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THE AGRICULTURAL RESEARCH SYSTEM OF PAKISTAN: THE REPORT OF THE MINNESOTA RECONNAISSANCE TEAM

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Minnesota Team
November 30 to December 17, 1981

Summary of Impressions of Pakistan
Agricultural Research Institutions

1. National priorities for research have not been determined on the basis of a carefully considered criteria yet relevant to the needs of the country.

2. Provincial priorities for research, as are national priorities, are strongly influenced by crisis management rather than carefully considered long term criteria.

3. The role of PARC in respect to planning, coordination, evaluation of research and dissemination of information at the national level has not been clearly defined at all levels of the provincial institutes and universities.

4. The organizational structure of PARC is adequate. However, its role as the leading agricultural research organization in Pakistan has not yet been fully implemented nor has efficiency in coordination at all administrative levels down to the various researchers been achieved.

5. Effective linkages between education, research and extension at the various levels -- district, provincial and national -- are weak.

6. There are very few linkages with agro-industry.

7. Physical facilities of research institutions in the form of land and buildings are adequate in most situations. However, equipment for laboratories and field research were seriously inadequate in all but a few laboratories.

8. Operating funds for research activities were limiting in most national and provincial institutions. Excess staffing and limited funds and flexibility in use of funds limit research output.

9. Library facilities were generally lacking and almost totally devoid of current journals at most research institutes and at all agricultural universities.

10. Manpower numbers appear adequate at the B.Sc. level to meet current government openings, but if an active private sector is to develop, greater number will be required. More M.Sc. level graduates are required in certain areas such as economics and pest control. The number of Ph.D.'s being produced both internally and externally is inadequate to meet the research and teaching needs.

11. The manpower shortage is particularly acute in the areas of plant pathology, plant protection, livestock nutrition and management, and production economics.

12. Lack of retention of staff is related to the poor salary structure but the lack of a vibrant, vigorous and stimulating intellectual environment limits both research and teaching productivity and also influences retention.

13. Quality of the students trained at the agricultural universities is questionable, due to lack of adequate basic science background, lack of research facilities, limited availability of current literature and lack of research oriented philosophy and attitude.

14. Managerial skills at all levels of the research system appear to be limiting the growth, development and productivity of scientists.

15. Neglected research topics:

    a. Soil and water management studies must be given high priority. The land and water are Pakistan's greatest natural resource. Desertification, salinization, excess runoff, erosion, flooding all are reducing these valuable assets.

    b. Range management -- studies are needed to develop and better utilize the 70% of Pakistan's land that contributes the least to the agricultural economy at the moment.

    c. Farming systems research is needed to understand current farming practices, to conduct tests and trials under farmers' conditions and obtain farmers' assessments of new technology.

    d. Animal nutrition/management research is limited by number of trained staff.

    e. Small ruminant animal research has received limited inputs and this perhaps is reflected in the high price of sheet and goat meat. The improvement of sheep and goats for milk and wool has not been pursued.

    f. Integrated research of reproductive physiology/epidemiology/management of dairy animals is warranted based on demand for milk.

    g. Long term studies for the genetic improvement of animals should be initiated.

    h. Fruit and vegetable research should be expanded to increase supply for improved diets and as potential export crops.

    i. Some research is needed on improving the efficacy of vaccines.

    j. Production economics and marketing research in almost all crop and livestock commodities is needed by the research institutes.

16. Other agricultural development needs observed:

Support services:

- feed and forage evaluation laboratory.
- soil and fertilizer testing laboratory.
- laboratory equipment repair and supply service.
- pesticides laboratory.
- disease/insect diagnostic services for plants and animals.
- statistical analysis/computer facilities.

Priority Areas Which Should Be Reflected in AID/Pakistan's Programs

Strategies should include the following:

1. Education is the basis for future agricultural capabilities, and the shortage of scientists is a key constraint already. The competency of the teaching/research staff at the universities must be upgraded to produce quality college graduates who will research the problems of the future. Institution building programs particularly for the weaker agricultural universities could make an important long term contribution to the research system.

2. There will continue to be a need for foreign training in the agricultural sciences to support the continued growth of the agricultural research system, but perhaps more importantly to upgrade the local universities capacity to educate young scientists. AID had played an important role in training researchers in the past and should continue to do so in the futire.

3. Pakistan has made substantial investments in land and water development. However, it does not appear that sufficient investment has been made in research to sustain and enhance the productivity of the land and water resources. Salinity, waterlogging and water management in the irrigated areas and erosion and range management in rainfed areas are among the problems that need greatest attention.

4. Most of the relatively easy payoffs to research on the major crops have already been made. Now the research system has to move into areas which are more expensive, risky, take more time before they will pay-off, and a few areas with potentially high payoffs which were neglected for historical reasons. These are research areas which are not easily justified to politicians. Therefore, they are the areas that AID should support in the future because in absolute terms the rates of return will be high although not as high as the previous rates of return from the green revolution. These areas include:

   a) Livestock research seems to fall into the category of neglected areas with high potential. Other donors are active in this area, but its importance in the Pakistani economy suggests that AID should also support research in this area.

   b) Research on rainfed agriculture is in the risky and longer term payoff category. However, research in this area has important income distribution implications since rainfed areas are among the poorest in the country.

c) Plant protection research, surveillance, and extension is another risky and more basic area which has proven its value in developed countries and now in the cotton crop in Pakistan. It needs long term support.

d) Farming systems research can only be effective and have long term payoffs if it is closely linked with the rest of the research system.

5. Although the research system has had some success in the past, institutional changes could make it much more productive and efficient in the future. These institutional issues need to be put high on the agenda of PARC and the provinces. Neither the team nor USAID can suggest the specific institutional changes that will increase productivity. However, USAID should press for changes that will:

a) Increase the linkages and planning within the provinces -- the provincial research coordination boards need to be made more effective.

b) Permit the movement of scientists, information and materials between federal and provincial research institutions and universities. This could break down the inbreeding and insularity of the provincial research institutions and universities. Regional research planning is needed to insure that the interests of farmers in different ecological zones are considered, but scientists, information and materials should not be restricted by provincial boundaries. Possibilities such as a national agricultural service or other institutional changes should be considered.

c) Strengthen the national priority setting and planning system for research through providing more resources for planning and by encouraging greater participation by provincial groups. A small analytical group at the center is needed to support this planning effort.

INTRODUCTION

This report is based primarily on a fifteen day visit to Pakistan during the first half of December, 1981 by four members of the faculty of the University of Minnesota. The team was composed of Dr. Bo Crabo, Department of Animal Sciences; Dr. Vernon Cardwell, Department of Agronomy; Dr. Paul Teng, Department of Plant Pathology; and Dr. Carl Pray, Department of Agricultural and Applied Economics. The team visited the main agricultural research institutions and universities in all four provinces* and had useful discussions with the Chairman, members and staff of PARC and the USAID/Islamabad staff. We also based our report on available written material, in particular Dr. Abdul Wahid's book Review of Agricultural Research System in Pakistan (August 1981).

We would like to thank the Chairman and staff of PARC for their assistance in preparing the way for us and assisting us while in Pakistan. We would also like to thank all of the scientists and administrators and educators with whom we met during our trip. Finally, we are very grateful to the USAID staff in Islamabad, Peshawar, Lahore, Karachi, and Quetta for their assistance in making this a smooth and useful trip.

This trip was part of a larger project on agricultural research funded by the Asia Bureau of USAID. As part of our study of Asian Agricultural Research Systems, we wanted an overview of the Pakistani system which concentrated on:

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*Our itinerary is Appendix I.

1. How research institutions work at present. In this context we listed 4 issues:
   a) Research planning by PARC and provincial research institutions.
   b) The adequacy of the university system to support the agricultural research institutes.
   c) The relationship between the public research system and private agro-industry and commodity groups.
   d) The relationship between the research system and farmers.
2. Past research which led to important economic and social benefits.
3. Possible areas for future payoffs.
4. Review role of USAID in the development of these institutions.

The AID mission in Pakistan was also interested in an overview of the agricultural research system, but their particular emphasis was on identifying possible areas for future USAID involvement. They were particularly interested in research which would help neglected regions.

In our initial discussions, the Chairman of PARC asked for our ideas about three particularly crucial issues which PARC and the Pakistan research system as a whole are faced with. First, the current institutional structure of agricultural research with particular reference to the relationships between provinces and the federal research institutions. Second, identifying the areas of research which can give high returns in the future. Third, the problem of manpower development with particular attention to the question of manpower retention.

This report attempts to address the issues raised by USAID and PARC. The introductory section identifies some of the past payoffs to research and the distribution of these payoffs. The second section deals with the main institutional issues, planning, coordination and linkages. The third section examines the research capability of the current system. It discusses the facilities and manpower and includes a discussion of the manpower retention issues. Section four identifies our impressions of high payoff areas of research in the crop, livestock and social sciences. Section five briefly discusses AID's recent involvement with research in Pakistan and our thoughts on future areas of AID involvement.

I. PAYOFFS TO RESEARCH AND INSTITUTIONAL STRUCTURE

Agricultural research has made an important contribution to the well-being of the people of Pakistan. If Pakistan did not have an agricultural research system, the price at which consumers buy basic food stuffs would be higher, the incomes of farmers would be lower, the foreign exchange position would be worse, and government revenue would be lower. Improved wheat varieties have kept the price of wheat down, increased farmers' net returns, and saved foreign exchange. Improved cotton varieties have helped keep cotton and cotton manufactured products competitive in foreign markets. Increased rice production and tobacco production has increased government revenues through increasing the profits of government corporations or government excised tax revenue respectively. Pray has calculated that the social rate of return to the money invested in crop research in the Punjab between 1947 and 1975 was over 30%.[1]

Crop and Livestock Improvement

The research work in both the crop and livestock sciences have had considerable impact on farmers. Local crop breeders played an important role in developing the green revolution wheat varieties and in spreading HYV rice varieties. They have produced a steady stream of cotton varieties with higher yields and better quality and higher-yielding varieties of sugarcane and maize. Recently, there have been important contributions in crop pest control with the reduction of rust in wheat and

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[1] Carl Pray, "The Economics of Agricultural Research in British and Pakistani Punjab, 1905-1975", Ph.D. Thesis, University of Pennsylvania, 1978.

the introduction of pest surveillance and control systems in cotton and perhaps rice. Forestry research has led to the control of certain destructive insects and the introduction of poplar trees which are commercially grown for matches and firewood in NWFP. Livestock research has had much less impact than crop research. There have been substantial payoffs to the research of veterinarians. The incidence of some important diseases has been reduced. Exotic breeds of cattle and village poultry have been introduced with some success. The recent development of an effective system for artificial insemination of buffalo offers the possibility that breeding and progeny testing of buffalos could have high payoffs.

The present allocation of resources between commodities is not clear because of the importance of multicrop institutions which have not broken down their budget by commodity. About all we can say is that crop research has received more resources than livestock research and within the crop sector, attention has been focused mainly on the major crops: wheat, cotton, rice, sugarcane and maize. Of these crops wheat and cotton have gotten the major portion of the funding. The precise size of the resources which have been devoted to each of these commodities and the question of how much should be devoted to them in the future will be one of the main questions dealt with in phase 2 of this project.

Impact of Research on Income Distribution

The impact of agricultural research on income distribution in Pakistan is still a matter of debate. This is another issue which the Minnesota project will study in detail during the second phase of this project. Our preliminary studies indicate that a considerable portion of the

benefits from the HYV wheat varieties were passed along to urban and rural purchasers of grain through lower prices. It appears that consumers of cotton cloth have also benefited from lower prices of seed cotton which held down the price of locally produced cloth. Producers have also benefited. Their costs of production have been reduced by using new technologies and in most cases this reduction in costs seems to have outweighed the reduction in prices. However, this last statement remains a hypothesis to be tested rather than a conclusion to be drawn from previous studies. Within the agricultural sector large landlords, small farmers, and the landless laborers seem to have benefited from the technology developed by research. Micro-studies in Pakistan and in other countries show that where agro-climatic conditions are right, farmers of all sizes use HYV's and fertilizer extensively. In addition, real wages in the agricultural sector clearly are rising which means that it is possible that the "Poorest of the Poor", the agricultural laborers, are also participating in the benefits of the new technologies. This relationship again is one that must be tested in the second phase of this project.

Research Impact by Province

The provinces which benefited most from past research have clearly been the Punjab and Sind. Table 1 shows the percent and area of wheat and rice varieties under new technology by province. This indicates the predominance of Punjab and Sind in these crops. Cotton is the other crop in which substantial progress has been made. This crop is grown only in Sind and Punjab. There has also been progress in maize, sugarcane, and fruit production. The benefits from these crops are more evenly spread throughout the country but official statistics on new varieties of these

Table 1. Provincial Population, Crop, and Livestock Statistics

	Punjab	Sind	NWFP	Baluchistan
Population 1981 (millions)	47	19	11	4
Cultivated Area (ha millions)	11.5	5.5	2.0	1.4
Wheat HYV Area (1000 ha)	4125	902	486	73
% of Province's Wheat under HYV's	83	88	65	39
Rice HYV's Area (1000 ha)	317	613	10	25
% Province's Rice Under HYV's	27	82	15	60
Maize Total Area (1000 ha)	326	24	348	3
Cotton Total Area (1000 ha)	1481	598	4	-
Sugarcane (1000 ha)	544	119	93	-
1976 (000 head)				
Cattle	8108	2854	3000	684
Buffalo	7979	1834	762	33
Sheep	8037	1829	3675	5075
Goats	7767	4237	4686	4441

Source: Government of Pakistan Agricultural Statistics of Pakistan 1980 Islamabad, 1981

crops are not collected. Since the Punjab still has a major share of each of these crops and the gains in these crops are probably not as large as in the major crop, it is safe to conclude that Punjab and then Sind have been the major beneficiaries of crop research. In livestock research, a similar distribution of benefits is probably true. Most of the veterinary research and past breeding research has been concentrated on improving buffalos and cattle, rather than sheep and goats which are most important in NWFP and Baluchistan.

The achievements of the research system which are mentioned above indicate that substantial improvement can be made in agriculture through research. However, the achievements which have had major impacts have been limited to a few crops and within these crops most of the contribution has been made by plant breeders. Considering the number of scientists in Pakistan and the amount of money that has been invested we would have expected more output from this system. Thus, ways of improving the output of this system through institutional changes are a matter which must be given top priority by Pakistan's research system. On the basis of our short trip to Pakistan, we cannot suggest specific changes. Rather we can identify some of the major types of institutional changes necessary.

Institutional Structure

Since about 1920 agriculture has been a subject which is constitutionally assigned to the provincial governments. This has meant that agricultural research, education and extension was carried out almost exclusively by provincial governments. In the mid-1920s the government of British India realized the need for some central body that would at least make sure that there was communication and some coordination of the provincial scientific

research. The result was the Indian Council of Agricultural Research established in 1929. Soon after partition in 1947, Pakistan established a Food and Agricultural Council, but this had little power and almost no money. It was not until the mid-1970s, when the Pakistan Agricultural Research Council (PARC) was formed, that a central council had much power.

PARC now has the authority to conduct research and has several research institutions under it including the National Agricultural Research Center (NARC) and the Arid Zone Research Institute. It still does not include all federal institutions that do agricultural research. The cotton, tobacco, forestry research institutions; the nuclear institutes for agriculture; the irrigation, the land reclamation, and water management research which is conducted by the Water and Power Development Authority (WAPDA) are not included in PARC.

The provincial research institutions remain very strong and independent. Most research is carried out by provincial research institutes. The universities do only a limited amount. Strong provincial research can have both positive and negative impacts on the efficiency of the research system. It can help make the research system more responsive to local needs, if there is a system through which farmers can articulate their needs. The negative side is well expressed in the Periera Report (p. 13) and applies to the education and research system as a whole: "Interprovincial restrictions act as constraints on agricultural progress and severely reduce the academic opportunities of each of the agricultural universities since they effectively restrict recruitment of staff to those trained in the same province. This is a formula which perpetuates weaknesses as well as strengths and leads to a somewhat static and complacent outlook".

Phase II of Asian Agricultural Research Project in Pakistan

For planning purposes it is not enough simply to identify areas which have given high payoffs in the past. The planners who have to decide between research and other agricultural projects need a more precise idea of the future returns to research investment. What they need are aggregate projections of returns to research or ex ante cost benefit evaluations of the returns to research. The commodity and major noncommodity areas which could payoff in the future need to be identified for planning within the research system. To gain political support for agricultural research it is important to identify the past and future beneficiaries of research and educate them about these benefits. Specifically the government has benefited from forest research and applied research in Virginia tobacco which they recognize and support. It is not clear that the government is aware of the revenue it has earned from rice research, nor that urban consumers see the link between wheat research and wheat prices. Also the research system needs to identify ways to help specific target groups which governments are trying to help, like "Poorest of the Poor" and nutritionally deficit groups. They will be benefited by some research strategies more than others.

The next phase of this project will deal with the issues raised in the previous paragraph. We will quantify previous aggregate rates of return to research. We will also disaggregate past net benefits by province, major commodities, consumers and several categories of producers -- large landlords, small farmers, and landless laborers. We will also attempt some analysis of future aggregate returns and the impact of different possible commodity and noncommodity research strategies on agricultural growth, income distribution, foreign exchange and nutritionally deficit groups.

II. PLANNING, COORDINATION, AND LINKAGES

Planning and Establishment of Research Priorities

National agricultural research priorities other than to increase food production and reduce importation of agricultural commodities were not clear to staff at institutes and universities. This broad objective is appropriate but a set of more specific priorities should be established which clearly communicates to all persons, at all levels, and especially to researchers, the national agricultural research priorities for the next 3 to 5 year period. Research priorities should be a moving set of priorities continually looking at the immediate and future needs of the country.

PARC has not gone through a thorough priority-setting exercise in recent years. However, it is now in the process of trying to set national priorities. It recently sent out a preliminary set of priorities for comment by provincial authorities. The problem is that the preliminary priorities did not provide a set of national goals for the agricultural sector or a methodology for using national goals to set research priorities. Hopefully, when the replies are received and a conference is convened to discuss them, the methodology and federal government goals will be spelled out as clearly as possible and then used to set research priorities.

Within the National Coordinated Research Programs, there is a fairly carefully worked out planning procedure called CAREPLANS. It was not clear that this procedure was in operation just yet, possibly because of shortages of staff. However, when it is operationalized, it could be quite effective. Once national priority topics with a high probability of pay-off have been identified the funding and resources made available to

the provinces should reflect the national priorities. PARC's national coordinated research projects can be an effective way to indicate priorities. Both the number of these projects and the financing of some should be increased in line with national priorities. However, there also needs to be money available (in addition to PL480 research money) for the research projects of individual scientists who have innovative ideas but are not attached to a coordinated program.

PARC will be able to carry out effective planning only if it devotes more of its own resources to this task. The appointment of a deputy director for long term planning and increasing the resources and staff of its planning division would be a step in the right direction. Strengthening the analytical ability of this division would allow long term planning and would permit the use of the CAREPLAN procedures. It also could provide the Chairman of PARC with the support that is necessary in his discussions with the provinces and other parts of the federal government.

Provincial level planning and coordination has to be strengthened. The Punjab Agricultural Research Coordination Board is starting to strengthen linkages and planning. There are still problems with this Board, but it has clearly helped integrate the university with provincial agricultural research. Now the university and research institutions at least know what other institutions are doing. Some attempt has been made to set priorities but with little success so far. In addition more funds for research from the provincial government have been channelled to the university; there is the possibility of placing university students and faculty at the research institutions to do research; staff of the research institutes will be able to use the university library; and innovations from the university and institutes will be accepted more

rapidly by the government because this board can act as an advocate of the innovation. However, to really do the job of planning, management, and evaluation, the Board needs more resources and staff. None of the other provinces have an active coordination board. However, these should be encouraged -- particularly in the Sind which has a large number of institutions doing research on agriculture ranging from the agricultural research institutes to general universities and private industry.

Provincial agricultural research priorities should be a reflection of local farmer needs. All major research institutions should preferably have a local farmer advisory board. Simply placing one or two farmers on the provincial coordination board probably is not sufficient to ensure their input. This is needed to help bring the concerns and needs of the farmers to the researchers, since some researchers are reluctant, or unable to even go to the villages and there is limited extension communication to the researchers in most areas.

Coordination of Agricultural Research

Coordination should be viewed in very broad terms, but the main emphasis should be on communication. There is a need to broaden both PARC's delegated and implied responsibilities of coordination of agricultural research to include all areas and all agencies at both the federal and provincial level even if the research activities are not under PARC or the provincial agriculture departments. With 19 national research institutes, 46 provincial institutes, 3 agricultural universities and other colleges conducting research there appears to be considerable scope for improving communication among groups engaged in similar research.

PARC activities should not replace provincial coordination but should facilitate provincial decisions by providing information on a national

basis. The proposed use of the CRISP reports for all research activity regardless of source of funding should permit communicating current research activities underway throughout Pakistan and could be used both by PARC and provincial governments to improve the coordination of research.

PARC has a particularly difficult task in coordinating activities with other federal institutions which do not come under its control. However, in the communications activities of PARC these institutions should be full participants. Another difficult area is social science research since this is carried out in a large number of institutions which do not have agriculture as their main focus. Thus, in the recent survey for the Agricultural Research Review Committee most of the social science research institutions were not included. They are represented on the PARC Social Science Technical Committee, but two of the strongest, PERI and PIDE,do not seem to be actively involved.

Coordination at the provincial level is also needed. The only agricultural research coordinating board which is operational is in Punjab. So far it has been more effective in its coordination and linkage role than in setting priorities and planning. The research review board operating under the auspices of the Punjab research coordination board is a desirable monitoring feature of any granting agency. Some concern has been expressed that the review board was not entirely objective in their evaluations. PARC may perform a useful national service by providing qualified scientists to assist in the provincial research reviews when requested and should stipulate reviews as a part of all PARC contracts.

Linkages

Linkages between research, extension and education within Pakistan are very weak. Education-research linkages exist on the surface, but are functional only occasionally and on an individual to individual basis, usually not institution to institution. The universities need access to the research facilities and information at the research institutes for better teaching and for expansion of graduate training opportunities as well as access to the research staff to enhance the breadth of subject matter specialization at the universities. The research institutes need to be able to collaborate with the disciplines and specialties within the universities not represented in the research institutes.

For many universities, a critical mass of faculty members necessary for offering graduate programs cannot be achieved without joining forces with the research institutes. The growing number of complex research problem areas will require the combined staff breadth of the institutes and universities to successfully cover the problem. Meeting the future manpower needs of trained research agriculturalists is dependent upon strong agricultural universities. Until critical masses of highly qualified staff are available at the universities, close linkage and coordination between research institutes and universities is needed. In the Punjab there has been an important increase in cooperation between the University and Institute in Faisalabad. This is due to two factors the Research Coordination Board and Dr. S. A. Quereshi's appointment as the head of the institute.

Research-extension linkages appear to be weak. Researchers do not have close contact with farmers for a variety of reasons. The lack of funds for travel was perhaps the most frequently mentioned reason. How

then are production problems identified? The veterinary clinic at Faisalabad provided ample opportunity for common livestock problem identification. There were no insect or disease clinics identified for plants. The Ayub Agricultural Research Institute is becoming involved with the World Bank's training and visit system and were in contact through the Plant Protection Institute. Good research-extension linkages are essential for a smooth flow of information, but we saw no evidence that a smooth flow existed. Another area of weak linkage identified by plant breeders and agronomists was maintenance and production of improved seed stocks. Identification and maintenance of progeny tested animals is of key importance to animal breeders, but is virtually nonexistant at present.

Linkages with international institutions such as CIMMYT, IRRI, ICRISAT, ICARDA, etc. are especially important for the exchange of research information, for seed stocks and for training and manpower development purposes. Both CIMMYT and IRRI have staff members located at PARC. We saw genetic material from CIMMYT, IRRI, ICRISAT, CIP and ICARDA in use at NARC and at the provincial research stations. The Cotton Research Institute at Multan was receiving genetic material through FAO. Some provincial institutes which had received substantial assistance in the past resented the fact that they now had to receive it through PARC. Some provincial research people said that the current system of uniform testing of international nurseries is good. Others felt continuity was lacking because some locally adapted materials were discontinued after one year because the lines did not have broad adaptation.

The linkages with agro-industry vary a great deal depending on the commodity. However, the linkages that do exist particularly in tobacco indicate that these linkages can be important to the government research

institutions in at least five ways. First, they can guide the government on what research is needed. In tobacco they have pushed for research work on cutting the costs of flue-curing and on improved quality of tobacco. In cotton in the past there has been pressure for higher quality lint. One of the reasons that there has been private sector involvement in cotton and tobacco research is the fact that quality is so important in determining the value of the crop. Second, the private sector can provide direct financial support to research institutions for specific projects, i.e. Pakistan Tobacco Company (PTC) is providing the government tobacco center a machine that will make briquettes out of sugarcane bagasse. The center will then test these briquettes against other sources of fuel to be used in flue-curing tobacco. Third, industry can provide technical support for research. PTC is the main source of new genetic material for cigarette tobacco. Fourth, these industries have provided political support for public research in cotton and tobacco and may have assisted the cotton and tobacco institutes to remain separate from PARC. Finally, private industry can play an important role in spreading new technology. In Pakistan chemical companies have played an important role in the spread of pesticides and Pakistan Tobacco Company has been an important agent in the spread of new varieties of tobacco.

It seems that there are a number of opportunities for the public sector research institutions to strengthen themselves through closer linkages with agro-industry. At present PARC is seeking the guidance of the carpet industry regarding the type of wool that it needs. Perhaps it could also assist in linking rice research more closely with the Rice Export Corporation in order to prevent research on fine varieties that will not meet the quality requirements of the export market. The Periera

Report has suggested that PARC should supplement the existing private sugarcane research "through contracts for field research and should prepare plans for a national sugar research institute." (p. 28) Several private companies are conducting research on grain crops. Rafhan Maize in Faisalabad has some research underway, and we were informed that the Glaxo Company recently started some agricultural research in NWFP. The public sector should be working in close communication with these private research efforts to encourage them, to learn from them, to get their support for public research, and to prevent useless duplication of efforts. There are also opportunities to gain guidance, political, and perhaps financial support in the livestock sector. The Poultry Research Institute in Karachi at present supplies vaccine to the commercial poultry sector but concentrates its research efforts on village, noncommercial poultry. It could start working more directly with this important and probably influential commercial sector at least to the extent of judging the productivity of the poultry seed stock which is imported and sold by the multinationals in Pakistan.

The Relationship Between PARC/NARC and the Provincial Research Institutions and Universities

This relationship is crucial to the success of PARC/NARC. All federal agricultural research systems are faced with the problem of generating political support for themselves. In the United States, the Department of Agriculture has built up support for itself by doing applied research in the districts of important congressmen. Other institutions have achieved this support by providing resources to state agricultural universities. The problem of generating lasting political support can be particularly difficult when the institution is started with foreign aid. PARC/NARC

must provide services to the federal government to build up its political support at that level and provide strong support to the provincial governments in return for the political support at the provincial level. Eventually, it may be able to do both, but at the moment it is clearly more successful at the federal level than at the provincial level. Most provincial scientists would be quite happy to go back to the weak research council of the early 1970s. If PARC/NARC can not build up strong supporters, a decline in foreign aid could mark the beginning of a period of instable financing for the council.

At the moment the most common view of PARC/NARC expressed by provincial officials is that PARC is attracting a large amount of resources and therefore their provincial share of research resources and also the provinces' absolute amount of resources is decreasing. This is particularly upsetting to them because they believe that the constitution says that the provinces should do all of the research and hence should receive all of this money. In addition they feel that the center is trying to dictate to them what research they should do, which again is beyond the rights of PARC. The evidence that they present to prove their point about losing resources takes several forms. In NWFP researchers complained that cess funds which they previously received have been diverted by PARC to its own use. At the new agricultural university in NWFP we learned that the two scientists who were doing good research had applied to PARC for jobs. In the Punjab there was little complaint about the loss of funds, but we were told that several of the best scientists at the Agricultural University had applied to PARC for jobs. The Ayub Agricultural Research Institute felt the loss of contact with the international research institutes which used to send germ plasm and scientists directly to Faisalabad but now sends the scientists and seed to Islamabad.

PARC needs to do what it can to change this perception of itself. The provincial agricultural research institutes and universities need to be turned into strong supporters of PARC/NARC if it is to survive a pull-out of foreign aid. PARC with its emphasis on coordination, planning, and doing research such as basic research or research on risky, marginal lands has no other natural constituency. It has to provide the provinces with services and win them over in relatively short period of time or it will have few supporters in the government or elsewhere. At the moment relations are perhaps at their lowest ebb. This is because Pakistan's system is in a transition period. PARC says that it will help the provinces to build up their scientific manpower through training and also through sending PARC scientists out to the provincial universities and research institutes. However, at the same time it is attempting to build up its own staff and the staff of NARC. The result is that during the last year 22 students were sent abroad for training by PARC of which half were PARC/NARC employees and the rest were from the provincial institutions. This leaves at most 11 people from four provinces and a large number of institutions. The other result of the current building period of PARC/NARC is the recruitment of good faculty and researchers from the provincial institutions. These people may not have been working up to their potential in the provinces because of provincial barriers to good research such as lack of incentives and the absence of equipment and literature, but to the provinces their departure will be a loss. It is not surprising then that the provinces have little faith that they will benefit much from PARC. This perception will not change until adequate training benefits, extra staffing, and other benefits reach the provinces. The earlier this is done the better.

The one benefit that we did see moving to the provinces from PARC was research funds. In the past much of the money was PL480 rupees. This program seems to continue to work quite well although the research done with these rupees is restricted to topics in which the U.S. is interested. Money, equipment, and germ plasm are also moving out to the provinces through the national coordinated research projects which include wheat, rice, maize and millets, oilseeds, potatoes and several new areas. While it may annoy the Punjab that it has lost the leadership of the wheat program and direct access to CIMMYT, it is clear that some of the other provinces have benefited from these programs. The benefits include not only the resources and germ plasm but also the possibility of gaining wider recognition for good work through the all-Pakistan variety trials. The national coordinated research projects is undoubtedly PARC's most important group of programs at the moment and the group that has given the most benefits to date. This is probably also the area which PARC should expand most quickly, both in terms of numbers of projects and resources devoted to them.

There are other services which could help the image of PARC in the provinces during the current transition period. First, it could provide some of the equipment which the research institutes need. These needs are discussed below but more repair and replacement needs will arise as current foreign aid projects end. Second, either central library facilities which can provide bibliographies and reprints or foreign exchange for purchasing scientific journals is badly needed. Third, short term training in areas such as research management and evaluation could be important.

III. RESEARCH CAPABILITIES

Facilities/Equipment

Physical facilities in the form of buildings, experimental fields and animal housing appeared in all instances nearly adequate. NARC, however, was under construction and only a few buildings completed.

Laboratory equipment was with few exceptions very inadequate. In most cases it appeared that foreign aid programs had equipped the institutions. With time the equipment had become outdated or nonfunctional due to lack of proper maintenance and of funds for the replacement of spare parts.

Instrumentation and laboratory services were needed in the following areas:

a) Soil testing lab - samples run free of charge for collaborating scientists and institutions.

b) Feed analysis lab - samples run free of charge for collaborating scientists and institutions.

c) Laboratory instrument shop - personnel trained to repair common laboratory equipment, serve as a store house and equipment lending agency for cooperating PARC institutions and scientists.

This would facilitate rapid initiation of new research and prevent long periods of inactivity due to equipment failures.

d) Pesticide residue laboratory.

Operating funds for research projects amounted to 2-25% of the total budget of these institutions. Funds for foreign made equipment and spare parts were allocated separately. In most instances foreign exchange and

operating funds were inadequate. Since this is a substantial constraint it is not surprising that areas requiring a minimum of equipment (for example, plant breeding) has achieved the greatest degree of success.

There were examples of well equipped facilities. However, in most instances these institutions were either recent recipients of foreign aid or doing work which directly related to an income generating activity such as production of vaccines for livestock (veterinary research laboratories in Karachi and Lahore), tobacco revenue (Pakistan Tobacco Board Research Center, Mardan), export revenue for cotton (Cotton Research Institute, Multan), or contract research (Irrigation Research Institute, Lahore). The NARC, which is currently under construction, is intended to be equipped with sophisticated technology for laboratory use. Another exception from the rule of poor equipment is the Nematode Center at the University of Karachi for studies on the taxonomy of nematodes.

The agricultural universities were poorly equipped. This was true, although to lesser extent for the well established Punjab Agricultural University. Computer facilities are almost nonexistent.

Libraries

All personnel at research and teaching establishments had very good proficiency in English and were able to utilize literature in this language. However, the libraries were with some exceptions extremely inadequate. Fair to good libraries were seen at Irrigation Research Institute, Lahore; Nuclear Institute for Food and Agriculture, Tandojam and the Cotton Research Institute, Multan.

Strengthening of the university libraries would benefit the research organizations located near them. It is not known to what extent libraries

at organizations like nuclear institutes can be utilized by universities and research institutes.

To establish a least cost solution to the problem of library service, perhaps a central library function with an efficient copying and dispatching system should be considered. The minimal needs for the libraries of research institutes are indexing systems and bibliographies. PARC should play an important role in strengthening library service capability. However, at the moment even PARC's library is not adequately staffed or equipped to service its own needs.

Manpower Needs

The crop research system seems to have a sufficient number of researchers. The research workers available in the animal sector appears insufficient since several vacancies were observed particularly in the husbandry area where veterinary degrees were required. Also, the social sciences seem to be short with a number of open positions. There will definitely be some deficiencies if the projected shift of emphasis towards areas such as plant pathology, animal nutrition, and farming systems takes place.

The universities generally have too little staff to do a good job in post-graduate education. Only 10-25% of the time of the teaching staff appears to be available for this purpose. The newly formed agricultural university of NWFP has a critically low number of staff members. Punjab Agriculture University has been able to develop critical masses of faculty to conduct post-graduate courses and research in most areas.

The quality of the available manpower measured by Ph.D.'s in research and post-graduate teaching positions varies greatly between institutions.

At two of the atomic energy commission research institutes and the Punjab Agriculture University 20-30% of the staff have Ph.D.'s whereas the provincial research stations have 0-10% Ph.D.'s on the staff. A particular shortage of Ph.D.'s exists in the livestock sector. It did not appear that research dedication or output was necessarily correlated to the number of Ph.D.'s on the staff. Nevertheless, it is necessary to educate more Ph.D.'s at foreign institutions to develop a critical mass of scientists in important subject matter areas, particularly for the universities.

Administrative skill is lacking in many institutes and can be considered a deficiency in the quality of manpower. The limited ability to manage available resources effectively is one of the major weaknesses of the system. Particular concerns were raised regarding the administrators' ability to involve younger researchers in setting research priorities and in the decision-making process and giving them credit for good research. There were exceptions notably at Ayub Agricultural Research Institute, at the Poultry Research Institute, Karachi and in the Animal Reproduction group at Punjab Agricultural University. Training in research administration, for example, courses arranged by PARC, may be a way to overcome the general management problem. However, the problem of developing younger scientists is a problem which goes much deeper into the structure of research institutions and Pakistani culture.

Manpower Training and University Development

To meet the manpower needs identified above Pakistan has to develop its own capacity to produce scientists. Foreign training will continue to be important particularly for Ph.D.'s, but due to the growing cost of

foreign training most of the Masters degree students and some Ph.D.'s will have to be produced locally.

On this trip we visited only one program that impressed us as being able to produce world class Ph.D.'s. That was the botany department of the University of Karachi. The agricultural universities at Faisalabad and Tandojam are allowed to give Ph.D. degrees, but at present give out very few. The quality of M.Sc. and B.Sc. degrees from the agricultural universities were thought to be declining by a number of people with whom we spoke, but we have no direct evidence on this. The indirect evidence was complaints of the Sind Civil Service Commission about the quality of graduates and the recent difficulties of finding good candidates for foreign fellowships and then getting them to complete their programs on time.

In order to have a successful research degree, universities must have not only an adequately trained faculty; but also active research programs which involve their students. Among the agricultural universities, Faisalabad had the strongest research program, but even there departments were constrained by shortages of funds, facilities, and recent scientific literature and perhaps some students were constrained by the absence of well trained advisors. The other agricultural universities were worse off. The basic sciences at these universities were generally quite weak. Thus, major institution building programs will be required if the weaker universities hope to produce research scientists. The training of Ph.D.'s abroad will be an essential part of any program to upgrade these universities.

There are several other measures to strengthen research at the universities which should be pushed forward. It would appear advantageous

that facilities and expertise at the provincial research institutes be utilized for M.Sc. student research. This was started through the Research Coordination Board and through personal contacts in Punjab but examples of such cooperation were rare in the other provinces. The universities of the provinces retain their own graduates to a very high degree. This counteracts the development of ideas and any means by which this tendency can be changed should be welcomed. PARC's attempt to send social scientists for M.Sc. outside of their home province is an example of what can be done.

PARC should move ahead with its plans to support research positions located at universities with the expressed purpose to conduct research of high caliber, guide graduate students and promote collaborative research among university and research institutes. This can only be accomplished if the individuals are very well qualified, highly motivated and dedicated to the concept of PARC/university/provincial research institute cooperation and to the improvement of the quality of research level of technical competence and research productivity of Pakistan. The success of such a program is also dependent upon the desire of the universities to make a change and having adequate financial and technical support for the individual to accomplish the objective.

Retention of Manpower

We were specifically asked by Dr. Amir Muhammed to address the complicated question of retaining highly trained and qualified people in Pakistan. Presently a number of Ph.D.'s are leaving the country primarily to other Muslim countries in the Middle East and to the West. Before addressing the problem itself, it may be said that the loss of people to

institutions paying much higher salaries may not be all bad. Instead it can create a situation in which younger researchers want to qualify for work abroad and so work for more research achievements. In addition, the researchers who return from abroad are a valuable source of new ideas.

For historical and institutional reasons the Pakistani government can not pay its scientists salaries as high as the best scientists receive abroad. Instead it must concentrate on the creation of institutions with high level of achievements which will provide a working atmosphere that will not only retain but also attract outstanding people. At the same time it must press for increased real incomes for good scientists through nonsalary benefits such as housing, transportation and other benefits and through salary increases whenever possible. The value of an effective scientist to Pakistan is so great the Pakistani government and donors must push forward as far as possible in this area.

A number of factors are needed to develop institutions which can attract and hold good scientists. These include:

1. On-the-job achievements (not necessarily earned degrees), ability to cooperate and to stimulate younger collaborators should be the criteria for advancement.
2. Seniority should count very little in promotion.
3. Committees for promotion need to be composed of professionals and need to use the services of experts from outside the province to a) judge the applicant's competency for the position and b) rank the applicants.
4. Senior administrators should assist younger collaborators to develop to the maximum of their ability.

5. A truly competitive hiring system between institutions in the various provinces needs to be in effect. At present universities hire mainly their own graduates and both universities and research institutions hire people from their own province.
6. Communication with other Pakistani scientists through journals and meetings must be encouraged.
7. Communication with the international scientific community is essential. Scientific journals must be readily available. There must be rewards for publications in international journals and opportunities for both junior and senior scholars to participate in international meetings. There must be opportunities for collaborative research and opportunities for post-doctoral research abroad.
8. Operating funds, equipment, and resources must be sufficient.

If facilities for research, the change of advancement and recognition based on merit, good colleagues and good salaries are offered, Pakistan should be able to retain a substantial number of Ph.D.'s. Throughout the Pakistan research system at the best institutes we found a sprinkling of Pakistanis who had worked abroad and came back. PARC/NARC seems to have attracted the most, but there were also returnees at PERI, the University of Karachi, and Ayub Agricultural Research Institute. These institutes in general have more of the facilities listed above. If these facilities have been successful in attracting back scholars who had international salaries, there is hope that they will be able to retain many of their young Ph.D.'s.

IV. RESEARCH AREAS WITH HIGH POTENTIAL PAYOFFS

Plant and Soil Sector

Research in the area of plant sciences needs to be directed at increasing crop productivity and maintaining that productivity under foreseeable changes in social and physical conditions.

Breeding for Durable Resistance to Diseases

Disease appears to be a major constraint in improving yield levels and in some years in sustaining achieved levels. Almost without exception, plant breeding is being undertaken in a manner that will favor "boom-and-bust" cycles, for e.g. the wheat rusts and chick-pea blight. Research needs to be directed at identifying germ plasm that possesses at least "partial resistances" against all pathotypes of all diseases.

Plant breeding has to remain the major thrust of programs in plant science - a resistant and high yielding cultivar is still the most convenient method of increasing total production. There is almost no expertise in the country in the area of durable resistance.

Agronomy (Improved Crop Husbandry Techniques)

A cultivar will achieve its maximum desired yield under optimum growing conditions that are also dictated by the economics of crop husbandry. Agronomic research, particularly if locality oriented, could lead to a narrowing of the gap between potential and actual yield on farmers' fields. Coupled with this must be an active extension program. In the short term, improved agronomic practices offer great potential for yield increases.

Seed Technology

There is almost no research being conducted to improve the quality of seed, even though this is an important production factor.

Plant Protection

Generally, the plant protection disciplines concerned with diseases, insects, weeds and nemotodes are very weak in Pakistan. For example, there appears to be only two virologists in a country where there are serious virus problems on many crops. Many of the gains from investing in plant breeding have been wiped out because there has not been corresponding strengths in the protection disciplines. The individual disciplines in plant protection need to be strengthened: plant pathology, entomology, nematology, weed science, etc.

Research activities in plant protection that will be beneficial are:

a) Surveys and surveillance systems to determine the key pests in the different agroecological zones and to quantify their effects on reducing yield.

b) Assessing crop losses caused by pests in the different regions, and researching the pest intensity - yield loss relationships (damage functions) for individual pests.

c) Determining the population dynamics or epidemiology of pests as influenced by the environment in different localities.

d) Basic research on the effect of weather variables like temperature and dew on events in the life cycles of pests.

e) Predictive systems for pest development and crop loss.

f) Determination of economic injury and threshold levels.

g) Research on host-parasite relationships and populations genetics related to parasite virulence and host resistance. This includes identification of the major pathotypes or races, major genes/ mechanisms of host resistance and methods for effective screening and transfer of resistance. Almost without exception, patho systems have not been clearly defined for the major crops.

h) Integrated Pest Management (IPM) The optimization of pest control using sound economic, ecological and social criteria.

Some expertise already exists in Pakistan on IPM, for example at the Cotton Research Institute, Multan. Generally, entomologists are more familiar with the concept than other plant protectionists. A priority area for training in all the plant protection disciplines is in subjects related to IPM: pest assessment, survey techniques, epidemiology crop loss assessment, pest forecasting and systems approaches. This has been the trend in the developed countries and developing countries are under more pressure to optimize control.

The feasibility of developing a national pest urveillance system should be explored and could be one of the major functions of the proposed National Institute for Pest Management or its equivalent. Except for cotton insects, little basic research has been conducted which can be used for IPM. The benefits of a national surveillance system are many:

1) It will further cooperation between the provinces and strengthen PARC's coordinating role.
2) The status of important pests will be systematically determined for major crops in the different agroecological zones. Furthermore, pest-host inventory built up over time with samples from surveys being made available to insect taxonomists, mycologists, etc.
3) New diseases will be detected and early warning given to direct research aimed at control.
4) Preharvest and postharvest losses may be identified and quantified for allocation of resources.
5) Changes in the virulence of pathotypes of any important diseases may be determined to allow changes in cultivar planting, and eventually,
6) With increased sophistication, pest surveillance will become a component of integrated pest management on individual farms.

Biological Nitrogen Fixation

This area seems very appropriate to PARC's stated objectives of conducting basic research with national implications. Indigenous symbiotic bacteria need to isolated for the various legumes in different regions and efficient strains selected. Research might further be directed at free-living organisms that fix N. Because N is a major factor in yield, this research should be given priority. NARC has initiated some work in this area and should be encouraged to pursue it more intensively.

Pesticide Toxicology

Indiscriminate use of pesticides in the developed countries resulted in disastrous consequences in many crops. While there appears to be signs that insecticides in Baluchistan are affecting populations of beneficial mites in apple orchards, quantitative data need to be collected. Studies should be made on residue pathways in ecosystems before the development of tolerant insects and pathogens becomes a major constraint to production. Because of the high cost of equipment needed for pesticide studies, PARC/NARC is in a strong position to provide leadership. Development of pesticide toxicology capabilities is a short term goal that has long term implications for the total agricultural system.

Cropping Systems Research

Pakistan is agriculturally, a very diverse country. Cropping systems research can lead to a clear definition of the systems under which each crop is grown and the constraints in each system to maximum production. System definition and constraint identification is a necessary prerequisite for developing methods to manage the constraints (social, economic, environmental, biological). That there is a gap in the yield levels of many crops, between potential and actual, suggests that constraints are operative in different parts of the country. The benefits from increasing yield by removing farm level constraints may even exceed increases in yield achieved through breeding in the short term. In the longer term, cropping systems research will lead to the design of more efficient production systems. This kind of research needs to be interdisciplinary, and although in Pakistan it has been identified with the social sciences, there must be a strong involvement of biologists.

Salinization/Sodification

This is a problem of national significance that PARC should address, especially from the crop angle. A coordinated project on this topic has been proposed and should be pushed ahead.

Plant Breeding

Breeding must remain the main strategy to produce high yielding crops resistant to pests and adapted to the different regions of Pakistan. To facilitate this, PARC should actively build up its genetic resources for major crops. There is much selection being done for high yield but less actual breeding except in the major crops -- wheat, cotton, rice and maize.

Strengthening Plant Research

Provinces in Pakistan differ markedly in their training, research and extension capabilities in relation to the above defined priority areas. The Punjab appears, to have the strongest institutions. This is due to the large investment made in the past on strengthening agricultural research and the important role of agriculture in the province. It would appear that, because the provinces differ in the stages of development vis-a-vis agriculture, their needs and priorities will differ. On the other hand, even a relatively sophisticated province like Punjab, has varied strengths between institutions and commodities. For example, in the Punjab we found the Cotton Research Institute and its FAO/UNDP Project to be strongly committed to basic research and to be well supported in terms of manpower, equipment and reference materials. On the other hand, at the Ayub Agricultural Research Institute there are some commodity programs which are poorly supported. It is our opinion that, while there is a need to strengthen the <u>overall</u> research, education and extension systems for agriculture in Pakistan in the long-term, for the short term, most benefits

may be derived by selective strengthening of identified institutions according to criteria agreed on.

Animal Sector

Background

Animal agriculture plays an important role in all parts of Pakistan supplying draft power, milk, meat, eggs, wool and leather. Some people estimate that livestock may contribute 50% or more of farm income in Pakistan (Wahid 1981). There is a national deficiency in milk supply and dried milk valued at Rs. 500 million is imported annually. Likewise, importation of fine wool takes place, whereas coarse wool and hides are exported. Shortages of meat and mutton has led to a ban on meat export and the installation of two meatless days per week. Increased consumption of meat and milk would be desirable from a nutritional standpoint. In comparison to the plant sciences, the livestock sector research and extension has been extremely neglected with the disease component being the possible exception.

Dairy and Meat Production (except small ruminants)

In the past it appears that milk has been a byproduct of bullock production for power. With increased tractorization there is an increased opportunity for specialized dairy production. It is our opinion that the correct decision has been made when crossbreeding the existing zebu cattle with various european breeds was started and it was decided to improve the Sahiwal breed and buffalos with genetic selection.

A cross-breeding program which is implemented in the field has an extremely high potential to increase milk production in a relatively short time. The selection program for milk yield in established breeds (including

synthetic breeds that may emerge from the cross-breeding program) has high potential for payoffs over a longer period of time. The program should be expanded. It is very important thar genetic selection for milk production includes selection for the ability to utilize forage very efficiently. It is also important that the number of production tested cows be increased so that a solid base for progeny testing of sires is obtained for the genetic program of Sahiwal cattle and buffalos. The selection procedure for A.I. bulls which was used until recently was not successful. We were told that the first completed progeny test for water buffalo bulls revealed that only half of the bulls used in the A.I. program influenced milk production positively.

Feeding and management of the dairy animals are extremely neglected research areas but are of great potential importance for increased milk production. The calving interval is very long both for cattle and buffalos (414-486 for cows and 530 days for buffalos on government farms and probably much longer in villages). Ideally the calving interval is believed to be 12-13 months for Western cattle. Economic analysis of the optimal calving interval for Pakistani cattle should be encouraged. Research aiming to decrease the calving interval by feeding practices, increased awareness of signs of heat, perhaps palpation of the ovaries regularly and diagnosis of reproductive diseases would have great potential to pay-off in short time. Researchers in animal reproduction at Faisalabad and Lahore appear to be willing to join efforts with the Extension Directorate of Punjab to intensify research in this field. A Buffalo Reproduction Institute has been proposed in Punjab. We do not believe that an Institute is needed, but Punjab may be the right place for a concentrated research effort in this important area, particularly with the unique semen production unit at Qadirabad located near the other research facilities.

The potential for an early payoff from nutritional research appears somewhat more complicated. Improved feeding practices would undoubtly increase milk production, but there are questions whether currently low prices paid for milk and meat can justify intensive feeding. Research on milk and meat marketing must be performed along with the nutritional aspects of meat and milk production to find ways to decrease the cost of production. The problem of milk marketing appears to be a complex one since most herds are very small. Also, there appears to be a discrepancy between the high prices paid for buffalo cows (Rs. 10,000) and the commonly expressed view that milk production is unprofitable. We are not aware of nay concentrated effort in establishing nutritional values for Pakistani feeds. The "oil cakes" constituting byproducts from edible oil production, byproducts from the sugar industry, chicken litter, straw and other refuse are feeds of particular interest for feeding out cattle and buffalo. It appears that PARC and NARC should assume leadership in this area. Nutritional resarch capabilities need also to be upgraded at the universities. More support is needed at the Livestock Production Institute at Baharduagar so that a data base can be established for economic analysis and advice to the farmer. There is an obvious lack of manpower trained in nutrition.

Small Ruminants

Relatively little research on small ruminants was seen. We noted that some attention was given to the possibility of producing two lambings per year. Most emphasis was given to wool research and increased meat production by use of "Teddy goats",small goats from Bengal which are kidding approximately twice a year with multiple births. There was an engoing project in Sind on socio-economic aspects of small ruminants.

The small ruminants possess enormous possibilities for improvement by utilization of the vast number of breeds in the world specialized for milk, mutton and wool production. Programs evaluating several of these breeds by themselves, crosses between them and indigenous breeds have the potential of identifying new breeds which might give multiple births, lamb more than once per year, have high milk production, rapid growth and wool quality suitable as carpet wool. Various types of such combinations may be used for different ecological and cultural parts of Pakistan. It is recommended that this research be given high priority and be located in Sind, Baluchistan or NWFP. However, it should be noted that the manpower for conducting such research is probably not available at this time. Similar research regarding dairy goats has potential for increased milk and meat production as well. Coordination with the small ruminant program of Title XII should be considered.

Poultry

Large scale commercial layer and broiler operations are developing within the private sector. Mortality and lower than expected feed efficiency for broilers are the two most prominent constraints to efficient production. Nutritional and economics research needs to be intensified to identify the most economical production system for broilers and eggs. The commercial operations utilized breeding stock developed by private multinational corporations. So far the government poultry research units have chosen not to aid the development of commercial birds except in the production of vaccines and advisory services. However, this would seem to be an area of research that would have high payoffs.

The Institute for Poultry Research in Karachi instead focused on producing an improved Egyptian dual purpose bird for the villages and was currently multiplying these for distribution free of charge to villages. No genetic selection appeared to be done, but the better cocks were intensively utilized by use of artificial insemination. Upgrading of the highly disease resistant domestic desi chicken was contemplated. There is considerable variation in the laying ability of desi chickens. Thus, there is a good possibility that selection and breeding of desi chickens will result in a superior bird for village use.

Animal Diseases

The team visited Lahore Veterinary Research Institute and the Poultry Research Institute of Karachi. Vaccine production was a major activity at both institutes and the Poultry Research Institute was to take over all vaccine production for poultry diseases shortly. Research regarding the efficacy of vaccines, durability of vaccines and immunity needs to be done. An example of a vaccine that needs to be investigated thoroughly in this respect is the vaccine against hemorragic septicemia.

Epidemiologic research and diagnostic capabilities need to be upgraded, at least regarding mammals. Successful programs in this area have been limited to the study of the impact of internal parasites in small ruminants and a proposed scheme for control of parasites. The economics of disease of the livestock needs to be explored particularly. Diseases like rinderpest and food and mouth disease in addition to the losses they cause in Pakistan hinder export of meat to most countries.

Extension

Extension may be the weakest link in the Pakistani agricultural system and extension is particularly weak in the livestock sector. In this sector the extension system is built around veterinary hospitals. The veterinarian has stock assistants whose work essentially consists of vaccinating animals in the villages. The veterinarian has a dual purpose degree in animal husbandry and veterinary medicine. Due to a number of reasons the veterinarian in essence functions for clinical veterinary medicine only and remains stationary at his hospital. The extension system for animal husbandry information is practically nonexistent. Punjab has recognized this fact and the university is issuing a B.Sc. degree in animal husbandry. However, the positions available for the graduates appear to be limited to livestock farms.

A reorganization of the extension system for the livestock sector may improve the situation. A reorganization should make the extension veterinarian responsible for preventive veterinary medicine (clinical medicine should be the responsibility of the private sector) and provide advisors to the farmers in husbandry and economic matters.

Integrated Farming Systems

Farming systems research which has a major emphasis on livestock is needed in Pakistan. The livestock population probably can not be increased over the current numbers without causing serious overgrazing and decreased crop output. Smaller farmer and landless people keep the majority of the livestock. The marketing channels for livestock products are not clearly understood which results in confusion regarding the profitability of the livestock sector. Thus the cropping systems approach

which brings together livestock scientists, crop scientists and social scientists is needed. Such studies should emphasize the comparison of farm income from livestock production, fodder production, intensified food crop rotations and cash crop production. Other economic factors such as the availability of labor, draft animals versus mechanization, and the social and cultural aspects of livestock production need to be considered as well. It was, for example, mentioned to us that the rather neglected area of range management could be better understood through studies of areas where tribes successfully restrict and rotate grazing versus areas where this is not done. Also, research on effective tillage practices with bullocks may be worthwhile, since at current rates of tractorization it would take another 80 years for Pakistan to be fully mechanized.[1]

High Payoff Areas in the Social Sciences

The payoffs to social science research in agriculture come in three areas. First, research can lead to government investments, regulatory policies and price policies which benefit certain groups or society as a whole. Second, social science research can assist other agricultural scientists in identifying and weighting the importance of constraints which farmers face in their efforts to improve incomes. This should help farmers and consumers by guiding scientists to work on the most important constraints. Third, more detailed farm management research may indicate that farmers are not maximizing their long run net income or profits. Then recommendations to farmers can be made which would improve their performance.

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[1] The current stock is 100,000 tractors, importation is 15,000/year; 10,000/yr are junked; and the estimated need for complete mechanization is 300,000.

The payoff of any of these types of social science research depends not only on the success of the research itself but also the utilization of these results by another government agency: policy research results have to be turned into actual policies; constraints research results have to be used by scientists; and farm management or farming systems research results have to be recommended to farmers by extension. The likelihood of implementation should be considered when deciding which projects will have rapid payoffs.

On our trip the overall impression was that agricultural economics is concentrating on policy research and that useful research in the other areas is almost nonexistent. Research in other social sciences has had almost no impact on agriculture. The main problem does not seem to be an overall shortage of funds for research projects, but a shortage of trained, motivated manpower to do the research. None of the provincial agricultural research institutes have senior economists. Most of them have sanctioned posts available but were not able to attract anyone. PARC has been trying to recruit economists for PARC, NARC, and for the provinces but they have been able to fill only a few of their positions so far. While we were in Pakistan the newly created Agricultural Prices Commission advertised 20 new positions for agricultural economists at the highest salary grades in the government to do policy research. This will increase PARC's difficulties in attracting good economists.

The other overall weakness in the rural social sciences is that there is little interaction with other agricultural scientists. This is partly due to the fact that there are no social scientists in the provincial agricultural research institutions. Likewise the main economics research institutions like PIDE and PERI only have social scientists. The agricultural

universities have the most interaction between different disciplines, but even there considerable improvement is possible. Even the constraints studies which are supposed to be multidisciplinary have no economists working on them at the moment.

Policy Research

At present the government is very involved in agricultural input and output prices through direct intervention such as subsidies, procurement and taxes and indrectly through its import and exchange rate policies. In the 1970s most of the decisions were made on an ad hoc basis with every little economic analysis to back them up. Recently at least some provincial governments and the central government have recognized the need for more analysis. About 3 years ago the Punjab Planning and Development Department decided to strengthen the Punjab Economic Research Institute (PERI) to meet its needs. Recently the central governments set up an Agricultural Prices Commission to meet its needs. PERI is now functioning quite effectively. However, the Central Agricultural Prices Commission is just starting to recruit staff and the other provinces do not have similar policy research financed by the government.

Since at least some sectors of the government recognize the need for economic analysis and the World Bank, IMF, and USAID are interested in such analysis, there is reason to believe that some of the results of policy research would be translated into policy. Clearly research on the size and impact of agricultural input subsidies has played a role in their recent decline. There is a series of important issues surrounding agricultural output and input pricing which need research. At the national level research is needed on:

1. The income distribution and production effects of the recent decrease in fertilizer and pesticide subsidies.
2. The impact of government internal procurement, ration shops, import and export policies, and price controls on the market price of major agricultural commodities and who benefits and who loses from these government interventions.
3. The agricultural export and import policy of the government.

At the provincial level marketing problems of specific commodities such as milk, meat, vegetables, and fruits must be examined. What are the implications of these problems for government investment and regulatory policies?

Another area of research is the evaluation of current and proposed agricultural investment projects. At present much investment is made with only a perfunctory analysis of its cost and benefits or with an analysis which is carried out by the donors rather than the Pakistanis. Research institutes should be playing a role in evaluating some of the key investment projects both at the federal and provincial levels and suggesting ways in which these investments could be made more effective. An example of this type of work is the water management research being conducted at the Mona Project.

The efforts launched by PARC to encourage accurate collection of output statistics are important. In Sind, NWFP and Baluchistan yield per acre statistics even of the major crops are little more than educated guesses. The estimates of the yield of minor crops in all provinces are based on what are officially called "subjective" estimates. Finally, the estimates of output in the animal sector which have improved greatly since 1975 are

still widely perceived as inaccurate. Although this is an important area at present, it should be taken over by the Prices Commission when that body becomes more effective.

Except in the Punjab, policy studies have also been limited by the absence of farm budgetary data. PERI now has a panel of 700 farmers and landless from whom they collect monthly cost and returns and household expenditure data. PARC is planning to fund a similar project in all provinces (and hopefully will use PERI for the Punjab), and the new Agricultural Price Commission says that it will also monitor farmer's costs and returns. Hopefully, APC will in fact be able to fund the collection of this information in Sind, Baluchistan and NWFP.

Research Planning and Production Economics

The second major area where the social sciences can contribute to farmer's and consumer's well being is through research which helps other scientists do their jobs more effectively. At present almost no work is going on in this area, and so this must be a high priority for PARC. This type of research is mainly concerned with developing research priorities at both the macro and micro level. At the macro level the main concern is setting priorities for the various commodity and major noncommodity research areas. At the micro level we are concerned with the constraints on farmers which prevent them from maximizing their net income.

The macro level work consists basically of working with scientists to identify commodities or areas of research which will have the highest payoffs. The federal or provincial government must provide overall goals for the agricultural sector. Agricultural scientists must determine the technical feasibility of commodity or noncommodity research programs which

are proposed. Social scientists can assess the probability of its acceptance by farmers and the economic and social impact of acceptance. The programs can then be ranked in terms of their net economic and social benefits and their impact on nutrition, the balance of payments, or any other goals of society. This does not have to be a particularly lengthly or time consuming process and part II of this project will provide an example of how this can be done.

Within the commodity programs, social science research can also provide valuable guidance on research priorities. In PARC's new system of CAREPLANS the first two steps are the identification of problems and "according of priorities". The criteria in the CAREPLAN procedure for according priorities are largely economic and social criteria coupled with an assessment of the probability of success. At present in some of the major commodities like cotton the major problems are known and research is being carried out on these problems. In wheat, constraints research is underway which should help determine priorities. However, in many other important crops like the pulses and oilseeds the major constraints to higher production and the relative importance of these constraints are not yet known.

What is required is constraints (problem identification) research and, as more resources become available, farming systems (problem solving) research. This must be done jointly by social and agricultural scientists. The first step is to review all available literature and talk to knowledgeable scientists, extension agents, and users of the crop. This will provide the hypothesis for some short and easily analyzed surveys of farmers who grow this crop. For these surveys both a social and agricultural scientist go to the farmer's fields, examine his crop, and ask

what the main constraints are. The results of these surveys can be used as hypotheses to be tested by IRRI-type constraints research which now is being supported by PARC. This research approach needs to be used not only with crops but also with livestock where there is considerable confusion about what the main constraints to production are.

The farming systems approach with its focus on the farmer and collection of detailed animal husbandry, agronomic and economic data is perhaps the only method of actually finding out how farmers make their decisions. However, this expensive and has a large requirement of trained manpower. It seems probable that the first payoffs from farming systems research will be in helping scientists set research priorities by understanding farmers' constraints in a whole farm perspective in a way that constraints research which focuses on a single crop can not do. One can explore the complexities of crop rotations and the role of animals only in this whole farm perspective. Also it is the ideal place to try out new technologies before their general release to farmers. Early evaluation of new technology can prevent the loss of government money and the credibility of researchers and extension agents who try to push uneconomic technologies. Evaluation and monitoring of new technologies indicates to researchers where more research needs to be done.

Research for Farmers

Finally there is research that will benefit the farmer directly by developing recommendations for managing his farm and marketing his products more efficiently. So far this type of research has had virtually no impact on Pakistani farmers. The most important reason for this is the fact that at present farmers know more about how to maximize their profits

or utility under village conditions than economists do. A second reason is that extension is very weak and could not spread better farm management techniques. It is only in recent years that economists have come to appreciate the complexity of peasant farming. In Pakistan economists are trying to understand its complexity with farm management surveys. However, until agricultural scientists begin to work with social scientists little progress will be made in finding ways to improve the farming system now in use.

All of the previously mentioned types of research can provide information that will benefit farmers directly. However, on the production side the constraints studies and cropping systems research are the most likely to identify farm management systems that can be recommended to farmers. Marketing research can have implications both for farmers and policy makers.

Summary

The government recognizes the need for more policy research and PARC has emphasized the need for production and marketing economics. Overall, there is still probably an overemphasis on policy research. However, at present the main constraint to all types of research is the shortage of social scientists. This must continue to be one of PARC's main priorities in training. New ways should be sought to induce Pakistani economists who are working or studying aborad to return home. Funding and institutional arrangements to induce social scientists from the universities and social science research institutions to collaborate with agricultural scientists or work for a short time at the agricultural research institutes should be developed.

V. USAID AGRICULTURAL RESEARCH PROJECTS

Past and Present USAID Research and University Projects

The USAID project at PARC/NARC has taken a long time to get underway. However, given the history of agricultural research in developing countries and the current direction of PARC/NARC, it seems very likely that they will have high payoffs. It has already had an important although unquantified role in preventing a return of the 1978 wheat rust epidemic. At the moment, it is concentrating considerable effort on gram blight. The solution to this problem would by itself pay for NARC. Many of its other efforts will not pay off rapidly. Arid zone research and barani research in general are not likely to pay-off immediately -- too little is known at present about agriculture in these areas. It seemed to the team that the research portfolio of PARC/NARC is quite well balanced between projects of short term and long term payoffs and thus, that this research will be paying for itself and yield a high rate of return.

There remains the problem of slow utilization of AID money and the slow development of the project. It seems that one of the major factors in the apparently disappointing performance was an underestimate of the institutional difficulties of implementing such a massive plan and perhaps of the leadership and managerial weakness of PARC in the early days. The leadership and management problems were probably not primarily due to weak individuals rather they were due to an insufficient number of trained managers to carry out the program. In recent years both the quality of leadership and the numbers of trained individuals has improved considerably. The institutional barriers were both within the federal government and the provinces. In both areas there were and continue to be, extremely strong

forces which oppose any centralization of power and research resources in PARC/NARC. The provinces have had the constitutional argument that agriculture is a provincial subject to support their position. Basically it has taken a military government and the wheat rust disaster of 1977/78 coupled with the current Chairman's leadership to knock down some of these barriers. Major institutional change such as the development of a national agricultural research system is necessarily a slow process. The difficulties were underestimated by AID. However, AID should be commended for sticking with the project because a pullout by AID would have crippled PARC. Now there is the possibility to make substantial gains.

The other recent aid project that has had a major research component is the CSU Water Management Project. The water management area was reviewed recently by an USAID team, and so it was not reviewed by this team. The one suggestion we have in this area, is that PARC or some organization needs to play a stronger role in establishing links between the large number of institutions which are dealing with this issue. At present, few of the institutions dealing with irrigation research come under PARC or the provincial agricultural research institutions and so, there seems to be little contact between the physicists, engineers, agricultural scientists and social scientists who are working on parts of this problem.

Perhaps the greatest impact of past AID programs has been in training scientists. The vast majority of todays scientists have benefitted from AID programs which strengthened their local B.Sc. and M.Sc. programs or funded their masters and/or doctoral programs abroad. In the absence of these programs, Pakistan's research system would have produced far less of practical value to farmers because of insufficient scientists. The

foreign exchange earned by these scientists in terms of reduced food imports and increased exports has paid for their training many times over.

A major component of this training has been the massive investment in the development of the agricultural university at Faisalabad. This program enabled the university to increase its faculty from 4 Ph.D.'s in 1961 to 81 in 1971 and total teaching faculty from 65 to 306 in the same period. The output of B.Sc.'s and M.Sc.'s increased from 68 and 24 respectively in the late 1950s to 347 and 116 in 1976. During the 1960s there were also USAID programs to build up the Agricultural College in Sind and the Faculty of Agriculture at Peshawar University in NWFP. The programs in Sind and NWFP were much smaller and of shorter duration than the one in the Punjab. The influence of these AID programs on research has been mainly through the graduates who now man the government research institutes in these provinces rather than through faculty research. Peshawar, in particular, has very few research projects underway. It was clear at all three agricultural universities that their primary emphasis was teaching, rather than research.

Areas for Future USAID Involvement

The agricultural universities are, at present, not providing much support to the research system. They have the largest concentrations of Ph.D.'s in the agricultural sciences and yet they do only a limited amount of useful research. They are turning out a number of B.Sc.'s and M.Sc.'s, but the quality of the graduates seems to be falling at some institutes and the numbers are not sufficient to meet government's needs. At present, there is no agricultural university in Baluchistan. The agricultural university in NWFP only recently split off from the general university.

The Sind Agricultural University is apparently stagnant, and Punjab which is doing good research and teaching in some areas seems to have declined in the last 10 years. At present, the World Bank has projects at the University in Punjab and Sind. However, we saw no signs of World Bank support for technical assistance which would probably be necessary for a successful project. NWFP is not receiving any aid at present, and so seems a logical choice for future assistance. Also, it seems to have quite a dynamic Vice-Chancellor who has a good track record at the Forestry Research Institute and good political connections. Leadership is of crucial importance in developing new institutions and so this Vice-Chancellor's presence is an important positive factor.

A number of the provincial research institutions need assistance. In assisting provincial research institutions AID has to make a decision about what role it wants to encourage PARC to play. If it deals with the provinces directly, it can undercut PARC's newfound influence. If it deals with the provinces through PARC, then PARC will be considerably strengthened. There are a number of weak provincial research institutions which could usefully use more money, particularly foreign exchange. PARC will have a much better idea what these needs are once the current review of research institutions is completed. Since most the provincial needs are not for large institution-building projects but for training, some specific equipment and library facilities, it would seem most efficient for donors to deal with a central institution which could identify these needs and supply them on a regular basis. This argues for more support at PARC.

If provincial institution-building is carried out directly, it probably should be part of a package which assists universities,

extension, research, and provincial agricultural planning institutions at the same time. In this way it might be possible to build in some institutional means of more closely linking these institutions and increasing demand for efficient provision of services.

The current World Bank and USAID money which is going into PARC and NARC would seem to be about all PARC can manage at the moment. Therefore, it seems that USAID probably would not want to invest more money there in the immediate future. However, there are areas which AID should continue to watch and perhaps provide assistance in the future. First, as mentioned above, PARC could be a useful means of providing needed foreign exchange to provincial institutions. This would probably require further expansion of PARC's manpower to manage this sort of program. Second, some research efforts with important income distribution goals and more basic research which will require long periods before there are payoffs may be difficult to support locally because local politicians may not have a long enough time frame -- for example, farming systems research, maintenance research like pest control, and soil and water management research. In these cases, AID might be able to provide useful support.

There are several subject areas which stood out as being in need of assistance at both the provincial and national levels. Livestock, which has been particularly neglected in the past, is now receiving considerable support from a variety of donors. At almost all of the livestock research institutes we visited foreign donors were providing technical assistance or such assistance had just ended. However, this is such an important area and there do seem to be opportunities for big payoffs to research and extension that we would urge USAID to explore the possibilities of assistance in this area. Another important area which needs attention

is plant protection. The possibilities and payoffs from crop surveillance and integrated pest management were described in Chapter IV. USAID might consider a project in this area which would include research, pest surveillance, strengthening the plant protection services in IPM and regulating the private sector which recently started providing pesticides.

Appendix I

ITINERARY OF AGRICULTURAL RESEARCH REVIEW TEAM - UNIVERSITY OF MINNESOTA NOVEMBER 28 - DECEMBER 17, 1981

Nov. 28	Dr. Pray arrives Lahore. Meets Brian Lockwood ADC, Dr. Jameel PERI.	
29	Dr. Pray, Crabo and Teng arrive Islamabad, 10:00 a.m.	
30	Islamabad	- 0830-1000 Chairman PARC. - 1030-1330 Visit NARC. Drive to Peshawar 1500. Arrive Peshawar 1800.
Dec. 1	Peshawar	- 0830-1030 Forest Institute. - 1030-1200 University of Agriculture. - 1210-1330 Pakistan Academy for Rural Development.
2	Tarnab	- 0830-1030 Agricultural Research Institute. Drive to Mardan 1200-1330 Tobacco Research Centre. Visit Pakistan Tobacco Company.
3	Lahore	- 0830-1000 Irrigation Research Institute. - 1030-1200 Veterinary Research Institute. Kala Shah Kaku - 1230-1400 Rice Research Institute.
4	Friday - Lahore - Meet most of expatriot. Agricultural experts at lunch party. Drive to Faisalabad.	
5	Faisalabad	- 0900-1230 University of Agriculture. Visit Villages.
6	Faisalabad	- 0900-1200 Ayub Agricultural Research Institute. - 1200-1400 Plant Protection Research Institute.
7	Drive to Lahore via Bahadarnagar 0730. Bahadarnagar Qadirabad	 - 0900-1100 Livestock Production Research Institute. - 1130-1330 Livestock Experiment Station. Cardwell and Crabo drive to Lahore. Pray and Teng to Multan.
8	Cardwell and Crabo visit Veterinary College. Pray and Teng visit Cotton Research Station and P.C.C.C. Cotton Research Institute, Multan. All fly to Karachi.	
9	Karachi	- 0830-1000 Poultry Research Institute. - 1030-1230 University at Karachi. - 1230-1400 Vetebrate Pest Control Centre. Cardwell and Crabo drive to Hyderabad. Pray and Teng stay at Karachi.

Dec. 10 Tandojam Cardwell and Crabo:
- 0830-1030 University of Agriculture.
- 1030-1230 Agricultural Research Institute.
- 1230-1400 Atomic Energy Agricultural Research Centre.

Drive to Karachi.
Pray and Teng fly to Quetta 0900.
Meet Secretary of Agriculture.
Quetta-Sariab Agricultural Research Institute.
Arid Zone Research Institute.

11 Pray and Teng visit villages near Quetta with Acting Director Fruit. Research Project.
Cardwell and Crabo arrive Islamabad.

12 Pray, Teng return to Islamabad.

13 Discussion with Chairman PARC (Dr. Amir Muhammad).
Then individual meetings with members of PARC.

14 Submission of brief report to Director AID/Islamabad, indicating their impressions about impact of agricultural research with particular reference to AID's past investments and strategy for future assistance.

15 Crabo and Teng leave.
Pray and Cardwell USAID and write-up.

16 Pray and Cardwell to PARC for discussions with training and planning officers.
Pray to P.I.D.E.

17 Cardwell departs.
Pray to P.E.R.I. in Lahore.

APPENDIX II

Impression of Research Capabilities of the Institutions Visited

Universities	Rating*	Institutional Links	Comments
University of Agriculture - -Faisalabad	6	Autonomous Provincial Dept. of Ag.	Largest concentration of Ph.D.'s in country. Some departments have research capacity, library weak in current scholarly journals, poor laboratories. Some World Bank assistance.
-Peshawar	3	Autonomous Provincial Dept. of Education	Now little research. Animal science and horticulture weak and no plant pathology or physiology. Some social science research at Institute of Development Economics. New V.C. dynamic and so there is hope for future.
-Tandojam	4	Autonomous Dept. of Education	Limited research capacity, very poor library. No functional laboratory equipment. World Bank assistance?
University of Karachi	8	Autonomous Dept. of Education	Biological Sciences Faculty seem to have equipment, and staff capabilities, and strong research program.
Pakistan Academy for Rural Development	3	Ministry of local government	Weak leadership and political change have left this institute without a clear role. Thus little is happening at present. Good physical facilities for training.

*A rating of 10 represents capability equal to World class institutions.

Research Institutions	Rating	Institutional Links	Comments
Livestock			
Poultry Research Institute - Karachi	7	Provincial Dept. of Livestock	Vaccine, microbiology/pathology and genetic units very active. No Ph.D.'s. Strong program for improving genetic stock of village birds but not of commercial birds.
Livestock Experiment Station - Qadirabad	3	Provincial Dept. of Livestock	Modest level of research. Crossing local and exotic cows.
Livestock Production Research Institute - Bahadarnagar	5	Provincial Dept. of Livestock	Good selection program for buffaloes and Sahiwal cattle recently started. Labs not too productive, UNDP/FAO Project there.
Veterinary Research Institute - Lahore	4	Provincial Dept. of Livestock	Some research but good program of vaccine production. Diagnostic capabilities are limited. UNDP/FAO Project.
Crop			
Agricultural Research Institute - -Quetta	3	Provincial Dept. of Ag. Baluchistan	Strong program in fruit research with FAO assistance. Few Ph.D.'s little incentive for good work. No substations. Only irrigated research.
-Tandojam	5	Provincial Dept. of Ag. Sind	Soils, entomology, physiology group most active. Rice, wheat, cotton breeding modestly productive -- other crops -- mostly testing.
-Tarnab	4	Provincial Dept. of Ag. NWFP	Program and overall priorities unclear. Little barani research.

Research Institutions (continued)	Rating	Institutional Links	Comments
Crop			
Arid Zone Research Institute - Quetta	5	Federal PARC	Just starting program. Important problems will be tackled. One of few institutes with livestock and crop scientists working together. Some link with ICARDA.
Atomic Energy Agricultural Research Center - Tandojam	4	Federal Atomic Energy Commission	Good plant science library. More basic in research approach. Somewhat more equipped. Breeding and mineral nutrition group most active. Output low -- perhaps poor director/leadership.
Ayub Agricultural Research Institute - Faisalabad	6	Provincial Dept. of Ag. Punjab	Good director. Strong wheat breeding -- links with CIMMYT. Virology good. Soils active and good work. No social science at present. Sugarcane research okay. Overall weak in plant pathology. Horticulture fairly strong -- close links to big orchard owners. Poor linkages with university and perhaps to farms, but are taking steps to improve this situation.
Irrigation Research Institute - Lahore	5	Provincial Irrigation Dept.	Effective links with irrigation department and Punjab University but not with WAPDA. Have history of hydrology research. Considerable contract work.
Nematological Research Center - Karachi	7	University of Karachi	1 Ph.D., well staffed and equipped. Doing survey work. PL480 research money.
Plant Protection Institute - Faisalabad	4	Institute of Ayub Agricultural Research Institute	Limited equipment -- staff seemed enthusiastic -- research was more of a monitoring function.
Rice Research Institute - Kala Shah Kaku	6	Institute of Ayub Agricultural Research Institute	Active breeding program, poor library. Other disciplinary programs not so active. Good linkages with IRRI.

Research Institutions (continued)	Rating	Institutional Links	Comments
Crop			
Tobacco Research Center - Mardan	6	Federal Ministry of Commerce	New institute, good leadership and equipment. Well-linked with farmers and industry. Still has to prove its worth.
NARC Islamabad	7	Federal PARC	Some units not operational. Operational units still small. Staff -- leaders good people who understand problems and have goals and objective clearly in mind. USAID and World Bank assistance.
Cotton Research Institute - Multan	8	Federal under Pakistan Control Cotton Committee	Probably the best institute visited in terms of quality of staff, equipment, current literature, and linkages with industry. Have done very good work in Integrated Pest Management for Cotton, FAO team and funding.
Cotton Research Station - Multan	5	Part of Ayub Research Institute	Good basic cotton breeding program. Has useful ties with NIAB and PCCC Institute.
Social Science			
Punjab Economic Research Institute - Lahore	6	Provincial, Planning and Development Department Punjab	Close contact with Punjab Planning Department so research relevant to policy. Ford Foundation/ADC Project just finished.
Applied Economic Center Center - Karachi	6	Institute at Univ. of Karachi	Several excellent young economists and statisticians are on the staff. Computer facilities good. National and provincial policy studies. Started with Ford money. Now takes government contracts.

Research Institutions (continued)	Rating	Institutional Links	Comments
Social Science			
Pakistan Institute of Development Economics - Islamabad	6	Federal Autonomous Institute under Planning Commission	Premier economic research institute but agriculture not high priority. Two Ph.D. economists full-time on agriculture. Contact with Federal government extensive. Considerable contract research for foreign donors.