology transfer activities can greatly increase the impact of limited resources. Universities, development projects, and commodity organizations are often overlooked as important potential providers of research support. In many cases, no one of them on its own has the resources required to address given research problems; or, as is often the case with universities, they lack the linkages necessary to give their research efforts a production-problem orientation. Coordinated research projects forcing scientists from different institutions to work together to plan and carry out experiments and other research activities can help in these situations. Close interactions between research, extension, and clients is essential for focusing research projects on significant production problems. On-farm testing as an integral component of the research process can enhance this interaction and can facilitate a rapid diffusion of research results. A successful example of how this can be achieved is the case of the Instituto de Ciencia y Tecnologias Agricolas (ICTA) in Guatemala where, through close collaboration with cooperating farmers, the research system has been able to have a major impact on the country's food production.

Increasing National Research Capacities through Donor Assistance

Donor assistance is one of the most important resources available to a small-country research effort. External resources can contribute not only by directly adding to national research budgets but also indirectly through the need to generate counterpart funding and by broadening the base of political support for agricultural research. In many cases, the possibility of generating much-needed foreign exchange resources through agricultural research projects will bring the support of groups and sectors of government that otherwise would not see the importance of or be interested in agricultural research. There are, however, some hazards in the extensive use of external and donor assistance to support national research programs. Small countries are particularly at risk because of the greater relative importance of external sources in the total available resources.

One problem is the impact of overreliance on external assistance on program orientation and the long-term stability of the research effort. External sources tend to rely too heavily on the project approach. Well-defined projects can be very effective in bringing concentration of efforts and high impact results but, at the same time, the project system lends itself to program fragmentation when many individual projects are independently negotiated with different assistance sources. This is especially so under the weak management conditions of many of the developing countries' research systems. Under these circumstances, there is a strong chance that the result will be a collection of loosely linked efforts and no coherent national strategy.

The effects of abrupt adjustments resulting from changes in donors' priorities are also important for program continuity and long-term system development, especially since domestic support is in many cases highly unstable.

Taking initiative for the development of a donor coordination mechanism appears to be an essential element of the agricultural research policy of a small developing country. An alternative in this sense is the creation of a country-level research support group bringing together all donor sources interested in assisting the country, with emphasis on long-term needs and goals and on the incremental steps required for implementation. The development of such a group and plan may prove to be a high-pay-off move, both for receiving countries and donors. For the recipient, it can be a very effective way of achieving the needed concentration of efforts continuity of support, and reducing administrative costs and management of external-resource workload. For the donor, it can reduce the costs of project searching and increase the return on their investments by complementing and supplementing one another and the national program, rather than wastefully competing for "good investment opportunities".

Reducing Domestic Research Needs by International Cooperation

Applied agricultural research is highly location specific. But no country need undertake on its own all of the research needed for meeting the requirements of its agricultural development. Generally, as we move from applied to basic research, location specificity diminishes and, consequently, transferability increases, opening the possibility for a country to benefit from research conducted in others or at the international level. Every national agricultural research system should be viewed as part of a world complex of research institutions and activities all contributing to and benefitting from a common pool of information and knowledge.

The transferability of research results does not imply that a country can do away with all of its research needs. At the very least, a country must have the ability to screen and interpret information from other sources and adapt imported knowledge to its local conditions. But transferability does open a number of opportunities for reducing research needs through information exchange and cooperative research schemes. The potential, however, is not the same for all countries. Countries in temperate regions will have a larger pool of knowledge and technologies to draw upon than those located in the tropics. At the same time, small countries sharing characteristics with larger neighbors, or that are part of relatively homogeneous regions, will benefit more from borrowing and will have better opportunities for information sharing and cooperation than those in relatively isolated situations.

The nature of the agricultural product mix will also affect the extent to which a country can benefit from borrowing. In products such as the cereals or those tropical crops, such as cassava, that are studied by the international centers, borrowing will be a more relevant strategy than in the case of those products that have received little attention from the international system, such as plantain, taro, or tropical fruits.

In terms of policy decision-making, the critical issues are what research to do domestically and for what research to rely on borrowing or cooperation, and to develop the instruments and mechanisms for facilitating the interaction between the national system and the sources of information outside the country. Different formats of bilateral cooperation, including the expatriate staff system, have been and are used extensively to help small developing countries access and use research results and technological information generated for other contexts. At the same time, over the last 20–25 years a number of very important information-sharing and cooperative research schemes involving small countries have been implemented.

The network of International Agricultural Research Centers (IARCs) of the Consultative Group for International Agricultural Research (CGIAR) and other international research centers such as ICIPE in Africa, CATIE in Central America, and AVRDC in Asia, are probably the most important of these schemes. Because of the crops and range of problems they address and because of their concentration in the tropics, the international centers are an institutional innovation of great significance for the small developing country. Active participation in the IARCs' networking activities and effective use of the centers' national research support services represent practical alternatives for allowing national programs to concentrate their limited resources on the technology application end of the research chain. A policy of active interaction of national scientists with international centers' personnel, in the countries themselves and at the centers through their training programs, can greatly contribute to the flow of relevant information.

Different forms of horizontal cooperation are also being used to increase the scope of national agricultural research systems, either through the exchange of information and/or the coordination and promotion of certain types of research. Bringing together countries with common problems and characteristics, these mechanisms help avoid wasteful duplication and allow the specialization of resources and a greater economic base to support certain types of research that no participating country on its own could afford. By pooling the strengths of each national program, they may be able to develop a research program of considerable strength.

CONOSUR and PRECODEPA in Latin America are two examples of successful regional cooperation. Each has its particular characteristics and each illustrates the different situations in which horizontal cooperation can be used.

CONOSUR is essentially a loose coordination and information exchange mechanism in which each country maintains executive responsibility and program independence. It is focused on five commodities: wheat, maize, sorghum, soybeans, and beef cattle. It includes the six countries in the southern tip of South America: Chile, Argentina, Uruguay, Brazil, Paraguay, and Bolivia. Its main components are a crop research information system, training, and staff exchange. Leadership for the different program components is divided among the countries, according to their relative strengths. Budget support comes from the countries and the Interamerican Development Bank (IDB). Administrative responsibilities

lie with the Interamerican Institute for Cooperation on Agriculture (IICA). The program is now completing its first phase of operation and has been renewed for a second period.

Initial evaluations identify the CONOSUR experience as one showing high benefit-cost ratios for all parties involved, and as an effective way to exploit the region's characteristics to further cooperation on a number of products of crucial importance to the entire region.

PRECODEPA represents another successful experience. Its characteristics, however, are significantly different from those of CONOSUR. PRECODEPA concentrates on just one product – potatoes – and full program coordination and promotion of research is the main strategy of the program. Participants are Panama, Costa Rica, Nicaragua, Honduras, El Salvador, Guatemala, Mexico, Cuba, the Dominican Republic, and the International Potato Center (CIP). The program is financed by the Swiss Development Cooperation Program and the participating countries. Administrative responsibilities lie with CIP and the countries themselves. Of the group, only Mexico has the ability to support a full research program. Through a common program and selective leadership, with each country assuming responsibility for a particular research area, the handicap of size has been removed, and progress has been made in crucial areas, such as seed production and plant protection.

CONOSUR and PRECODEPA represent two alternatives for horizontal cooperation: loose cooperation or strict program coordination with division of labor. When the group includes large and small countries or the products involved are of great importance to the national economies, the CONOSUR model would appear to be the more effective approach. In regions of small countries or in dealing with products of less relative importance, the PRECODEPA model would be preferred.

Finally, I would like to point out that horizontal or regional cooperation schemes may substantially increase the capacity of the countries involved to take advantage of the IARCs' resources. By coming together, the countries can make a stronger case for specific demands on the international centers. PRECODEPA has brought CIP's attention to a region where individual country-center linkages would have been difficult to justify on the basis of each country's own potato production situation. The potential of the CONOSUR model as an outreach mechanism for the IARCs is reflected in the increasing attention it has received from CIAT and CIMMYT, and in the fact that these centers are formally involved in developing a similar program for the Andean region.

V. SUMMARY AND FINAL CONSIDERATIONS

We have attempted to describe the principal components of a national agricultural research policy and relate them to the situation of the small developing countries. In doing so, the importance of properly defined objectives, the nature of the issues, the process behind determining how much to invest in research, and the research system's institutional setting planning mechanism were discussed in their role as agricultural research policy instruments. Wherever relevant, alternative approaches and the factors affecting them were also presented.

The small developing country's conflict between needs and available resources was brought into focus, the basic point being that research needs in general are not directly related to country size, while resources usually are. Pressure on resources comes from two sources: the diversity of needs the research system must consider and the minimum critical mass requirements of research.

Because of the nature of agricultural production, environmental characteristics, consumer demands, and political considerations, small countries face research needs quite similar to those of larger countries. But, if research is to be successful, certain minimum standards of professional expertise must be met. Without them, useful results are unlikely and resources are wasted.

Finally, several policy alternatives were discussed. Small countries must make the best use of national and international resources. Research efforts must be brought into focus and more closely tied to extension, to increase relevance and applicability of research results. Donor assistance must be coordinated. But the most significant and potentially useful alternative for small countries is better and more effective use of international cooperation.

Bringing countries together enlarges the economic support base, offers hope for otherwise insoluble problems, and makes the most of each small nation's particular research strength.

The policy alternatives mentioned above have been presented in general terms. The issues discussed do not represent an exhaustive treatment. In considering applications, it would be necessary to rediscuss their validity under the characteristics of each particular situation. In this sense, how to concentrate efforts without loosing political support; the viability of establishing donor coordination schemes; and how to prevent international cooperation from distorting national priorities appear to be relevant areas of inquiry.

SELECTED BIBLIOGRAPHY

Andrew, C. O. and P. E. Hildebrand. 1982. *Planning and conducting applied agricultural research*. Westview Press, Boulder.

Arndt, T. M., D. G. Dalrymple and V. W. Ruttan, eds. 1977. *Resource allocation and productivity in national and international research*. University of Minnesota Press, Minneapolis.

Arnon, I. 1975. *The planning and programming of agricultural research*. Food and Agriculture Organization of the United Nations (FAO), Rome.

Bengtsson, B. M. I. and G. Tedla. 1980. *Strengthening national agricultural research*, SAREC Report R1: 1980. Swedish Agency for Research Cooperation in Developing Countries, Stockholm.

Convenio IICA-Cono Sur/BID. *Programa Cooperativo de Investigación Agrícola*. Instituto Interamericano de Cooperación para la Agricultura.

Convenio IICA-Cono Sur/BID. 1984. *Cronología de Actividades 1978-1983 del Programa Cooperativo de Investigación Agrícola*. ATN/SF-1586-RE. Montevideo, Uruguay.

Drilon, J. D., Jr. 1977. *Agricultural research systems in Asia*. Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Laguna, Philippines.

Evenson, R. and Y. Kislev. 1975. *Agricultural research and productivity*. Yale University Press, New Haven.

Gamble, W. K. 1981. *The role of agricultural research in developing countries*. Fiji Agricultural Journal, (1981)43(2), 53-58.

ISNAR. 1982. *A review of the agricultural research system of Malawi*. The Hague.

ISNAR. 1981. *Kenya's national agricultural research system*. The Hague.

ISNAR. 1982. *A manpower and training plan for the agricultural research system in Kenya 1983-1987*. The Hague.

ISNAR. 1984. *Agricultural research in Ivory Coast: presentation, evaluation, proposals for improvement*. The Hague.

ISNAR. 1983. *The national agricultural research system of Rwanda*. The Hague.

ISNAR. 1984. *Agricultural and livestock research in Upper Volta*. The Hague.

ISNAR. 1983. *La recherche agricole à Madagascar. Bilan et perspectives du FOFIFA*. The Hague.

ISNAR. 1983. *Development of an agricultural research system*. Somalia. The Hague.

ISNAR. 1981. *The agency for agricultural research and development of Indonesia*. The Hague.

ISNAR. 1982. *Review of the program and organization for crops research in Papua New Guinea*. The Hague.

ISNAR. 1982. *A review of the agricultural research division of Fiji*. The Hague.

ISNAR. 1982. *Solomon Islands agricultural research, extension, and support facilities project*. The Hague.

ISNAR. 1983. *Strengthening agricultural research for national development in the South Pacific*. The Hague.

ISNAR. 1983. *Report to the Pakistan agricultural research council on selected aspects of the Pakistan agricultural research system*. The Hague.

ISNAR. 1981. El sistema de investigación agropecuaria y transferencia de tecnología en Costa Rica. The Hague.

ISNAR. 1982. *The agricultural research system of Guyana*. The Hague.

ISNAR. 1983. *El sistema de investigación agropecuaria en la República Dominicana*. The Hague.

ISNAR. 1981. *Strengthening national agricultural research systems in Africa*. The Hague.

ISNAR. 1982. *The role of international associations in strengthening national agricultural research*. The Hague.

ISNAR. 1983. *Agricultural research for development: potentials and challenges for Asia*. The Hague.

ISNAR. 1983. *Selected issues in agricultural research in Latin America*. The Hague.

ISNAR. 1984. *First congress of the African Chapter*. The International Federation of Agricultural Research Systems for Development (IFARD). The Hague.

Johnson, D.G. 1982. *Agricultural research policy in small developing countries*. In: C.W. Howe, ed. Managing renewable natural resources in developing countries Westview Press, Boulder. pp. 64-94.

Moseman, A. H. 1970. *Building agricultural research systems in the developing nations*. Agricultural Development Council, Inc., New York.

Mosher, A. T. 1982. *Some critical requirements for productive agricultural research. International Service for National Agricultural Research*, The Hague.

Murphy, J. 1983. *Strengthening the agricultural research capacity of the less developed countries: lessons from AID experience*. U.S. Agency for International Development, Washington.

Oram, P. A. and V. Bindlish. 1981. *Resource allocations to national agricultural research: trends in the 1970s*. ISNAR/IFPRI, The Hague/Washington.

Pinstrup-Andersen, P. 1982. *Agricultural research and technology in economic development*. Longman, Inc., New York.

Piñeiro, M. E. and E. J. Trigo, eds. 1983. *Technical change and social conflict in agriculture, Latin American perspectives*. Westview Press, Boulder.

Ruttan, V. W. 1982. *Agricultural research policy*. University of Minnesota Press, Minneapolis.

Schuh, G. E. and H. Tollini. 1979. *Costs and benefits of agricultural research: the state of the arts*. The World Bank, Washington.

Scobie, G. M. 1979. *Investment in international agricultural research: some economic dimensions*. The World Bank, Washington.

Strengthening agricultural research and extension: the World Bank experience. 1983. Report No. 4684. The World Bank, Washington.

Supporting papers: World food and nutrition study. Volume V. 1977. National Academy of Sciences, Washington, D.C.

Trigo, E. J., M. E. Piñeiro and J. Ardila. 1982. *Organización de la investigación agropecuaria en America Latina*. Instituto Interamericano de Cooperación para la Agricultura (IICA), San José.

Trigo, E. J., and M. E. Piñeiro. 1981. *Dynamics of agricultural research organization in Latin America*. In: Food Policy, Volume 6 No. 1 February 1981. IPC Science and Technology Press Ltd.

Trigo, E. J., and M. E. Piñeiro. 1984. *Funding agricultural research*. In: Report of a Conference, Selected Issues in Agricultural Research in Latin America, Madrid, Spain, September 26 - October 1, 1982. pp. 76-98.

Valverde, C. 1984. Informe. *Misión de Revisión del Programa Regional Cooperativo de Papa*.

Venezian, E. 1984. *International Cooperation in Agricultural Research*. In: Report of a Conference, Selected Issues in Agricultural Research in Latin America, Madrid, Spain, September 26 - October 1, 1982. pp. 99-120.

Estimated cost of a minimum research module for one product[1] (in US$)

I. **Direct research costs,** including on-station and on-farm research activities (70% of total budget)			216,000
A. *Personnel*			
1. 4 chief researchers, M.S. or Ph.D. 3 person/years in plant breeding, agronomy, and pest & disease control, and 1 person/year equivalent in socioeconomics and other specializations, according to requirements (soils, physiology,, etc.) Total cost per person/year US$ 20,000	80,000	173,000	
2. 8 specialists, university graduates. Total cost per person/year US$ 8,500	68,000		
3. Training Calculated on the basis of 2x1 rate of retention; total rotation every 20 years; cost of US$ 70,000 per Ph.D. (M.S. 60%) Total annual cost for a permanent team of 2 Ph.D. and 2 M.S. (approximately). Also includes short-term training.	25,000		
B. *Services and materials* Calculated as 12.5% of direct costs.		27,000	
C. *Equipment* Calculated as 7.5% of direct costs.		16,000	
II. **General Costs and Administration** (30% of total budget) Includes direction, support and services (administration, laboratories, library, communications, field, etc.)			93,000
A. *Personnel* 60% of general and administrative costs.	56,000		
B. *Services and materials* 25% of general and administrative costs.	23,000		
C. *Investments and equipment* 15% of general administrative costs.	14,000		
TOTAL BUDGET			309,000

Percent summary by broad budgetary items:

A. *Personnel*	72.5%
B. *Services and materials*	17.5%
C. *Equipment*	10.0%

[1] Estimates were made using the budgetary structure of the international agricultural research centers as a guideline for determining the percent of each item of expenditure.

Table 2.1 - Central America and Selected Countries of the Caribbean Region: Average Value of Production 1979-81 by Crop (in 1000's U.S. dollars)

Subregion/ Country	Land Area Permanent Crop & Arable (in 1000's ha)	Maize	Rice	Cassava	Cotton	Beans	Potatoes
	(1980)					(Average 1979-80 only)	
Caribbean							
Barbados	33	248.0	—	110.6	—	—	
Cuba	3,200	11,780.0	199,878.6	35,853.0	5,854.0	16,107.0	25,629.6
Dominican Republic	1,230	5,698.0	168,790.6	14,794.6	10,573.3	26,774.0	2,190.3
Grenada	14	120.5[1]	—	—	—	—	—
Guadeloupe	49	—	—	110.6	—	—	—
Guyana	380	33.6	118,967.0	—	—	—	—
Haiti	890	22,225.0	41,237.0	27,974.6	9,595.6	29,806.0	999.0
Jamaica	265	703.6	884.0	2,550.6	—	—	1,131.6
Martinique	26	—	—	105.5[2]	—	—	—
Trinidad & Tobago	158	620.0	7,337.3	553.3	—	—	—
Central America							
Belize	52	2,202.6	3,914.3	—	—	619.5	—
Costa Rica	490	9,791.0	83,017.3	1,871.0	24,815.6	7,158.5	3,048.6
El Salvador	725	63,448.0	23,651.0	2,360.0	327,351.6	26,708.5	618.6
Guatemala	1,834	125,731.0	17,169.6	885.3	873,528.6	50,937.5	4,474.0
Honduras	1,757	42,483.3	14,090.3	885.3	44,048.3	22,853.0	555.0
Nicaragua	1,516	26,974.6	22,977.3	2,826.0	402,079.0	31,384.5	222.0
Panama	574	8,030.3	72,418.6	4,514.6	—	2,546.5	1,336.3

[1] Average 1979-80 only
[2] Average 1980-81 only

Table 2.2 - Central America and Selected Countries of the Caribbean: Percentage Values of Average Value of Production 1979-81 by Crop (in 1000's U.S. dollars)

Subregion/ Country	Maize			Rice			Cassava			Cotton			Beans			Potatoes		
	0.5%	0.75%	1%	0.5%	0.75%	1%	0.5%	0.75%	1%	0.5%	0.75%	1%	0.5%	0.75%	1%	0.5%	0.75%	1%
Caribbean																		
Barbados	1.2	1.9	2.5	—	—	—	0.6	0.8	1.1	—	—	—	—	—	—	—	—	—
Cuba	58.9	88.4	117.8	999.4	1499.1	1998.8	179.3	268.9	358.5	29.3	43.9	58.5	80.4	120.5	161.1	128.1	192.2	256.3
Dominican Republic	28.5	42.7	56.9	843.9	1265.9	1687.9	73.9	110.9	147.9	52.9	79.3	105.7	133.9	200.8	267.7	10.9	16.4	21.9
Grenada	0.6	0.9	1.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Guadeloupe	—	—	—	—	—	—	0.6	0.8	1.1	—	—	—	—	—	—	—	—	—
Guyana	1.7	2.5	3.3	594.8	892.3	1189.7	—	—	—	—	—	—	—	—	—	—	—	—
Haiti	111.1	166.7	222.3	206.2	309.3	412.4	139.9	209.8	279.7	32.8	49.2	95.9	149.0	223.5	298.1	4.9	7.5	9.9
Jamaica	3.5	5.3	7.0	4.4	6.6	8.8	12.8	19.1	25.5	—	—	—	—	—	—	5.7	8.5	11.3
Martinique	—	—	—	—	—	—	0.5	0.8	1.1	—	—	—	—	—	—	—	—	—
Trinidad & Tobago	3.1	4.7	6.2	36.7	55.0	73.4	2.8	4.1	5.5	—	—	—	—	—	—	—	—	—
Central America																		
Belize	11.0	16.5	22.0	19.6	29.4	39.1	—	—	—	—	—	—	3.1	4.7	6.2	—	—	—
Costa Rica	48.9	73.4	97.9	415.1	622.6	830.2	9.4	14.0	18.7	124.1	186.1	248.2	35.8	53.7	71.6	15.2	22.9	30.5
El Salvador	317.2	475.9	634.5	118.2	177.4	236.5	11.8	17.7	23.6	1636.8	2455.1	3273.5	133.5	200.3	267.0	3.1	4.6	6.2
Guatemala	628.7	942.9	1257.3	85.8	128.8	171.7	4.4	6.6	8.9	4367.6	6551.5	8735.3	254.7	382.0	509.4	22.4	33.6	44.7
Honduras	212.4	318.6	424.8	70.5	105.7	140.9	4.3	6.4	8.6	220.2	330.4	440.5	114.3	171.4	228.5	2.8	4.2	5.6
Nicaragua	134.9	202.4	269.7	114.9	172.3	229.8	14.1	21.2	26.3	2010.4	3015.6	4020.8	156.9	235.4	313.8	1.1	1.7	2.2
Panama	40.2	60.2	80.3	362.1	543.1	724.2	22.6	33.9	45.1	—	—	—	12.7	19.1	25.5	6.7	10.0	13.3

Table 2.3 - Selected Countries in Africa: Average Value of Production 1979-81 by Crop (in 1000's U.S. dollars)

Subregion/ Country	Land Area Permanent Crop & Arable (in 1000's ha)	Maize	Rice	Cassava	Cotton	Sorghum
West Africa	(1980)					
Benin	1,795	41,666.0	6,004.0	98,056.0	42,164.0	9,09[illegible].6
Bissau (Guin.)	285	412.0	10,927.0	—	—	563.6
Equatorial Guinea	230	—	—	5,854.3	—	—
Gambia	270	1,455.0	12,569.3	774.6	3,902.6	—
Liberia	371	—	97,643.0	33,640.0	—	—
Sierra Leone	1,766	1,617.3	194,243.0	10,110.0	—	1,334.6
Togo	1,720	18,545.3	8,744.6	50,104.3	35,055.3	—
Comoros	91	620.0	5,726.6	9,535.6	—	—
Cape Verde	40	463.6	—	664.0	—	—
Reunion	52	1,779.6	—	442.6	—	—
East Africa						
Mauritius	107	167.6	—	—	—	—
Somalia	1,066	13,888.6	1,829.3	3,530.3	9,189.3	17,598.0
Central Africa						
Burundi	1,305	16,940.0	3,558.6	130,783.3	13,092.0	11,346.6
Gabon	452	1,121.3	417.0	11,268.3	—	—
Rep. Congo	669	1,768.6	1,66[illegible].0	58,082.0	—	—
Rwanda	975	10,253.3	1,701.0	51,659.3	—	20,586.3
Sao Tome	36	124.0	—	323.0	—	—
South Africa						
Botswana	1,360	1,235.6	—	—	5,854.0	3,269.0
Namibia	657	4,331.6	—	—	—	321.6
Lesotho	292	14,920.3	—	—	—	8,196.0
Swaziland	204	10,330.6	2,085.0	—	58,065.0	206.6

Table 2.4 - Selected Countries in Africa: Percentage Values of Average Value of Production 1979-81 by Crop (in 1000's U.S. dollars)

Subregion/ Country	Maize 0.5%	Maize 0.75%	Maize 1%	Rice 0.5%	Rice 0.75%	Rice 1%	Cassava 0.5%	Cassava 0.75%	Cassava 1%	Cotton 0.5%	Cotton 0.75%	Cotton 1%	Sorghum 0.5%	Sorghum 0.75%	Sorghum 1%
West Africa															
Benin	208.3	312.5	416.7	30.0	45.0	60.0	490.3	735.4	980.7	210.8	316.2	421.6	45.5	68.2	90.9
Bissau (Guin.)	2.1	3.1	4.1	54.6	82.0	109.3	—	—	—	—	—	—	—	2.8	4.2
Equatorial Guinea	—	—	—	—	—	—	29.3	43.9	58.5	—	—	—	—	—	—
Gambia	7.3	10.9	14.6	62.8	94.3	125.7	3.9	5.8	7.7	19.5	29.3	39.0	—	—	—
Liberia	—	—	—	488.2	732.3	976.4	168.2	252.3	336.4	—	—	—	—	—	—
Sierra Leone	8.1	12.1	16.2	971.2	1456.8	1942.4	50.6	75.8	101.1	—	—	—	6.7	10.0	13.3
Togo	92.7	139.1	185.5	43.7	65.6	87.4	250.5	375.8	501.0	175.3	262.9	350.6	—	—	—
Comoros	3.1	4.7	6.2	28.6	42.9	57.3	47.7	71.5	95.4	—	—	—	—	—	—
Cape Verde	2.3	3.5	4.6	—	—	—	3.3	5.0	6.6	—	—	—	—	—	—
Reunion	8.9	13.3	17.8	—	—	—	2.2	3.3	4.4	—	—	—	—	—	—
East Africa															
Mauritius	0.8	1.3	1.7	—	—	—	—	—	—	—	—	—	—	—	—
Somalia	69.4	104.2	138.9	9.1	13.7	18.3	17.7	26.5	35.3	45.9	68.9	91.9	88.0	132.0	176.0
Central Africa															
Burundi	84.7	127.1	169.4	17.8	26.7	35.6	653.9	980.9	1307.8	65.5	98.2	130.9	56.7	85.1	113.5
Gabon	5.6	8.4	11.2	2.1	3.1	4.2	56.3	84.6	112.7	—	—	—	—	—	—
Rep. Congo	8.8	13.3	17.7	8.3	12.5	16.7	290.4	435.6	580.8	—	—	—	—	—	—
Rwanda	51.3	76.9	102.5	8.5	12.8	17.0	258.3	387.4	516.6	—	—	—	102.9	154.4	205.9
Sao Tome	0.6	0.9	1.2	—	—	—	1.6	2.4	3.2	—	—	—	—	—	—
South Africa															
Botswana	6.2	9.3	12.4	—	—	—	—	—	—	29.3	43.9	58.5	18.1	27.2	32.7
Namibia	21.7	32.5	43.3	—	—	—	—	—	—	—	—	—	1.6	2.4	3.2
Lesotho	51.7	77.5	103.3	10.4	15.6	20.9	—	—	—	290.3	435.5	580.7	1.0	1.5	2.1

RESEARCH POLICY LINKAGES: A CASE IN DEVELOPED COUNTRIES

D. De Zeeuw

Ministry of Agriculture and Fisheries
The Hague, Netherlands

INTRODUCTION

The Netherlands never has had an independent agricultural research policy, and it is my sincere hope that my country will stay in this blessed state as long as the sea level allows us to exist. What we have, however, and have had for more than a hundred years, is a government agricultural policy. Research has always been part of this policy, but never in all these hundred years have our research mandarins felt an urge to establish an independent agricultural research policy. I agree with them.

Man has always explored the natural world, in order to understand it better, in order to enhance his chances of survival, and in order to improve his life. Our modern day division of labor has delegated exploration of the natural world to professionals, and now professional scientists have to perform the same role for society as a whole. Not just in order to improve their own lives, but to improve the society or its communities, business or otherwise, of which they are members.

A society or community that delegates the exploration of the natural world to experts does so with a certain purpose in mind, and this purpose determines the direction of any number of non-research ancillary activities. So scientific research is only one of many different kinds of interdependent human activities, all harnessed in an effort to achieve a specific or a wide complex of ends and purposes. This is the way it is in Dutch agriculture.

We want to feed our population, we want to export our products, and in doing so, we would like to make some money too. For this reason, our government has an agricultural policy, not a separate policy for agricultural research.

However, if those of us who have a special responsibility for organizing and leading agricultural research want to talk about how they go about doing their jobs, and if they want to call this "agricultural research policy," it is alright with me, as long as you, and they, do not forget my reservation. Not having an independent agricultural research policy is one of the reasons, I think, for the success of Dutch agriculture.

GENERAL BACKGROUND

We founded our first university in 1575, and ever since, the Dutch government has been committed to science. However, for reasons that are beyond my comprehension, most present day students of science policy state that Dutch science policy started in the 1960s, after OECD's Harvey Brooks told us to start. So we'll take it from there.

First, Parliament established by law the Scientific Advisory Council. The council reports to the government; its reports are usually made public. On the whole, the council has performed well, advising on the division of the science budget, pointing out weaknesses, and stimulating new developments. The council is independent, certainly does not act as a spokesman for the scientific community, but it does have a keen eye for the possibilities of scientific research, and it has always sympathized with the views of those members of the scientific community who try to keep Dutch science up to international standards.

Besides the council, we have a minister of science and education. At the beginning of the 1970s, the cabinet was enlarged with a new minister, responsible for science policy at the national level. And I am sorry to say that ever since, the Dutch science budget has been in steady decline. In fact, once ranked among the big spenders in the science league, the Dutch science budget per capita is now among the lowest in the industrialized world. Furthermore, the economic recession has forced the government to apply major cuts in general government spending, with the result that our budget for agricultural research will

diminish by at least 10% over the next few years. We feel very strongly about this, because Dutch agriculture – primary production and agribusiness – is one of the very few sectors of the economy that is still profitable. Of course, the government faces enormous difficulties, and we feel confident that once the budget is balanced the government will start to invest in science again, but until then, we have to hope that foreign competition will not get too far ahead of us. Today, the minister of science and education is again, just as in the period before 1970, our science policy minister, coordinating the research activities of all other ministers, and responsible for the quality of the Dutch research effort in general. The coordination task proved to be very difficult, if not impossible. One of the reasons is the gap that exists between the minister's position and the position of the science consumer.

The minister of science policy does not primarily take ideas from the market, the public or industry, nor from social institutions, but mainly from desk studies, which generally are not rooted in society itself. Furthermore, the Dutch character being what it is, means that everyone does not like integrated or overall approaches. The Dutch keep minding their own business.

We do not like to boast – the agricultural community certainly has its faults – but there is one common characteristic in Dutch agriculture that has a tremendously beneficial influence on its economic performance, and that is the common tendency and will to cooperate. Therefore, we feel that a more cooperative attitude towards other government departments would greatly increase the usefulness of the department of science policy. As members of the agricultural community, we have always tried to cooperate with the science policy minister and his staff, especially when we expected a profit. But there are only a few formal linkages, under the auspices of the minister for science policy, between agricultural research institutions and non-agricultural research institutions.

Agricultural research is very much on its own, as is the agricultural community. We do not like it this way, but I believe it is a common cultural phenomenon in the industrial world. There is a gap between city and country. It is very interesting to note that today's newspapers, which used to depict farmers as backward and grumbling halfwits, guilty of the rape of our beautiful countryside, have discovered that the countryside is populated by highly skilled entrepreneurs, using advanced technology, and selling their products all over the world. This newspaper coverage is meant to set an example to industry. So maybe the gap is closing.

DUTCH AGRICULTURAL RESEARCH

Before we get into today's main topic, we have to clarify some points about Dutch agricultural research. I will not tell you why we have research at all, because the reason is self-evident. The question is what research do we have, and what do we leave to others? We may be a rich country by international standards, but we are also a small country, so we have to limit our choice of research subjects. The first implicit decision we made years ago is not to duplicate research and development already being carried out by private enterprise. By hindsight, the majority of innovations that were generally considered to have been decisive for the shape of modern agriculture, have come from industry and other forms of private enterprise. Farm machinery, the internal combustion engine, electricity as a power source, agricultural chemicals, microprocessors and computers have all originated in industry. Farm cooperatives, public sale of farm products, joint marketing organizations, agricultural banking, farmers' organizations, all of great social and economic importance, are products of private enterprise. So, there exist vast areas of research and development we never enter, and I believe it is the same in most other countries. We do, however, and in this we are not unique, occupy ourselves with the implementation on the farm level of innovations that have originated elsewhere. Next, we long ago made the decision, also implicit, not to channel major amounts of our restricted budget into subjects that cannot be expected to be applied at the farm level within a period of, say, 10 to 15 years. If these subjects are studied elsewhere in the scientific world, be it national or international, we content ourselves with a small scale involvement in order to stay in the picture. Our experts are on stand-by. We cannot afford, for instance, to spend tens of millions of Dutch guilders a year on photosynthesis alone, much as we might like to do so.

We limit our research involvement to those subjects we absolutely have to study because they cannot be left to others. We are pragmatic about this, and our position, I think, makes good sense.

This policy still leaves us with a broad spectrum of disciplines and subjects ranging from soil fertility to plant breeding.

In our year-to-year management, but also in our day-to-day management, we have to make decisions about these subjects. We have to decide what scientific disciplines to have, how many of them, and what subjects their yearly programs should be devoted to.

How do we arrive at our decisions?

Decision-making is a dynamic social process, and an ever continuing process, and if we try to pinpoint highlights of the process, or if we try to identify persons or bodies that seem to hold key positions in the process, we most certainly distort reality. By hindsight, so called "decisions" may look like conscious and explicit acts of will of only a few very important individuals, but in reality, such decisions are hardly ever taken. We always seek consensus, and we practically always find it.

Why do people in the Netherlands feel that balancing the budget and getting business on its feet again ought to be the major goals of government policy? They did not think so five years ago, and they do not think so now because the government has told them to. The government has, however, made both goals major objectives of its policy, but has this been an independent decision? No, government could have done otherwise. It is the same way with agricultural policy. One morning you wake up and you realize that there is a general feeling in the agricultural community that some hitherto unknown problem should be tackled. So you tackle it. You can hardly do anything else; it is the logical thing to do. Of course, there are exceptions, but I think one should be very careful to identify this person or that body as the origin of a "decision." Things simply do not work this way.

Our research institutions, our agricultural experiment stations, our agricultural research university, are all incorporated in an extensive network of formal and informal connections. This network is so closely knit, and the flow of information through it is so intricate, that it really defies description. Having said this, I will now set out to describe it.

THE AGRICULTURAL INFRASTRUCTURE

I have already mentioned to you a number of essential facts about the Dutch agricultural community. We summarize:

* We do not have an independent agricultural research policy;
* The agricultural community and agricultural research are very much on their own. We are not isolated completely, and let me assure you that we do not feel lonely, but we tend to mind our own business, we try to find "in-house" solutions;
* In agriculture, there exists a strong tradition of cooperation;
* Dutch agricultural entrepreneurs are highly skilled and they use the latest technology;
* In spite of the recession, agriculture is still profitable (although I have to emphasize that the average farm income is still below standard);
* We only take up research subjects if we cannot leave them to others.

It is my belief that the key to the economic success of our agricultural enterprise as a whole lies in the highly competitive nature of the Dutch farm population. Our farmers want to be independent and stay in business, so they try their utmost to produce more, to lower production costs, and to improve the quality of their products. They have developed a keen sense for consumer demand, and they react very quickly to changes in the market. Here we have classical examples of market-pull in innovation. In some cases this pull is really so strong – in greenhouse horticulture for instance – that farmers almost literally pull preliminary results out of our scientists hands and start experimenting on their own. If they hear about developments abroad, they at once come and ask why we are not doing something about them. Still, many farming families exist on a low subsistence level, and if you are very cold blooded about it you have to conclude that this means there are too many farms in the Netherlands. But this fact does not seem to sharpen rivalry among Dutch farmers. On the contrary, they try to cooperate even more in a concerted action to beat foreign competition.

Our farmers' skill in farm management and in the use of modern technology depends to a large extent on two factors. First, the majority of our farmers learn their profession in one of the many kinds of agricultural schools. We have educational institutions at all levels of schooling after primary school, up to university level. In the second place, after they have left school, farmers find a vast amount of specialized information at their disposal, ranging from journals and magazines, salesmen and fairs, to highly specialized extension services.

The Department of Agriculture and Fisheries is very fortunate to have control not only over the agricultural extension service, but over agricultural education too. In fact, most major policy instruments are under this department, and this saves us an amount of red tape.

More important, of course, is the fact that agricultural education is incorporated into the agricultural infrastructure. I think this must be the reason why the distance between education and the real world is shorter than in most other sections of the economy. Of course,

communication between farmers and extension officers is a two-way street, and thus, the extension service is able to inform the ministry about farmers' needs. So, we talk to those responsible for education and extension, telling them what scientists are up to, and they tell us what they are doing and what they think we should be doing. To us, this feedback is very fruitful indeed.

In an analogous way, all policy instruments of the ministry are linked. May be this is the time to tell you an interesting fact about the ministry's staff, and indeed about the staff of all other agricultural bodies. Many of their academic staff received their degree from our one and only agricultural university, the one here in Wageningen. So they all have a common background, they may even have studied together. They know what agriculture is about – in fact a great number of them grew up on a farm – and they have become research-minded. They have learned to value the possibilities of research, they know their way about in the agricultural research community, and they know to whom to turn if a problem comes up. One of the advantages of being a small country is that many fruitful linkages spring up on their own, and do not have to be forced upon an organization by management. Distances are short, and the common background simplifies communication.

Of course, farmers also have their own organizations. These organizations can bring powerful pressure upon the government, and over the years they have acquired great negotiating skills. I will not try to give you the complete picture of farmers' organizations. It is sufficient to say that there are three kinds of organizations. We have professional organizations, for instance of poultry. Then we have product organizations, comprising for instance all potato interests, and finally we have general organizations, comprising all interests of the agricultural community.

We talk to all of them, and they talk to many members of the ministry's staff, so we are certainly well informed on farmers' needs and wishes. Some of these discussions occur within the formal framework, many are of an informal nature, and naturally we have them at different, appropriate levels. Yet close relationships exist between our research establishments and farmers' organizations.

Our agricultural experiment stations are jointly financed, on a fifty-fifty basis, by government and farmers' organizations. Farmers have to pay a special levy for this. The stations are governed by boards made up of representatives of both the farming community and the ministry, and so the farming community exercises a decisive influence on the stations' research programs. Money always buys power. Our research institutes are also governed by boards on which the farming interest is represented among others. Although here the ministry has the main say, the influence of the farming community should not be underrated. Remember, we try to govern by consensus.

This certainly is not all. Apart from all these organizations and representations, we also have a National Council for Agricultural Research. This independent advisory body serves as a meeting platform for both government, science and the science consumer, the latter being either the farming community, the agribusiness, or the nature conservation interests.

Among the many subcommittees of the council are the product advisory groups, mainly comprised of representatives of professional and product interests. Every five years, the council advises the Ministry of Agriculture and Fisheries on the reprogramming of agricultural research in general.

The minister, of course, has to account for his policy in Parliament, and Parliament also exercizes its influence on research policy, usually on a general level. Since the decrease in the number of farmers in our country, the agricultural vote has lost part of its importance. Nevertheless, the farm lobby stays very effective, and it has been successful in warding off disproportionate inroads on the agricultural budget.

Usually the major part of the parliamentary debate is taken up by social and economic topics, but every now and again research figures in the debate too.

In summing up, we may conclude that the Netherlands does not lack formal linkages between research, other policy instruments, and the agricultural community. Nor do we lack linkage at a national level between the agricultural research community and other elements of the Dutch science community, for this linkage is looked after at Cabinet level. As I told you before, I do not believe this description explains much. In a democracy, the acts of government express the will of the people. Government never leads but it always follows developments in society. So if government and non-governmental bodies show linkages, and much consultation and cooperation at every level, these phenomena should be interpreted as signs of many linkages and of close cooperation within the community itself. It is my belief that basically policy decisions in agricultural research originate in informal linkages at the personal and small-group level. The decision in "statu nescendi" as you might call it, then spreads around, gains support, and in the end is formalized by those that are formally responsible.

Privately owned industrial companies are run on a different basis, of course, but bear in mind that the agricultural community is made up of nearly 200,000 small private companies, so that each scientist potentially has 200,000 customers.

Let me put this whole story in a few words.

Ours is a small country. Distances are short, communication is easy, "everyone knows everyone," most policy instruments are under one agency, agricultural education is excellent, our farmers are highly skilled, they are very competitive, and they exert a strong technological pull. We have a rich social life, the countryside is covered by all kinds of organizations. We have a strong agricultural lobby. And to all these ingredients, you have to add the one ingredient that is the cream in our coffee: a very strong tradition of cooperation. I do not know where and when in history this tradition originates. But experience has taught us that cooperation is profitable, and we like profits. So agricultural research is incorporated in a closely-knit network of relationships. Scientists do not only talk to other scientists, they talk to extension officers, they talk to farmers, they talk to government officials. They know what is expected of them, and they try to fulfill these expectations. And even a scientist who is not a leader in his field may still be very effective because his work is not only printed in learned journals, but finds its way directly to the customer as well to the customer who also happens to be his boss.

Now, please do not think that we in management pass our days in idleness, waiting for our policy to shape itself. We have a lot of work to do, and we have important decisions to make. But that is a different story altogether.

RESEARCH POLICY LINKAGES: A CASE IN DEVELOPING COUNTRIES

S. Qasem

University of Jordan
Amman, Jordan

GENERAL REMARKS

Research policy is still in its formative stage in the majority of developing countries, especially small ones. Whilst all developing countries have research institutions to serve agricuture, many still suffer from constraints which weaken research performance and impact.

In recent years, the majority of developing countries have shown more interest and concern in strengthening their national agricultural research institutions, with the belief that such institutions could develop into effective instruments of change and improvement in the output of the agricultural sector.

Needless to say, developing countries vary greatly in the degree to which they have developed their research institutions. In the process of such development, each country has achieved some progress in establishing its research institution(s), but the vast majority are far from having a well-articulated research system. Various concepts of research institution building are still being debated, and a wide range of experimentation has been going on in different countries.

It is beyond the objective of this presentation to review the complex issues of research institution building in agriculture. It will concentrate more on the complex issue of policy level linkages.

LINKAGES: WHAT THEY ARE AND HOW THEY WORK IN THE PROCESS OF RESEARCH FORMULATION IN DEVELOPING COUNTRIES

We speak of linkages here as those set of relationships which exist between various individuals, groups and/or institutions concerned with deciding on agricultural research policy and how such policy affects the performance and output of research in achieving desired goals. Linkages may be formal or informal; they are formal when they are specified in legislative acts or similar orders. Linkages can also be viewed as vehicles or instruments among entities which facilitate group action. The type, clarity, and strength of linkages that exist among various entitities may determine to a large degree the level of success of research institutions in serving the needs of its environment.

In the institution building perspective, William J. Stiffin (1972) (1) writes about linkages as those "exchanges that take place between the organization and entities in its environment", and he classifies them into four types:

1. *Enabling.* Relationships with "entities that control the allocation of authority and resources needed by the institution";
2. *Functional.* Relations with "organizations performing functions and services which are complementary in a production sense, which supply the inputs, and which use the outputs of the institution",
3. *Normative.* Relations with "institutions which incorporate norms and values relevant to the doctrine and program of the institution";
4. *Diffused.* Relations with "elements in the society that cannot be clearly identified by membership in formal organizations".

The definition of policy in Webster's Dictionary is "a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions." In relation to agriculture, then, the term implies an agreement among concerned parties to select a course of action which will guide and determine decisions related to agricultural research.

---

(1) Stiffin William J.: *The Institution Building Perspective: Properties, Problems and Promise*, pages 113 to 148 in: Institution Building, A model for applied social change. Edited by D Woods Thomas, et al, Shenkman Publishing Company, Cambridge, Massachusetts, 1972.

In this presentation, we are concerned with agricultural research policies which are conducive to the development of a national system responsive to the needs of the agricultural sector in a particular environment, and has the capacity to provide the technical input and knowhow appropriate and relevant to it.

In the course of its development and performance, leaders of an agricultural research institution in developing countries take many decisions. Some of these decisions are of policy nature. How these policy decisions are influenced by others outside research institutions and how these decisions influence the interests and expectations of other groups concerned with agricultural research are the topics of our paper. The subject then is how research relates to the needs and aspirations of those which research institutions serve. To clarify our presentation we must address the following:

1. Entities involved in relationships (linkages) dealing with agricultural research policy. These are as follows:
   - leaders of agricultural research;
   - leaders of agricultural production or service institutions or organizations in the public sector;
   - decision-makers in the planning and finance institutions of the public sector;
   - directors of marketing and/or agribusiness firms in the private sector.
   - farmers, leaders of farmer organizations and others who deal with agricultural production in the private sector;
   - agricultural committee members in the legislative body of the country.

2. Policy issues of research which are sensitive to relationships or linkages and can influence the national goals and/or needs of one or more of the various participants. These issues may be summarized as follows:

   - degree of autonomy of research institutions and how it influences performance;
   - research programs and how they relate to national development objectives and/or farmers' needs;
   - level of financial support and how it influences institutional performance on the one hand, and how it is consistent with research productivity or output on the other;
   - methods used to determine research priorities, to evaluate institutional performance and impact, and to coordinate work of the institution in the overall national scientific effort.

3. The process through which the various participants interact on the national scene and how they reach agreement on policy issues, in order that the country may have a viable and effective research institution, is the third point that should be considered in our presentation.

4. And, finally, any influences that may come from entitities outside the national scene and may have bearing on national research policy.

POLICY LEVEL LINKAGES IN DEVELOPING COUNTRIES

The question of autonomy of research institutions

Agricultural research activities started in the vast majority of developing countries as a structure under the ministry of agriculture. The status of these structures has changed in various ways in the last 25 years. In small developing countries, agricultural research is still under the umbrella of the agricultural ministry. However, some enjoy a higher degree of autonomy from the routine and bureaucratic procedures of the ministry than others. The demand of research leaders in these countries has been that research institutions should have flexible procedures, which are consistent with the nature of research activity. Research, these leaders state, is a technical activity which is different from other services, and should be given an environment, in which to operate, that is free from administrative constraints imposed by the existing routine and bureaucracy of the ministry. There are several issues which are involved in the autonomy question, and these include differential salaries for researchers and other workers, different promotion criteria, incentives for workers, and more flexible financial procedures.

The argument from the other side (ministry officials and others concerned) usually is that the sought after autonomy produces administrative problems in other departments, and that such autonomy minimizes the ministry's influence in orienting and guiding research programs.

The issues at hand are clearly policy matters which in most cases require legislative acts of the highest order. The crucial participants in these issues are:

1. Research leaders who should put their case in the clearest terms and should move in the political arena to promote support and provide alternative relationships (institutional linkages) which will minimize or solve the complaints of the other side;

2. The minister and other high officials of the ministry of agriculture, who often resist changes;
3. Leaders who have the executive power to make changes of the magnitude required and who should become aware and convinced of the value and positive aspects of such changes.

There is no one identifiable process through which issues like this are resolved in developing countries. In some cases, pressure to make such changes comes from the foreign agencies which provide loans, technical assistance funds, and/or objective advice and consultation. In others, it comes when the country faces a crisis caused by technical problems which were expected to be solved by competent and effective research institutions. In all cases, however, resolution of such questions requires patience, endurance and a power of persuasion on the part of research leaders and practitioners. Can the farmers help in resolving such issues? In some instances, where output had an impact on farming, the farmers could be organized into a pressure group to bring about changes. In this latter case (the farmers being a crucial factor) the situation seems to go through a vicious circle. If the research institution is truly suffering from lack of autonomy, how can it be effective and productive enough to recieve farmers' support?

Major areas of research programs

Who identifies and determines the major program areas of research institutions? What is the process through which research programs are determined? How do these programs relate to the national food policies, the development plans of the agricultural sector and/or the farmers needs? And how do these programs relate to the problems involved in the adaptation of technological inputs and knowhow transferred by the public and/or private sector agencies from outside the country? Again, there is no one single pattern in one individual country which constitutes a representative or typical case in which these questions are resolved. Therefore, this presentation will focus on the issues most frequently encountered which are common to the largest number of small countries. The process of research program identification, in which the researchers are, of course, the crucial participants, usually is as follows.

The collected topics are either reviewed by heads of departments or by members of the research council, or just passed on to become the research agenda for that year or for the coming years. The changes made in the original proposals are usually minimal.

Some of the exceptions to this process are:

- research projects financed by outside technical assistance agencies, which are most probably suggested by that agency or reviewed to fit conditions set by the agency before financial support is approved;

- research programs financed through World Bank loans, which are - subject to conditions which usually include participation of research clients in the process of project (or program) identification;

- research projects financed by a national planning agency, by groups and/or institutions interested in a particular commodity, or by local agribusiness firms, are usually subject to conditions which include participation of research clients in the identification process before support is approved.

The degree of congruency of research programs with national food policies, development plans, and/or farmers needs, is a controversial issue in the majority of developing countries.

The controversy is as follows:

National planners and policy makers charge that many of the projects carried out by the researchers are not related to food policies or development plans. The same charges come from farmers who claim that they do not find answers to the problems facing them in the field. The agribusiness groups complain little, but the able ones seek paths that are para-research institution oriented, to ensure that the technology inputs they import fit local conditions.

Researchers, on the other hand, reply that although the country does have development plans or food policies, these are not clear enough to become operational in formulating research programs. They also state that they are not involved in the planning process, and thus are not well aware of the needs and how to meet them.

It is evident that stronger linkages can minimize complaints. In the case of development plans, projects come from the top with little analysis of the socioeconomic and political forces working in the society. The same can be said for research programs. They are identified by a group which is on top, insofar as farmers are concerned. Some countries have become aware of the importance of improvements in relationships, and have taken measures that include:

- Wider participation from research clients in program identification. In the majority of cases, such participation is not formally organized. Furthermore, participation of farmers does not have enough leverage

to make substantial changes. Farmers rarely control funds for research, and they are rarely represented in the decision-making process;

- More control of funds available to research institutions, through conditions set by planning agencies and/or organized groups of commodity production. In these cases, planners act on behalf of farmers and other clients of research to ensure that research programs are consistent with development priorities, and with what they believe are the more pressing problems facing farmers;

- Inclusion of farmer leaders as members in policy-formulating bodies of agriculture.

FINANCIAL SUPPORT TO RESEARCH

The pattern in developing countries is that funds spent on agricultural research come from the government. In the majority of small countries, the research budget is dealt with like that of any other governmental department. In many countries, research funds do not even appear as a separate line item in the ministry's budget. It is uncommon to find cases where budget figures are broken into specific allocations for programs.

The following is a typical case of how budgets are made and approved. The research director, sometimes in consultation with heads of units, prepares the budget of his institution, based on guidelines given to him by the particular authority. The budget figures appear in lump sums as salaries, capital, and operational expenditures. With the undersecretary of the ministry, he then determines where certain cuts in the process should be made. The undersecretary, accompanied by the ministry's budget officer, meets with the central budget director of the government. Again, cuts are made, either across the board or in certain areas. The research leader may or may not accompany the undersecretary in the budget discussions. Further cuts may be made later when the cabinet of ministers approves the national budget. Usually research budgets, especially operational funds, are the first to suffer from any cuts. Research leaders are not involved in any policy decision concerning research budgets. Links with other groups like farmer leaders and policy makers are not strong in generating support. It is clear that such support is also linked to how much participation others outside the research system may have in program affairs, evaluation of impact, and other policy matters related to research. The way research leaders reason, is that since either the minister or budget directors are responsible for deciding on funds to be allocated for research, why should they then seek support from less important persons? In conclusion, one might state that research leaders have little motive to seek the support or the satisfaction of other participants and particularly clients, because they have little influence in determining the amount or areas of allocation. National budget directors are usually more interested in making budget cuts than in discussing the urgency or quality of services provided by research institutions.

POLICY ISSUES

Other policy issues such as coordination, evaluation of impact of research, and determination of research priorities, are all matters which are highly sensitive to linkages. In many developing countries, these activities are not institutionalized. The question is not who should evaluate, it is in many cases whether evaluation should take place or not. Research priorities are linked either to major program areas, which we have discussed before, or to projects within major areas. This process is at present left for researchers to decide upon. What usually happens is that funds are spread over most projects, no matter how thin they become. Somehow, researchers agree with each other to maintain the breadth of research activities. Any cutting of funds resulting from piority determination encroaches on one of the researchers' domain.

The result is usually that all research projects are maintained from one year to another, regardless of the level of funding. Eventually, the whole system suffers. What is worse is that researchers continue to complain about the low level of funding. It is clear that formal links with participants outside researchers' circles are needed both for evaluation and for priority determination.

As for coordination with other institutions, present methods used for such processes are not effective. Coordination is supposed to take place in committee or council meetings. Representatives of various institutions who are members in such committees meet on occasions.

There are several weaknesses in the present relationships under such arrangements:

1. Councils or committees make recommendations and have no power to enforce measures, and thereby obtain results;
2. Often, coordination power is overshadowed or obstructed by legal barriers of individual institutions;
3. Compromises are usually made among members, especially if they are all members of one institution. However, coordination, like evaluation and priority determination, is an activity which should be performed by entities external to the institutions.

AGRICULTURAL RESEARCH POLICY AND ORGANIZATION IN SMALL COUNTRIES: SCIENTIFIC LINKAGES IN A DEVELOPING COUNTRY

C. R. Panabokke

Ministry of Agriculture
Colombo, Sri Lanka

INTRODUCTION

This case study is concerned with a small developing country where the national research system comprises around 500 research scientists distributed across six older, established research institutes set up a little over 50 years ago, and five more recently set up multi-commodity or regional research centers catering to the new agricultural development regions.

These 11 research institutes fall within five line ministries within the overall government structure. There is no coordinating agency equivalent to an agricultural research council, within the governmental structure, responsible for formulating national policies and priorities, nor any formal mechanism for inter-ministerial coordination of the national research effort.

The older single-commodity institutions that deal with export oriented plantation tree crops have had a relatively stable source of funding for research activities, in the form of a return on the value of the export product. These institutes have been able to build up a significant store of basic and applied research information over the years, especially in relation to the commodity that falls within their mandate.

The few older multi-commodity institutes, as well as the more recently established research centers, deal with the main domestic staple food crops and a range of internally consumed commodities. These institutes receive their funding from annual appropriations, which are subject to the vagaries of financial allocations dependent on the state of the national economy. These institutes have been able, over the years, to build up a useful store of basic resource information on soils, hydrology, and pest and disease epidemiology, as well as an interdisciplinary approach in respect to the main staple food crops and a few high value commercial crops.

The small and medium size island countries of Asia and the Pacific are characterized by varying degrees of agroecological diversity, which necessitates a spread of research effort across several crops.

The faculties of agriculture, which usually come within the jurisdiction of the Ministry of Education, are primarily engaged in teaching. The private sector plays a very limited role in agricultural research.

EVOLUTION AND PRESENT STATE OF LINKAGES

1925 to 1950

The older research institutes were set up after World War I, when the government as well as the planting community recognised the need for research support in respect of the main staple crops and the export oriented plantation crops. By the nature of the mandate assigned to these institutions, the character of research carried out was mission oriented. It included both applied research and basic research that aimed at contributing to the solution of problems.

The main disciplines represented at the early stages of these institutes were those of agricultural chemistry, plant pathology, entomology, and agricultural botany. The initial phase of research was mainly concerned with the application of the disciplinary sciences to characterize and understand the soil, crop, pest and disease environments. Generating a store of supporting basic research information was essential for solving problems concerning pest and disease control, crop management and efficient use of fertilizer.

The scope of the supporting basic research studies carried out by the respective disciplinary divisions was more of an attempt to understand the underlying processes, rather than a search for new principles. Linkage to information

from other countries in the tropical regions was mainly through journals that covered similar disciplinary areas, as well as through personal contacts abroad.

Despite the discipline-oriented structure of the research institutes, informal interdisciplinary efforts were directed towards the solving of urgent problems. Linkages between institutions were mainly within the same discipline because the exchange and comparison of research information was more readily understood and transferable within the same disciplines.

1950 to 1970

The older research institutes had a modest expansion with additions of the new disciplinary divisions of plant physiology, biochemistry, agroclimatology, process technology, and agronomy. New gaps in the supporting basic research information were identified and had to be bridged, in order to seek solutions to the new problems pertaining to pest and disease, and plant nutritional disorders.

The multi-commodity centers that were set up in the newly developing agricultural regions did not have a full complement of disciplinary divisions. They were headed by a senior scientist who could have come from any discipline. One or two key disciplines were represented, and crop research officers were assigned to individual crops or group of crops. Despite the lack of strong discipline-oriented units within these research centers, the results of the applied research carried out in the experiment station fields provided answers to the pressing problems encountered by small farmer communities within the region.

1970 to present

The rice variety improvement program had evolved to a stage where the need for a strong interdisciplinary effort was recognized. It became clear that problem area scientists, such as entomologists, pathologists, soil scientists and agronomists, have to be closely integrated in the variety improvement program, not only to clarify and sharpen the breeding objectives, but also to closely participate in the screening, testing and evaluation of breeding lines.

Incorporation of pest and disease resistance, soil problem tolerance, and more efficient utilization of applied inputs required a clearer understanding of races of blast, biotypes of planthopper, soil characteristics, and farmers' use of costly inputs.

Effective linkages with the International Rice Research Institute were essential in accelerating the varietal improvement of rice for the different edaphic regions identified within the country.

This interaction between the basic and applied research within the rice variety improvement program was made possible because of the availability of a critical mass of scientists, adequate financial support, and good linkages with an IARC. The role of the social scientist was also being increasingly recognized and accepted in several facets of the national rice research program.

With the growing strength of the IARCs, problem area scientists in the different multi-commmodity centers are now able to tap the sources of basic supporting research that are coming out of IRRI, ICRISAT, IITA, and CIP. This is not confined to access to a wider collection of germplasm of the mandated crops. Basic understanding of soil-plant-water relationships from ICRISAT and IITA in respect of the Altisols, have provided local soil scientists with a significant body of data which has helped them to reduce the time and cost involved in conducting similar lines of study. Similarly, plant breeders now have better access to the information on resistance to different pests and diseases, and they also have a clearer understanding of underlying relationships.

INFLUENCE OF COUNTRY CHARACTERISTICS

The structural organization of the national research system and the availability of stable funding over a reasonable span of years have an important bearing on the balance that the working scientists can achieve between basic and applied research.

The individual research institutes should also have a balanced mix of relevant basic disciplines and a minimum of strength of highly trained, experienced senior scientists, who can decide what lines of basic research should be pursued. They should also be able to select international information that would enhance the cost effectiveness of their research operations. These conditions do not exist in a satisfactory measure in all research institutes.

With the dispersion of research institutes among several ministries, and in the absence of an apex agricultural research council or equivalent coordinating agency, no clear national guidelines can be formulated for a rational distribution of resources between basic and applied research.

The single commodity export-oriented crop research

institutes, with a stable source of funding, have an easier task in long-term program formulation with a view to achieving a reasonable balance between basic and applied research.

Each research director of an institute has to make a difficult decision on the balance to be maintained between basic and applied components within the program and projects under his purview. He has to seek the advice and guidance of senior experienced researchers, and also to use his own judgement. Where funds are limited, and where he has no senior experienced assistance, his task is more difficult. There are no formal mechanisms by which he can draw on the expertise of other institutes.

The head of a discipline division has the freedom and flexibility, within his own available resources, to adjust the balance between basic and applied research. The basic research that he identifies and pursues will be chosen largely on the basis of his own experience and what he considers would best serve the needs of applied research work in the institute. In fact, it could be observed that the linkage between basic and applied research is more clearly expressed within the discpline divisions.

In the case of national coordinated programs on rice, food grains, roots and tubers which are supported by adequate donor assistance and fall within the research division of the agriculture departement, there have been better opportunities for achieving a balance beteen basic and applied research, both within disciplines and across disciplines. The inter-disciplinary task forces that have been set up for the main problem areas pertaining to these crops have been the chief instruments for achieving this linkage. The seasonal reviews provide a suitable forum for the diagnosis of special problems, and these are then broken down into researchable components.

While it is recognized that applied research has to be conducted within the environmental regions where the crops are grown, no clear guidelines are yet available on whether some components of the basic research could be carried out at a central location or institute. Over a period of years, research scientists who have been working at the regional centers have moved to the central institute. These experienced senior researchers constitute a valuable resource for undertaking lines of basic research in the experienced stage of their careers.

EFFECTIVE USE OF AVAILABLE RESOURCES

Small countries with a diversified ecology face the dilemma of spreading their limited resources too thinly over a wide range of crops. The scarce financial and manpower resources set a limit to the number of crops to which a critical mass of essential disciplines could be allocated.

In a structure where there is a central or national research institute linked to regional research centers, and where the regional research centers have a major focus on applied research, it would be logical to locate the basic disciplines that cut across regions at the central institute. The organizational structure should, however, permit researchers to move freely in two directions between basic and applied research assignments, without being permanently embedded in either.

The more important aspect is the process of identifying what basic research is essential and what would have the best pay-off. No clear guidelines or procedures are available in this area. The best judgment of a peer group, or even perhaps of an exceptionally creative researcher, would be an acceptable approach.

It is quite unlikely that there are entirely unexplored areas of basic research, that need to be addressed in order to support present day needs of applied research in the tropical environments of small countries in Asia and the Pacific. There is a considerable body of basic research information that has been generated for both soils and crops in similar environments, across many research institutions. Selective tapping of this information, and its validation and testing under the actual country conditions, would be a more realistic approach. The resource inventories and soil classification data now available for both big and small tropical countries enable an easy transfer of basic research information, within similar soils and environments.

A small core of highly skilled, experienced researchers representing the key discipline areas should be built up within the national system; and one of their important tasks should be the screening and selection of internationally available basic research information that would be relevant to situations encountered within the country.

It would, therefore, be appropriate for small developing countries to ensure the availability of a critical mass of relevant discipline researchers, within the system, who perform both functions of conducting some lines of essential basic research and of retrieving relevant basic research information from international sources.

SCIENTIFIC LINKAGES OF AGRICULTURAL RESEARCH SYSTEMS FOR SMALL COUNTRIES

D. Boynton

Cornell University
Ithaca, USA

According to the outline prepared by your organizing committee, this subject follows a discussion on national policies determining the agricultural research emphases and make-up of the institutions carrying them out, and it will be followed by a discussion on research-farmer linkages. Although these three aspects of a national agricultural research system are inextricably interrelated, it is useful to look at them separately, so long as we appreciate that the research activity is bounded by policy decisions and that the only justification in the long run is an improvement in agricultural technology that benefits farmers and the society in which they live.

In my discussion, I will be concerned with countries that are not only small in physical dimensions, but relatively non-industrialized and therefore heavily dependent on agriculture as a basis for both subsistence and for foreign exchange. Since my illustrations will be drawn from personal experience in Central America, some basic data on political, demographic, and economic circumstances in the past decade are worth looking at. These countries lie between latitudes of about 8 and 16 degrees north. Mexico lies to the north, Panama to the south. When they separated from the Spanish empire in the period between 1821 and 1828, they attempted to form a single nation called Central America, but decisive political factions, poor communication systems by road and sea, and poverty, resulted in the creation of five separate states: Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica. Political instability reigned in the four northern countries and resulted in military regimes, tending to be dominated by a land-owning oligarchy. Costa Rica, to the south, developed a relatively stable democracy. In the last few years, civil war has dominated two of the other countries, El Salvador and Nicaragua, and at present the latter has become a socialist state.

Table 1 shows some recent statistics on population, dependance on agriculture, gross national product, and dependence on agricultural exports for foreign exchange (1, 2).

The major export crops are coffee, bananas, sugar cane, and cotton. Maize and sorghum are the principal cereals, although some rice and wheat are grown. The common bean is the principal food legume, and white and sweet potato and yuca are the most important root and tuber crops. Each of the five countries has a considerable range of ecological zones associated with different rainfall patterns and with different elevations, which determine the crops best adapted to an area. In addition, there are important differences within the countries in the roads, access to markets, and other infrastructural facilities that favor or limit production of some crops in an area. Thus, the dominant farming system of each area is determined by the interaction of ecological and social factors.

A look at the agricultural research organizations in these five small countries can give some understanding of the linkages that are needed to develop improved agricultural productivity.

The five Central American countries have central planning offices which are responsible to the governments for the formulation of plans that carry out the basic policies of economic development that have been decided upon. Insofar as agriculture is concerned, two kinds of product market are involved: internal and export. Although food crops and animal products may be exported, the major markets are for internal consumption, and the goal of self-sufficiency is a high priority in the national plans of all five countries. Since agricultural exports are the major source of foreign exchange, and economic development depends on a favorable basis of payments, great emphasis is placed on export crops and animal products.

While the annual range in temperature and sunlight is not great in these five tropical countries, there are very significant regional differences in the seasonal cycles of rainfall, and the average temperatures are cooler at high elevations than close to the sea level. Each of the countries has important regional climatic differences which determine the ecological zones best adapted to specific crops. Also, the historical development of each country,

since the Spanish conquest and independence, has influenced both land ownership and land use. The larger, more productive farms have been concentrated in the hands of politically influential owners who dominate the production of export crops. In Guatemala, in addition, there is an important part of the society which is ethnically quite separate, whose greatest concentration of population is on the high west cordillera.

As we might expect, agricultural research developed first as a result of the interest by producers of export crops in improved technology that would alleviate important production and marketing problems. The sponsorship of the research was crop-specific: bananas, coffee, sugar and cotton were the principal export crops and the production of each was the basis for associations of farmers growing them. In the case of bananas, the industry was developed largely with foreign capital, and was dependent on American and British shipping companies which plied the waters between the Caribbean and Pacific ports, American and European coastal cities. The production was managed in enclaves of these companies, and the production research was carried on by company personnel and their consultants. In the case of the other export crops, research on production problems was usually carried on by special groups of technologists whose research organization was financed by the governments involved. Thus, in Costa Rica, Guatemala, and El Salvador, separate coffee research institutes carried out the research work on those crops. In some instances, the crop associations supplemented government budgets in order to bring in consultants on specific problems. There was little interest in research on food and fiber crops for national consumption in these countries until after World War II. Then, it became evident that growing population and limited land resources made higher production per unit of land necessary in the less developed countries of the world, including Central America. This recognition was stimulated by the interest of industrialized countries, and resulted in the creation of the Food and Agriculture Organization of the United Nations, the Interamerican Institute of Agricultural Science in the Organization of American States, in formulation of agricultural research groups financed by philanthropic organizations such as the Rockefeller Foundation, and in the emergence of bilateral agricultural development programs financed by industrial nations including the United States (USAID), Canada, Great Britain, and European countries. Initially, these bilateral contracts emphasized the creation and strengthening of extension activities, on the assumption that the appropriate agricultural technologies were already developed, and what was needed was to transfer them to the less developed countries. The assumption proved to be erroneous (3).

In this same period, a long-term cooperative program, in which the Rockefeller Foundation worked with the government of Mexico in establishing a research staff to improve the production of maize and wheat, proved very successful and became the model on which the present international crop and research centers were based. As these international centers were becoming established, however, self-evaluation of their effectiveness in providing technology adapted by farmers were made. It became evident that the new technologies were adopted mostly by large, well-funded farmers, but had little effect on the small farmers who constituted the majority of the rural population (4). As a result of these findings, both the international centers and the bilateral programs for agricultural development have introduced research on the special economic restraints of peasant farmers (5).

One can see the effects of this evolutionary process on the agricultural research organization (7) of the Central American countries. For the purpose of this discussion, I will use the example of ICTA, the Guatemalan Institute of Agricultural Science and Technology, which was created in 1972. The figures given have been taken from a paper presented by Fumagalli and Waugh at a Bellagio conference in 1977. Figure 1 describes the relationships of ICTA to the other principal entities in the public agricultural sector of Guatemala. At the top, the national planning office, at the level of the presidency, specifies the guidelines under which the agriculture sector Planning Office develops. At the level of the Ministry of Agriculture, ICTA is one of six institutions in the public sector. Agricultural Extension is under the responsibility of DIGESA, which not only transmits the research results to the farmers, but also works with BANDESA, the agricultural credit bank, in planning and administering the provision of supervised credit to the farmers. INDICA, the marketing agency, is a separate entity.

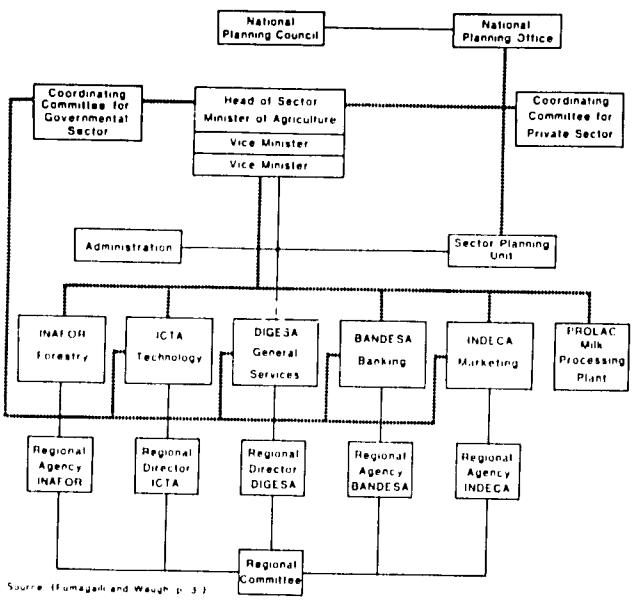
All six of these institutions are organized on a regional basis and their regional agencies are coordinated by a regional committee. The regions are identified in Figure 2. In general, the regions and subregions represent distinct ecological zones, and therefore distinctive crop and marketing constraints that determine the farming systems.

Figure 3 provides information on the internal organization of ICTA. The work is organized under the Technical Unit for Production. Seven crop production units, and one animal production unit, are identified. Soil management and socio-economics are separate disciplines. Training, communication, seeds, experiment stations, and laboratory analysis are separate services.

Table 1: Some Statistics Relevant to Agricultural Development of the Five Central American Countries (See references 1 and 2 for sources)

	Honduras	Guatemala	El Salvador	Costa Rica	Nicaragua
Population 1979 millions	3.1	6.8	4.5	2.2	2.5
Area in square miles	43.3	42.0	8.1	19.7	57.1
Populations in Agriculture % 1979	64.0	57.0	52.0	37.0	45.0
GNP per capita	400.0	700.0	530.0	1130.0	770.0
Economic land in crops 1976 (% total)	9.0	21.0	42.0	11.0	13.0
Fertilizer consumption kg/ha 1976	27.0	50.0	153.0	114.0	30.0
Tractor density (no ha/1,000)	1.2	2.2	4.5	12.0	0.9
GDP (% of 1970-77)* Agriculture	32.1	—	27.9	20.6	23.2
Exports (food) (% total 1977)	72.0	—	—	74.4	56.0

* GDP is GNP less income from abroad.



Source (Fumagalli and Waugh p. 3)

Figure 1: Public Agricultural Sector

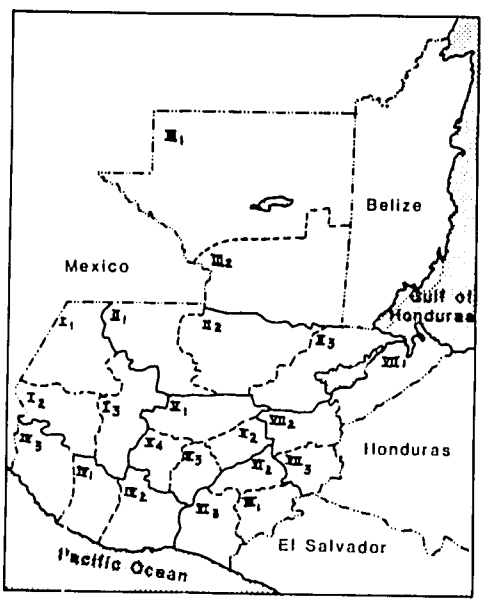
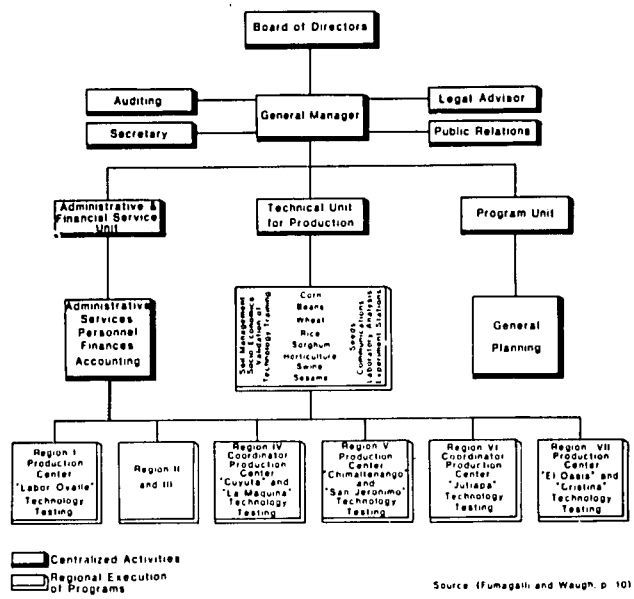


Figure 2: Regionalization of the Public Agricultural Sector, Guatemala



Source (Fumagalli and Waugh, p 10)

Figure 3: Organization of ICTA

Figure 4 shows the linkages of organizations outside the national agricultural sector, to the entities within it, in terms of the generation, validation, and transfer of new technology. The principal international agricultural centers operating directly in Guatemala are the Center for Improvement of Maize and Wheat in Mexico, and the International Center for Tropical Agriculture in Colombia. Both the Food and Agriculture Organization of the United Nations, and the International Institute of Agricultural Sciences of the OAS, support several research and development programs in Guatemala. In addition, there are a number of bilateral contract programs supported by the United States, Canada, and European countries. Within Guatemala, there are important linkages with the University of San Carlos, in training engineers and agronomists with other governmental ministries and

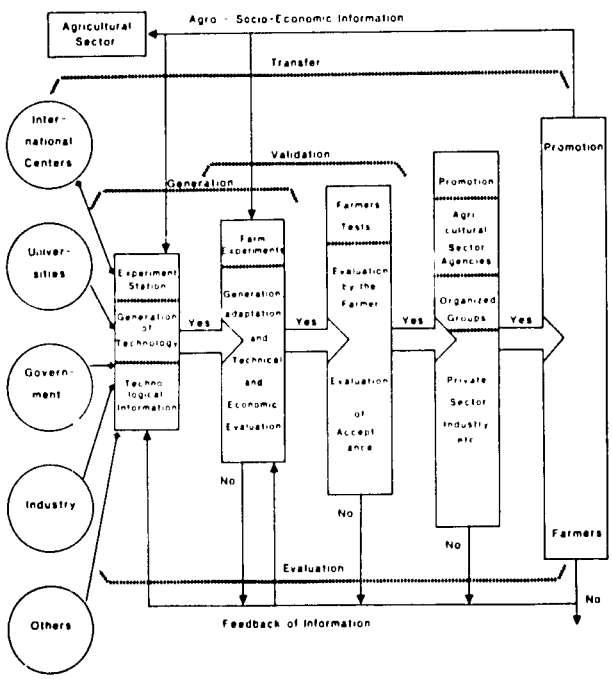


Figure 4: Technological System for Agriculture

Source (Fumagalli and Waugh, p 14)

agencies, and with industrial organizations. Figure 4 also introduces the concept of feedback as a necessary process in the agricultural research program. I am sure that Dr. Hildebrand will deal with this in his discussion of linkages with farmers. ICTA was a pioneer in organizing its research with small farmers on the basis of socio-economic studies made in the communities to be served, and in the intense and exemplary conduct of the research, so that there would be interaction not only between agronomists and socio-economists, but also a continuous communication with farmers themselves.

SUMMARY

The key scientific linkages basic to the success of ICTA's system are as follows:

1. Between the ICTA Technical Unit for Production, and external international and national institutions, whose programs of research and training can contribute to the capability of ICTA to generate useful technological information;

2. Between the ICTA Technical Unit for Production, and DIGESA and BANDESA, in the promotion and financing of production research technology and in the training of DIGESA and BANDESA technical personnel;

3. Linkages within the ICTA Technical Unit for Production of the agronomic and socio-economic units, both at the level of planning and in extension of the research activities.

In view of the relative instability and limited resources of the national institutions involved, dependance on international centers for generation of much of the fundamental research needed must be expected. The help of other international institutions and bilateral programs of agricultural development of industrialized countries can provide support for essential national research programs. The national agricultural research programs need to be oriented toward the most important practical problems limiting production of the basic food and export crops. A few carefully chosen experimental field stations representing the major ecological zones should concentrate on application of promising new technology to local problems. The major field research should concentrate on adoption of improvements at the farm level. These should be carried on with the combined participation of the research and extension personnel, in active cooperation with the farmers involved.

Although the organizational framework for ICTA provides the opportunities to achieve these goals, its success in doing so depends on the development and retention of a core of well-trained professional staff members working as interdisciplinary teams within a relatively stable agricultural research system.

The other four Central American countries have agricultural research programs that are organized with variations on the above pattern. That of Honduras is modeled after Guatemala's. That in El Salvador is somewhat more centralized and has less linkage with small farmers than the others. Nicaragua was attempting to make clear linkages with the small farmers at the end of the Somoza regime. Costa Rica's was rather strongly regionalized and their personnel was the best trained and distributed. All five countries rely very heavily on assistance from international centers, international agencies, foundations, and foreign agricultural development programs for complementary help.

Subjects for further detailed study are the coordination of external assistance programs in the strengthening of agricultural research in small developing countries, and a centralized data bank using standardized methodology to provide information on ecological and socio-economic factors influencing agricultural development of small countries.

REFERENCES

1. *World Tables*. Second edition (1980) from the World Bank. John Hopkins Press. Baltimore.

2. International Agricultural Development Service. *Agricultural Development Indicators*. A statistical handbook. 1980. New York.

3. Rice, E. B. *Extension in the Andes. An evaluation of official US assistance to agriculture extension service in Central and South America*. Agency for International Development. Evaluation Paper 3A. April 1971.

4. CIMMYT. *The Pueblo Project: seven years of experience*. 1967-1973. El Bataan, Mexico. 1974.

5. Norman, David W. *The Farming Systems Approach Relevancy for the Small Farmer*. MSV Rural Development Papers, Paper No 5, Michigan State University. East Lansing. 1980.

6. Fumagalli, A. and R. Waugh Sr. *Research in Guatemala*. Paper presented at the Bellagio Conference in Italy. ICTA, Guatemala, 1977.

7. Whyte, William F. and D. Boynton. *Higher yielding human systems for agriculture*. Cornell University Press. Ithaca. 1983.

RESEARCHER-FARMER LINKAGE FOR TECHNOLOGY AND AGRICULTURAL DEVELOPMENT

P. E. Hildebrand

University of Florida
Gainesville, USA

Researcher-farmer linkages are basic to effective agricultural research policy and organization. This paper is organized into three sections. The first discusses how, where, when, why, by whom, and with what methods researcher-farmer contact is carried out. Emphasized is researcher-farmer linkage for purposes of technology development, including dissemination. This purpose also serves other applied research involving policy and infrastructure implications. The second section deals with these policy and infrastructure implications. Finally, the third section discusses the implications of researcher-farmer linkage for research policy and organization.

RESEARCHER-FARMER LINKAGES

How

In a word, researcher-farmer linkages must be based on confidence. Historically, farmers are suspicious of any representative of government. In many developing countries, the fear is that government knowledge may be utilized in some form for tax purposes or in other means detrimental to farmers' best interests. In developed countries, the concern may be about time spent with the government official at no apparent benefit, if not detriment, to the farmer. Confidence can be gained when farmers are convinced that researchers are going to be working in a partnership with them to help solve problems which are important to the farmers and have been articulated by them to sympathetic representatives of government.

Technology development research in what is now called the Farming Systems approach provides an entree for creating the confidence necessary for an effective and efficient researcher-farmer link. Research conducted on farms in partnership with farmers, and on problems of direct and immediate concern to farmers, particularly when conducted on a realistic basis, provides farmers with confidence that the researchers are attempting to help improve their lot.

Where

To be effective, technology development research must be conducted in such a way that a clientele can be clearly identified. Farming systems practitioners use the term Recommendation Domain to identify homogenous groups of farmers. Research conducted with farmers who are representative of a specific domain provides the basis for extrapolation to all farmers in the domain. Research efficiency is improved because locations for on-farm research are selected for specific characteristics. Resources are not wasted on obtaining research results for conditions which do not apply to the recommendation domain. Extension efficiency is improved both because the clientele can be clearly identified, and because the technology developed and being disseminated precisely fits the agro-socioeconomic conditions of the clientele.

When

On-farm research in partnership with farmers is to be contrasted with researcher managed and controlled experiments on farmers' fields, but conducted under the conditions of an experiment station. The purpose of the two types of trials is distinct. Research conducted in partnership with farmers and under real farm conditions is designed to evaluate the effect of alternative technologies under the conditions in which they would be put into use if they were to be adopted by farmers in the recommendation domain. This means that each location, or farm, is different in many ways from the other locations or farms, and that research techniques therefore need to be different from experiment station practices where locational differences are minimized by following prescribed experimental procedures.

Farmers are by nature experimental. However, many cannot accept undue experimental risk. Technology should be evaluated under their conditions and in partnership with them only when researchers have a fairly high degree of confidence that this technology will be effective when used under real farm conditions. This

means that the technologies usually will have been evaluated on local experiment stations and perhaps in rented fields on a few farms prior to being placed in farm trials in partnership with farmers. By extrapolation, this implies that experiment station research, at least in part, is oriented toward the solution of farmers' problems as defined by the researcher-farmer linkage.

Why

In the process of technology development, there are at least three critical reasons for this researcher-farmer linkage or partnership. The first relates to quantity of resources, the second to quality of resources, and the third to the all-important factor of management of scarce resources, including management time.

A standard production function is an estimation of the response of the output of a production process to a variable input when other inputs into the production process are held at a fixed or constant level. The level at which these fixed inputs are held influences the shape and/or level of the production function. Yield gap or constraint analyses have amply shown that responses on farms differ significantly from responses under controlled conditions such as those used in usual experimental procedures. Conclusions as to the significance of responses and/or their profitability, based on higher levels or better quality of fixed resources than are available to farmers, can lead to faulty recommendations. If other farmers try the technology, they can be disillusioned at best, or subject to a loss of profit, cash invested or family sustenance at worst. Such a situation can be avoided if technology is evaluated under the conditions in which it would be used by farmers if and when adopted by them.

Quality of resources can have an impact very similar to that of quantity, and at times the two are difficult to separate. Soil quality, basic animal nutrition, and reliability of irrigation water deliveries are biophysical examples. The socio-economic conditions which farmers face, as distinct from physical, biological, and climatological conditions, are also qualitative and quantitative and have an important impact on the adoptability of technology. Farmers are the ultimate decision-makers regarding adoption. Prior evaluation and understanding by researchers increases the probability that technologies are acceptable to the clientele but the farmers' own evaluation is the final link in the chain. Technologies or goods and services created in the absence of a close clientele-researcher linkage often are rejected or accepted only after significant modification. Absence of researcher-farmer linkage can only decrease the efficiency of the technology development or research process. One need look no further than the inefficiencies created in centrally-planned economies where decisions are made by bureaucracy with little consideration of the needs, desires, and conditions of the user. This is also the reason why extension in many areas has become an agency trying to sell poorly adapted products rather than one oriented toward solving farmers' problems.

Three important functions of farmer management are evaluating alternative technologies, adopting them, and learning to use those which are being adopted. Wake (1984) describes two activities in the learning process. One is the activity of learning from secondary information, either oral or published in one form or another. The second is hands-on learning. The shape of the learning curve is, perhaps, debatable, but if one considers a learning process beginning at a level of no-knowledge, an S shaped curve could be envisioned. In a highly developed economy with a sophisticated farm clientele, secondary sources can easily be conceived as allowing movement along the learning curve to the point where initial hands-on learning results in rapid gains. In a very poorly developed economy, with little availability of secondary information, early hands-on learning by individual farmers probably is a tedious process with only slow gains during early attempts.

Early adopters provide a community learning experience which augments the amount of secondary information available to later adopters. Early adopters also modify or adapt a technology to local conditions, so that the technology is more suitable to a specific community. However, those who are better able to take the risk of early adoption usually have a different resource base than later adopters. Their results differ from those of later adopters with an inferior qualitative or quantitative resource base.

The farming systems approach to technology development is an organized complement to community adaptation and learning in agriculture. It provides the additional benefit of allowing for adaptation and evaluation of alternatives under the conditions of the majority of farmers in a community or recommendation domain, and not just under the conditions of the most progressive farmers. This increases the efficiency of the technology development and adoption process and effectively combines research and extension activities.

By whom

The term researcher is used in a broad context. Researchers at different levels in the institutional hierarchy will have varying intensities of contact with the clientele. Those researchers who comprise the on-farm research teams will have the most continuous contact with farmers. In many small or poor countries, these teams may be comprised

largely of sub-professional personnel. Professional level personnel in many countries may have to support two or more on-farm teams. Their contact with the clientele will necessarily be less but it is still critical. If support personnel do not work on farms with the teams as often as possible, they will not be able to communicate with their own team members, who would be speaking with a much better understanding of reality. Even national level commodity team scientists should maintain researcher-farmer linkage. This linkage not only provides the researchers with a better understanding of the farmers' situation, it also creates confidence and a sense of accomplishment that is too often lacking among research personnel.

The farmers involved in researcher-farmer linkage are those who are representative of a specified recommendation domain. A recommendation domain is comprised of a group of farmers, whose farms are homogenous with respect to specific farm activities. An individual farm can be in more than one recommendation domain at any one time and can change recommendation domains if the technology used is changed. Individual farm members can also belong to different recommendation domains. The women may be in one recommendation domain with their crops while the men are in another with crops which are predominantly managed by them. Commercial crops on a farm may be part of a different recommendation domain than the subsistence crops on the same farm.

Methods to provide researcher-farmer linkages

A farm is a complex organization with many facets. Most farms are comprised of one or more household units with a complex set of functions designed to provide for the welfare of family members. Many products are required and several means are used to achieve desired ends. In order to approach an understanding of the farm, a team of researchers from a number of disciplines is essential. It is not sufficient for members of a number of disciplines to work individually in a given area or on a given problem. Rather, it is critical that different disciplines work together in the technology development process (Hildebrand, 1981). Technology development in recent years has been oriented primarily toward biological interventions. It was therefore reasonable that heavy emphasis be placed on the biological sciences. However, it is also critical that the social and economic sciences be included in the multi-disciplinary teams involved in researcher-farmer linkage.

That linkage usually begins with an initial characterization of an area, frequently using a rapid reconnaissance survey for the purpose of identifying tentative recommendation domains, evaluating constraints to the farming systems within those domains, and determining possible interventions for the improvement of those systems.

Characterization, evaluation, and refinement of recommendation domains is a continuous process. The multidisciplinary team uses several means including on-farm trials, directed or verification surveys, and frequent researcher-farmer contact to achieve a better understanding of the clientele and to initiate evaluation of technological alternatives.

Researchers must keep in mind that the major objective of conducting on-farm trials is to evaluate the potential response of technological alternatives under the real and varied conditions to be found on the farms in a specific recommendation domain. Disciplinary training has convinced most researchers that it is necessary to reduce sources of variation from non-studied variables to a minimum in order to effectively determine significant differences among levels of treatment or treatment variables. To gain the most benefit from on-farm research, researchers must comprehend the value of working with variability among farms and not attempt to follow disciplinary mandates that dictate controlling this variability. One statistical procedure which shows great promise in helping researchers to evaluate technological alternatives when subjected to the variability of individual farmer management is modified stability analysis (Hildebrand, 1984a). This analysis utilizes the environment within which a product is produced as an independent variable reflecting soils, climate, and socioeconomic conditions, including management. Against this independent variable, results can be measured by any of the relevant evaluation criteria including yield per hectare, production per unit of cash input, yield per unit of labor in a critical period, or any other criterion which is relevant to farmers in a recommendation domain. The procedure also provides a method by which recommendation domains can be refined or partitioned.

GUATEMALA: ONE INDICATION OF SUCCESS

Perhaps the best example of a national research institute which has followed the farming systems approach, is that of the Guatemalan Institute of Agricultural Science and Technology (ICTA). In the early 1970's, Guatemala embarked on a daring endeavor to significantly modify the impact of its investment in agricultural research and technology development. In 1973, when the new institute was established, Guatemala was importing large amounts of the basic grains needed as food. The primary goal of the institute was to achieve self-sufficiency in the production

TABLE 1: Comparison of Production, Yield and Importation of Basic Grains in Guatemala: 1973-1983

	Unit	Maize	Beans	Rice	Sorghum
1973					
Production	metric tons	659,530	58,460	19,370	60,840
Yield	kg/ha	1,180	636	1,600	1,360
Area	ha	558,920	91,920	12,110	44,740
Imports	metric tons	72,050	390	210	150
1983					
Production	metric tons	1,031,260	102,800	42,320	99,040
Yield	kg/ha	1,636	986	2,850	2,080
Area	ha	630,350	104,260	14,850	47,600
Imports	metric tons	2,440*	–	140**	160**
1973-1983					
Increase in:					
Production	%	56	76	118	63
Area	%	13	13	23	6
Yield	%	39	55	78	53

Source

Adapted from Banco de Guatemala

Notes

* Animal feed
** Improved seed only, not for consumption

of these basic grains, utilizing primarily the small farmers who produced approximately 65% of the grain in the country. The methodology developed by ICTA has been well documented and the results achieved within one decade are gratifying if not startling. Imports have been reduced to a minimum, and yields have been increased up to 70% even in the face of large increases in area of production (Table 1), which normally results in reduced yields. Seldom, if ever, has a country achieved self-sufficiency in four basic food products simultaneously over such a brief period of time.

POLICY AND INFRASTRUCTURE RESEARCH

The farming systems approach to technology development with its strong researcher-farmer linkage, is directly amenable to augmenting infrastructure and policy research. The multidisciplinary teams involved at the farm level can provide direct information to policy makers and infrastructure managers, and can incorporate information received from them in the development of alternative technologies (Hildebrand, 1984b). Economists and social scientists, in particular, can help provide policy makers and infrastructure managers with much more realistic information on probable responses to policy and infrastructure stimuli than is possible from studies of models based on data from standard statistical survey techniques.

Directed surveys are occasionally conducted by the multidisciplinary teams for purposes of answering specific questions regarding technology development. The same types of directed surveys, if not conducted so frequently that they interfere with ongoing work, could provide specific responses to policy makers and infrastructure managers.

Because of resource constraints, many multidisciplinary teams have a minimum, often only one, of economic and social scientists. If research for policy and infrastructure is to be an important component of the work of multidisciplinary teams with researcher-farmer linkage, the proportion of social scientists and economists necessarily must increase. This increase should not be to the detriment of efforts in the biological sciences. Rather, the teams should be made larger by one or two individuals. These individuals would not have sole responsibility for policy and infrastructure research, but should be completely integrated into the multidisciplinary teams so they have a thorough understanding of the agro-socioeconomic conditions of the clientele.

IMPLICATIONS FOR RESEARCH POLICY AND ORGANIZATION IN SMALL COUNTRIES

Poor countries in general, and poor, small countries in particular, have little justification for conducting anything

other than applied, problem-solving research. Larger, wealthier and better developed countries, as well as the international agricultural research center network, must carry most of the burden of the more basic research activities required as input into the applied research of poor countries. Fortunately, experience has shown that applied agricultural research can be effective in solving both micro and macro level problems in small countries, and effective researcher-farmer linkage is the key to efficient applied research. It must, therefore, receive top priority in research policy in small countries.

Effective applied research, with strong researcher-farmer linkage, requires an investment in field personnel, and transportation and logistic structures for them to be efficient in the field. Incentives are required to attract quality personnel to isolated areas in the interior of many countries. Administrative structures must provide the flexibility required to operate efficiently without being bogged down by bureaucracy paper work at central offices in place of action in the field.
Research policy must support this type of structure and program.

The need for transportation, field logistics, and incentives for quality field personnel is often construed as unreasonably increasing the cost of a nation's agricultural research program. However, if emphasis is placed on efficient applied research with a strong researcher-farmer linkage, the traditional large investment in elegant experiment stations, offices, and laboratories can be minimized. Research policy should consider the investment in a strong field research program as an alternative to and not an addition to an expensive, centrally located research facility. This is not to say that support research is not needed. Rather, support research can be conducted with more modest national facilities, and with more use of the international agricultural research network.

Agricultural development will not occur as a result only of the development of appropriate technology. Provision must be made for required infrastructure to provide a constant and reasonably priced supply of the technology or its components and market infrastructure must provide efficient commercialization channels. National agricultural research policy, therefore, must link technology and infrastructure development. This linkage can be provided via multidisciplinary teams with strong research-farmer linkage.

Development also cannot occur unless technology is made available to farmers. Extension services are traditionally the purveyor of this service. Effective multidisciplinary teams working in well identified recommendation domains can work with 50 to 100 farmers each year. It is well known, if not well documented, that good technology travels rapidly from farmer to farmer and widespread adoption occurs even in the absence of organized extension effo. s Strong researcher-farmer linkage is an effective extension procedure and should be considered by policy makers as such. Some specialized extension services can be utilized by farm level multi-disciplinary teams for providing pamphlets, audiovisual materials, and other equipment to improve presentations at field days and less formal gatherings. Integration of extension personnel into these multidisciplinary teams should also be part of agricultural policy. This integration will involve a small proportion of the total extension personnel of a country. The remaining personnel can be freed for the many other duties which are always placed with extension.

National agricultural research policy should also attempt to link university level research with the applied research organization. On the one hand, this implies that universities will not be directly involved in the kind of farm level development research which has been discussed. The nature of most university research does not make it amenable to providing responsibility for development research. However, this does not mean that research conducted at the university level cannot be applied research and provide input into the main agricultural research organization. A close university linkage helps orient that research and provides students with valuable applied research experience. It also provides the research organization an opportunity to evaluate graduating students to help them in their own personnel selection process.

Finally, national agricultural planning research activities can certainly benefit from a strong linkage with the farm level multidisciplinary teams. However, care must be exercised by national planning groups not to usurp the time of the farm level teams. The primary product of these teams must be the development of technology. However, it has been seen that they can provide valuable information for policy makers. If these teams are augmented with social scientists or economists, they can be particularly useful to national planning activities.

In summary, strong researcher-farmer linkage is possible. It increases efficiency of technology development, and can serve as the focal point for extension, university, policy, infrastructure, and international agricultural research network linkages. A strong researcher-farmer linkage, then, can easily be envisioned as being the key ingredient in national agricultural plans for development.

REFERENCES

Byerlee, D. L. Harrington and D. L. Winkelman. 1982. *Farming systems research: issues in research and technology design*. American Journal of Agricultural Economics 64 (no. 5) 897-904.

Gostyla, L. and W. F. Whyte. 1980. *El ICTA en Guatemala: la evolución de un modelo de investigación y desarrollo agricolas*. Rural Development Committee. ARE no 2. Cornell University. Ithaca, New York.

Hildebrand, Peter E. 1981. *Motivating small farmers, scientists and technicians to accept change*. Agricultural Administration 8 (1980-81) 375-383.

Hildebrand, Peter E. 1984a. *Modified stability analysis of farmer managed, on-farm trials*. Agr J 76 (March - April) 271-274.

Hildebrand, Peter E. 1984b. *Summary of FSR/E participant, activities, products and time frame*. Farming Systems Support Project Newsletter. Vol 2 No 1. University of Florida, Gainesville.

McDermott, J. K. and D. Bathrick. 1981 *Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and its impact on agricultural research and farm productivity*. US Agency for International Development, Washington DC.

Shaner, W. W., P. F. Phillip and W. R. Schmehl. 1982. *Farming systems research and development, guidelines for developing countries*. Westview Press, Boulder, Colorado.

Wake J. L. 1984. *The cost of learning by doing effect on technology adoption*. MS thesis, University of Florida.

Whyte, W. F. and D. Boynton. 1983. *Higher-yielding human systems for agriculture*. Cornell University Press, London and Ithaca.

ORGANIZATION OF AGRICULTURAL RESEARCH IN THE NETHERLANDS WITH SPECIAL REFERENCE TO POTATO RESEARCH AND FARMERS' PARTICIPATION

D. E. van de Zaag

Research Coordinator
Wageningen, The Netherlands

INTRODUCTION

At the request of the organizers of the workshop on "Agricultural Research Policy and Organization in Small Countries," the organization of agricultural research in the Netherlands will be discussed in general and, in particular, the organization of potato research as a case study. Special attention will be paid to the participation and involvement of the various branches of the potato industry (such as growers, breeders, merchants, and processors) in potato research activities and policy, and to the application of research results in practice. Before doing this, it may be necessary to explain why, from all research activities, potato research has been especially chosen as a case study. Three reasons can be given:

1. The importance of the potato crop in the Netherlands

The potato has been an important crop in this country for many decades and in the last two decades it has become even more important. There is no other country in the world where 25% of the arable land is cropped with potatoes, and where almost 50% of the income of farmers with arable land is derived from this crop. Moreover, about two thirds of the total production (seed, food potatoes, and potatoes for starch production) is exported in fresh or processed form, so that both production and research have become somewhat internationally oriented.

Since the 1920s, research has played an important role in potato improvement by starting with the well-known research by Dr. Quanjer and Dr. Oortwijn Botjes on potato virus and on the role of aphids in virus transmission.

Although it is difficult to prove, it is my opinion that the strong position of the Dutch potato industry today is due to the well-developed potato research program in this country, and to the strong involvement of growers, breeders, merchants and processors in potato research policy.

2. The increasing importance of the potato crop in many developing countries

The increasing importance of the potato in developing countries is shown in Figure 1. During the last 15 years, total production has almost doubled due to an increase in yield per hectare and to an increase in the area cropped with potatoes. Moreover, the increase in edible energy and protein yields per hectare for potatoes was somewhat higher than that for wheat or rice (Figure 2), despite the green revolution in wheat and rice varieties.

3. Organization of potato research and the participation of the potato industry

There is no doubt that of all agricultural research activities in the Netherlands, the participation of the potato industry in potato research has been greater than that for other crops or other fields of research.

ORGANIZATION OF AGRICULTURAL RESEARCH

As there is no time to give detailed information about the organization of agricultural research in general, I will confine myself to an outline sketch of this research, accepting the risk that in some places the picture might be slightly distorted. However, this can have an advantage in that the reader may get an overall picture of the organization more readily when not distracted by details which are not important for our purpose.

Figure 3 is an attempt to give such a draft outline of the organization of agricultural research, and I would particularly draw your attention to what has been described in Figure 3 as the main characteristics of research. These characteristics emphasize perhaps too strongly the differences between some departments of the Agricultural University and the related research institutes.

Experiment Research Stations are usually situated in a main area of crop production. They are commodity or farming type oriented, and deal with aspects of a specific branch or sector of agriculture. Staff and activities are half financed by the Ministry of Agriculture and Fisheries and half by farmers' and growers' organizations. The financial contribution by farmers and growers gives them a great influence in the selection of research projects.

The station can rely on specialized research institutes for long-term projects and more specialized subjects such as plant breeding, crop protection, agricultural engineering, soil fertility, etc. The management of the institutes (and also of the stations) is governed by a board of which several members are appointed by national agricultural organizations, to promote an appropriate level of input in the selection of research projects. In some cases, organizations contribute financially to specific research projects (up to 10% of the total budget), but in general, the budget of institutions is fully financed by the Ministry of Agriculture. The staff of the stations and institutes have the status of public servants.

The Directorate for Agricultural Research of the Ministry of Agriculture and Fisheries coordinates the activities of the institutes and stations. Departments of the Agricultural University are primarily established for education and basic research, but often staff members also deal with applied research. The university is fully financed by the ministry. In all types of research establishments, research is dedicated not only to the needs of the agricultural industry, but also to the benefit and welfare of society.

In order to provide channels for liaison between departments, industries and stations, the National Council for Agricultural Research was established. All aspects of the agricultural industry, the Advisory Service, the Ministry of Agriculture and other organizations interested in research are represented in the National Council. Apart from the task of promoting contact between scientists at the bench, the council makes proposals for a national plan for all agricultural research to the ministry.

The national plan is implemented by means of programs in which new perspectives for research and the possibilities for, and problems of, agriculture are kept in balance. When planning programs, those who lead research and those who use it are always kept in close contact. In the following section, this mutual influence of practice and science in regard to the potato will be discussed in more detail.

POTATO RESEARCH

Potato research institutes, where most of the potato research of a country is concentrated, do not exist in Western Europe or in North America. This is in contrast to most countries in Eastern Europe, where such research institutes do exist, e.g. DDR, Poland, USSR, and CSSR. The Central Potato Research Institute in Simla, India is also well known. In the Netherlands, there are some 30-35 scientists, mainly concentrating on potato research, who are employed in 3-4 departments of the University, 8-10 research institutes and one experimental station. The advantage of this system is that they can do their research in close cooperation with their colleagues working in the same field of research or discipline, such as crop protection, breeding, physiology, etc., and that they can use sophisticated equipment that has been developed for specific research disciplines.

The disadvantage of the system is that because the potato research workers are divided over many research institutions, close cooperation between them is hampered and the essential cross-disciplinary research is not stimulated, even when the majority of the research institutions are located in the same place, Wageningen. Moreover, the participation and involvement of the various branches of the potato industry in potato research are much more difficult to organize when the research is divided over so many institutes.

In what way can the disadvantages of a system without a central potato research institute be removed? I believe that we have been successful in this respect by establishing two institutions in the Netherlands:

- A committee (Dutch Potato Association – DPA) in which the various branches of the potato industry are represented. The DPA advises the National Council for Agricultural Research and the board and directors of the research institutions on potato research;

- A staff member of the Directorate of Agricultural Research, who is responsible for the coordination of all potato research.

4. To advise special funding agencies of the potato industry about financing special potato research projects.

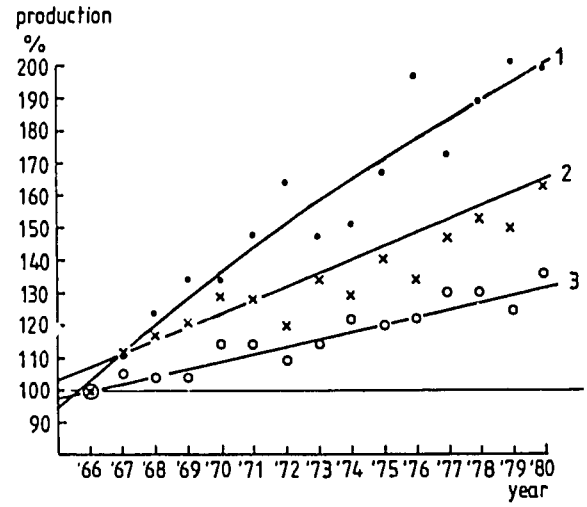
DUTCH POTATO ASSOCIATION

The DPA consists of:

- Four representatives of the growers (seed, food potatoes, potatoes for the starch production, and growers' organization);

Fig 1. Development of the total production of (1) wheat (•), (2) rice (x) and (3) maize (o) in developing countries with market economies.

1) $\hat{y} = 45.89 + 4.2206x - 0.0546x^2$
   $(100 = 48.2 \times 10^6\ t)$
   $r = 0.96$
2) $\hat{y} = 139.45 + 4.48x$
   $(100 = 133.7 \times 10^6\ t)$
   $r = 0.92$
3) $\hat{y} = 59.13 + 1.39x$
   $(100 = 60.4 \times 10^6\ t)$
   $r = 0.95$



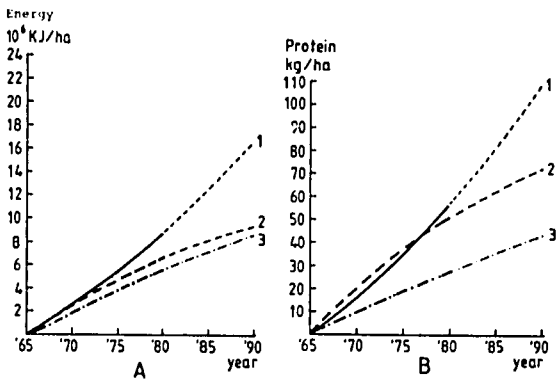


Fig. 2. Accumulated calculated increase in yield expressed in terms of energy (a) and protein (b) for (1) potatoes, (2) wheat, and (3) rice (70% edible) in developing countries with market economies (Van der Zaag & Horton, Potato Research 26 (1983): 323-362).

Fig. 3. Sketchy outline of agricultural research in the Netherlands

	Research institutions		
Type:	Agricultural University	Research Institutes	Experimental Research Stations
Number:	1	22	10
Basis of the organization:	Research disciplines	Research disciplines	Farming types
Place:	Wageningen	Mainly Wageningen	Production regions
Main characteristics of research	1. More basic than applied research.	1. More applied than basic research.	1. Applied, adapted and on-farm research.
	2. Determined by training students.	2. Participation of government and interested organizations.	2. Strong participation of growers.

- One representative of the breeders (in the Netherlands there are many private breeders);
- Four representatives of the merchants (seed and ware, export and inland, wholesale and retail);
- Two representatives of the processors (starch and derivates, and processed products for human consumption);
- Two representatives of the Potato Marketing Board (Produktschap voor Aardappelen);
- One Director of the Inspection Service (NAK);
- One Director of the Plant Protection Service (PD);
- One representative of the Ministry.

The chairman of the DPA is the coordinator for potato research, and the secretary is the senior potato specialist of the Research Station for Arable Farming and Field Production of Vegetables.

The main tasks of the DPA are:

1. To advise the National Council for Agricultural Research about potato research;
2. To advise the boards and directors of the research institutions about potato research in their institutes or stations;
3. To draw the attention of the Advisory Service or of the potato industry to specific developments in the crop;

This task is executed by:

1. One annual meeting to discuss all aspects of potato research, including the appointment of the money spent on the various fields of research (see Table 1);
2. One annual meeting (1 or 2 days) where one of the four fields of research (breeding and varietal assessment; plant protection; crop husbandry including physiology, etc.; storage, quality, and processing) are discussed in extenso with the Directors and senior research workers of the institutions concerned (including departments of the University);
3. Discussion of relevant topics in special meetings;
4. Preparation every five years of a report about developments expected in the potato crop which may need special research attention.

To execute these activities, it has been shown to be extremely important that the secretary be a senior potato specialist well informed about potato research, about the Advisory Service and about practical developments. The DPA has the advantage that the chairman, who is also coordinator of potato research, is also well informed about what is going on in research.

In the activities of the DPA, the translocation or the formulation of wishes of the potato industry into research projects have never been a problem. We are aware that this is also due to the choice of the right secretary and chairman.

COORDINATOR OF POTATO RESEARCH

One of the staff members of the Directorate Agricultural Research is responsible for the coordination of potato research acts through:

- The DPA, of which he is the chairman;
- Contacts with the directors and research workers of the research institution where potato research is done;
- The establishing of working groups, in which potato research workers usually of different disciplines work together on specific topics such as "Growth vigor of seed potatoes," "Effect of water supply on yield and quality," and "Use of true potato seed." There are in total eight such working groups of which the coordinator is the chairman. He can only do this work as long as he is recognized as a potato specialist.

Is potato research in the Netherlands in balance with, or adjusted to, the problems and possibilities which exist in the field of the potato crop?

It will be difficult for me, so closely connected with this work, to give an unbiased answer to this question. Nevertheless, I dare say that in general the potato research program in this country is well balanced, and by this I mean that the research projects reflect reasonably well the problems and possibilities of the potato industry.

This is achieved by:

1. The interest of the directors and research workers in what is going on in the potato industry. The fact that several research workers have been born on farms may affect their attitude;
2. The influence of the members of the board of those research institutes where potato research is a substantial part of their whole research program;

Table 1: Budget of Potato Research by the Ministry of Agriculture and Fisheries, in Millions of Guilders.

Year	1974	1975	1976	1977	1978	1980
Total	11.2	12.1	13.1	14.6	15.4	18.0
Percentages						
Breeding and varietal research	26	29	30	28	29	33
Soils and fertilization	3	4	6	6	6	6
Crop husbandry and physiology	11	9	10	12	12	12
Mechanization, labor and economy	4	4	2	4	6	4
Diseases and pests	17	18	16	14	15	16
Storage and processing	39	36	36	36	32	29

3. The influence of the DPA and the potato research coordinator on the research program.

It is extremely difficult to weigh these three effects. In my opinion, the influence of the DPA in combination with the research coordinator can be rather strong, because of the interest of the research workers in solving problems which exist in practice, and of the interest of several board members of the research institutes in potato research. Two examples will be given to demonstrate the influence of the DPA on potato research.

1. The distribution of funding from the Ministry of Agriculture and Fisheries for the various fields of research is given in Table 1. In 1977, after long discussions, the DPA decided that research on special aspects of diseases and pests and on breeding should be extended and that research on storage and processing could possibly be slightly decreased. Table 1 shows the effect of this advice to the National Council for Agricultural Research.

2. About five years ago, the DPA discussed all aspects of the research on the potato cyst-nematodes. The conclusion was that the chairman/research coordinator should establish a working group of scientists working on this pest. The first task was to prepare a survey of, and recommendations for, urgent research on potato cyst-nematode. The recommendations were accepted by the DPA and resulted in an extension of this research with two research workers and four technicians, of which the two scientists and three technicians are paid by funds provided by the potato industry.

The adaptation of research results before introduction into practice, and the introduction and application of these results into practice

Research results which are important for growers and which can be applied without further experiments on farms are introduced into practice by:

- the National Advisory Officers via the regional Advisory Service;
- the potato specialists of the Research Station for Arable Farming and Field Production of Vegetables via the regional Advisory Service.

If the research results of the University or of the research institutes need further research on farm level and/or need some adaptation before introduction on farms, this is done by the potato specialists of the respective research stations. It is done on the experimental farms of the research station, or on the regional experimental farms, or in commercial farms, depending on the nature of the problem. Research results to be applied by merchants and processors are usually introduced to these branches by the Institute for Research on Storage and Processing of Agricultural Produce (IBVL).

The introduction or adaptation of research results do not present problems. In general, we are more afraid of a too rapid than of a too slow introduction of new findings into practice. Of course, there are exceptions. Years ago, the

DPA stimulated research on the control of groundkeeper potato plants. Research institutes found it difficult to develop techniques for controlling groundkeepers. But in the end, the techniques which were developed proved too difficult to introduce into practice on a large scale, mainly because the growers were insufficiently conscious of the danger of groundkeepers in transmitting diseases or pests from one season to another.

Comparison of the participation of the potato industry in the Netherlands with that of other countries

It is risky to compare the participation and involvement of the potato industry in potato research in the Netherlands with some other European countries without any special study. What is said here must be considered therefore as a personal opinion based on few observations. Potato research in the UK is in general of a high standard, but I believe that the link with the potato industry is far less developed in UK than in the Netherlands. This may be due to the organization and possibly also to the tradition of the research workers to be scientists first and foremost.

In the Federal Republic of Germany and in France, the participation and involvement of the potato industry is also less developed than in the Netherlands.

In Italy, Spain, and Portugal, the importance of potato research is so small, despite a large potato production, that it is difficult to talk about farmers' participation in potato research in these countries.

In the USA, especially at the land grant universities, potato research is strongly adjusted to the problems and potential of the potato crop in the relevant state. So far as I have seen, this is not due to an intensive participation of the various branches of the potato industry in the potato research policy but more to:

1. Financing special research projects (State Potato Committees);
2. Extension officers working usually in the same university and even the same departments as the research workers. The combination of research and extension is gratifying.

In developing countries, the success of national potato program depends largely on the degree to which these programs are adjusted to the problems and possibilities existing in potato production and consumption. In most of these countries, it is difficult to attract the attention of potato growers to research programs. It is then the task of the leader of the program and its research workers to be well informed about what is going on in practice. This is often insufficiently understood, which is one of the reasons why the results of so many programs are rather poor. However, Colombia is a country with a very successful potato program. During the last two decades, potato production in Colombia has tripled (Figure 4) and consumption per capita doubled (Figure 5). It may be

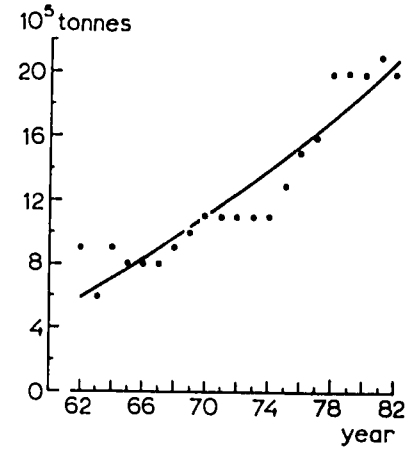


Fig. 4. Development of potato production in Colombia.

$\hat{y} = 0.397x - 0.00791x^2$
$r = 0.992$

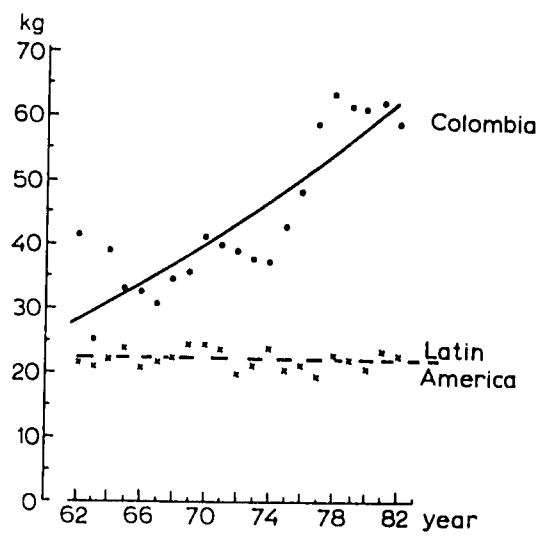


Fig. 5. Calculated consumption per head in Latin America and in Colombia.

Latin America:
not significant.
Colombia:
$\hat{y} = -0.5x + 0.01539x^2$
$r = 0.99$

assumed that the National Potato Program, which started in 1952, has everything to do with this success. At the moment, 12 research workers belong to the program, and about 26 research workers, who have as their main task potato research, are located at various institutes, but their potato research is coordinated by the program. Varieties which have been bred by the program are grown on 80% of the area cropped with potatoes. It is my opinion that the well-balanced research program, which is well adjusted to the problems of practice, and the well-established links with the Advisory Service (in the same organization), are the secret of the success of potato production in Colombia.

CONCLUSIONS

1. The success of potato production in a country is determined by the degree to which a well-balanced research program can be established and executed.

2. The participation and involvement of growers, breeders, merchants, and processors is important to achieve such a well-balanced program.

3. If this participation of the potato industry is not possible, it is extremely important to incorporate one or two potato specialists in research management, who are well informed about potato research and about what is going on in the potato industry.

4. In the Netherlands, it has been proven that the special committee, in which the various branches of the potato industry are represented, can play an important role in increasing the participation and involvement of the potato industry in research.

The success of such a committee depends largely on:

- The interest and capability of the members of the committee;

- The capability of the secretary and chairman to act as liaison officers between science and practice;

- The degree to which the directors and research workers are interested in solving practical problems.

RELATIONSHIPS BETWEEN RESEARCH, EXTENSION AND FARMERS IN A SMALL DEVELOPING COUNTRY: THE CASE OF RICE IN THE DOMINICAN REPUBLIC

F. Doorman
CENDA, Santiago, Dominican Republic

and

F. Cuevas Pérez
ISA, Santiago, Dominican Republic

SUMMARY

In this paper, we will elaborate on the relationship researcher-extension agent-farmer in rice cultivation in the Dominican Republic. After a brief general description of rice cultivation and research in the country, we will indicate how these three parties view their contribution to increasing production levels in rice growing. We will point out that the objectives of the system of generation and transfer of rice technology are determined almost exclusively by national interests, and not by farmers. The latter lack ways of indicating their needs and priorities to rice researchers, as a result of which the system of generation and transfer exists as a one-way flow of information only: from the research institute, via the extension service, to the farmer.

Nevertheless, recently farmers' interests have been taken more into account in Dominican rice research. We will present two examples of this phenomenon: ratooning and sowing out of season. Ratooning, or obtaining a second crop from the stubble of the first one, is used as an alternative for double cropping by a considerable number of farmers. Although yields of a ratoon are lower than those of a sown crop, profitability for the farmer is usually higher because of low production cost. Also, a number of bottlenecks in the production of a sown crop can be avoided. Therefore, ratooning can be considered as an efficient production system within a context of a number of constraints limiting the practice and profitability of double cropping.

Sowing out of season, that is, in months where unfavourable conditions are liable to reduce yields, is a practice widely encountered in the rice producing region of Nagua in the north-eastern part of the Dominican Republic. Unlike ratooning, farmers do not have a preference for sowing out of season. They are forced to because of the severe constraints in their production conditions. Due to the magnitude of the problem, as far as the number of farmers affected and yield reductions are concerned, technology directed at decreasing the negative effect of sowing out of season might help to considerably increase production levels in the Nagua region.

What concerns us in the topics discussed above is, first of all, an explanation of the fact that until recently practices and problems of importance to farmers have been overlooked by national rice research. In the second place, we want to indicate how these topics came to be included in rice research efforts after all (albeit on a limited scale), in spite of their earlier exclusion. We will illustrate that, in the case of ratooning, this was due to a personal interest of rice researchers. On the other hand, in the case of sowing out of season, it was the result of directed effort at problem identification among small scale rice farmers. We will conclude by expressing the hope that in the future this latter approach will gain a certain degree of acceptance in setting priorities for agricultural research.

INTRODUCTION

Rice is the most important staple in the Dominican Republic. In area sown, production value and labor, and capital invested, it is second only to sugarcane (SEA 1981, page 5). According to Corderro (1978, page 1), some 98% of the physical rice area is officially classified as irrigated. However, about one fourth of this land has such a poor irrigation infrastructure that rice grown on it would be better defined as upland rice grown under favourable conditions. In 1983, 99,733 hectares were sown with rice (Cuevas Pérez, 1983). On a physical rice area of 90,400 hectares, this implies that the average number of cropping cycles for that year was only about 1.10. This figure indicates that double cropping is more the exception than

the rule. This is surprising, considering the fact that the larger part of the rice area is dedicated exclusively to the cultivation of this crop.

In certain regions of the country, ratooning is practiced instead of sowing a second crop. In 1982, about 12,000 hectares were ratooned, almost 20% of the 62,000 hectares sown during the first cropping cycle. If one were to consider a ratoon as a second crop, the average number of cropping cycles in 1982 would amount to 1.24.

About half of the physical rice area in the Dominican Republic is in the hands of the Dominican Land Reform Agency. In the years 1975-1982, an average of about 35% of total national rice production was grown on Land Reform farms (Cuevas Pérez, 1983). According to data of the 5th Agricultural Census, held in 1971, about half of the area under irrigated rice cultivation in the Dominican Republic consisted of farms smaller than 100 tareas (about 6 hectares). Thus, it may be stated that an important part of Dominican rice production takes place on small farms.

Since the 1960s, rice research has been conducted at the Centro de Investigaciones Arroceras (CEDIA), located near the town of Bonao in the fertile lands of the central region of the Dominican Republic. Rice breeding has been the most important and successful component: at present, major areas are sown with locally released varieties such as Juma 57, Juma 58 and Juma 60. Apart from these varieties, a package of recommendations was developed, based on the sowing of two crops per year, and including an ample use of modern inputs such as fertilizers, pre-emergent herbicides, fungicides, and insecticides.

Recommended sowing dates are the months of December and January for the first cycle, and June and July for the second. The rationale behind these dates is to avoid the unfavorable climatic conditions by which rice sown in the August to November period is affected.

In spite of the existence of the high yielding varieties and the aforementioned recommendations, national rice yields have remained somewhat below expectations. In 1982, an average of 3.6 tons of paddy per hectare was obtained. In comparison, countries such as Colombia and Venezuela had already harvested an average of 4.2 tons and 3.9 tons respectively in 1975 (Scobie & Posada, 1977, page 134).

Nevertheless, there has been a fairly continuous increase in yields since the sixties. In the last decade, yields increased from an average of 2.98 tons of paddy per hectare in the 1973-1977 period to 3.33 tons in the 1978-1982 years, an increase of 11.6%. Although no systematic research has been carried out to explain this fact, there is good reason to assume that it is a result of the combination of improving production conditions (water management, machinery, and credit) and the, albeit partial, adoption of the new technology package developed by CEDIA. By now, the use of new varieties and modern inputs such as fertilizer, herbicides, and pesticides is predominant, both in small and large scale rice cultivation.

However, in spite of these improvements, constraints in production conditions still form a major impediment to raising yields to the desired levels. This is especially valid in the small farm sector, as will be indicated below.

The relationship researcher-extensionist-farmer

Apart from the rice research institute, there is another government institution exercizing a major influence over Dominican rice cultivators. This is Fomento Arrocero, the department of the Ministry of Agriculture which directs the implementation of rice production policies in the Dominican Republic. This department basically defines the technological package to be demonstrated to farmers and, to a lesser degree, influences research topics.

Priorities for research are set in accordance with one of the principal objectives of Dominican agricultural policy: the attainment of self-sufficiency in rice production. As a consequence, ever since its foundation in 1963, CEDIA's research efforts have been directed at raising production levels as rapidly as possible. The institute aimed at the creation of a technological package, based on high yielding varieties, to increase national rice production. It was assumed that farmers would automatically adopt and benefit from this package. However, consultation with farmers or their representatives was and is minimal and certainly not institutionalized. Direct contacts between farmers and researchers are infrequent, and take place almost exclusively on field days in which research results and demonstration trails are presented to audiences of extension agents and selected farmers. However, in these cases communication is also limited to a one way flow of information: the scientist comes to teach and demonstrate, not to listen. Comments or criticism by farmers are usually treated in a defensive manner, rather than as a basis for dialogue on the latter's problem as the following example indicates.

> On a field day in which a number of recommendations were given on fertilization, the scientist involved advised farmers who transplanted mechanically to administer the first application at three days after transplanting.
> A (large) farmer remarked that in his fields that

> would be impracticable, because 3 days after transplanting the first seedlings, he would still be planting in other parts of his fields. The researcher, rather than entering in a dialogue with the farmer to obtain more information on the problem or to find a solution to it, merely responded that larger transplanting machines would shortly be available. These could do the job more rapidly, so that it would still be possible to follow his recommendation (CEDIA, 1984).

As in the case of researcher and farmers, the communication between researcher and extension agent is also characterized by a one-way flow of information. As far as new technology is concerned, extension agents are kept "up to date" in courses which are occasionally taught by researchers. For the rest, contacts between researchers and extension agents are virtually non existent. In fact, even in the one-way flow of information described above there are problems. Frequently, research results are transferred to extension agents either not at all, or only partially, or in a distorted form.

> A striking example of the latter is that for several years now extension agents all over the Dominican Republic have been using a standard formula for fertilization. Nevertheless, the Taiwanese expert on soil fertility, who has been working at CEDIA for over ten years, did not even know of this standard recommendation.

These kinds of problems may be due to the fact that Fomento Arrocero plays a major role in extension agents' on-the-job training. It seems that the translation of research results into recommendations is mainly done by this department, with insufficient consultation of CEDIA scientists. On the other hand, the latter could perhaps be blamed for a lack of initiative in preparing the results of their research for dissemination.

The third relationship to be examined is the one between extension agent and farmer. In this case, communication is also mainly a one-way process. Extension agents transmit the recommendations of CEDIA's technological package to farmers, who may or may not adopt them. As explained above, these recommendations supposedly apply to all of the Dominican Republic, without taking into account the considerable differences between different rice producing regions as far as climate, soils, and infrastructure are concerned. As a result, the recommended technology is not always applicable for farmers, or may not be the best alternative from a farmer's point of view. The latter is reinforced by the different objectives of farmers and the originators and transmitters of the technology package. The former strive for a maximum income with a minimum input, while the latter aim at maximum production levels. These conflicting objectives are most apparent in the practice of ratooning, as opposed to double cropping, one of the cases to be discussed in this paper.

As a consequence of the above, farmers are not too receptive to recommendations made by extension agents. Usually, during field days or visits by extension agents, they will express their admiration for the new practices, and will then reject those they do not consider applicable or profitable under their conditions. This is, of course, noticed by extension agents, who realize that their effectiveness in having farmers adopt CEDIA's recommendations is at best limited. Although they recognize that part of the lack of interest can be attributed to a limited applicability of those recommendations, they also consider most farmers as too uneducated and too traditional, in the sense of resistance to changing their practices, to adopt the new technology.

Leaving aside the validity of this latter assumption, it does seem clear that extension agents are in a difficult position. They find themselves in a situation in which they have to transmit a message with limited applicability, the contents of which they are unable to influence, and in which their clients are not interested.

In conclusion, the state of affairs in the Dominican system of generation and transfer of new rice technology may be summarized as follows:

1. Priorities in rice research and extension of its results are determined by national policy, with virtually no direct influence from farmers or their representatives;

2. Communication between the three parties involved, researchers, extension workers, and farmers, consists of a one-way flow of information. There is little or no institutionalized feedback from the farm to the research station, neither directly nor indirectly via the extension service;

3. On the part of rice research, this lack of feedback has led to a focus on a number of specific topics and the exclusion of others. In the following, we will discuss two of the latter, the way they were identified, and their relevance as subject matter for rice research.

CASE 1: SOWING OUT OF SEASON

The problem

The technological package developed by the rice research institute, CEDIA, is based on the concept of double

cropping. With this purpose in mind, it is recommended that the first cropping cycle be initiated in the months of December of January, and the second one in June or July. In this manner, sowing in late August, September, October, or November is avoided. Establishing crops in these months has been proven to result in significant yield reductions, due to low temperatures and lack of solar radiation in the winter months, and the effect of strong winds in January and February. The latter affect the rice plants at the flowering stage and result in a high percentage of unfilled spikelets.

Although farmers recognize that sowing out of season results in lower yields, it is nevertheless a widely encountered practice in the area around the town of Nagua, in the northeast of the Dominican Republic. According to data from a survey executed in 1983 (1), some 60% of all second cropping cycles of 1981 and 1982 were sown out of season. This led to average yield reductions of some 15% as compared to crops sown in season (before mid-August) in those two years (Table 1). The figure of 15% is of course indicative: factors other than those associated with sowing in or out of season may also have influenced these differences. Nevertheless, in trial research executed in 1982 (2), yield reductions averaging some 20% were obtained for the most widely used varieties in the Nagua region, thus validating the survey data.

Considering these losses, and farmers' awareness of them, why do the latter still establish crops after mid-August? The answer is simple: because they have no alternative. The region faces two major problems in rice production: periodic shortages of irrigation water, and a very limited availability of machinery for land preparation. Both problems result in delays of weeks, or sometimes months, in establishing the crop. Farmers have to wait for the tractors to prepare their land or the water to irrigate their plots during the final stages of land preparation (puddling) and transplanting. Moreover, the insufficient water supplies make farmers wary of sowing before or during the dry months of February and March. The preferred practice is to establish the seedbed of the first cropping cycle in March, and transplant in April, with the coming of the rains. Planting in December or January would imply a considerable risk of the crop being affected by drought in its most vulnerable growing stages.

(1) Survey on rice cultivation executed by the Adaptive Agricultural Research Project, CENDA, Santiago.

(2) Trials executed at the El Pozo research station by the Adaptive Agricultural Research Project, in collaboration with the rice research institute, CEDIA, Juma, Bonao, and the Instituto Superior de Agricultura (ISA), Santiago.

Thus, if water and machinery are available on time, the first crop is sown in April, and, if short or medium cycle varieties are used, harvested in July. That leaves precious little time for establishing the second cropping cycle in time, and any delay will result in its being sown out of season.

What, if anything, do farmers do to mitigate the negative effects of sowing out of season? Lesser yields are generally accepted as inevitable, but still, some measures or adaptations are practiced to at least limit these reductions as much as possible. First, farmers generally sow varieties which have been proven to be somewhat less susceptible to the unfavorable climatic conditions of the winter months. One of these is the traditional tall variety "Inglés", which is photosensitive and mature in the month of January.

Some agronomic practices are also applied by farmers. To compensate for reduced tillering, some farmers increase plant density and fertilizer application. Also, seedlings are sometimes planted in an inclined position which, when older seedlings are used which have already formed one or more nodes, leads to the development of several tillers per node. Finally, a solution to sowing out of season may be not sowing at all, but practicing ratoon instead. This way, time is saved by eliminating land preparation and shortening the growing cycle of the second crop. Less water is required, and there is no need at all for machinery for land preparation. The technicians' and farmers' views on sowing out of season are schematically depicted in the diagram overleaf.

What does the case of sowing out of season indicate? First of all, that some of the recommendations developed at CEDIA are not feasible for farmers, either because there is too much risk involved (as in the case in starting the first cropping cycle in December/January), or because farmers simply cannot adhere to them since they lack control over specific production conditions.

In the second place, it is apparent that problems resulting from a lack of production conditions are not perceived by rice researchers, at least not as problems to be investigated. Recommendations for the optimum sowing date exist, but when farmers are forced to sow after this optimum, there is no advice available.

Thirdly, both the above mentioned problems seem to result from a lack of communication between farmers and investigators. There is little or no feedback from the small farm to the research institute. Correspondingly, small farmers' problems are only taken into account if they fit directly into the framework of research priorities as dictated by national policy and perceived by researchers.

Identification of the Problem

The topic of sowing out of season was one of several problem areas identified through the research activities of the Adaptive Agricultural Research Project (3). One of the major objectives of this project was to provide that element in the Dominican system of generation and transfer of technology which had been lacking until then: feedback from small and medium-sized farmers to agricultural researchers. In other words, this was an attempt to change the one-way flow of information, from research via extension to farmers, into a two-way flow, by adding an upward flow from the farm level to the research station.

To obtain information at the farm level, a four-step methodology was used (see Diagram 2). First, through the application of selection interviews, baseline information on rice cultivation and related factors was gathered, and informants were selected who would serve as case studies. Then, in the case study phase, an exhaustive, qualitative inventory was made of farmers' decision-making, production conditions, problems resulting from those conditions, and farmers' solutions (adaptations) to those problems. In a third phase, the main findings of the case study phase were quantified by the execution of a survey among a representative sample of cultivators. And finally, a few selected problems encountered in the case of study phase were evaluated in on-station and on-farm trials, in terms of yield reductions and the effectiveness of farmers' adaptations.

The problem of sowing out of season was identified in the case study phase. During the interviews, farmers consistently reported lower yields in the second cropping cycle as compared to the first one. However, it was not immediately apparent that this resulted from sowing out of season, as farmers reported that the second crop always yielded less than the first one. The reason was, of course, that first cropping cycles were started in March or April, as a result of which second cropping cycles were very seldom started before August. Therefore, Nagua farmers had little opportunity to compare second cropping cycles sown in season with those sown out of season. Thus, although the problem of sowing out of season definitely existed in the Nagua region, it was not conceptualized by farmers as a matter of growing the second cropping cycle in or out of season, but rather as a problem of general reduction in yields in the second cropping cycle.

(3) The project's full name is Adaptive Agricultural Research on Small Scale and Rice Cultivators in the Dominican Republic. It is a joint effort of the Agricultural University of Wageningen, the Netherlands, and the Ministry of Agriculture of the Dominican Republic, with financing by the Dutch Ministry of Development Cooperation. The project has been based in the Centro Norte de Desarrollo Agropecuario (CENDA), Santiago, R.D., since 1981.

From the above, it can be concluded that problem identification at farmers' level through interviewing is not simply a matter of asking what the farmers' problems are. Furthermore, once certain problems are identified in farmers' terms, they have to be "translated" into concepts used by researchers. Thus, on the one hand, there is a need for reliable methods to obtain the information sought after at the farmers' level; on the other hand, sufficient knowledge of both the farmers' and the researchers' interpretations and perceptions is necessary to translate farmers' problems into topics which can be investigated by agricultural researchers.

In the case under discussion, it was possible to identify the problem of declining yields in the second cropping cycle as the problem of sowing out of season. It was recommended that the rice research institute investigate ways to diminish the negative effects of sowing out of season through the development of tolerant varieties. Also, investigating agronomical practices which could compensate for lesser tillering and panicle formation was advised. This research could be partially based on farmers' adaptations: increasing plant density and fertilizer application.

Although rice extension agents and researchers considered ratooning as a backward and good-for-nothing practice, farmers continued to defend it and demand ratooning capacity in new varieties. There was a confrontation between the "official" technical position and the rice farmers of the north-western region.

Extension workers and researchers had to stress government policy: increase rice production to attain national self-sufficiency. In order to produce more rice, it was thought that double cropping the new improved varieties was a must. Since research had already demonstrated the feasibility of increased output through double cropping, extensionists were convinced that it was a matter of continuous pressure to get farmers to use the more advanced, productive technology. The pressure to stop the practice of ratooning had two major characteristics: it was recommended that farmers did not get credit for the ratoon crop, and there was practically no research on the system, so that extension agents did not have anything to recommend to farmers who wanted to ratoon their first crop. The only supporters of the ratoon crop were the farmers, and they were the only ones who knew anything about it.

RATOONING AS A RESEARCH TOPIC

During 1976, we were in the process of releasing the variety "ISA-21", after introducing it from Centro Internacional de Agricultura Tropical (CIAT) of

Table 1: Percentage of Crops Sown out of Season (in Second Cropping Cycle) and Yield Reductions in Two Land Reform Projects in the Nagua Region, Dominican Republic

Project	% of Cropping Cycles sown Out of Season	Average Yields In Season (Tons/ha)	Average Yields Out of Season (Tons/ha)	% Yield Reduction
El Pozo	63.6 (N=283)	3.19	2.78	12.9
El Aguacate	46.3 (N=86)*	1.97	1.40	28.9
Average**	59.6 (N=369)	2.90	2.46	15.2

Notes:

* The number of crops sown out of season in El Aguacate is relatively low since many farmers, because of shortages of water and particularly machinery for land preparation, only sow one crop a year. If this crop was initiated after 1 July and before 15 August it was considered as a crop sown in season in the second cropping cycle.

** Weighed on the basis of total number of second cropping cycles.

Table 2: Yields and Production Costs of the First and Second Crop in 1979 and the First Crop and a Ratoon in 1980, on the Farm of Vasquez Quintero (178.32 ha), Juma Abajo, Province of La Vega, Dominican Republic*

Year	Crop	Yields Ton/Ha	Yields kg/Ha/Day	Production Costs Per Ha	Production Costs per Kg
1979	First Crop	5.01	33.40	791.74	0.15
	Second Crop	4.14	28.55	782.75	0.19
1980	First Crop	3.91	26.06	939.41	0.24
	Ratoon	2.34	26.00	238.05	0.10

Notes:

* Variety "Juma 57".

Source:

Cuevas Pérez and Núñez Jiménez (1981).

Table 3: Costs and Benefits, in RD$* per Hectare, of a Second Crop and a Ratoon in Two Zones in the Dominican Republic in 1983. Based on Data from 184 Farms in the Central Region for the Second Crop**, and 36 Farms in the North-Western Region for the Ratoon

Activity or Input	Second crop		Ratoon	
Land Preparation	195.73		—	
Inputs	366.65		100.33	
Seed		70.28		—
Fertilizer		168.70		79.50
Herbicides		75.68		—
Insecticides		25.92		11.93
Fungicides		20.03		5.72
Raticides		6.04		3.18
Labour	383.52		211.79	
Levelling		83.16		—
Dike Construction		13.20		—
Cleaning of Irrigation and Drainage Canals		33.23		24.96
Sowing/Transplanting		46.59		—
Weeding (Manual)		129.27		134.20
Input Application		78.07		52.63
Harvest	156.93		91.74	
Other Direct Costs	73.30		29.10	
Indirect Costs	12.71		11.45	
Total Production Costs	1188.85		441.41	
Yields (Tons/Hectare)	4.99		3.22	
Price Per Ton	320.00		320.00	
Gross Production Value	1596.80		1030.40	
Benefits	407.95		588.99	

* 1 RD$ = 1 US$

** The data presented are based on those of a first crop. Production costs of a first and second crop are considered equal; for yields, an estimate of 90% of those of a first crop were taken (De Groot 1983, page 10)

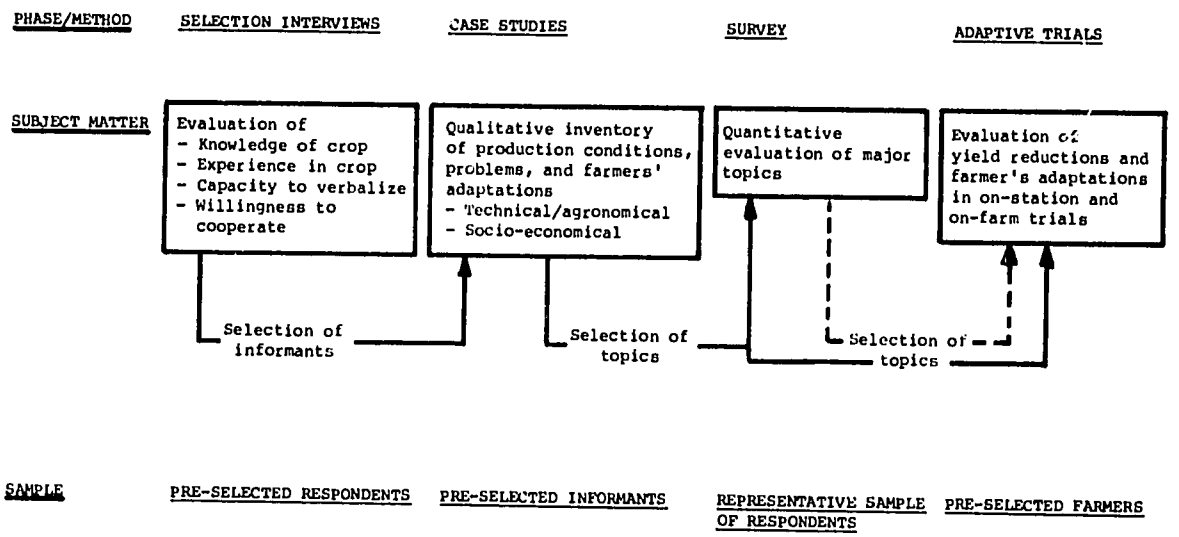


Figure 1. – Methodology used in the AAR project.

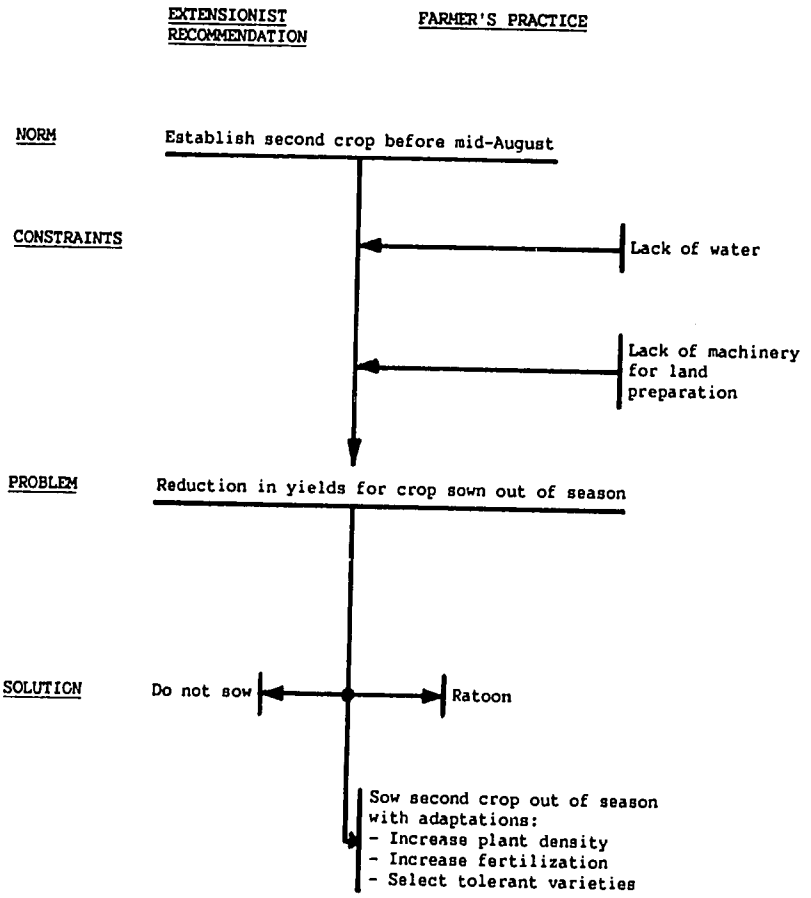


Figure 2. – The problem of sowing out of season as perceived by agronomists/extensionists and by farmers.

Colombia. The farmers that we encountered asked about the ratooning ability of the new variety and, of course, we did not have an answer to that question. So, in order to study that "simple" question, I decided to try ratooning for the first time in my career (Cuevas Pérez and Quezada, 1977). The major objective was to include ratooning ability as a new trait in testing new varieties.

After evaluating ISA-21 for ratooning ability, I decided to look into the literature, since no agronomist was available to assist me in that area. The more I read about it, the stronger was the feeling of ratoon as a second class cropping system. However, the interest of farmers was not forgotten.

Two things helped me to continue my research on ratooning: I was working for the Instituto Superior de Agricultura, an autonomous institution which allowed me to try research topics banned to researchers working for the government; and I left the country to study for a Ph.D, which gave me the opportunity to present a research proposal on ratooning for my dissertation. Since my major was plant breeding, my research was on the breeding behavior of ratooning ability (Cuevas Pérez, 1980). It should be pointed out that most of my colleagues felt that I was working on a very strange topic.

CASE 2: RATOONING

Background

The release of semidwarf rice varieties and their associated technological package (improved methods of land preparation and planting, higher doses of fertilizer, herbicides and pesticides) became the central paradigm of increased yields for Dominican rice workers in the early seventies. It was demonstrated, by several cycles of research, that the adoption of the new package could significantly increase farmers' output and profit. Rice farmers were encouraged to change their traditional, tall, high lodging and heavily mixed varieties for the new improved types, which were more responsive to improved cultural practices.

Farmers questioned the higher investments required and the sensitivity of the new varieties to poor land preparation and weed control. Those questions were generally answered by trying to provide better credit facilities and by making machinery available. The improvement of general farming conditions was started. The adoption of the technological package was slow but consistent, usually associated with improvements in irrigation, drainage, and credit facilities.

It was observed that the adoption of the new varieties was particularly slow in the north-western region. Of special significance was the fact that, although farmers were not planting new varieties, they were using the other components of the new technological package. It was thought that farmers' reluctance was a result of not using sites within the region to test the new varieties and that farmers were more "traditional" than those in other regions.

As a result, the new varieties were tested in the north-western region and their yield advantage demonstrated; however, a large number of farmers continued to plant traditional tall varieties. In 1974-75, a new variety was selected by a farmer and was widely adopted throughout the region. The new variety was as tall as the old ones, but still preferred over the improved types. Thus, farmers were willing to change varieties and use the improved practices, but demanded varieties with characteristics which were only offered by the traditional tall ones. The explicit demand was for a variety with good ratooning ability.

Ratooning

The practice of ratooning takes advantage of rice stubble to obtain a second crop, which does not require land preparation and planting. After the "planted" rice crop is harvested, farmers cut the remaining plant parts to a height of 3-7 cm and manage the regrowth as their second crop. Most writers agree that ratoon crop yields are lower than those of the "planted" crop.

After returning to the Dominican Republic, I presented a paper at a meeting in Colombia (Cuevas Pérez and Nónez Jiménez, 1980), which I think documented the farmers' point of view and has contributed to changing the attitudes of Dominican agronomists. In that paper, we demonstrated that farmers insisted on ratooning because it was both more profitable and efficient (Tables 2 and 3).

THE RATOON CROP AND RICE SELF-SUFFICIENCY

The main objection against the ratoon crop is that its lower rice output would make importation necessary. However, it can be argued that to grow a "planted" crop, more imported inputs are needed than to produce rice through ratooning. The data presented in Table 3 will serve as an example. The cost of the second crop of 1983 was RD $1188.85/ha of which 195.73 (16.47%) were spent in land preparation and 366.65 (30.85%) on inputs (fertilizers and pesticides). Both land preparation and inputs have a large component of imported goods such as machinery, fuel,

fertilizer components, and all pesticides. On the other hand, the ratoon crop of the second semester of 1982 had a cost of RD $441.41/ha, with no costs in land preparation and only 100.33 (22.58%) spent in imported inputs. On the basis of these figures, the discussion on ratooning should consider whether importing machinery and agrochemicals is more desirable than importing the amount of rice which would have been produced if a second crop had been planted. Table 3 shows that the ratoon crop yielded about 65% of the second crop, which was sown in season. The average yield difference between a ratoon and a second crop will probably be even less in those regions where sowing out of season is more frequent (see Case 1).

In spite of the arguments put forth above, ratooning is still seen as an impediment to obtaining self-sufficiency in rice production. Although researchers and extension agents now better understand the farmers' point of view, ratooning continues to represent a topic of confrontation between farmers and the official technological package.

GENERAL DISCUSSION

Rice research in the Dominican Republic has basically been done by the government, with the objective of attaining national self-sufficiency. This approach has obviously had to select investigation in topics with the highest impact on national rice productivity in the short term. This method has been partly successful. However, it has also led to the exclusion from agricultural research of topics that are of interest to farmers. Of the two cases presented here, one topic, ratooning, has been deliberately left out of rice research. The other case, sowing out of season, has not been recognized as a problem by both researchers and farmers. This is mainly due to the fact that emphasis in rice research has been on the development of high yielding technology under good production conditions, rather than the creation of technology adapted to poor production conditions.

Did farmers come up with a request to investigate the problem of sowing out of season? The answer is no: it was a recommendation made by the researcher who did the problem identification studies, as a result of his analysis and interpretation of data supplied by farmers. The reasons for farmers not coming up with the recommendation are probably twofold.

In the first place, the problem of low yields in the second cropping cycle is considered as a given fact, not as a problem that can be investigated and, at least partially, resolved.

In the second place, if farmers would consider the problem in terms of a resolvable one, they would demand an adjustment of conditions rather than technology. In other words, instead of asking for a variety which would produce well sown out of season, they would demand more tractors and a better irrigation infrastructure as, in fact, they are already doing, and have been doing for a long time.

Is it legitimate for a researcher to offer recommendation for technology development to agricultural researchers, if these do not enjoy the whole-hearted support of farmers and their organizations? In the case of sowing out of season, farmers themselves never came up with recommendations, and their reaction was lukewarm when they were told about them. Does the researcher have the right to offer his solutions to the problems encountered (in this case, adapted technology) rather than those suggested by farmers (improvement of conditions)? (4)

We would answer both questions affirmatively. First, because farmers may not be aware that there might be a partial technical solution to their problems, because they have little basis for comparison. As indicated above, this is at least partially the case in sowing out of season in the Nagua region.

In the second place, recommending to scientists working in agricultural research the farmers' solution for improvement of conditions is of little use. The construction of irrigation reservoirs and canals is not their responsibility, but the business of institutions such as the Land Reform Agency, the Water Management Institute, and the Agricultural Credit Bank. And in the third place, the scientists involved in problem identification have to take into account other aspects than the farmers' interests. A farmer may not be aware of or interested in the fact that the State's financial situation does not allow for any major investments in his region's infrastructure and that consequently other, cheaper solutions must be sought. The agricultural researcher, however, should take into

(4) Important in this respect is that the large majority of the farmers in the Nagua region are Land Reform beneficiaries, and strongly dependent on the State. Since government institutions have monopolized all essential services such as irrigation, credit, marketing, and extension (with the partial exception of land preparation, in which there is a contribution of the private sector), farmers look to the State for the solution of their problems. As farmers see that access to irrigation water, tractors, and credit are better arranged for in other Land Reform Projects or on privately owned farms, they demand equal conditions, rather than technology to alleviate the effects of the constraints in their current conditions.

account how scarce government funds can be spent most effectively, which may imply a less than optimal solution for the farmers who formed the target group of the problem identification research.

CONCLUSIONS AND RECOMMENDATIONS

Through the discussion of two cases, we have tried to illustrate in this paper the relationship between research, extension service and farmers in a small developing country, the Dominican Republic. We have indicated that under a strict mandate from Dominican Republic policy-makers, rice research has been directed toward those areas where quick results in raising production levels were most likely. This has led to the exclusion of other topics of interest to farmers. Two of these topics, sowing out of season and ratooning, were discussed.

It is important to point out the circumstances under which these two cases came to be investigated. On both occasions, they were identified outside of the mainstream of agricultural research by researchers with opportunity and freedom to pursue their own interest. In the case of ratooning, the opportunity occurred within the framework of thesis research and work in a non-governmental institute. In the case of sowing out of season, the topic evolved out of research financed from abroad, with time and resources far above those at the disposal of local Dominican researchers. The latter are bound by the mandate put to them by policy-makers on the one hand, and by limited resources on the other. To include the sort of adaptive research necessary for improving production in ratooning and sowing out of season would either require a considerable expansion of research activities, or the substitution of some of the present research orientations.

Out of the topics discussed above, there is still one more point that comes to the fore: the one-way flow of information from researcher, via extension agent, to farmer. This situation stands in sharp contrast with that in developed countries, where there is intensive dialogue between the three parties. For instance, as was indicated in other sessions at this seminar, potato far[illegible]s in the Netherlands exert a major influence over research programs. In contrast, in the Dominican Republic, the farmer does not suggest. He listens, looks, and then accepts, adapts, or rejects. Small Dominican farmers screen the new technology, but do not participate in its generation, neither by asking for research on specific topics, nor by actively discussing its merits and drawbacks. The only feedback researchers receive is indirect: the total, partial or non-adoption of the new technology.

We believe that adaptive research, directed at improving production under current, less favorable conditions, might yield considerable benefits in countries such as the Dominican Republic, both at the farm level and the national level. However, to be successful, it must be based on a thorough analysis of farmers' production conditions, needs and wishes. The big challenge is, first, to create a dialogue between researchers and farmers that will result in joint problem identification, if need be, with the assistance of social scientists as in the case of the AAR project. In the second place, the question is how to determine research priorities within the context of the limited resources available. That is to say, on the basis of a dialogue between farmers and researchers, those topics would have to be identified which offer the potentially highest returns both from the farmers' and the national point of view.

BIBLIOGRAPHY

1. Centro de Investigaciones Arroceras (CEDIA). 1980. *17 anos mejorando la producción arrocera nacional.* Secretaría de Estado de Agricultura, Santo Domingo/ Juma, Bonao, Dominican Republic.

2. Centro de Investigaciones Arroceras (CEDIA). 1984. *Eclipse.* vol 1. no 4, page 2. Juma, Bonao, Dominican Republic.

3. Cordero Mora, J. M. 1978. *Areas Arroceras de la República Dominicana.* Departamento Fomento Arrocero, Secretaría de Estado de Agricultura, Juma, Bonao, Dominican Republic.

4. Cuevas Pérez, F. 1980. *Inheritance and associations of six agronomic traits and stem-base carbohydrate concentration on ratooning ability in rice (Oryza sativa, L).* PhD Thesis, Crop Science Department, Oregon State University, USA.

5. Cuevas Pérez, F. 1983. *Informaciones sobre arroz.* Instituto Superior de Agricultura, Santiago, Dominican Republic.

6. Cuevas Pérez, F. and N. Quezada, 1977. *Anotaciones sobre los arroces ISA-21 y ISA-22.* Listín Diario, edition 6 August. Santo Domingo, Dominican Republic.

7. Cuevas Pérez, F. and A. Núñez Jiménez. 1981. *El costo de producción y le eficiencia de retoño del arroz en la República Dominicana.* Instituto Superior de Agricultura, Dominican Republic/CIAT, Cali, Colombia.

8. Doorman, F. 1983. *Adopción y adaptación en el uso de tecnología en la producción de arroz. Resultados del estudio de casos en el cultive de arroz entre pequenos productores en la región de Nagua.* Informe No 1: Aspectos tecnológicos. Versión completa. Inv. Agro-soc. sobre Yuca y Arroz, CENDA, Santiago, Dominican Republic.

9. Groot, J. P. de. 1983. *Cómo evaluar el retoño en el cultivo del arroz.* Centro de Investigaciones Económicas y Alimenticias, Instituto Superior de Agricultura, Santiago, Dominican Republic.

WORKING GROUP 1
RESEARCH POLICY LINKAGES

Participants: W. K. Gamble, N. Collins, S. Qasem, P. St. Clair and E. Trigo

The working group on policy level linkages based its discussion on the presentations made on the first day of the workshop, but also considered the implications for policy-level work of the presentations made in both the sessions on scientific linkages and research-farmer linkages. The group did not concentrate on identifying specific research topics, but on attempting to point to areas where more information is needed and consequently research could be done profitable. The discussion touched on four main areas: research policy formulation, research policy implementation, the minimum system issue, and finally resource acquisition and use.

RESEARCH POLICY FORMULATION

Here the discussion evolved out of the concept that agricultural research and agricultural research policy can not be considered in isolation of the totality of the agricultural system. An effective research policy has to consider all the factors that affect farmers' decisions and at the same time respond to the country's development objectives. In a way, the policy formulation exercise can be seen as a balancing act between these two constituencies. Furthermore, farmers are not an homogeneous category but a highly heterogenous sector and the particular needs and how each grouping behaves with respect to technology have to be carefully considered if the technology generation process is going to be successful.

Within this area, research efforts should focus on:

* the constraints on the performance of the research system imposed by inefficiencies in other components of the agricultural system – credit, inputs, marketing price policies, etc.

* mechanisms to facilitate the participation of the research system in the agricultural policy formulation process.

* mechanism to increase farmers and other sectors participation in the development of agricultural research policy.

The study of success and failure stories was identified as a possible approach to the study of issues in the area of research policy formulation. The study of specific cases could help (a) constraints on the effectiveness of the research system coming from other agricultural policy components and services, and (b) identify mechanisms for increased participation and better flows of information among all the different sectors that should be involved in the policy formulation process; that is planners and policy-makers, secientists, and the users of research.

RESEARCH POLICY IMPLEMENTATION

It was felt that it is not enough to achieve or promote better policy formulation. There is the need to assure congruence between policy direction and the research activities that are actually implemented. Again, here the effort should be in connection with the mechanisms and incentives to guide researchers' behavior in the problem identification and program development processes.

THE MINIMUM SCALE FOR A PRODUCTIVE RESEARCH SYSTEM

The scale problem was extremely discussed during the workshop. As was streesed in the paper by Gamble and Trigo, the basic problem confronting small countries is the conflict between resources and needs; between what a country can spend on research and the magnitude of the research effort it has to undertake to supports its agricultural production and needs. An important element in this conflict is the fact that the research effort can not be taken to be infinitely divisible. Quite on the contrary, there are minimum critical mass requirements in terms of disciplines and human resources that have to be met if results are to be obtained. The magnitude of this minimum critical mass, however, is not known. There have been several intuitive efforts to estimate it but this is not enough. Formal work is needed first to test whether or not there is a minimum size of effort below which no results can be expected and to establish what are the factors that determine what that minimum size should be in each case.

RESOURCE ACQUISITION AND USE

How to expand resources and better use of what resources are available to a national research system was also identified as a crucial issue where more information would be highly beneficial. This was brought to the attention of the workshop by several presentations and discussed at length. The idea of coordination and countries working together to solve common problems or in areas that they can not take up all by themselves appears as one of the alternatives that cannot be overlooked. What is needed in this respect is an analysis of the available experiences, their essential operational characteristics, and whether or not they could be replicated in environments other than those where they originated.

WORKING GROUP 2
SCIENTIFIC LINKAGES

Participants: D. Boynton, C. Panabokke, J. J. Hardon, M. Wessel, G. Van Dijk, P. Zuurbier

DEFINITION OF LINKAGES

"The continuing relationships in which mutual advantages are involved".

SCIENTIFIC LINKAGES

They appear on three levels, at least:

1. Relationships between the international scientific community and the national institutes in the small countries;

2. Relationships between the national research institutes on a bilateral basis.

3. Relationships between the scientists.

POINT 1

What we have:
- centres of excellence where fundamental research is done, located in the larger, richer countries;
- international agricultural research institutes functioning as knowledge brokers;
- national centres in small countries.

One of the main problems is the lack of use for the small countries of the relevant results of supportive research done on other places.

What is needed: to create conditions for successful networks of institutions to improve the linkage between supportive research and its utilization in small countries.

What we know about these conditions is the importance of:
- information transfer and the accessability of that information;
- researchers qualified to select and interpret the supportive research results;
- mechanisms for selecting and transferring information;
- informal communication between researchers.

What we need to know: those specific managerial arrangements that have to be made for linking the international research community and the researchers in small countries.

POINT 2

What we have:
- many small countries familiar with short-term research inputs on national scale;
- existing cooperation of national research centers, on a regional level, around specific problem areas or commodities.

One of the problems is the lack of policy and communication to link the existing national centres within one country, or on a regional level.

What is needed: favorable conditions for transferring non-coupled institutes into mildly-coupled institutes, for information exchange, programming, or even policy.

What we know is the importance of:
- autonomy of researchers and their institutes;
- policy differences between national institutes;
- different environments (political, financial, users) of the institutes.

What we need to know: specific mechanisms favoring the linkages between national institutes within one country, or on a regional level.

POINT 3

What we have:
- All kinds of formal and informal relationships between researchers and research groups;
- All kinds of vertical and horizontal linkages between policy, research management, researchers, and users.

One of the problems is the low efficiency of these linkages.

What we know is the importance of:
- the role of research managers to bring researchers together;
- the role of international courses and seminars to bring researchers and their managers together;
- the capacity of researchers to communicate their research projects;
- the cultural aspects.

What we need to know: the mechanisms favoring inter-researchers communication (training, rewards, career planning, project organization and management, research planning).

WORKING GROUP 3
RESEARCHER/FARMER LINKAGES

Participants: N. Röling, J. Casas, F. Cuevas, F. Doorman, P. Hildebrand, J. van Ruiten and L. Box

WHY ENGAGE IN RESEARCH ON RESEARCH?

The first question to be tackled was introduced by Hildebrand: "Why engage in research on agricultural research?". His point of view was that research on research is an academic activity. What is needed is practical work, from which farmers can profit. Farming Systems Research (FSR) is sufficiently developed to be applied. Farmers can benefit from such work, and are not likely to do so from academic research on research. Casas disagrees; FSR is not as developed as it seems, some of its methods may not be as trustworthy as Hildebrand suggests, and more information is needed about other approaches as well. Social scientists can shed light on the ways agricultural researchers do their work, define their problems and transmit their solutions. Furthermore, he pointed out that the objectives of farmers and farm-workers are not necessarily the same, because of different interests. Researchers must become aware of this. Box concludes that one approach should not exclude the other. Straightforward application of FSR, without adequate evaluative research, may not be good for science, nor for agricultural development. There are serious questions about the relatively quick (and possibly clean) methods with regard to their validity and reliability. Therefore it would be good to know if and how it is possible to make shorter surveys, in contact with farmers, to analyse farmers needs, and to make good proposals for an agricultural policy, research or extension.

On the other hand, one should not engage in research for research's sake. If this new field is to make its case, it is by showing that its conclusions stand the tests for relevance to problems experienced by farmers, researchers, or both.

PROBLEM AREA 1: CONFLICTING INTERESTS OF FARMERS AND GOVERNMENTS

Cuevas introduced the problematic of defining interests of different groups or categories. In particular, the interests of national governments may not coincide with those of particular categories of farmers, as was shown in the case of ratoon cropping in the Dominican Republic. Research should establish both sets of priorities and mediate. Involving farmers in research may allow identification of constraints.

Röling refers to the work by Birgegard on the hierarchization of problems. All categories or interest groups have limited views on the future (researchers not excluded). These different hierarchizations should be transmitted to policy makers, to make them aware of the particular rationality of the groups concerned.

More research is needed on the ways in which problems are defined by different participants in agricultural development, and how these problems can be tackled. Although certain methods and techniques are available, more information is needed on particular cases of successful problem identification and translation into agricultural research programs.

PROBLEM AREA 2: POWER RELATIONS IN RESEARCH PRIORITIES

Röling states that it is one thing to identify the problems, and another to have them researched. The question is: "How can farmers exert some influence on research programs?" Casas refers to the important function of organizations like cooperatives in this respect. In France, he became aware of their importance, since the research-demand function was integrated into these institutions. One might formulate this question in somewhat more general terms and ask: "What have been the cases of technology generation considered successful by both public and private interest groups, and what was the role of farmers' interest groups?" Case studies are suggested for different types of technology generation, involving different types of farmers' organizations. How did researchers work together with farmers' organizations, and on what basis? A distinction is made between special purpose, or commodity oriented, farmers' organizations,

and general interest groups. Case studies are suggested on:

- coffee and rice growers associations in Colombia;
- general purpose organizations in the Dominican Republic and their effects on particular research programs (such as rice);
- cooperatives in France;
- general purpose vs special purpose organizations, and their effects on potato research in the Netherlands.

PROBLEM AREA 3: WHAT IS THE PLACE OF AGRICULTURAL SCIENCE IN SOCIETY?

Agricultural science has not been the object of many studies, compared to other fields of science such as nuclear physics or genetics. Much more is known about technology development in these fields than in agriculture. Nevertheless, great contributions have been made, as was shown by Van der Zaag in his case on potato research in the Netherlands.

One should also be aware of the methods used, and results obtained, in these adjoining fields. Adequate attention should be paid to philosophy and history of science. Paradigms and models operative in agricultural science, and the changes they undergo, are suggested as case studies.

PROBLEM AREA 4: WHAT ARE THE CHANGING RELATIONS BETWEEN RESEARCH AND EXTENSION SERVICES?

Many countries are evaluating their extension services and the programs they have provided. New functions are attributed to the extension services, such as the generation of reverse transfer of information (from farmers to researchers and policy makers).
In what ways can extension services be converted into productive agents of reverse transfer? The case of the Dominican Republic is mentioned as one in which this process is currently taking place.

PROBLEM AREA 5: FARMER-RESEARCHER COLLABORATION IN FIELD TRIALS

The whole area of on-farm trials, adaptive trials, etc., was not discussed due to lack of time. However, it is an area of vital interest. Case studies, evaluating different modes of farmer participation in experimental trials, are needed: conversely, more should be known about possible researcher participation in informal trials performed by farmers.

AGRICULTURAL RESEARCH POLICY AND ORGANIZATION IN SMALL COUNTRIES

Summary of Researchable Topics

L. De La Rive Box, and J. Van Ruiten

Agricultural University
Wageningen, The Netherlands

BACKGROUND

There is still a large number of food deficit countries. Possibilities of expanding agricultural production by bringing more suitable land under cultivation are becoming scarce. Hence, increased food production will largely have to result from improving the yield per hectare, which requires continuous advancements in agricultural production, agricultural policies and appropriate agricultural technology. A special problem is presented by numerous small countries which lack both financial and human resources to attain the research capacity required for national agricultural development. There is growing awareness that standard organizations for agricultural research, characterized by a broad coverage of all or most basic requirements of agricultural production systems on a national basis, are outside the financial reach of many of the smaller countries, now and in the future. There seems to be a general lack of viable alternative research structures appropriate for such situations.

The aim of the workshop on Agricultural Research Policy and Organization in Small Countries (hereafter called the Workshop) was to analyse problems inherent to the development of agricultural research capability. Such an analysis might suggest ways to obtain more systematic information on how agricultural development policies, requirements of agricultural production systems, and avaiable resources, influence the nature of agricultural research systems.

One of the objectives of the Workshop was to produce a list of researchable topics in this field.

The secretariat examined all suggestions made during the Workshop and thereafter. On this basis, we have tried to make a list of issues which satisfy three criteria:

a) Relevance, as evidenced by the fact that they were mentioned by more than one person during discussions;

b) Coherence, or association with the general topics of the Workshop;

c) Researchability, or possibility to formulate it into a way that can be studied, given the present state of knowledge and the resources available.

METHOD USED

The following steps were followed:

1) Two persons kept note of all suggestions made during, and after the Workshop; this provided an initial list;

2) All discussions during the workshop were tape-recorded; we noted from these tapes all suggestions not previously written down. This gave a second listing;

3) On the basis of these two lists, with a total of about 150 suggestions, we selected a number of issues on the basis of the mentioned criteria. This list was discussed with members of the editorial committee and can be found below. We have reduced the list to a small number of topics (13), to make it easier to handle. It was also felt that some consistency was needed between the topics. The authors have therefore taken some freedom in defining the topics.

LIST

Throughout the workshop, participants called for case studies on specific topics. It was felt that very little was known, and that more general knowledge needed to be based on more case studies.

Case studies by themselves, however, may provide data which are not comparable. It is necessary to set these cases in a more general framework, which allows for comparison and analysis.

Therefore, we have defined 13 general topics for research, and indicated the type of case study which could be profitable. It is hoped that such studies can be undertaken by participating institutions, and that the results can be discussed in periodic seminars, in view of comparison and analysis.

TOPIC 1 - REGIONAL NETWORKS

In all research systems, international linkages occur. In the case of small countries, a specific form of international linkage is the regional network, such as the West African Rice Research Collaboration, or the association of Central American and Caribbean countries in CATIE. What were the original objectives of these networks? Under which conditions have they operated? How do participating institutions evaluate the results? Why is it that among European Community member countries a coordinated agricultural research system has not emerged? Case studies could be made of the two networks mentioned, and others like CONOSUR and PRECODEPA. In other words: we must identify and study success and failure cases, to identify possible problems and solutions.

TOPIC 2 - NETWORKS AND IARCS

Most countries have developed some type of contact with an IARC over the past decade. From the perspective of the country, which types of relations (like instruments of communication, coordination and research programming) have proven effective, and which not? The small country perspective is important, since other studies are undertaken through the IARC system from their point of view.

Case studies to be undertaken in the same type of countries mentioned under point 11; possibly even in the very same countries.

TOPIC 3 - BILATERAL ARRANGEMENTS

Many national research institutions have developed bilateral arrangements with research institutions abroad, both for training and for research programs. North American universities, for example, long have had standing programs in South American countries. What have been the results of such bilateral arrangements, when compared to arrangements channeled through IARC's?

Case studies on aspects of this question have been conducted by individual donor countries, but could be complemented to provide a full picture of the effects of particular bilateral arrangements. In this category, the work of foundations and other aid agencies could also be included.

TOPIC 4 - PROBLEM FORMULATION

Before a problem is formalized into a research design, it has generally undergone several stages of reformulation. On the whole, little is known about the ways in which agricultural researchers pick their problems. What are their personal objective? Why have reseachers picked problems to be studied, how has the problem definition changed over time, and what has been the influence of different institutions or interest groups on problem formulation and priority setting? Furthermore, what are the hidden assumptions about the role of the researcher in the different types of research? What is the justification for the different techniques used in assessing the needs of various client groups? How are the interests of governments made to tally with the interests of the different client groups (such as farmers)?

Studies on this problem have been conducted in the US, but would merit replication in other reseach systems.

TOPIC 5 - SOLUTION EVALUATION

The path from initial research finding to final farmer recommendation is a long one. Until recently, evaluations concentrated on the effectiveness and efficiency of unidirectional transfer, such as often is assumed in agricultural extension. Recent experiences suggest that solutions are continuously adapted, and that simple transfer is the exception. In what ways do agricultural researchers interact and communicate with other parties (institutions, interest groups or individual farmers) to adapt their recommendations, and in what ways did this affect their research planning?

Farming Systems Research and Extension studies have examined certain aspects of these questions. Case studies on changes in particular research programs are needed, to see in what ways researchers contributed to the adaptation of their initial recommendations, and in what ways feedback from third parties contributed to changes in research policy or programming. Furthermore, on the policy level, obstacles must be identified which hinder the flow of problems and solutions between the policy and research level. What are the best procedures to suppress these obstacles?

TOPIC 6 - AGROCLIMATIC ZONING

Climatic and soil classification, for relatively small regions, could be a way to focus more attention on to the results of local investigations. It would make comparison of different areas much more useful and realistic. Also, it

could be a base for socio-economic studies. Specially for small research sytems, a generally accepted system of agroclimatic zoning would be an attractive proposition.

TOPIC 7 - PRIVATE OR PUBLIC AGRICULTURAL RESEARCH

Most discussions deal with public agricultural research systems. Both in poor and in rich countries there exists a sizeable, and possibly increasing, participation of the private sector. This participation is mainly confined to high value crops, rather than to basic food crops. What is the division of labor between these two sectors in particular research organizations, and what are the weak and strong points of each, that planners should keep in mind? Which are the policies small countries should follow, to get the maximum benefit from private research and development activities? Or are the only beneficiaries just one or a few enterprises? What does it mean for the type and quality of contacts that a researcher has with the "outside world", and how does this influence his objectives and motivations?

Studies are available on the macro level, especially with regard to the negative effects of transnational companies entering the field of agricultural research and development. Little knowledge hs available on the effects of smaller companies, functioning at the national or local level.

TOPIC 8 - RESEARCH ORGANIZATION IN CAPITALIST AND SOCIALIST ECONOMIES

Most of the literature on agricultural research organization deals with OECD countries, and a few large states in the Third World. Little is known about the Second World. Since many Third World Countries have state-dominated economies, not unlike the socialist countries, more needs to be known about the structure, specific problems and effectiveness of research systems in such countries.

Studies on the larger socialist countries (USSR, China) are available, but material on the different strategies of smaller socialist nations (Poland, Cuba, Hungary) is lacking.

TOPIC 9 - FARMER PARTICIPATION IN AGRICULTURAL RESEARCH POLICY, ORGANIZATION AND EXECUTION

Existing studies suggest that farmer participation is higher in the rich than in the poor countries. Substantial differences exist, however, according to type of research (different crops have different degrees of participation) and to country (high participation among US wheat cultivators). In what ways is the involvement of this particular group desirable and possible, aside from the issues already mentioned under other points? What have been the cases of successful technology generation, and what has been the role of farmers' organizations in this respect? Why is it that in some environments the channels between organized farmers and researchers seem to develop better than in others? Farming Systems Research studies have provided initial clues, especially relating to Latin American research systems. More work is needed on Africa and Asia, and on the rich countries.

TOPIC 10 - MANAGEMENT OF RAPIDLY CHANGING BUDGETS FOR AGRICULTURAL RESEARCH

A number of poor countries have experienced rapid increases in their budgets, through allocations based on loans or gifts. The contrary occurs in many rich nations, where substantial budget cuts are the order of the day. In what ways do especially poor countries or organizations manage these rapid changes and maintain, or improve, the quality of the output?

A paucity of studies in this topic is signalled.

TOPIC 11 - MINIMUM SCALE

Given the limited (financial, human) resources in small countries, what is the minimum scale of an effective research operation, considering the diversity of agricultural production in the topics? In this respect, the following question is relevant: how could lower limits be established in basic and applied research? In addition to fixing lower limits in basic research, it would be essential to ascertain what kinds of such research really need to be done, which is not already available in other countries (see also point 6).

Case studies could be suggested in different types of small countries (rich and poor; small, or very small; agricultural export oriented, or oriented to local markets).

TOPIC 12 - CONVERSION OF EXTENSION SYSTEMS

Many developing countries have invested large sums in the development of agricultural extension systems. The

effectiveness of these systems has been called into question, and presently many states are reviewing their extension systems. One serious question deals with the possibility of promoting reverse transfer of information, from the farmer to those who are in charge of agricultural development. To what extent have successful transformations been made, and what are possible models for cooperation between the research and extension services, considering the important role of private enterprise in many countries? A second question concerns development of farmers procedures to identify and explore new knowledge. Is this possibly an alternative to dissemination of information?

Reseach programs are being developed in the field of extension education; linkage with these programs is called for.

TOPIC 13 - SOCIAL SCIENCE CONTRIBUTIONS TO AGRICULTURAL RESEARCH

Social scientists play an increasing role in agricultural research, both in the generation and in the transfer of technology. Their participation is implicit in many of the previously mentioned points. What have been the contributions made by social scientists, and under what conditions can a profitable integration with technical disciplines take place?

Studies are available on social science contributions in IARC's; much less is known about their participation in smaller scale research systems, for example, in cooperation between experimenting farmers and scientists.