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**THE RESEARCH MASTER PLAN**

for the

**NATIONAL  
AGRICULTURAL RESEARCH CENTRE**

A Consultants' Report

by

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OCTOBER, 1998

ISLAMABAD, PAKISTAN

**NARC / USAID / MART - WINROCK**

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**CONSULTANTS' REPORT**  
**on the**  
**RESEARCH MASTER PLAN**  
**for the**  
**NATIONAL AGRICULTURAL RESEARCH CENTRE**

October 5, 1988  
Islamabad, Pakistan

**MEMORANDUM**

Date : October 5, 1988

To : Dr. Abdus Salam Akhtar, DG, NARC  
Dr. Murray D. Dawson, MART, NARC

From : A. Colin McClung and Ludwig M. Eisgruber

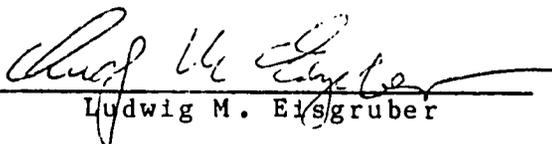
Sub : **Consultants' report: NARC Research Master Plan**

In accordance with prior discussions and the relevant terms of references we are herewith submitting to you a document entitled "Consultants' Report on the Research Master Plan for the National Agricultural Research Centre (October 5, 1988)." This document has been prepared after receiving comments on a preliminary version of this report by the same name (and dated August 25, 1988), after discussing revised sector statements with NARC scientists and administrators, and after participating in the (October 2 - 4, 1988) "NARC Research Master Plan Symposium".

We wish to compliment you and your colleagues for the very significant and successful efforts you have undertaken to achieve the important goal of developing a Research Master Plan. We trust that the Consultants' Report will contribute to the quality and effective implementation of the NARC Research Master Plan.

Thank you for all the support you have given us in the task of preparing the "Consultants' Report on the Research Master Plan for NARC". We also wish to acknowledge the extensive and patient cooperation we received from all NARC scientists and staffs in the review of their sector plans, in the compilation of resource benchmarks, and in all aspects of preparation of this report.

  
A. Colin McClung

  
Ludwig M. Eisgruber

## FOREWORD

The consultants prepared this report during two duty tours in Pakistan; Aug 6 to 25, 1988 and Sep 25 to Oct 6, 1988. The main body of the report, pages 1 to 65, was prepared during the first tour. On Aug 25 it was submitted to the Director General of NARC with a covering letter (Annex 7) which explained that it was an unedited, preliminary report. The actual document was entitled "Consultants Report on the Research Master Plan for the National Agricultural Research Centre". It bore the date Aug 25, 1988 and was labeled "Preliminary". It was also specified that contents had not been reviewed with NARC scientists and were subject to correction. It was suggested that the Director General might wish to share portions of the report with various members of his staff for reference as they prepared their sector statements for the Master Plan and for the symposium scheduled for Oct 2 to 4, 1988. The Director General did, in fact, provide each NARC unit with appropriate portions of the Aug 25 document.

During the interval between the two tours the consultants made a number of editorial changes. Many of these were simply to improve the construction and readability of the report but some constituted additions, modifications and deletions. For the convenience of the reader of the report who has read the earlier version Annex 12 lists those changes or additions in the main body of the document which are deemed to be substantive.

During the second consultancy additional material was added to the document in response to the new terms of reference and to complete actions called for in the original terms of reference. The new material is found in section III.B and in Annexes 7 to 13.

The original scope of work for this consultancy was set forth in Terms of Reference provided to the consultants before their arrival in Pakistan. These might be summarized as follows: The consultants would meet with all research leaders responsible for preparation of portions of the Master Plan and would read and review all of the documents prepared for the Master Plan. In addition to reviewing the contents of these documents, the consultants would comment on the procedures used in developing the Master Plan and in reaching conclusions about research subjects, priorities among subjects, funding needs, etc.

Immediately upon arrival in country, the consultants met with the management of NARC and with the Chairman and other officials of PARC. It was concluded that more direct participation of the consultants in the review process would be desirable, particularly in priority setting. It was recognized that the draft proposals arising from individual research groups within NARC resulted in a total program that would require many times the levels of staff and funds currently available to the organization. Although some increase in funding over the coming years is likely, it is unrealistic to expect funds to multiply several-fold in a period of 12 years. In light of these

observations it was agreed that the consultants would to the extent possible suggest or recommend priorities among programs and on research subjects within programs. They would also recommend procedures for improving priority setting. The revised terms of reference are shown in Annex 1.

The scope of work for the second consultancy, called for further meetings with NARC scientists to review and discuss their sector statements for the Master Plan and for the completion of certain items left un-done at the end of the first consultancy. The specifics, as agreed upon following arrival of the consultants in Pakistan in September, are set forth in Annex 8.

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## SUMMARY

1. The NARC Research Master Plan is to be based upon the NARC mandate. The mandate is itself under scrutiny and may be somewhat modified, although probably not to a major degree. Significant features of the mandate which influence the planning process call for NARC to, (a) undertake research on subjects of national importance which are not being looked into by other institutions or where its specialized staff and facilities are particularly needed to solve problems, (b) place a major emphasis on farming systems research, (c) avoid duplication of research to the extent possible and take active steps to strengthen provincial research units, (d) conduct advanced or specialized agricultural research which will be in the nation's interest and maintain and understanding of and competency in new research methodologies that may have future application, (e) take an active leadership in assembling, evaluating and maintaining germplasm resources for agricultural crops and for fostering the utilization of these resources within Pakistan, and, (f) take particular responsibility and leadership for research on barani (rain fed) agriculture.
2. In suggesting mechanisms for NARC to use in deciding upon priorities among commodities the consultants recommend the use of a modified checklist system wherein a set of criteria are selected and then applied to the various commodities. Those commodities which fit the criteria best are given highest priority and those which fit less are given lower priority. Suggested criteria for NARC included: (a) fit to the NARC mandate, (b) suitability of climate/ecology at NARC for field work on the commodity, (c) potential impact of the research, (d) cost of the research, (e) importance of the commodity both present and potential, (f) availability of staff and, (g) extent of research at other centers both in Pakistan and abroad. Rating of low, medium and high were proposed for field work and of plus or minus for advanced technology types of research.
3. NARC conducts primarily what might be called "core" research for which it is responsible by mandate. It also conducts research as a part of its participation in national coordinated commodity programs. It is recommended that the two types of activity not be confused in the Master Plan and that the Plan deal with the core research which NARC conducts under its mandate.
4. For wheat, rice and maize it is suggested that NARC's role in core research should focus chiefly on assembling, evaluating and maintaining genetic resources and on the application of advanced research techniques. NARC will have a significant role in these commodities as part of coordinated programs but it is recognized that there are substantial scientific staffs dealing with these commodities at provincial centers. For all these commodities the concentration of crop production and of relevant scientific staff elsewhere suggests a provincial focus. For rice, the climatic/ecological conditions at NARC also suggest a lower priority for field work at NARC.

5. For sorghum, millet, fodder crops, pulses, oil seeds, selected vegetables and potatoes it is recommended that NARC take steps to form full scale research programs to develop the technology required to meet the nation's goals. These commodities fit the NARC mandate and they suit the climate of NARC's location and the barani agriculture bias mandated for NARC. They fit into various farming systems. They are deemed to have substantial importance to the nation at present and to have much more potential importance in the future. These commodities are receiving much less attention at provincial centers as compared to the premier cereals and far less than their actual and potential importance would justify.
6. For fruits and sugar it is recommended that NARC provide support in terms of germplasm acquisition and maintenance and application of advanced technology. NARC can do rather little with them in the field because they are primarily or solely grown in other climatic regions.
7. NARC has the potential to contribute significantly to all commodity research in Pakistan through application of advanced research techniques and through the use of its specialized equipment.
8. Research on cattle and buffaloes for meat and milk should be focused on animal health maintenance and on nutrition. These are seen as factors which seriously limit production in Pakistan. Breeding of large animals has a slow pay off and is costly and is suggested to be of lower priority for NARC.
9. Sheep research should emphasize nutrition and health but might also include crossing programs for improved wool quality. With respect to the latter duplication of research conducted previously should be avoided. Potential research on goats as part of a small ruminant program should be evaluated.
10. Research on poultry should be focused on product quality and health and on the application of advanced technology to deal with problems which may arise, particularly in the disease area.
11. Fisheries research should be limited to a few species and should be focused on farm pond aquaculture with continuation of on-going work in reservoir fisheries.
12. The staff and facilities of the animal science section of NARC represent an important resource for advanced research on problems in this field.
13. Research on honey bees and silk worm should focus on pressing problems which arise. There is a large existing body of technology for these commodities which can be applied and which the NARC scientists are well qualified to adapt and extend. Because these are small scale commodities and are likely to remain so they should not place an unrealistic burden on limited research funds.

14. NARC should continue to foster high quality research in the crop protection areas of plant pathology, entomology and weed science. Their efforts should be focused on the same commodities that are given high priority by NARC. In cooperation with provincial units they should support all commodities through application of advanced techniques.
15. It is recommended that NARC substantially elevate the size and status of the agricultural economics unit. It has substantial contributions to make to all commodity programs as well as in resolving non-commodity issues.
16. Range Management/Agroforestry because of its barani orientation and its relationship to achieving national goals in animal production, should be given priority.
17. Research on tissue culture should be continued at its present level and expanded as new techniques reach or approach the level where they can be applied. It should focus on priority crops of the nation.
18. Cytogenetics research should be tied to priority crops and to problems where a unique contribution can be made in solving a difficult genetic problem.
19. The divisions on Plant Introduction and Germplasm resources have an essential role in the future of Pakistan agriculture and should be closely linked to international germplasm programs. Procedures followed should foster evaluation and utilization of germplasm as well as acquisition and should stimulate the use of these resources.
20. Non-commodity programs such as Land Resources, Water Resources, Nutrition and Food, Farm Machinery and Agricultural Economics should to a major degree focus their attention on priority commodities of NARC and on the application of their disciplinary expertise to barani agriculture.
21. Recommendations on priorities within both commodity and non-commodity programs are dealt with in each of the program discussion sections of this report and are not included in this summary. It is recognized that priorities within program are less susceptible to treatment by the checklist system of prioritization. The returns are achieved through the effect they may have on commodity production.
22. Associated activities and research support units at NARC can contribute both directly and indirectly to provincial research as well as to the research work of NARC. These areas include the programs of Scientific Information and Publication, Computer and Statistics, Training and Technology Transfer.
23. Examination of current funding levels makes it evident that NARC needs major increases in operational funds before there are any increases in staff. Even if substantial increases in funds

are made available as now projected, there will be no opportunity for adding staff for the next 2 or 3 years at least. All funding additions that are currently projected will be needed to meet operational costs. During this period expanded staff support to high priority areas will have to come from transfers from other programs. There appears to be some scope for this if NARC management should so choose.

24. Most sector papers reviewed need a reduction in scope and higher degree of specificity before they are included in the Research Master Plan. Numerous suggestions towards that end are made in this report. The various planning units may find these suggestions useful in identifying the one or two areas of research thrusts to be pursued early on in the planning period.

25. NARC is successfully pioneering the farming systems approach. However, numerous opportunities for interdisciplinary cooperation exist elsewhere, and NARC will benefit by recognizing them in the Research Master Plan.

CONSULTANTS' REPORT  
on the  
NARC RESEARCH MASTER PLAN

I. INTRODUCTION

A. THE NATIONAL AGRICULTURAL RESEARCH CENTRE (NARC)

1. History of NARC 1/

The only research establishments in Pakistan at the time of independence were the provincial research stations, which were established in undivided India in all provinces to undertake applied and adaptive research on the agricultural commodities of the provinces. Although central research organizations existed in India before independence and continued thereafter, no central research institution or organization existed in Pakistan after independence. The question of whether there should be a central research organization in Pakistan and what its nature should be was discussed on many occasions and in successive federal cabinet sessions. In 1968 and 1972, joint Pak-US Agricultural Research Teams undertook extensive reviews of the situation. The recommendations were widely discussed at the provincial level and subsequently approved by the Inter-Provincial Coordination Committee and the Federal Cabinet in December 1970.

Upon the request of the Government of Pakistan, the USAID agreed to support a project to implement the major recommendation of the aforementioned bilateral committees, namely, the development of a National Agricultural Research Center (NARC) with facilities for laboratory and field experimentation, a library and a computerized database for agricultural research. The PC-I project proforma, signifying an agreement between the Governments of Pakistan and the US, was signed into effect in December 1982. Construction commenced immediately, and the new National Agricultural Research Center was inaugurated on March 27, 1984, by General Zia-ul-Haq, President, Islamic Republic of Pakistan. Since then, the NARC has grown into a sizable research organization. By 1988 NARC had 331 university trained scientists, of whom 51 held Ph.D.'s, and 237 had master's degrees.

2. The Mandate of NARC

A clearly articulated mandate is crucial for the development of a Research Master Plan for NARC. Although no such statement--formally approved by the PARC Board of Governors, widely publicized, and generally accepted -- exists at present, the statement contained in the PC-I proforma for the overall scheme for "Strengthening of Agricultural Research Capabilities in

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1/ Abbreviated and modified from (Muhammed, 16 and PARC 20) entitled "Strengthening of Agricultural Research Capabilities in Pakistan"

Pakistan" provides an excellent starting point. This statement was approved by the ECNEC and is summarized as follows:

"i) The major goal of NARC is to conduct research in areas of national importance where such research is not currently being undertaken or is seriously inadequate and it can best be done at a well-equipped properly staffed and funded central institution, where facilities are available to all the scientists in the country.

"ii) A major emphasis in NARC research will be the Farming Systems approach where the production technology available for various agricultural commodities will be synthesized into an integrated system suitable for different agro-ecological regions and socio-economic groups.

"iii) Besides laboratory research on selected aspects of plant and animal genetics, pest management, soil and water management, etc., NARC will also have a Training School to impart theoretical as well as practical training in crop production and related techniques to provincial scientists.

"iv) The other facilities at NARC will include a reference library and a centralized information service to provide the latest research information to all the research scientists in the country.

"v) The Plant Introduction Centre (PIC) and the National Unit on Plant Genetic Resources (PGR) are also to be located at NARC. The main objective of these groups is to collect and preserve the genetic resources of various plants so as to save them from extinction, to transfer their desirable traits for development of high yielding varieties with other important genetic characters like resistance to diseases, insects and other environmental stresses.

"vi) NARC will provide a focal point for all the agricultural research scientists of the country to jointly discuss and plan their research activities on different commodities, and undertake research on common problems."

The foregoing statement of a mandate for NARC has found its way into literature with various modifications. These modifications call, for instance, for emphasis on agricultural problems of barani (rainfed) areas, for undertaking basic research on complex agricultural problems, for supporting provincial institutions by conducting fundamental research, and for providing facilities for graduate and post-doctorate research for all scientists to solve complex problems for which their respective institutions are not adequately equipped. These additions do not appear to be at variance with the original statement of the mandate for NARC but are merely extensions or applications of principles expressed in the original formulation to a specific case. Therefore, the mandate for NARC as stated in the PC-I appears valid and workable, and it is, therefore used as

the overall basis for forging priorities for a NARC Research Master Plan.

## B. NARC's MASTER PLAN FOR RESEARCH

Agricultural research in developing countries has been in a dynamic phase over the past one to two decades. In this period a wide range of national and international activities led to the "Green Revolution". In most developing countries the results have reversed the trend toward more frequent and more severe food shortages that marked the 1945-65 period. These successes have changed national leaders' perceptions of agricultural research as an academic pursuit to one that can engender enormous national benefits. Because of this recognition, substantial funds from many sources have been channeled to agricultural research. And it is basically the reason that institutions such as NARC have come into existence.

As large amounts of funds have been invested in agricultural research, it is only natural that the leaders who fostered research activities and the public that they represent should require a close accounting of how the funds have been spent and a regular assessment of the work that is being done. At the present time, several billion dollars per year are being spent on agricultural research in the developing countries. To a certain extent, the increased questioning of research goals and funding requirements is a result of past successes. As food supplies improve, the public tends to ask if additional research is essential. Fortunately the environment remains highly favorable to research, but it is incumbent upon the research systems to establish a research plan that will clearly state objectives and set priorities.

The international donor community also has strong interest in the planning process. Often donor assistance will be substantially increased if it is clear how the proposed research fits to long range plans and needs. Furthermore an overall research plan helps demonstrate to the public that research expenditures are well focused on national needs. The public's expectation that research will be increasingly focused and accountable comes at a time when many developing country research entities are themselves calling for greater clarity in planning. Research directors of institutions that have grown rapidly feel the need to describe linkages between different units and to identify gaps in the research agenda. Individual scientists also benefit from charting a course towards specific objectives. Not only does their standing as members of a research team improve, but their professional output is also more likely to be recognized.

These and other benefits of planning are causing institutions around the world to plan research which heretofore has often been done on an ad hoc basis. The interest in better planning is also notable in the developed countries when the same factors are at work and where the public is taking an increased interest. Interestingly the developed countries often find it more difficult to produce a rational plan because of large and long established systems that grew with little planning or for which

plans were never adequately revised as needs changed. Young institutions in the developing countries may find a formal planning process easier to introduce and more immediately useful than will the older ones in the developed countries.

### C. THE PLANNING PROCESS

#### 1. Priority setting criteria.

Procedures for establishing priorities in agricultural research can range from very simple and instinctive actions that require relatively few supporting data to complex ones that may require a large support staff and extensive data to support cost/benefit analyses. In the past decision makers in Pakistan have used relatively simple but practical bases for deciding on research activities. In the early days of the Green Revolution, for example, decisions were made to focus research on the two major commodities, wheat and rice, and to aim for changes that would substantially improve yield potential and response to inputs. Varietal resistance to prevalent diseases would be necessary as would means of controlling insects. The factors looked at by the decision makers in reaching these conclusions included the potential impact of the research, its cost and its feasibility. A significant factor in setting priorities in those days was that the international research centers for rice and wheat (IRRI and CIMMYT) could greatly augment the resources of scientific personnel available to the total effort. At the time, the level of trained staff available in Pakistani institutions was quite limited even for these two premier commodities. Without giving this procedure of priority setting a name, the decision makers were using what ISNAR (Contant, 7) has called the "check list" procedure for priority setting in agricultural research.

In attempting to suggest or recommend priorities in the present Master Plan, the consultants will basically use the same check list procedure. It should also be noted that for NARC today, decision making on priorities should also take into account work being done in other research institutions in Pakistan. These efforts are far larger and better funded than they were just a decade or two ago. Also work being done in other countries and at the international centers should be taken The scope of research of the centers has, of course, greatly expanded in the last two decades.

ISNAR scientists have commented that the check list procedure is simple to apply but requires much understanding by the user of both agricultural research and development. They also note that the method does not include explicit quantification of what is important and what is not and must rely on the experience and perceptiveness of the checklist-user to avoid major errors. Likewise it relies on the user to determine the art of the possible: what is feasible within the existing institutional and cultural or political environment. The consultants submit that their credentials are distinctly limited in many areas and perfect in none and that their suggested or recommended

priorities should be screened and modified by those who are qualified or required to decide on these issues. The review should include rebuttals by the scientists whose proposals are being prioritized and at times it should include outside experts in particular subject matter areas. It should be noted, however, that the size, scope and range of research proposed by NARC scientists is so much larger than could be carried out within the projected budgets during the Master Plan period that the first approximation in priority setting need not be highly precise. That is, the cost and feasibility factors of the research Master Plan are so predominant that a substantial reduction is not only essential but it is relatively easy. The most difficult issue in the initial stages may be to decide how to maximize the contribution of available scientific expertise which may not mesh precisely with research subjects of highest priority.

## 2. Funding assumptions

The amount of work that can be done by NARC over the balance of this century will be substantially influenced by available funds, something that is almost impossible to guarantee over an extended period. In attempting to deal with the problem, the consultants have made assumptions regarding funds. These assumptions are based on recommendations by the National Commission on Agriculture (NCA). In this regard attention is called to paragraph 16.18.4 (page 261) in the publication "Report of the National Commission on Agriculture", Ministry of Food and Agriculture, Government of Pakistan, March 1988 (17). This paragraph states that, "The allocation of resources to agricultural research should be increased by 15 percent during the Seventh Plan and 10 percent thereafter per annum till they reach at least 1.5 percent of agricultural GDP. (At present they are only at 0.75 percent)". While this level of funding may not be achieved or NARC may not receive an amount equal to the average, it is assumed that increased funding approximately at this level will occur. Refinements in priority setting should enable the NARC management to adjust to actualities over the coming years.

An additional assumption is that whatever funding may be available to NARC, NARC will strive to achieve a ratio of operational/total funds equal to 0 percent and of staff costs/total funds equal to 60 percent. Therefore, no additional staffing will take place until such ratios are achieved or at least approximated. This assumption, too, is based on an NCA recommendation.

Finally, it is assumed that staff costs increase by 3 percent per annum.

Annex 10 provides additional specifics on assumptions regarding resource availability and resource projections.

## II. OBSERVATIONS, SUGGESTIONS AND RECOMMENDATIONS

### A. PRIORITIES AMONG PROGRAMS

#### 1. Areas of Current Emphasis

The discussion of priorities among the various research programs and activities carried out at NARC will be done in the context of the assumptions set forth in the previous paragraphs of this report and with the various qualifications which have been mentioned. Some assumptions relate to the mandate of NARC, some to important criteria such as potential impact of research, cost, feasibility, availability of professional staff and level of work in progress at other institutions in Pakistan and abroad.

#### a. Commodity programs

Table 1 presents an application of the check list system of priority assessment for the major commodities under study at NARC at the present time. Simple ratings of low, medium or high are applied to some items on the check list while others are dealt with on a plus or minus basis. While the procedure is simple, it can yield significant conclusions. For example it shows that wheat, rice and sugarcane are crops that not occupy a central place in the field research activities at NARC. It concludes that, in the case of rice and sugarcane, the climate and ecology at NARC do not fit and that in the case of wheat, the crop is not as commercially important in the NARC area as it is in other parts of the country. It shows that there is a low relative and absolute level of staff to work on these commodities at NARC and that there is a high level of work on them at other Pakistan research centers. It shows that for wheat and rice, there are sources of advanced technology abroad which may be tapped by the Pakistan research system. The conclusion, therefore, is that wheat, rice and sugarcane research at NARC should consist only of plant introduction and plant genetic resource maintenance (including appropriate evaluation of the genetic material) plus advanced research to deal with special problems. The latter would probably be in the areas of insect and disease resistance and grain quality improvement or modification. If this analysis stands scrutiny, work at NARC on wheat, rice and sugarcane should be curtailed in an orderly manner and the resources transferred to commodities with higher priority for NARC.

For certain other commodities, the same sort of check list analysis leads to the conclusion that full-scale field programs plus those identified as advanced research and germplasm maintenance are indicated. These commodities are ones for which the NARC environment is suitable (they are mostly barani crops), there is high potential impact to be expected from work at NARC, the projected costs are manageable, the feasibility of success is good (estimated time requirement plus likelihood of positive results) and there is less work at other research centers in Pakistan. For some, it is noted that there are excellent sources abroad for assistance in advanced technology. Within this group

of commodities are sorghum, millet, fodder, pulses, oil seeds and vegetables. If this analysis stands the test, then additional NARC resources should be channeled to these programs. Efforts should be made by NARC to maximize the flow in resources from abroad and to collaborate actively with all Pakistani units at work on them.

The check list analysis for livestock in Table 1 is divided into two parts; one for work on nutrition and health and one for animal breeding. This was done because of the probable wide disparity of results to be expected from these kinds of research activity. Experience in animal research throughout the world indicates that research on breeding of large animals is a costly and time consuming process. While the expectation of eventual success may be good, the level of improvement is generally moderate and spread over many years. The research feasibility rating goes down substantially because of this. Also, the requirements for skilled management in order to realize the benefits of improved breeding may be quite demanding on the research establishment. For these reasons a separate check list appeared necessary in order not to bias the support of more rapidly productive kinds of animal research. This portion of the table suggests that animal breeding research should be limited to sheep with the objective of improving the quality of apparel wool in Pakistan. This would be accomplished by crossing domestic sheep with exotic breeds and selecting ones that produce improved wool type but retain the desirable characteristics of the native stock. It is suggested that for dairy and beef animals the input be reduced to herd maintenance. No activity in poultry breeding is suggested.

The check list makes a case for active programs in animal nutrition and health maintenance for beef and dairy animals and for sheep. Advanced research on diseases of these animals is indicated as needed to deal with existing problems. The case for nutrition is further supported by the high priority assigned to work at NARC on fodder crops.

#### b. Non-commodity Programs

The modified check list procedure for setting priorities is primarily useful in dealing with commodities or with those factors that have a direct effect on output of commodities. Thus NARC programs that deal with crop diseases, entomology and weeds can be tested by the check list technique. Those portions of the soils program that relate to fertilizer usage are also in this category. Because crops that are listed for high priority would all require significant research on pest control and fertilizers, it follows that the NARC programs that deal with these subjects are also of high priority. This conclusion is further reinforced when it is noted that the "advanced research" identified as an important contribution of NARC to all crop production in Pakistan will include research on plant diseases, insects and weeds.

Table 1 A CHECKLIST OF PRIORITIES AMONG NARC COMMODITY PROGRAMS

Commodity	Climate Ecology at NARC	Fit to NARC Mandate		Potential impact from NARC		Cost	Commodity importance		Staff Available	Work at Other Centers			Indicated NARC Program (Distinct from National Coordinated Programs)
		Field	Adv	Field	Adv		Pres.	Fut.		Pakistan	Abroad	Adv. tec	
Wheat	M	L	(+)	L	(+)	M	H	H	L	H	Adv (-)	H	Plt Gen Res - Adv Tech
Rice	L	L	(+)	L	(+)	M	H	H	L	H	(-)	H	" "
Maize	M	M	(+)	M	(+)	M	M	M	L	H	(-)	H	" "
Sorghum & Millet	H	H	(+)	H	(+)	M	L	H	M	L	(-)	H	Full field; PGR Adv Tech
Fodder	H	H	(+)	H	(+)	M	M	H	M	L	(-)	M	" " " "
Pulses	H	H	(+)	H	(+)	M	M	H	M	L	(-)	H	" " " "
Oil Seeds	H	H	(+)	H	(+)	M	M	H	M	L	(-)	H	" " " "
Vegetables	M to H	H	(+)	H	(+)	M	M	H	L	L	(-)	M	" " " "
Fruits	L	L	(+)	L	(+)	H	M	H	L	L	(-)	M	Plt Gen Res - Adv Tech
Sugar	L	L	(+)	L	(+)	H	H	H	L	M	(-)	M	" "
Potato	M	M	(+)	M	(+)	M	M	H	L	M	(-)	H	Full field; PGR Adv Tech
Beef Nutn & Hlth	H	H	(+)	M	(+)	H	H	H	M	L	(-)	M	Action programs on nutn and health maintenance
Dairy Nutn & Hlth	M	H	(+)	M	(+)	H	H	H	M	L	(-)	M	(Beef dairy & sheep)
Sheep Nutn & Hlth	H	H	(+)	M	(+)	M	H	H	H	L	(-)	M	Adv. tech.(diseases)
Poultry Nutn&Hlth	H	H	(+)	M	(+)	M	M	M	M	L	(-)	M	Technology transfer
Honey Bee	H	H	(+)	H	(+)	L	L	L	H	L	(-)	M	Low priority
Silk Worm	M	H	(+)	(?)	(+)	M	L	L	M	L	(-)	M	Production research
Fisheries	M	M	(+)	M	(+)	H	L	M	L	L	(-)	M	Herd maintenance
Beef (Breeding)	H	H	(+)	L	(-)	H	H	H	M	L	(-)	L	" "
Dairy (Breeding)	M	H	(+)	L	(-)	H	H	H	M	L	(-)	L	" "
Sheep (Breeding)	H	H	(+)	M	(-)	M	H	H	M	L	(-)	L	Breeding for fine wool
Poultry (Breeding)	H	H	(+)	L	(-)	M	H	H	M	L	(-)	L	No activity

Several other research subjects now on NARC's agenda are also distinctly within NARC's mandate and stand the test of potentially contributing to improved production of priority crops. These include tissue culture, cytogenetics, nutrition and food as well as plant introduction and germplasm preservation. None of the other research centers in Pakistan are staffed and equipped to do the research on these subjects that can be done at NARC. There is no doubt that these areas of activity should remain prominent on the NARC research program. NARC's research programs on land resources, water resources and range management appear to be distinctly within the NARC mandate. Properly carried out they will return substantial benefits to the nation in terms of crop and animal production as well as in sustaining the resources on which the nation's agriculture depends. The principal job of the NARC management in these programs is not to decide whether they should be supported but to determine at what level. In the long run they are vital to the nation's well-being, but in the short run they may be less vigorously supported without serious repercussions. It appears that they should be kept at their present level for the time being and then expanded when funding support will permit.

The BARD Project of NARC is in some cases treated as a commodity program, which of course it is not. It is a project of limited duration that deals with a number of cereals, oilseeds and pulses in rainfed farming systems. NARC management indicates that following completion of the BARD project, elements that it includes will become an integral part of NARC's long term research. This area of research fits the NARC mandate on rainfed agriculture and the commodities in the BARD project place well in NARC's long range priorities. Inclusion of BARD activities in a long term NARC program appears appropriate. This can best be done by assuring that appropriate components are built into the various commodity and other research units rather than by perpetuating the BARD activities as a separate unit of NARC.

Programs in agricultural economics cannot be easily evaluated because beneficial effects of the studies do not relate directly to increased agricultural output. For this reason, administrators and researchers in the biological fields have been slow to recognize the substantial benefits that can derive from appropriate economics research. In Asia, for many years, the two types of specialists worked separately, but since the international centers demonstrated the value of this discipline in planning and evaluating crop research, it has been increasingly common to include economists in multidisciplinary research teams. Elsewhere in this report, recommendations will be made for substantially increasing NARC's research in agricultural economics. It is no doubt of high priority to NARC.

The Farm Mechanization Project of NARC is somewhat difficult to analyze as regards priority within NARC for it relates first to the industrial sector and not directly to agriculture. Much of the work of the unit consists of helping industrial firms to test, evaluate and adopt farm machinery items that industry is

considering for manufacture and sale in Pakistan. The unit informs private industry of machinery adaptation opportunities and then assists in adapting ones that industry chooses. One must note that in most developing countries, particularly in Asia, private companies do this on their own without drawing on the limited research funds available to the public sector. It seems quite possible that greater return on research funds would be obtained through biological research directed toward improving any one of a range of commodity production systems of importance to Pakistan. NARC management might wish to evaluate these alternatives as it seeks ways to sharpen its research focus.

Farming systems research at NARC has been mandated as one of its key areas of responsibility and it is somewhat redundant to comment on its priority. It is of high priority by definition. It would be appropriate to comment, however, that the decision of NARC to emphasize farming systems research appears to have been a sound one. Such work is needed not only on the complex farming systems of barani areas but in the irrigated regions of the country as well. It is a subject that has been largely neglected by institutions that focus on specific commodities.

## 2. Gaps in current programs

The NARC program is a very broad one in which no important element appears to have been completely omitted. Furthermore a strong case would have to be made for adding any new elements until the priority areas now identified are adequately funded. However there may be reductions in research emphasis in some areas that would release funds for use on other subjects. Also new funds that may be acquired could be used for filling gaps. A strong candidate for increased emphasis is the field of agricultural economics. The importance of greater emphasis in this area, along with specific suggestions regarding needed research, will be presented in the review of the sector program statements in economics.

### B. REVIEW AND COMMENTS ON SECTOR PROGRAM STATEMENTS

In this section we will attempt to review the program sector statements that were supplied to us by NARC. A list of the individual documents (totaling 55 separate items) is given in Annex 3. Some of these documents represent revisions of earlier ones and our comments will usually refer to all the versions for a specific commodity or program. Also it will be noted that some commodities are dealt with as a group by a team of scientists and are always reported upon in an integrated statement. Our comments will be presented as a combined statement for such groups. Other individual commodities at NARC are researched by separate teams but several commodities may be grouped together for reporting purposes. In this report, those which are researched by separate teams will be discussed separately. Another fact that should be noted here is that several of the teams reporting in this group serve not only as NARC units but also include persons with responsibilities to coordinate large

national coordinated programs. This may cause some confusion about what is genuinely NARC's program and what is work done elsewhere but coordinated by a scientist who is based at NARC.

## 1. Cereals and Fodder

This group of activities at NARC constitutes one of the largest and most complex research undertakings of the organization. It might, in fact, be considered not one program but a group of programs which share many research techniques in common but each of which has its own set of objectives and needs. As a result of differences among the crops as to where they are grown and where the scientists working on them are stationed, there are distinct differences in how they function and what NARC's role is. These will be reported upon singly or in groups in the same fashion as they are reported upon by NARC scientists.

### a. Wheat, barley and triticale

Wheat is, of course, far more important than barely or triticaie. The sector statement in fact refers almost exclusively to wheat; so the following comments will deal only with wheat.

The NARC sector statement for wheat provides information on area, yields and total production for the nation and on the national research effort. Excellent progress has been made since the work started in the 1960's. Wheat area has expanded at an annual rate of about 1.8 percent and total production at an annual rate of 6.2 percent since 1967. This growth rate is substantially above the population growth rate and the nation is self sufficient in this commodity.

Current Work. In the wheat germplasm development work at NARC materials are currently being received from international sources including CIMMYT, ICARDA, FAO, and USAID. Frequently these materials consist of international nurseries or yield trials that are screened and evaluated for potential use in developing new wheat varieties for Pakistan. A second approach involves conventional breeding to incorporate desired traits into different genotypes. A crossing block of about 3000 varieties is planted for use as potential parents in the national program. These varieties are classified for resistance to specific diseases, yield potential, agronomic characteristics, growth duration, quality, etc. Yield stability is an important objective. Grain quality work at NARC focuses on milling characteristics, protein content, dough properties and suitability for unleavened bread, raised bread and other uses.

NARC scientists participate in a program to test the accuracy of a computer simulation model (CERES) for predicting grain yields and other characteristics under various agro-ecological situations.

On-station research in agronomy includes testing various

wheat varieties for resistance to herbicides. Other studies aim to evaluate the effects of moisture stress on different varieties and to characterize root systems of contrasting genotypes. Date-of-planting studies are being conducted.

In barani systems research, the wheat program has taken the lead in integrating efforts of scientists from eight disciplines including various biological fields as well as social sciences. Effects of differences in cropping patterns, tillage procedures and fertilizer practices are being measured in relation to moisture conservation and weed control as well as yield and maintenance of soil productivity. Some of this work is done on the station, but much of it is done in farmers' fields. Other work in farmers' fields relates to fertilizer usage, disease resistance evaluation and weed control problems.

Proposed Work. The projections of the NARC wheat program to the year 2000 call for extension of plant breeding to the development of high yielding, disease resistant varieties adapted to the various regions of the nation. Increased emphasis would be placed on varieties for marginal conditions. These would include wheats with winter hardiness, adaptation to marginal soils, to rainfed conditions and to saline areas. Efforts would be made to broaden the genetic base of commercial wheat to reduce the danger of epidemics. Proposals in agronomy would include studies aimed at improved efficiency of input usage, an examination of fertility requirements (including micro nutrients) and of moisture conservation and weed control.

In the area called "strategic research" the wheat group proposes work on breeding methodologies, techniques for germplasm conservation and evaluation, studies on stress tolerance, use of wheat multilines, hybrid wheat, marker-facilitated selection of quantitative characters, callus culture and plant transformation, individual cell-level screening for disease resistance, epidemiology studies and others.

#### Recommendations for Wheat

(a) Differentiate between work of the national coordination program and that of NARC. Particularly show what is NARC's own program.

(b) Clarify management aspects of wheat research at NARC. The national coordinator for wheat may continue to be based at NARC, but he should not simultaneously be the principal investigator for the NARC program. When feasible, transfer the wheat coordinator to a provincial base where wheat science and wheat production are concentrated.

(c) Designate the following NARC program in wheat:

-Plant Introduction. The wheat unit at NARC would receive genetic materials from CIMMYT, ICARDA, FAO, USAID and others. Some would be nurseries to be planted for

screening/evaluation at NARC as well as at other cooperators within the NCP. Others would be potential parental lines for long term preservation.

-Plant genetic resource preservation. The NARC wheat team would be responsible for evaluating materials for desired characters and selecting those for inclusion in the gene bank. They would also work with the PGR unit in increasing germplasm from time to time to ensure that viable seed reserves are available.

-Barani wheat production systems. Within the national coordinated wheat program, the NARC wheat group would assume agreed-upon responsibilities that its location in a barani region suits it to handle. In such studies the wheat group of NARC would be the same as any other member of the coordinated systems.

-Advanced technology. Making use of physical facilities at NARC and drawing on scientists with special expertise, NARC should handle some of the studies cited for the future as follows: Grain quality evaluation, stress tolerance selection criteria, marker-facilitated selection of quantitative traits, callus culture, and individual cell-level screening for disease resistance. It should be emphasized that this is only intended as an indication of the type of advanced technology development the NARC might do because it has staff capability in these areas. The wheat proposal that we were shown lists these subjects for future attention without making a strong case for any one of them. It should also be noted that the specialists capable of doing most of this work are in NARC programs other than wheat and also that they all have other demands on their time.

#### b. Rice

Rice has been a research subject in Pakistan for many years. In 1965 cooperative arrangements were started with IRRI, which resulted in rapid acceleration of this work and led to major increases in rice production. In 1975 an NCP with rice was established to bring greater focus to the overall program. While requirements vary from one part of the country to another, the collaborative program has proven itself.

Current Work. The NARC sector statement for rice describes a current program that tests adaptability, yield performance and grain quality of nurseries received from international sources. Crop and soil management studies deal with fertilizer usage, weed control and direct seeding of rice. Pest management work includes studies of the population dynamics of different insects, the screening of breeding materials and the evaluation of stem borer incidence in cropping patterns that include zero tillage of wheat. Grain quality studies relate to milling efficiency, cooking qualities and other characteristics of basmati rice.

Proposed Work. The rice sector report proposes a long list of projects to be carried out between now and the year 2000. They include all of the subjects now under research plus many more. Resistance will be sought to cold temperature and to salinity as well as to insects and diseases. Basmati continues to be emphasized with efforts being made to find ways to reduce production costs. Interest is expressed in rice cultivars for use as fodder as well as grain. Intensified work is proposed on planting procedures, fertilizer practices and other practices that might reduce production costs. Integrated pest management remains a high priority subject. Mass rearing of pests is proposed to produce insects for use in testing for insect resistance. A search is proposed for chemical characters that can serve as selection markers in identifying insect-resistant lines. Studies are projected on environmental factors and cultural practices that influence the incidence of insects in rice-based cropping systems. Continuation of work now in progress dominates the proposals for agronomy. Post harvest and grain quality work will aim for rapid procedures to permit breeders to evaluate quality characteristics. Studies will be made on storage interactions with basmati grain quality, on the nature and level of storage losses and on environmental factors that affect milling efficiency and cooking quality of rice.

#### Recommendations for Rice

(a) Distinguish between the work on rice that is part of the coordinated program and that that is not. Presumably much that was written in the rice sector report was NCP work, for it dealt with subjects that are specific to other locations.

(b) Clarify management aspects for rice. It is illogical to have the rice coordinator located in a non-rice growing zone. Take steps to relocate him at a provincial center where rice production is intense and rice science is strong.

(c) Define the NARC rice program as follows:

-The only regular on-going responsibilities of the rice group at NARC will be to work with the Plant Genetic Resources groups to obtain rice nurseries and potential parental lines and to ensure that these are properly evaluated and the selected stocks maintained in a viable state over the years.

-NARC scientists with particular expertise will work on specialized subjects such as those cited in the rice proposal for possible future work. For example in the proposed development of direct seeding techniques for rice, the Farm Machinery Institute would be a leading contributor. Among other proposals from the list presented by the rice group, it is noted that the subjects were listed without any strong case being made for implementation. However the following subjects are listed for possible implementation at

NARC: development of techniques for measuring stress tolerance in rice, identification of secondary gene products that may serve as markers in breeding for disease or insect resistance, and physico-chemical characterization of flooded soils as regards factors that affect fertilizer efficiency.

### c. Maize

Maize is the third most important cereal crop of Pakistan. While it falls well behind wheat and rice, it is a basic food crop in some areas. It is also used for fodder. The maize group at NARC projects an increase in annual production of maize of about 50 percent by the end of the century.

Current Work. The maize program at NARC along with the group has responsibilities for acquiring and maintaining maize germplasm. The coordinator of the NCP for maize is based at NARC. As part of its mandate, the NARC group screens and evaluates germplasm from international sources. Maize breeding work that is carried out at NARC relates particularly to the needs in the region of Islamabad in which the NARC station is located and in similar areas elsewhere in the nation. Maize for fodder as well as for grain is important. Early and medium maturing lines are needed and focus is on drouth tolerant types. Weed control work in barani maize is currently underway. Agronomic studies also include work on fertilizer usage. Studies in maize pathology include work on stalk rot. The field biology of stalk borers is under study. Other work on these pests includes screening for resistance and evaluation of insecticides for their control.

Proposed Work. The focus of proposed work remains one of obtaining higher yielding, early maturing maize varieties that are tolerant to drouth stress, are resistant to stalk rot and can be grown at a higher planting densities. In addition, resistance to salinity and to water logging are stated objectives. Selection for "stay-green" characteristics and higher biomass production reflect the continued interest in maize for fodder as well as grain. Weed control research is proposed. Production of stalk borers for artificial infestation is proposed. The NARC maize scientists list plant breeding as the first priority discipline for attention during the first Master Plan period. At the second priority level, they identify pathology, entomology, agronomy and economics. Examination of specific project proposals discloses continued concern with stalk rots and stalk borers. While specific areas which require attention in economics are not identified, there is apparently a feeling that a better understanding is needed of economic factors affecting maize. Third priority in maize is attached to animal sciences, reflecting the fodder application of the commodity. Similar priority is assigned to biotechnology suggesting that the maize scientists feel that this area of research may offer opportunities for maize improvement.

## Recommendations for Maize

(a) Identify those portions of the work on maize that are part of the NARC's own program and those that are part of the national coordinated activities.

(b) Clarify management relationships for maize. If possible, separate the dual assignment that causes the national coordinator for maize also to serve as principal maize investigator for NARC. Consider transferring the position of coordinator to an institution in the provinces where maize research is emphasized. This will encourage cooperation between NARC and the provinces and strengthen provincial research.

(c) Identify the following functions for the NARC maize unit:

-Plant genetic resources. The NARC mandate ensures that the center will be the leader of all maize introductions. Breeding nurseries from abroad should be received by this unit and grown out at NARC as well as at other NCP centers. The maize team along with the PGR group should take responsibility for evaluating and preserving genetic materials.

-NCP activities with maize. The maize unit at NARC should be an active member of the national coordinated program and should conduct agreed-upon tests of maize in the climatic zone of Islamabad.

-Advanced research. The NARC staff who are qualified for specialized investigations should be brought into maize research as needed. No specific studies of this were suggested in the maize sector report.

## d. Sorghum and Millet

These crops serve an important function in Pakistan because of their capacity to produce grain and fodder under adverse soil moisture conditions. Under such conditions production is relatively low, but with better moisture conditions the species are capable of producing high yields. They are rugged crops, generally less demanding than maize and they fit well into the cropping pattern as rainfed summer crops, which are harvested in time for wheat planting. These are staple foods in some parts of the country and are feed and fodder crops wherever they are grown. With increasing demands for animal feed and fodder, these crops are expected to become increasingly important. Current yields in Pakistan are well below those obtained in many other countries. Prospects appear excellent for substantial improvement through the use of improved varieties and cultural practices. This is a new research program at NARC. It was started in 1986 when the maize,

sorghum and millet program was divided to enhance attention to the latter two commodities.

Current Work. The NARC unit regularly receives breeding materials from abroad, mainly from ICRISAT but also from the USA and elsewhere. These are tested at NARC and are also distributed to provincial stations as part of the NCP for the commodities. The NARC sorghum and millet team also actively collects, evaluates and conserves native germplasm of Pakistan in cooperation with the NARC genetic resources unit. An active sorghum breeding program is underway based on pure line selection of native materials and on crosses with exotic materials. Selection is focused on earliness, seedling vigor, grain and forage yield and quality. Crosses with exotic lines aim for intermediate height and adaptation to various ecological zones. The final product of the breeding program must be superior cultivars that are well adapted to local environmental conditions and experience has shown that this is best achieved by crossing local and exotic materials. Hybrids developed at other institutions, particularly ICRISAT, are tested at NARC. Such testing involves evaluation of parental lines and local production of hybrid seed. Studies in agronomy are focused on planting dates, plant population in sorghum, and responses of sorghum to nitrogen fertilizer. Millet is investigated in parallel programs as regards collection of local germplasm and development of national and international trials.

Proposed Work. In the coming years, it is proposed that the collection of indigenous cultivars of sorghum and millet be intensified to ensure that valuable genetic materials will not be lost. At the same time, it is proposed the importation of exotic materials from other countries and from international centers be intensified. This material is particularly needed as sources of early maturity, drought and salt tolerance and resistance to insects and diseases. The development of cultivars that are useful for fodder as well as grain will continue to be emphasized. Early maturity is highly important because of the need to prepare for wheat planting following the harvest of sorghum and millet. Strong seedling vigor is needed to improve prospects of acceptable stands under the hazardous growing conditions that prevail in barani areas in the early monsoon period. Projections call for agronomic studies under both irrigated and barani conditions. NARC's direct role would be chiefly to study barani conditions, but they would actively encourage provincial involvement to broaden the understanding of the two commodities and to maximize their contribution to Pakistan. Among the agronomic studies called for are ones dealing with plant populations for new varieties, fertilizer usage and weed control. Attention would be given in some ecological conditions to intercropping of sorghum and millet with grain legumes.

The sorghum and millet team emphasizes the importance

of working with farmers. They state that to get a clear picture of existing sorghum and millet production and consumption patterns and to identify production constraints, there is need to conduct farm-level surveys in the main production areas in collaboration with social scientists. They also comment that a major part of the agronomic work with sorghum and millet should be done in farmers' fields.

Interdisciplinary collaboration is called for by the group in developing tillage operations related to moisture conservation, plant stand establishment and plant development. Appropriate machinery is needed for seeding and harvesting these commodities. The sorghum and millet sector statement emphasizes the need for collaboration with the Farm Machinery Institute.

### Recommendations for Sorghum and Millet

(a) Make this group directly responsible for developing a full-scale multidisciplinary program aimed at improving technology for these commodities.

(b) Specify that initially the principal investigator of the NARC project will also be the national coordinator for sorghum and millet. Further specify that this dual role means that the coordinator has substantial research resources under his direct control, but that his responsibility to work with and to strengthen provincial institutions is undiminished. If provincial research strength in the commodities develops sufficiently, the dual role should be discontinued by creating separate posts for coordination of the national program and leadership of NARC's own work.

(c) Establish research objectives for the Master Plan along the lines given in the sector report on sorghum and millets. Specific actions are as follows:-

-Collect indigenous cultivars; import and evaluate exotic materials; identify sources of early maturity, seedling vigor, drought and salt tolerance, and resistance to insects and diseases.

-Establish crossing programs leading to development of sorghum and millet varieties for use in different ecological zones of Pakistan. NARC's goal would be to assure that all available genetic resources are evaluated and utilized in achieving the nation's goals in grain production. Materials would be shared with provincial units at all stages and release of new varieties would be based upon NCP coordinated research.

-Recognize the dual fodder and grain uses of these crops. Seek varieties with early maturity, seedling vigor, drought and salt tolerance and resistance to insects and disease.

-Conduct agronomic experiments on plant population, fertilizer usage and weed control with most such experiments being in farmers' fields.

-Conduct socio-economic surveys of production and consumption patterns for sorghum and millet; develop tillage operations that foster plant stand establishment, seeking participation of the FMI; draw an other units of NARC for special studies as needed.

#### e. Fodder crops

At present the national supply of meat and milk products falls substantially below demand, and projections indicate that demand will increase considerably more rapidly than the population growth rate. It is estimated that by the year 2000, the demand for meat may triple, while that for dairy products will double. It is estimated that feed and fodder supplies at present are some 30 percent below the needs of the existing livestock population. If the national goals are to be achieved for meat and dairy products, it is obvious that the importance of fodder production cannot be overlooked. To deal with the problem, a NCP for fodder research was established in 1975-76. A number of leading provincial institutions collaborate in this work. The coordinator of the program is based at the NARC.

Current Work. The fodder program focused first on traditional fodder crops such as sorghum, millet and maize in the Kharif and on ones like mustard and barley in the Rabi. Attention has turned to other crops as well. These include lucerne, berseem, oats, elephant grass and cowpea. The fodder program has participated in collection, evaluation and maintenance of indigenous germplasm for various fodder crops and in assembling exotic germplasm. Independently or in collaboration with other NARC units, the fodder research group has maintained a crossing program to improve the quantity and quality of fodder. Particular attention has been given to sorghum and sorghum-sudan grass crosses. Selections have been made for palatability, productivity and resistance to diseases and insects. Agronomic studies have included time of planting, seed rates, the use of fertilizer and the frequency of cutting.

The proposals of the Fodder Program emphasize collaboration with the Animal Science group, the CDRI, the Pest Management Project and with provincial research institutes. Work will continue on the fodder species currently under study and new ones will be added. Emphasis will be on fitting the fodder crops to ecological conditions and to the farming systems that exist in various regions. Mention is made of including fodder-producing shrubs and trees in appropriate systems. They will give attention to hay or silage making as a means of meeting the needs of the animals during periods when grazing or fresh fodder opportunities are deficient. It is proposed that laboratory facilities as well as feeding trials be employed to evaluate fodder quality. Also, attention to seed supplies is called for.

## Recommendations for Fodder Crops

(a) Designate the NARC group in fodder as responsible for developing a full-scale, integrated research project aimed at increasing the quantity and quality of fodder available to the nations' livestock population.

(b) Specify that the leader of the group will serve jointly as the national coordinator for fodder and the principal investigator at NARC. Specify further that the dual role is intended to accelerate achievement of national goals in livestock production and that all efforts must be taken to involve provincial research units in these undertakings.

(c) Establish research objectives which will foster the intensification of animal production systems of the nation with particular regard to barani areas. Specific actions would include the following:

-Collect, screen and distribute fodder species and varieties for potential use in Pakistan. Work with all interested provincial institutions in evaluating these materials. Collaborate with the Plant Introduction and Plant Genetic Resource groups of NARC in acquiring and preserving fodder species.

-Develop breeding programs for promising fodder species. Cooperate with units such as the sorghum and millet group in improving fodder cultivars.

-Establish close working relationships with the NARC Animal Institute.

-Conduct studies on fitting fodder species into different farming systems and ecological zones. Give full attention to agroforestry systems and the opportunities for utilization of fodder from woody species.

## 2. Pulses and Oilseeds

### a. Pulses

Current Work. According to the sector paper, current research on pulses at NARC is confined to (a) collection, distribution, and documentation of germplasm material, and (b) screening of germplasm material for important diseases, insect pests, and for other desirable characters. The sector paper provides a considerable amount of information on the nationally coordinated research program on pulses. However, this national coordination effort, while necessary and highly commendable, should not be considered as part of the NARC research program. (see also recommendations under B.1.a. Wheat and B.1.b. Rice).

Proposed Work. It is not entirely clear what the proposed program is envisioned to be, as statements of proposals are

intermingled with research to be carried out at NARC and through the Nationally Coordinated Program in pulses. Also, various lists of proposed projects given in the sector paper differ from one another. With these caveats in mind, it is the best interpretation that of the proposed projects two are concerned primarily with pathology, one deals with pathology and entomology, two address primarily breeding/genetics, one is in the area of farming systems research, and one examines primarily agronomic issues. Projected manpower requirements to accomplish the proposed (NARC) research program in pulses over the next 12 years are estimated to be 95 scientist-years (or about 8 scientist-years annually).

#### Recommendations for Pulses

(a) It is recommended that scientists at NARC confine their research largely to three areas of emphasis. These areas build on scientists' expertise, the comparative advantage of NARC with respect to available facilities, national impact, and the complementarity to other research activities at NARC.

(b) The first of the recommended areas parallels the NARC role suggested for rice and wheat, namely introduction, screening and evaluation of local and exotic varieties of pulses and maintenance of a gene bank. The second area deals with basic and applied studies in pathology and entomology. The third area is farming systems research.

(c) It is further recommended that scientists working with pulses identify those pulses, diseases, and insects that will receive their immediate attention. As research results become available over the next few years, these priorities may change. However, initially it is not sufficiently specific for planning to state that research will be done on "chickpea, lentil, etc." and "pigeonpea, cowpea, common beans, faba beans, etc." As it is not possible to conduct research on all of these species simultaneously, researchers should select for initial research those that appear to have the highest potential of pay-off in the near future.

(d) Finally, it is recommended that the research plan be developed in such a manner that there is a clear distinction between research and related activities that are part of the nationally coordinated program and those that are not.

#### b. Oilseeds

Current Work. Researchers in the oilseeds unit have, since its establishment in 1984, concentrated on sunflower, soybeans, and safflower. Within these crops, by far the largest effort went into collection, evaluation, maintenance and dissemination of germplasm. There was also a modest amount of breeding, some agronomic work, some recording of disease incidences, and some selection for disease resistance.

Proposed Work. The sector paper proposes that concentration of effort on sunflower, soybeans, and safflower continue. The germplasm collection and evaluation activity is also retained. The proposed breeding program is expanded considerably over that of the past. Development of machinery for planting, harvesting, and threshing is proposed as an area of research for all three crops. The needed manpower requirements for the proposed research program are 39 scientists. This compares to four currently assigned to this program. Many of the proposed additional scientists are in subject matter areas in which no research programs are proposed, such as pathology, entomology, agronomy, and economics. No additional manpower requirements are listed for engineering, although machinery development is listed as a proposed research program.

#### Recommendations for Oilseeds

(a) The scientists' proposal to concentrate on just three oilseed crops is commendable. There is also good justification to continue efforts in the collection, evaluation, maintenance and dissemination of germplasm. In principle, the proposal to continue and perhaps to expand work in breeding is also justified. However, the proposed breeding program is far too comprehensive. As presented, it cannot be accomplished with resources that may be available even under the most optimistic projection. Therefore, it is recommended that the researchers develop a smaller and more specifically stated list of breeding objectives. While NARC would take an active role in genetic evaluation and utilization efforts the actual naming of varieties would follow the established pattern of involving provincial units in coordinated testing.

(b) The objective of developing machinery for planting, harvesting, and threshing of oilseeds would appear to be best accomplished under the leadership of scientists of the FMI. To be sure, involvement on the part of biological scientists in the development of the machinery is not only desirable but necessary. However, the demands on the time of the scientists at the oilseeds unit for development of machinery should not be large.

(c) Introduction of oilseed crops is likely to cause some significant changes in farming systems involving not only crops but also livestock. Hence, any knowledge gained from research on oilseeds should be tested in a farming systems context as soon as possible. It is, therefore recommended that farming systems research be made an explicit component of the research program in the oilseeds unit.

(d) To conduct meaningful farming systems research, a minimal amount of agronomic, entomology, and pathology research on oilseeds will be needed either prior to or concurrent with the farming systems research. It is recommended that these research needs be explicitly

identified in the research master plan.

(e) To implement the above recommendations, it will undoubtedly be necessary to increase the number of scientists assigned to work on oilseed crops. In view of the important role these oilseed crops may play and because of the additional complexity these crops are likely to introduce into farming systems and the livestock sector, an increase in resources dedicated to research on oilseed crops seems reasonable. However, an increase such as proposed by the sector paper (from four to 39 scientists) does not appear to be realistic.

### 3. Other Crops

#### (a) Horticulture

Fruits and vegetables are important commodities in Pakistan. They are grown mostly for domestic consumption, but they have export potential. Variations in growing conditions related to differences in latitude and altitude, make it possible to grow an exceptional array of fruits and vegetables. They range from temperate-zone species to truly tropical ones. As internal transportation has improved, it has become increasingly feasible to produce such commodities in remote parts of the country where unique ecological niches make growing certain crops particularly advantageous. At the same time, growth of urban centers has increased the demand. It is generally recognized that per capita consumption of fruits and vegetable is higher in urban populations than in rural ones. Improvements in fruit and vegetable production will benefit all levels of society but the principal beneficiaries will be small producers. Potential benefits are well balanced between improved human nutrition and income generation.

Present Work and Proposed Work. The sector report for horticulture at NARC presents a large amount of information about work that is now in progress and work that is proposed. Many commodities are on the agenda and several different research institutes in Pakistan are involved. The situation is sufficiently complex that we will not try to differentiate between work in progress and work proposed. Rather we will give a sampling of the commodities and the research subject matter of concern to the horticulture group. We will then make some suggestions about establishing directions and defining NARC's program more clearly.

Fruit commodities of interest are peach, nectarine, apple, plum, almond, olive, persimmon, apricot, pear, sweet orange, mandarin, grape, loquat, strawberry, raspberry, cherry, kiwi, fig, pomegranate and avocado. Much of the proposed research relates to evaluation of the cultivars and of rootstock and grafting techniques related to certain of the species. Some proposed studies with fruits relate to production techniques and a few are concerned with insect problems.

The vegetables of interest include tomato, egg plant, pepper, cucumber, lettuce, peas, carrots, radishes and mushroom. Evaluation of germplasm for factors such as higher yield, tolerance to high temperatures, resistance to specific diseases and insects, and crossing programs to combine these characteristics into improved varieties are widely mentioned research activities. Studies on fertilizer use, planting dates, cultural practices such as mulching, shade growing, use of plastic covers to extend the growing season and others are also on the agenda.

For the future, studies on stress tolerance are mentioned as are studies on extending the availability period of vegetables. Post-harvest problems and physiological studies are listed. The use of biotechnology and other advanced techniques is suggested.

#### Recommendations for Horticulture

(a) Separate the horticulture statement into two programs; one for fruits and one for vegetables. Even if they are grouped together for administrative purposes the two have mostly different requirements. Presumably different groups of scientists work on each and this might be mentioned in the documents which are prepared.

(b) Separate the activities that are actually done by NARC scientists as a part of NARC's own program from those that are in fact a part of a national coordinated program.

(c) Establish lists of commodities of potential interest for investigation in Pakistan. The fruit list appears to be fairly complete as given, but there are some important vegetables that may be of importance are omitted from the sector statement. They should at least be considered when priorities are being set. The list is for selection purposes and should be longer than can be researched at the outset.

(d) Establish selection criteria for these sets of commodities using criteria suggested elsewhere in this report such as potential impact of research, importance of commodity (within the group being prioritized), feasibility, and other factors which may be unique to these commodity groups. For vegetables add factors such as nutritional value. Apply the criteria to the lists and rank the different species into relative priority for research. Take the top 6 to 10 as the ones to be investigated in Pakistan.

(e) From the list derived using broad selection criteria (previous paragraph), select five or six vegetables that suit NARC's situation. A somewhat different set of selection criteria will be needed. Factors such as suitability of the NARC climate/ecology should be added. A parenthetical recommendation at this point is that NARC's barani mandate should be adjusted if vegetables are to be included at NARC. Vegetables in barani agricultural systems can benefit the

entire system by making good economic use of small quantities of irrigation water that can often be collected even in dry areas.

(f) After selecting the priority species for study at NARC, do a third prioritization that deals with research subjects such as breeding for disease and insect resistance, for tolerance to hot weather etc.; insect control by other means; disease control; fertilizers; planting techniques etc. This list of research activities and the list of vegetables combine to describe NARC's vegetable research program.

(g) Review results being obtained each year and make adjustments in the annual research workplan. In 5 years run a thorough evaluation of the results and consider major changes including the suspension of lines of research and even termination of work on a given commodity. Changes may result from success or from intractable problems which have been encountered.

(h) Assign surveillance duties to key scientists to keep abreast of important commodities that may be added to the priority group. Know where to find information about these crops in case Pakistani farmers run into problems on crops or subjects not being investigated.

(j) Make a parallel series of determinations for fruit crops. A superficial examination of the role of NARC for fruits suggests that less will be done at NARC because the climate does not suit as many fruit species as it does vegetables.

#### (b) Potato

This commodity has proven to be a far more successful source of food for people and income for farmers in Pakistan than most would have deemed possible a few years ago. The area planted to potatoes has grown about three-fold in the last 20 years and the commodity has gone from being a minor food to being an important staple. Current production amounts to more than 1 million tons per annum. Better genetic material, coupled with improved production of tubers for seed has provided the basis for this surge. It is not only a good income earner for farmers, but a source of nutritious food for urban dwellers at reasonable cost during much of the year. To a degree that is often overlooked, it is a source of high quality protein as well as of calories.

Current Work. The potato program at NARC receives financial support from the Government of Switzerland under a project entitled "A Cooperative Program for Research, Productivity and Marketing Improvement of Potato in Pakistan". The project aims to improve and stabilize the income of potato producers and to improve the supply of fresh and processed potatoes to consumers. The project deals with the potato production system including

research technology transfer, seed production, farming systems studies, farmer training and market and utilization studies. Attention is given to coordination of work of potato-related agencies. The program represents an effort to understand and improve the efficiency and stability of the whole potato production system of the nation.

Proposed Work. Proposed future research to the year 2000 seems to be divided between continuing and expanding current lines of work and the initiation of more basic investigations. Work is proposed in screening of resistance to late blight, scab, cyst nematodes and viruses and a search for varieties adapted to temperature and moisture stress and to salinity. Along with these studies, would be work on improving seed potato quality and availability through production research and through help to seed production schemes or associations. Some of this work would require advanced techniques for producing virus-free planting material and for rapid multiplication. Efforts to use true potato seed will also be made. Cold storage and marketing studies are proposed. In another group of subjects, it is proposed that work be undertaken using genetic engineering techniques of cytoplasmic fusion. Investigations of physiological processes of potatoes are projected, including studies on photosynthesis, respiration and carbon partitioning.

#### Reccmmendations for Potato

- (a) Establish institutional relationships to ensure that active potato research will be continued beyond the termination of the Swiss-supported project. Continued integration of expertise from a range of disciplines is recommended.
- (b) Utilize research results from abroad to the maximum extent possible. Continued close collaboration with the International Potato Center (CIP) is recommended. The 12-year projection should show how these linkages will be maintained.
- (c) Indicate linkages with other research institutes in Pakistan. To what extent is the current work collaborative with provincial institutions?
- (d) Do not undertake advanced studies for which NARC has no comparative advantage. Concentrate on mission-oriented research.

#### c. Sugarcane

Increased sugarcane production is one of the goals of the Government of Pakistan. Domestic supplies do not meet demand and importations are necessary. Unfortunately the NARC station is not located in a climatic zone where sugarcane can be produced. The role for the institution appears to be one of introducing genetic materials from abroad and passing them through a phytosanitary screening process before transferring them to the provinces.

The sugarcane sector statement lists a number of research activities that are currently underway, but it appears that they are part of a coordination arrangement and not actually a NARC program.

It should be noted that a number of NARC scientists have specialized training that could be helpful in planning a research program for sugarcane and whose involvement in subsequent studies could be invaluable.

#### 4. Natural Resources

##### a. Land resources

The land resources section of NARC has the mandate to (1) support the commodity research programs at NARC as well as the national commodity programs, (2) initiate soils research in neglected areas, (3) strengthen existing soils research in the country and (4) arrange training programs for provincial research and extension workers. It collaborates with various other institutions, both federal and provincial, to achieve mutual goals and to avoid duplication. This collaboration includes work with institutions such as ones dedicated to forestry where soils expertise is needed. International collaboration along subject matter lines involves agencies in Canada, USA, Syria, Germany, Japan, Switzerland, U.K. and the Netherlands. Such collaboration relates to specific research for which the overseas center has particular expertise.

Present Work. Current research in soil fertility and plant nutrition is aimed at a better understanding of the nutrient status of the nation's soils, leading to more rational and more efficient fertilizer use. Particular attention is being paid to potassium for which crop responses are said to have been variable and unpredictable. Responses to zinc are widespread and this element is under study. Special efforts are made to develop soil fertility information for the barani areas. The development of soil testing procedures for predicting fertilizer responses is a priority objective.

The management of flooded soils is a separate research area. The objectives are to develop more efficient fertilization practices. Participation with IRRI's rice fertilization network, "INSFER" is a part of this effort.

Research on soil chemistry and clay mineralogy is aimed at acquiring a better basic understanding of Pakistan's soils particularly in relation to fertilizer needs and interactions. Soil biology research of NARC is strongly oriented to nitrogen fixation, particularly by Rhizobium. This work includes identification of more efficient Rhizobium strains and the mass production of inoculum. Some work is being done with Azolla.

In addition to these areas of research, the land resource group conducts studies on stress physiology and its amelioration.

This includes effects of stress on reactions of plants to salt and the stress characteristics of specific genotypes.

Proposed Work. Proposals call for soil fertility evaluations to continue with the principal crops and to expand to include species not previously studied such as fruit crops. Studies on flooded soils will include soil fertility evaluation, nutrient management under direct seeded rice and fertilizer application procedures for cold water areas. Soil chemistry and mineralogy studies will focus on nutrient supply in relation to clay mineral characteristics and on sulphur balance in soils. Soil biology will continue work on nitrogen fixation and will also include the study of losses of nitrogen through denitrification and volatilization. Mineralization and immobilization of nitrogen, and phosphorus and sulphur in flooded soils will be studied. Stress physiology will continue to be investigated along current lines. Initiation of work in soil physics is proposed. This will include studies of water and salt movement under rainfed conditions and on soil physical conditions in relation to tillage and other practices.

#### Recommendations for Land Resources

(a) Provide the Land Resources group with funds for continued implementation of current approved research. Support should focus on funding operational needs including approved laboratory equipment and supplies and emphasize field-oriented research.

(b) Tie research of this section closely to the needs of the commodities that are receiving priority attention by NARC. The Land Resources group is uniquely qualified to apply basic knowledge and research capability to food production problems. Close linkage to crop-oriented units is essential.

(c) Implement collaborative research on seedbed preparation where poor tillage procedures, salt accumulations, crusting, and other factors can adversely influence seedling performance and stand establishment.

(d) In collaboration with international centers seek to adapt and apply the findings of their research to Pakistan and avoid duplication of work already accomplished.

#### b. Water resources

Current Work. The water resources research program lists three central areas, namely, (a) soil and water conservation and watershed management to control soil erosion and to improve agricultural production; (b) irrigation systems development and irrigation management at the farm level to improve productivity per unit of water used; and (c) agro-meteorology, micro-climatology and agricultural hydrology.

In the broad area of watershed management, three projects

seem to have been undertaken. These projects have recently been re-organized under a research program of soil and water conservation. A description of the nature of the research activities and results is not available.

Two projects have been undertaken in the irrigation systems and management area. They dealt with water management and control system development for ARI's in Pakistan and with the feasibility of developing low cost/high efficiency irrigation systems (sprinkler and trickle).

Meteorological activities are concerned with the "establishment and strengthening of agro-met observations and data collection for fine tuning of agro-ecological zoning in Pakistan".

Proposed Work. The Water Resources Research Section proposes to continue a research program in three areas, namely, soil and water conservation for Barani lands and watersheds, irrigation systems and management, and agricultural meteorology. Projects under the first of these areas include soils-water-plant relationships, conservation tillage, soil and water conservation database development, simulation of resource management strategies, and simulation of rainfall-runoff-soil loss functions.

Listed under the major heading of "irrigation systems and management" are projects such as water measurement and control system development, high efficiency irrigation systems (both of them continuing projects), improving water use efficiency at the farm level, design and layout of improved water delivery systems at the farm level, irrigation and energy scheduling at watercourse command areas, and computerized irrigation management strategies at the farm level.

Finally, the three proposed projects under agricultural meteorology are designed to study the usefulness of meteorological and climatological information in formulating recommendations for planners, researchers, extension agents, and farmers; use of agro-meteorological and micro-climatological information for the development of high yielding cultivars, appropriate farming systems, etc.; and furnishing of advisory services to farmers in the in ICT area to select suitable farming systems and to perform various agricultural activities based on agro-met data.

#### Recommendations for Water Resources

(a) Develop statements of the proposed research program for the unit in more specific terms, taking into consideration, among other things, the recommendations offered below. As it now stands the research program proposed by the water resources research section is too broad and general.

(b) Develop a strong program in water conservation and water use efficiency for barani lands and watersheds. This should

be done in cooperation with the farming systems unit, the agricultural economics research unit, the horticulturists, and the agricultural engineers. Research to develop, adapt and demonstrate integrated land and water use techniques, using sub-watershed/catchment approaches with the aim of increasing productivity and management of resources for Barani lands seems to offer productive research opportunities because other scientists at NARC are pursuing research on crops such as vegetables which might be introduced into the Barani areas. With higher value crops and irrigation innovations, farmers in the Barani areas might find significantly different farming systems more profitable than present ones.

(c) Continue programs of design, testing and adapting, of improved water delivery systems at the farm level. However, several factors should be taken into account in developing a focused research program. First, research in the area should be confined to crop and geographic (type of farming thrusts) of NARC. Second, any developments which can be carried out by the technology transfer unit should be treated accordingly. Finally, there should be close cooperation with the FMI.

(d) Develop collection, (from the NARC station as well as other locations), analysis and dissemination of agro-meteorological data into an active research project at NARC. The development of an agro-met historical database in collaboration with the Pakistan Meteorological Department and WAPDA can be made part of this activity. This recommended activity will within a few years provide a solid database for expanded research on the relationship between obtainable agro-meteorological data and recommendations for decision making at the farm and policy level.

### c. Range Management/Agro-Forestry

Current Work. To improve range forages, a cooperative research program on fodder and forages was initiated in 1975. The section paper, "Range and Forest Management", does not provide an account of what has been accomplished since, either at NARC or any of the other cooperating units.

The range management section paper also reports on the initiation of a remote sensing project in 1982. The first phase of the project, which concentrated on exploring the use of satellite and aerial photographs in mapping land use of the Pothwar Plateau, ended in June 1987. The second phase is to concentrate on establishing a Remote Sensing Unit at NARC.

A research activity on cloud seeding was also undertaken by this unit.

Proposed Work. In the range forage production area, the range unit proposes research activities in five areas, namely,

(a) collection and selection of germplasm adapted to different ecological conditions of Pakistan; (b) development of improved techniques and grazing systems; (c) evaluation of forage quality through biochemical analysis and feeding and digestion trials; (d) development of packages of technology for commercial ranching; and (e) development of silvo-pastoral technology packages for barani areas. To accomplish the proposed research, it is estimated that the number of scientists required would have to increase from the present contingent of 5 scientists (1 Ph.D. and 4 M.Sc.'s) to 12 scientists (4 Ph.D.'s and 8 M.Sc.'s).

The proposed research activities in remote sensing are expected to produce canopy reflectance models of major crops to facilitate interpretation of real-time satellite data, to develop a computer based inventory of natural resource for environmental/agricultural management, and to develop and validate an early warning system for various crops and natural resources.

A cooperative project (with the Pakistan Air Force) in cloud seeding is proposed to determine if increased precipitation can be achieved in areas of need.

#### Recommendations for Range Management

(a) Pursue collection and selection of germplasm of range forage plants adapted to different ecological zones of Pakistan. This activity fits well under the NARC mandate and is very complementary to similar work conducted on a number of other crops.

(b) Research on the development of improved techniques and grazing systems, development of technology packages, and development of silvo-pastoral technology packages should be given high priority. However, this is a very broad research area. It is therefore recommended that a much more specific research plan than is reflected in the sector paper be prepared. For instance, what types of livestock will be considered? In which agro-ecological zone will the experiments be conducted? What techniques, e.g., range seeding, restricted grazing, supplemental feeding, etc. will be analyzed?

(c) Elsewhere (see animal nutrition and fodder and forage production) it is recommended that feed conservation be given more attention. For some agro-ecological zones where "technology packages" are being developed, innovative technology in feed production and feed preservation may have a significant role to play. The range management unit, in close cooperation with animal science units and the the fodder and forage unit, should address the role of feed conservation in the development of technology packages for meat production from range lands.

(d) It is recommended that research that requires feeding

and digestion trials be given low priority. Such trials often do not yield enough more information about nutritive value of feedstuffs, particularly the more common ones, than biochemical analysis of feed will yield or than can be found in literature to justify the added time and expense.

(e) Cooperate with the animal nutrition and animal health units of the ASI and the forage unit in matters dealing with feeds and nutrition. All of these units propose to employ feeding trials in their research programs. Any possible complementarity should be exploited. A formal arrangement for coordinating these trials should be considered.

(f) If developmental funds are available, establish a remote sensing unit at NARC. This effort would be confined to the development of basic skills and the acquisition of basic equipment. Implementation of such components as hard-wire link between NARC and satellite ground receiving stations, real-time analysis of satellite data, and dedicated aircraft appear premature.

(g) As part of the developmental effort in remote sensing one or two applications, such as the establishment of an apicultural/natural resources inventory with periodic updating capability should be devised.

(h) Initially avoid attempts at applications which require rapid data collection, analysis, and dissemination, as it is unlikely that either available technology or skills present at NARC will be successful in providing results which are superior to conventional and far cheaper approaches.

(i) Except for training purposes, do not devote resources to the development of canopy reflectance models of the wheat crop. There are no reasons that would lead to the conclusion that canopy reflectance of wheat fields in Pakistan is different from that in other countries where numerous models have already been constructed. Also, construction of reflectance models by itself provides no information for policy makers or farmers. Reflectance models are developed as a component of bigger schemes, such as crop acreage and crop yield estimates. Very large and expensive efforts have to-date failed to provide superior technology over conventional procedures.

(j) At the end of the planning period, carefully evaluate if a remote sensing effort should be continued at NARC and, if so, in what direction. In any case, this activity should be viewed as having low priority at NARC at this time and should be carried out only if developmental funds are available specifically for this purpose. Probability is low that results will be forthcoming during the planning period which will be substantially useful to policy makers and/or farmers.

## Comments and recommendations in Agroforestry

In respect to agroforestry the consultants were not informed on their first consultancy that the range management unit is also charged with work in this area. In the absence of this information it was stated in the preliminary report that, "Agroforestry deals with farming systems in which woody species are treated as farm crops grown along with more conventional crops of various kinds. Generally the woody species are multipurpose ones that can be used for food or feed as well as for wood and fuel. Efforts to improve supplies of wood products for all purposes rank high in the national priorities of Pakistan. So, as has been noted at NARC, are efforts to produce animal products and in this effort the need for fodder is acute. Furthermore, the beneficial use of marginal lands in barani areas is highly important in many areas of the nation. At the same time it is essential that the soil resources of the nation not be depleted by erosion of agricultural regions that are already marginal. It appears that most aspects of agroforestry lie within NARC's mandate and that much is already in place at NARC that could contribute to agroforestry research. Other Pakistani institutions have expertise in trees and forestry per se, but lack some of the expertise to deal with the entire agroforestry spectrum. While this would perhaps not be considered a gap in NARC's current program, it is an area that might be given priority as soon as funds will permit. In the meantime, it is recommended that NARC units discuss these issues with appropriate institutions within the nation and that they keep abreast of activities in agroforestry elsewhere in the world."

It is recommended that the Range Management/Agroforestry section take necessary steps to develop collaborative work along these lines.

### 5. Crop and Environmental Protection

The NARC activities carried out in crop and environmental protection are done by the Crop Diseases Research Institute, which is an integral part of NARC, and the virology, weed sciences and entomology programs of NARC. Although these four units are identified as a working group and may collaborate to varying degrees, their work is reported separately.

#### (a) Crop Diseases Research Institute (CDRI)

In its sector review, CDRI stated that it does work of three types: "(1) Problem-oriented basic research in the area of phytopathology, (2) Coordinating phytopathology research in the country, and (3) Helping the plant breeders of the country in developing disease resistant varieties of crop plants". To achieve these objectives, the institute maintains linkages with the commodity research groups and with provincial institutions.

Every effort is made not to duplicate research being done at other centers.

Current Work. Because of its close involvement in all of the commodity programs of NARC, CDRI's work includes most of the important diseases of wheat, rice, maize, sorghum and millet that affect production in Pakistan. CDRI's involvement is nationwide because of the close association with the national commodity programs. CDRI's contribution may involve basic studies of disease physiology and epidemiology as well as studies related to genetic resistance to disease. CDRI states it does not study chemical means of disease control because this line of research is done by provincial organizations.

Proposed Work. The work proposed by CDRI to be carried out to the year 2000 consists primarily of a continuation of the work now being done. This is true to the extent that the projects all bear the same titles and are labeled as "continuous". However, there are stated priorities among the different research areas and it is evident that work under any given title may be expanded both horizontally and vertically in the coming years. For example, mention is made of searching for resistance to major diseases of wheat in related genera and species and transferring it to wheat in cooperation with the cytogenetics unit. Priority at CDRI is normally assigned to those crops which have been assigned priority by NARC and the nation. Hence the proposal gives first priority to wheat, rice, maize, sorghum, millet, and sunflower. Other commodities are given low priority. CDRI does not specifically mention the potential use of new research techniques in its proposed program for the coming 12 years but indicates that it intends to strengthen linkages with disease research centers in other parts of the world. The present staff of the CDRI appears to consist of about 20 scientists and proposals call for increasing this to about 50 scientists by the year 2000.

#### Recommendations for CDRI

(a) Provide CDRI with adequate support to continue implementation of the approved projects now in place. Such support should concentrate on operational funding, including laboratory equipment, computers and vehicles for travel as needed for laboratory research, studies on epidemiology, trends in pathogenicity and other approved subjects. Modest staff increases might be justified but not large ones until the proposed research activities are more clearly defined and articulated.

(b) Maintain CDRI's close association with all NARC crop research units and expand the CDRI program to include new crops as they are added.

(c) Combine all of the units dealing with phytopathology into one department with administrative and management responsibility for plant disease research. There appears to be little justification for maintaining a separate plant

virology unit. Likewise the presence of institutes, as well as research "units" within a centre such as NARC appears to invite a feeling of inequality without any compensating benefits.

#### b. Plant virology

Work on virus diseases of plants at NARC is done by a small research group working separately from the main body of plant pathologists who work in CDRI. The group consists of five scientists who work in collaboration with commodity programs, particularly with potato, sugarcane, vegetables and pulses. The sector report for this group indicates that they are well supported in terms of laboratory equipment and greenhouse facilities.

Current Work. The virology research program aims to compile data on distribution of virus diseases in Pakistan and estimate economic losses; identify and characterize important viruses; investigate modes of transmission; purify viruses and produce antiserum. In combating virus diseases, the virology group screens genetic material for resistance to viruses and collaborates with commodity programs in developing resistant varieties; produces virus-free planting material of potato, sugarcane, citrus and tomato; develops other control measures for selected viruses.

Proposed Work. In addressing the question of a research program for the balance of the century the virology group proposes collection and characterization of viruses leading to a type culture collection; maintenance of type specimens of insect vectors; description of viruses, their distribution, properties and control measures; establishment of regional diagnostic virology clinics; development of a national sera bank for viruses; preparation and distribution of virus-free clonal planting material; a long list of advanced research subjects.

#### Recommendations for Virology

(a) ~~Discontinue plant virology as a separate research program.~~ Integrate this unit with CDRI into a new Plant Pathology Department of NARC.

(b) Describe a new research program based on the present-day needs of the priority commodities of NARC. Those priority commodities that encounter problems with viruses should become the focus for the virology group. If vegetables are given high priority at NARC, there will probably be numerous calls for participation by the virology group. Draw on technology developed elsewhere to the extent possible and undertake advanced studies in virology only as necessary to deal with mission-oriented investigations.

#### c. Entomology

The entomology program in its sector report cites three

guiding objectives (1) Protect major economic crops and livestock from insect pests through suitable and easily adaptable technology, (2) develop a forecasting system and make the process (of insect control) preventative rather than curative, and (3) develop environmentally safe plant protection systems. It is noted that losses due to insects may be encountered in both the production and post-harvest stages and that most commodities are susceptible in one or both stages.

Current Work. The current work in entomology focuses on rice and sugarcane, which suffer substantially from insect pests. Studies with these commodities include developing surveillance procedures for monitoring field populations of pests. These studies are coupled with research to determine the most critical times for taking control measures. Other research relates to identifying genetic lines resistant to specific insects and breeding programs to incorporate these characters in improved varieties. Control by fumigation is studied for stored grain insects of all the major cereals. . Other stored grain studies relate to attempting to identify cereal varieties in which the stored grain resists insect damage. Still others relate to the ecology of stored grain insects and possible biotypes of these pests that are resistant to insecticides. Work is also underway on monitoring and forecasting of insect problems with barani fruits. The work includes ecological and biological studies on these insects.

Proposed Work. The entomology group proposes to expand work on the same subjects now being investigated and to add work under fifteen new titles. All of the existing projects are rated as first or second priority activities. The new ones have some second priority designations but others are listed as 3rd, 4th or 5th priority. The new titles include development of methods for control of pests in fruits and vegetables and studies on pheromones as research priority areas. Lower levels of priority are assigned to a range of activities that include studies of biotypes of insect pests of rice and wheat, development of computer models for forecasting insect outbreaks, studies on insect vectors of plant viruses, environmental concerns and similar subjects. Four projects dealing with insect pests of livestock are listed but they are listed as 5th category and to be started about 1995.

#### Recommendations for Entomology

(a) Review all priorities in the entomology program for both current and proposed projects. Some of the subjects assigned first priority seem to have very little chance of success. One example is the objective of breeding cereal varieties in which the grains are resistant to storage insects. Development or adaptations of fumigation procedures for stored grain is a more feasible approach yet both have the same priority. Re-consider the livestock insect questions. Perhaps some work might be justified in identifying problems of insects on livestock and seeking

some control before the end of the century.

(b) Reduce the manpower proposals in line with project priorities and normal research policy. The project lists 171 scientists as already assigned and engaged in the current research program. It is proposed to double the number to 342 for the same subjects and to add 347 more for additional subjects. This degree of expansion is not to be expected in any program and would probably be harmful to progress if achieved.

#### d. Weed Science

The weed science sector report describes a program of "problem oriented basic and applied research on biology, ecology, habitat, distribution, ... and population dynamics of weeds". The objective of this work is the "development of socio-economically acceptable and environmentally safe weed management technology". The weed science group also has the objective of coordinating weed research and information at the national level.

Present Work. Work is in progress on integrated weed management which aims to combine chemical control methods which involve mechanical and cultural management techniques. New herbicides are being screened and methods of application that are easier and more efficient are being studied. Cultural management methods include intercropping, planting procedures, water and fertilizer management and mulching. Work is also in progress on interaction of weeds with light, temperature and moisture as they affect germination, seedling growth and reproduction of weeds. It is noted that much of NARC's weed control work is done in farmers' fields.

Proposed Work. It is proposed that work be continued on most of the subjects that are now under study except that studies on improved application methods would be phased out after about 5 years. All other activities are considered as "continuous" projects. New subjects proposed for investigation include increasing herbicide efficiency by use of surfactants and by mixing; development of biological control methods which include insects/herbivores and pathogens; using treatments which kill seed or alter seed performance; improving mechanical weeding tools; studying longevity of weed seed; evaluating the persistence of herbicides in the soil; studying the effect of herbicides on nodulation of legumes; forecasting weed problems; biology and ecology of aquatic weeds. The present staff in weed sciences amounts to 88 scientists while the projected level to be achieved to the year 2000 is 124.

#### Recommendations for Weed Science

(a) Re-evaluate priorities in weed sciences. The proposed activities have merit in most if not all cases but they vary widely in feasibility and potential impact. Take into account research with weeds that is going on in other parts

of the world and avoid repeating studies unnecessarily.

(b) Maintain close linkages and collaboration between the weed science group and the commodity groups. The impact of weed science on agricultural production and farm income will be through increase in the commodities that are produced and through decreases in production costs.

(c) Do not attempt to coordinate weed research on a national basis. It is noted that the principal group working in Pakistan on weed science is the NARC group. They should offer training courses, hold professional meetings and seminars and generally foster exchanges of information with other individuals or centers within Pakistan where weed science is being started. For certain studies, NARC may be able to offer chemical analysis and other kinds of support to scientists elsewhere in the country. But coordination is more appropriate along commodity lines than along subject matter or discipline lines.

## 6. Animal Science

Projections show that demand for meat in Pakistan may more than triple by the year 2000. Over the same period, demand for milk and dairy products is expected to double (National Commission on Agriculture, 17). Although consumption of fish and fish products is very low in Pakistan (1.1 kg per capita annually), the average annual growth rate from 1970 to 1985 has been 6.5 percent. This situation clearly challenges Pakistan's agricultural research sector to provide new technology to meet the increasing demand. This challenge is compounded by the estimated 30 percent current shortfall in feed and fodder supplies. Thus, production of meat and meat products cannot be increased without also increasing the feed basis. Therefore, the research currently conducted and proposed by scientists at NARC is important particularly because other livestock research institutes are largely devoted to quasi commercial production of vaccines. Furthermore, the Animal Science Institute<sup>1/</sup> at NARC is the only animal research institute that is integrated into a research institute where most agricultural disciplines are represented, thus offering an excellent basis for much needed interdisciplinary cooperation between, say, forage production specialists and animal nutritionists.

The scientists at the Animal Science Institute have proposed an extensive research program that addresses many issues that must be resolved if Pakistan is to bring production in line with projected demand. The proposed research plans also are consistent with recommendations by the National Commission on Agriculture and the National Agricultural Research Plan. However, it is unlikely that the large resource requirements underlying the proposed research programs can be attained. Also, the possibility

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<sup>1/</sup>It is understood that this "Institute" may be re-identified as a "Department".

of interdisciplinary cooperation with other NARC units is not sufficiently explored. Finally, there does not seem to be a clear separation between research activities, on the one hand, and extension, service, and potential commercial activities on the other.

As the animal science research program at NARC is large and complex, it will be discussed below in components which correspond to the sector papers prepared by the researchers or to logical groupings within these papers.

a. Animal breeding and genetics, reproductive physiology, and embryo transfer

Current Work. In animal breeding and genetics, activities are indicated in upgrading local cows in the Islamabad district through crossbreeding (with Jersey), study of the adaptability of Jersey cows to local climatic conditions and evaluation of a buffalo herd at the ASI Experiment Farm. (A study on machine milking of buffaloes is also listed, although it is not clear how this study relates to genetics and breeding).

In reproductive physiology, a number of studies are carried out with the object of increasing the reproductive efficiency of buffaloes and to improve preservability and fertilizing ability of buffalo semen.

In the area of embryo transfer, various techniques and superovulation treatments are explored with respect to their impact on recovery and transplantation of embryos in cows and buffaloes.

Proposed Work. Three projects are proposed in the area of breeding, namely, performance evaluation of herds of cattle and buffalo at ASI, production of superior cattle/buffalo through selective breeding, and upgrading of native cattle in the Islamabad district through crossing with Jersey semen.

The numerous proposed studies in reproductive physiology continue current efforts to improve reproductive efficiency, primarily in buffalo, to reduce the calving interval and age at maturity in buffalo, and to improve semen preservability and fertilizing ability.

Proposed embryo transfer research will aim to establish successful transfer techniques primarily for local cattle and buffalo, but also for sheep and goats.

Recommendations for breeding and genetics, reproductive physiology, and embryo transfer.

(a) The research program proposed in reproductive physiology should be given high priority. It promises to provide basic understanding of the physiological relationships that may result in substantial improvement in the productivity of

buffalo. Such research requires specially trained scientists who are equipped with proper laboratories. Further, successful findings can be transferred to and implemented in other regions of Pakistan. But while the proposed research appears appropriate and of high priority for NARC, it will be difficult to justify a resource commitment for other than those projects identified by the scientists as having priority I.

(b) Low priority should be given to breeding programs of large animals. Experience around the world shows that research on breeding of large animals is costly and slow. Almost always improvements in nutrition and health will initially increase animal productivity faster, by larger amounts, and with lower costs than breeding. In Pakistan, milk production might be increased by 100 percent if all animals in milk received a full diet that meets their daily appetites, even without changing the present low nutrition mix (National Commission on Agriculture, 17). Therefore, breeding of large animals involving exotic breeds appears to have low priority relative to research on nutrition and feed production.

(c) Classify and separate to what extent cross-breeding of indigenous and Jersey cattle is research and to what extent it is technology transfer (extension). Discussion with scientists and comments in the sector statements suggest that the impetus for the cross-breeding program is more of an extension effort than a research effort. If it is primarily the first, the cross-breeding program should be removed from the research master plan, and budgetary issues and potential cost recovery schemes should be considered.

(d) Similarly, the proposed research program in breeding and genetics includes an extensive artificial insemination effort in the Islamabad area that seems to be mostly the commercial application of a well understood technique. Whether this is an appropriate activity for NARC and, if so, whether it requires as many as eight AI technicians per year - as is proposed - is best resolved outside the process of developing a Research Master Plan for NARC, as little research in the commonly understood sense of the word is involved.

(e) With a view towards the long run, a modest effort in embryo transfer techniques and associated sciences appears an appropriate research program of medium priority for NARC, particularly as far as super ovulation in buffalo is concerned. Embryo transfer with sheep and goats should receive low priority.

(f) As soon as techniques have matured, transfer the technology to the provinces, the private sector, etc. Assure that NARC does not become a "service agency" for providing embryo transfer.

## b. Meat production and dairy technology

Current Work. A number of studies have been conducted on the influence of growth promoters on growth, carcass traits, and meat quality of buffalo calves, on the beef production capabilities of calves raised in feedlots vs. traditional grazing, on the mutton production potential of Kajli lambs and on microbiological aspects of meat at different stages of processing and handling.

Studies have also been carried out on the quality of milk supplied by different sources and at different intervals of its distribution in Islamabad. Finally, a number of studies dealt with milk processing, such as yoghurt making, selection of starter culture, and preservation of raw milk.

Proposed Work. Of the five meat production projects proposed, three deal with technical and economic efficiency of meat production (from cattle, buffalo, sheep and goats) based on feeding trials; one will examine the efficient utilization of slaughter house by-products and one will deal with the entire complex of standardization of physical, chemical, handling, preservation, packaging, and grading characteristics for beef and mutton.

The proposed dairy technology research deals with the preparation of various milk products at the farm level, the development of starter culture for the improvement of indigenous fermented milk products, and microbial aspects of dairy products with reference to public health.

### Recommendations for Meat Production and Dairy Technology

- (a) Continue research efforts in feeding systems, but be specific with respect to which animal categories and feeding systems should receive priority. For reasons of complementarity with other on-going and proposed research, emphasis on sheep is recommended.
- (b) Low priority should be given to research on the development of utilization of slaughter house by-products.
- (c) Coordinate feeding trials with other units. The range management, sheep production, animal nutrition, among others, all propose feeding trials. A coordinating committee should be considered to assure complementarity and to avoid duplication.
- (d) Transfer major responsibility for economic analysis to the AERU.
- (e) Implement the proposed research program for dairy technology. It is a logical extension of past and current activities. However, the scale of activities proposed is increased manifold over the current effort, i.e., from a current assigned manpower of 12 scientist-years to 54

scientist-years. This is unrealistic and unnecessary. It is recommended that the scientists reduce their proposed scope of work by being more specific about exactly which of the "different milk products," "indigenous fermented milk products," and "various milk components" they deem to have highest priority for research. This can be done on the basis of economic importance of product, likelihood of success, etc.

(f) Evaluate the extent to which microbiologists, nutritionists, etc. in the meats, dairy, and products quality labs can cooperate to increase effectiveness of research efforts and impact of research results.

### c. Poultry Performance Testing

Current Work. Current work consists of performance testing of various commercial broiler strains and commercial layer strains in Pakistan.

Proposed Work. Proposed work consists of continuation of currently ongoing work. In addition, activities dealing with development of broiler and layer breeds and study of meat quality of various poultry strains/breeds are suggested. Resource requirements for these activities are projected at 54 scientist-years for the 12-year period, or 4.5 scientists per year.

### Recommendations for Poultry Performance Testing

(a) De-emphasize poultry performance testing. This can be done by involving farmers in this activity or by transferring this activity to the technology transfer unit. Also, several public institutions exist which can carry out performance testing and breeding, and the results are highly transferable from one ecological zone to another, particularly for commercial operations. Also, investments in the development of poultry and egg production have largely taken place in the private sector, and this pattern is expected to continue (Report of the National Commission on Agriculture, 17).

(b) Consider expanded efforts in studies of poultry meat and egg quality, processing, preservation, etc. They may have a role at NARC, particularly if such activity is seen as part of a larger effort in food science and technology (see also comment above regarding research on meat quality and products quality lab as well as section "2. Nutrition and Food").

### d. Animal nutrition

Current Work. Of 11 currently active projects, four examine the potential role of urea in feeding of various kinds of livestock, three analyze the nutritive values of crop residues and plants, three are specialized feeding trials, and one is a

microbial study of fish raised on biogas effluents. The animals used in the experiments, as per the sector paper, are buffalo heifers, sheep, and fish. Other animals may have been studied but are not mentioned.

Proposed Work. The sector paper lists the following three objectives for research in animal nutrition for the balance of this century: (a) to harness the large reservoirs of crop residues, agro-industrial by-products and animal wastes for the utilization in livestock feeding; (b) to identify feasible systems for farmers, commercial feed millers, and agro-industries for the production of economical and balanced ruminant feeds; and (c) to establish national analytical standards for evaluating the nutritive value of feeds. A total of 13 research projects are listed in support of these objectives. Most of the topics address either objective (a) or (b); none address objective (c) explicitly. Three of the research projects appear to have only indirect relationships to any of the objectives.

The projected manpower resource requirements for the proposed research program are 360 scientist-years.

#### Recommendations for Animal Nutrition

(a) Scale down the proposed research effort. Improved animal nutrition (along with improved animal health) is an effective means of increasing availability of meat, dairy products, poultry and eggs relatively rapidly in a developing agriculture. Also, information on nutrition is generally easily transferable from one region to another. Hence, the research effort in animal nutrition must be viewed as an important and appropriate component in the research portfolio of NARC. It is, however, recommended that the research plan be examined further to increase its specificity, to show more clearly how the various research projects relate to the stated major objectives, to enhance its relationship to other research conducted at NARC and to reduce cost. It should be asked whether the continuation of certain research efforts is necessary. For example, several years of research have already been devoted to research on varietal differences in the nutritive value of wheat and rice straw. Fifteen more years of research are proposed, but it is doubtful that resources devoted to this area have as high a potential pay-off as research on other topics - within and without the field of animal nutrition. Similarly, 25 scientist-years are proposed to study the effect of physico-chemical and biological treatments on the nutritive value of crop residues, and 36 scientist-years are proposed for the development of technologies to produce solidified blocks, briquettes, pellets, liquid supplements, etc. These efforts are continuations of previous and current research projects. How are an additional 61 scientist-years justified? By now, the scientists should have a reasonably firm idea about which physico-chemical and biological treatments and which technologies to produce blocks,

pellets, etc. have potentially high pay-off. It is recommended that only such treatments and technologies be researched and that this be so stated in the Research Master Plan.

(b) Determine what roughages, green fodders, and silages merit trials based on a priori assessment or knowledge of likely significance and pay-off. Then design projects which are more nearly in line with available resource. The sector paper proposes to devote 30 scientist-years (over the next 12 years) to a study of digestibility and nitrogen balance trials on sheep for the evaluation of nutritive value of various types of dry roughages, green fodders and silages. Such resources are not likely to be forthcoming.

(c) Give low priority to the establishment of nutrient requirements of various classes of livestock and to studies on the mineral metabolism in lactating animals. Results in the literature in this area are transferable to a substantial degree, and the proposed 92-scientist years over the planning period cannot be justified.

(d) While there are likely redundancies in the proposed research program, some omissions are also noted. There is a near absence of proposed research on new agricultural feed sources. The increasing importance of oilseed crops (and also pulses as well as improved or new forages) may have significant impact on the amount, type and timing of available feed. It appears important that these are considered by scientists in animal nutrition at NARC, as NARC will almost certainly emerge as the initial national leader in the development of these crops. It is, therefore, recommended that animal nutrition research take into account these complementarities. Likewise, in developing specificity about research to be undertaken, NARC's likely emphasis on sheep and some aspects of buffalo should be taken into account when livestock types on which nutrition research is to be carried out are specified. Finally, the process of recommending specificity should take into account the fact that farming systems research is a major undertaking at NARC and that a forage research program exists. The efforts of these programs should neither be duplicated nor ignored.

#### e. Animal health

Current Work. The Animal Health Section of the Animal Science Institute emphasizes diseases of buffaloes. Ongoing research includes improvement of haemorrhagic septica vaccine, diagnosis and control of sub-clinical mastitis, epidemiology and pathogenesis of paraphistomiasis, immunology of hydatidosis, and incidence and control of theileriasis.

Proposed Work. A program with the following objectives is being proposed: (a) Improvement of vaccines and other prophylactic measures against major livestock diseases; (b)

Development of cost-effective, rapid and accurate diagnostic methods for animal diseases; (c) Studies on newly emerging diseases of livestock and poultry in Pakistan; and (d) Elucidation of pathogenesis of major livestock diseases of Pakistan. Thirteen specific project titles are listed in support of these objectives. The proposed research is expected to require a total of 115 scientist-years over the 12-year planning horizon. This compares to 45 scientist-years (i.e., about 4 scientists per year) currently available to the unit.

#### Recommendations for Animal Health

(a) The unit's statement of objectives for future research are quite general. Similarly the research project titles provide little guidance about the types of animals or types of diseases that should receive priority. In fact, although the report on current work explicitly indicated that emphasis was on diseases of buffalo, proposed future work relates, in addition, to cattle, sheep, goats, and poultry. It is recommended buffalo and sheep be emphasized. Such research will build on past activities and accomplishment and will be complementary to areas of emphasis that already exist or will likely exist at NARC. Nonetheless, it is important for the unit to maintain a broad base so that there is a capability to respond, along with other research institutions, to incidences of new diseases.

(b) Continue the current and proposed research which deals substantially with development of new vaccines. It is strongly recommended that the unit confine its activities to research and testing and refrain from commercial or quasi-commercial production of vaccine.

(c) A study of economic losses due to animal diseases is proposed, and 8 scientist-years are budgeted for this purpose. The study does not appear to have the same priority as other proposed research, has inflated manpower requirements, and should not be carried out by the animal health unit where the necessary expertise is not likely to exist (such a study should be carried out by the AERU in cooperation with the animal health unit).

(d) The proposed program lacks adequate emphasis on research on prophylactic husbandry and nutritional practices. Such research should be given higher priority along with development of vaccines.

(e) It is perhaps premature to begin a genetic engineering research program for vaccine production. However, a small amount of time should explicitly be budgeted for one scientist to keep abreast of literature and laboratory work in this area so as to be able to provide an informed judgment about when the NARC should actively begin work in this area.

#### f. Sheep and wool

Current Work. The current program aims to evolve fine wool sheep through crossbreeding, breeding of sheep for increased mutton and carpet wool production, documentation of genetic characteristics of sheep in Pakistan, utilization of agro-industrial by-products, and establishment of winter active pastures in temperate and semi-temperate zones of Pakistan. Four scientist-years are currently devoted to this activity annually.

Proposed Work. The general objectives for the next 12 years are (a) to bring about the desired level of improvement in quantity and quality of carpet wool and mutton production potential of sheep, and (b) to develop effective and efficient management systems to optimize productivity of sheep and wool. In support of these objectives, 13 project titles are given, covering the subjects of nutrition (1 project), feed production, feed preservation, and feeding (2 projects), breeding (5 projects), wool quality, wool processing, and wool marketing (3 projects), physiology of adaptation (1 project), and husbandry (1 project). The proposed research is estimated to require 270 scientist-years over the next 12 years, or about 23 scientist-years annually.

#### Recommendations for Sheep and Wool

(a) Continue a breeding program with emphasis on improved wool quantity and quality. This can be accomplished by crossing domestic sheep with exotic breeds and selecting ones which produce improved wool but retain the desirable characteristics of the native stock. This is an activity well suited to the national characteristic of NARC.

(b) Study characteristics of wool of all Pakistani breeds and catalogue genetic characteristics of sheep in Pakistan. Care should be taken not to duplicate research done previously on wool quality.

(c) De-emphasize other proposed research projects, such as production and preservation of feeds, feeding trials, marketing and cooperatives. These either have lower priority or appear to be better carried out with primary responsibility resting with other units, such as the forage production unit, the animal nutrition unit, the meat production unit, and the agricultural economics research unit, though close cooperation with the sheep and wool unit would be expected.

(d) Evaluate the need for research on goats as part of a small ruminants program at NARC.

#### g. Fisheries

Current Work. The current research program emphasizes two areas, namely, the selection, controlled breeding and fingerling

rearing of catla catla; and studies on cage culture and fish stock assessment in Rawal Lake. Current manpower consists of seven resident scientists and four field staff.

Proposed Work. The objectives of the proposed work is given as (a) increasing fish production on a per unit area basis under various farming systems to improve farm income with special focus on small farmers; and (b) optimum utilization of water resources with potential for aquaculture. A total of nine project titles are provided to lend more specificity to the general objectives. The proposed projects deal with fish farming (2 projects), breeding, genetics, and underlying biology (2 projects), fish diseases (1 project), hydrobiological studies (1 project), reservoir cage/pen culture (1 project), and economics and marketing (2 projects). The proposed program is estimated to require 19 resident scientific officers and 10 field staff (or nearly three times as much staff as is currently available).

### Recommendations for Fisheries

(a) It is recommended that the fisheries unit emphasize research related to farm pond aquaculture. This strategy allows a manageable research program given available and potential additional resources, provides opportunity for generating expertise in an area of significance, will establish NARC as the center of expertise in Pakistan in this field, and will allow the fisheries unit to participate in major NARC programs, thus increasing its influence and effectiveness.

(b) Even within the confines of farm pond aquaculture, the researchers should concentrate on a few species with potential high pay-off. Fin fish should initially receive priority, with shrimp/prawn being included in the program next.

(c) In its research on farm pond aquaculture, the researchers should strive for a well rounded program and address issues of husbandry, nutrition, breeding and genetics, basic biology, fish diseases, and product quality. Expertise in most of these areas appears to be available at NARC.

(d) The potential for cooperation between the fishery and other units should be explored to preserve resources, to improve the quality of research output, and to increase the potential impact of research output. In particular, there appear to be excellent opportunities for cooperation with the farming systems and agricultural economics units. Indeed, the marketing and economics studies proposed by the fisheries unit should be undertaken only in cooperation with the agricultural economics research unit, and most of the leadership and resources for this type of study should probably come from there.

(e) The reservoir fisheries research program should be maintained at its present level. It should only be expanded after resources become available beyond those needed to establish a first-rate farm pond aquaculture program. At any rate breeding, production of fingerlings, nutrition, etc. are highly complementary for farm pond and reservoir fisheries.

(f) Hydrobiological studies of water bodies should not be undertaken until after the priorities indicated above have been satisfied.

## 7. Agricultural Economics 1/

Current Work. Research and related activities in agricultural economics at NARC are carried out by the Agricultural Economics Research Unit (AERU). The unit was established in 1984, currently has a staff of four scientists, and an (1987/88) operating budget of Rs. 68,500 (down from Rs. 242,000 two years earlier).

To date, the AERU has produced 10 research reports, dealing primarily with costs of production and farm level technology assessment. Much of the research was conducted jointly with biological scientists. The AERU also carried out a number of seminars/workshops.

Proposed Work. The scientists of the AERU have proposed a much expanded research program. The proposed topics range from technology assessment to demand and supply analysis for commodities and inputs, from commodity marketing to household economics, from dynamics of technical change to crop insurance, and from farm income estimates to foreign exchange earnings analysis.

The scientists also propose workshops on topics such as research methodology, farming systems approach to research and extension, land use planning, project planning, forecasting, survey statistics and methods, and agricultural modeling, among others.

The proposed program would require a much larger staff than is currently available, namely:

Chief scientific officer	1
Principal scientific officers	2
Senior scientific officers	6
Scientific officers	12

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1/ For a more detailed discussion of the agricultural economics programs, proposed program, and recommendations see Annex 5.

## Recommendations for Agricultural Economics

(a) The social science program should be substantially elevated in size and status. The social science activities at NARC are currently too limited. The lack of a quantitatively and qualitatively strong social science program represents a serious "gap" in the research program at NARC.

(b) The AERU should also be offered the same administrative/organizational status as the other research units at NARC<sup>1/</sup>. As an early requirement, all senior positions of the unit should be filled quickly. A firm and aggressive staffing plan (see Annex 5) should be established for filling of the proposed positions.

(c) Future micro economic studies should concentrate on commodities and areas of projected emphasis at NARC, namely, oilseeds, pulses, vegetables, land and water management, farming systems, and livestock production.

(d) In the area of disciplinary economic analysis, efforts should initially be confined to theories and methodologies in farming systems and the types of studies carried out by the unit (institute). Empirical analyses in this area should focus on structural changes in agriculture as a result of introduction of new technology, income shifts, etc. The analyses of the impact of technologies on structural changes should focus on the technologies developed by NARC and emphasize the same commodities and sectors emphasized by NARC.

(e) The agricultural economists should also develop data banks in the above areas.

(f) Finally, workshops/seminars etc. should be conducted largely in the areas in which the economists are conducting active programs. It does not appear to be a prudent use of resources for economists to teach short-courses in statistics or project planning, when no research programs are conducted in these areas and when other units are likely to be more qualified.

### 8. Agricultural Engineering

Research at NARC in the field of agricultural engineering is limited to the work of the Farm Machinery Institute (FMI). This group concentrates on adapting machinery developed elsewhere in the world to Pakistan and then assisting private industry in

<sup>1/</sup> This recommendation is based on the consultants' understanding that elsewhere a committee of consultants has recommended an administrative structure of comparable and equal administrative units (specifically, departments), and that the committee's recommendation is receiving favorable consideration.

moving it into production. In practice, FMI does the adaptive design work on items that it deems potentially appropriate for use on Pakistan farms. It then makes known these things to private industry. If the design is derived from an imported unit not covered by patents, a local manufacturer can start production as he wishes. If there are patents on the units, licensing in some form becomes necessary. If an industrial firm is interested in one of the designs, FMI may depute staff to help develop the line for private manufacture.

Present Work. Present research includes product development of a multicrop seeder, a grain combine, a stationary sugarcane set cutter, and a rice thresher. Industrial extension is underway on a sugarcane planter, a groundnut thresher, a rotovator, and a wheat thresher. Topics of studies on mechanization are rice production mechanization, mechanization database, mechanization impact, and mechanization demand. Testing and standardization is proceeding on a sugarcane set cutter and planter, a buffalo milking machine, a tractor, assorted field machinery, and a sugarcane harvester. Various kinds of training are offered.

Proposed Work. The long list of proposed activities contains 33 project titles, many of which involve machinery design or development. The statement of proposed future work lists the following: (a) sugarcane production mechanization: planting, ridging, harvesting; (b) rice production mechanization: seed drill, weed control, harvesting; (c) oilseed production mechanization: planting/drilling, inter-row cultivation, harvesting, seed-cleaning; (d) vegetable production mechanization: seed bed preparation, planting/transplanting, plant protection and weed control, post harvest handling/storage; (g) fruit production mechanization: pesticide application, fruit picking, post-harvest handling/storage; (h) animal production mechanization: milking equipment, housing/sanitation equipment, fodder harvesting and handling equipment, animal waste management; (i) irrigation management: furrow and bund makers, mechanized irrigation equipment, (j) instrumentation and control: computerized data acquisition and processing, computerized drafting/designing; (k) management and socio-economics: machinery management modeling, mechanization impact studies, machinery demand studies, industrial feasibility studies; (l) controlled environment agriculture: environmental control, temperature, light, humidity and CO<sub>2</sub> level, peat preparation and disinfection: equipment, water supply equipment and structural design.

### Recommendations for Agricultural Engineering

- (a) Reduce the emphasis of FMI on the industrial sector and draw more on crop production specialists and on farm-based studies to define priorities.
- (b) As emphasis on industry is reduced, focus on projects that represent bottlenecks in production of priority crops. Study the present production systems and the directions in which they are evolving to identify critical operations

where appropriate machinery might be used. Draw on talent at NARC, in the provinces, and in private industry to define bottlenecks. Study farmer operations directly. When a design is identified wholly or in part, attempt to interest private industry in its development.

(c) Look for inter-commodity design needs. For example, many independent observers believe poor seedbed preparation hampers crop production in Pakistan and the land resource division of NARC proposes to study seedling establishment. When promising approaches are identified FMI should collaborate with the soil physics group and the crop commodity specialist to develop the needed equipment.

(d) Change FMI into a Department of Agricultural Engineering and define its mandate more broadly to foster research on other aspects of agricultural engineering, such as soil and water and agricultural structures.

## 9. Apiculture and Sericulture

### (a) Apiculture

Beekeeping serves as a source of income for small farmers through the harvest and sale of honey and it helps crops producers through pollination. Many beekeepers may get more income from the pollination service than from the honey produced.

The apiculture unit at NARC has a good understanding of the potentials of beekeeping in Pakistan and a wealth of information to pass on to farmers. They are also capable of researching problems encountered in the field both by drawing on information from abroad and by researching the problem in-country when necessary. They appear to be at home in discussing beekeeping problems with farmers or with researchers in the field.

Nevertheless it must be remembered that the beekeeping industry will always be a small one. Even results which have a strong multiplier effect on a beekeepers' incomes will have modest impact on the nation because of the small basic size of the industry.

### Recommendations for Apiculture

It is recommended that the apiculture group be funded to support an active technology transfer program plus research when necessary to deal with pressing problems. Longer range activities of research should not be undertaken when so many promising opportunities to apply current technology are available.

### (b) Sericulture

Sericulture is another ancient agricultural practice that has continued into modern times. Unfortunately it lacks the dual role of beekeeping. The attractiveness of sericulture to farmers

depends upon alternative opportunities for the producers as well as on the price of silk in the world market, where it competes with man-made fibers.

The sericulture group appears to have a sound grasp of the biological essentials of silk worm culture and to be capable of dealing with the silk worm technology. This may also be partially true for the crop science phase of producing mulberry for feeding but it is apparent that the system is more complex than that of beekeeping just as the economic status is less clear.

### Recommendations for Sericulture

We recommend that the sericulture be viewed as an exploratory project that will focus on application of known technology. Results should be monitored on a regular basis and the unit should not necessarily be considered as a continuing long term activity of NARC.

### 10. Tissue Culture and Cytogenetics

Tissue culture and cytogenetics represent a recent NARC investment in extending its capacity to carry out advanced and specialized research. In determining priorities and in decisions on funding levels, some of the same considerations apply to each of them. These are not areas of activity for which returns on investment in research can be easily estimated. In a sense they represent NARC's expression of confidence in the potential contributions from advanced research techniques. Tissue culture techniques can be seen as an entry point for using the techniques of biotechnology. This emerging field is in a highly dynamic state and under intense study in advanced laboratories around the world. Cytogenetics is an older field that has had a useful role in crop improvement and that may be expected to be increasingly useful as it is coupled with advanced techniques.

In a memorandum, Dr. Bill C. Wright (32) made the following comments about research in biotechnology ".....to be in a position to apply the more sophisticated biotechnology techniques to research in the future when they have been evolved by the universities and research institutions in developed countries, research systems in developing countries should begin (or continue) to train young scientists in the various fields of biotechnology. This, in itself, implies that a modicum of research in these areas must be carried out in developing countries because a scientist cannot keep abreast of his or her discipline unless he or she is able to conduct research. The trick is to strike the right balance between doing enough research to keep the scientists knowledgeable in their disciplines, and not spending an inordinate amount of money on this high risk research area."

#### a. Tissue Culture

Research at NARC involving tissue culture has been possible

since 1981 but was hampered until greenhouse facilities were completed in 1985. Even in the start-up period however, the techniques were successfully applied.

Present Work. The first tissue culture research at NARC was undertaken to obtain virus-free seed potato tubers. Potato cultivars were cleaned of viruses and then multiplied to produce several tons of basic seed. Subsequently several types of rice experiments were conducted. Among them were ones in which cell cultures were used to screen for salt tolerance. Callus tissue of wheat has been cultured in vitro and experiments have been successfully completed in which date palms were multiplied by shoot tip culture.

Proposed Work. It is proposed that to the end of the century, cell culture research will include propagation techniques for horticultural crops, in vitro cryo preservation of potato tubers, elimination of viruses from vegetables and their mass multiplication, cell selection for disease resistance and improvement of salt tolerance, in vitro mutation breeding, anther culture of rice and wheat to develop stress tolerant lines, anther culture in brassica

#### Recommendations for Tissue Culture

Continue tissue culture research at its present level and be prepared to expand support as new techniques approach the stage where they can be applied. Keep the research balanced in dealing with exploratory uses of the new technology as contrasted with ones already operational such as meristem culture for cleaning up virus-infected plants. In all probability these applications will more than pay for the exploratory studies.

#### b. Cytogenetics

Current and proposed work. Work in cytogenetics started in NARC in 1985, but laboratory facilities were not operation until 1987. Exploratory work has been done with wheat, rape, mustard and grasspeas. Projects proposed by the cytogenetics unit for the next 12 years are alien genetic transfer in wheat, species introgression in Brassica, cytogenetics studies in grasspea, introduction of seed sterility in tea, developing seedless fruits.

#### Recommendations for Cytogenetics

- (a) Fund the unit at a level adequate to permit full utilization of current talent. Expand as applications are identified.
- (b) Consider work done to date as exploratory. Plan future work in close association with crop improvement program.
- (c) Tie cytogenetics work to priority crops and to problems where a unique contribution can be made by breaking a

genetic bottleneck. Concentrate on one or two problems. Do not spread the experimental effort so thin that progress is bound to be slow.

## 11. Plant Introduction and Plant Genetic Resources

The PI and PGR units have an important function to perform for research at NARC and at other research institutions of Pakistan. Their efforts are essential to ensure that needed plant germplasm from the rest of the world will be introduced into Pakistan and that Pakistan's own genetic resources will be collected. They must take steps to ensure that material from both sources will be evaluated, preserved and ultimately utilized. Many other scientists must share the responsibility if the desired goals are to be achieved. Collaboration between PI and PGR and between them separately or jointly with scientists and institutions abroad and within Pakistan is the key to success in this undertaking.

The present terms of reference give PI responsibility for seeking and importing germplasm of new crop plants and unexploited species from the rest of the world. They have some responsibility for evaluating the initial performance of these introductions, for distributing the germplasm, and for documentation of its performance.

The general orientation and activities of PI are determined in consultation with technical working groups and research committees of NARC. Currently they are focusing on introduction of (a) crops deemed to have promise for marginal lands (ones with tolerance to drouth, salinity and waterlogging), (b) species which produce edible or industrial oil, (c) fodder species for periods of low availability, (d) horticultural plants and (e) medicinal plants. Many of these are priority crops with NARC or at least do not conflict with NARC priorities. Some may be on the priority lists of other Pakistani agencies.

The PI Sector Program report suggests two operational changes: (a) The PI terms of reference should give PI responsibility for all germplasm introductions, not merely for that of new crops, and (b) a special committee should be established to advise on the kinds of germplasm to import.

The PGR group has responsibility for collecting, evaluating and conserving germplasm within Pakistan. Target crops are cereals, food legumes and pulses, oilseeds, and vegetables. For some crops, rice for example, this means collecting germplasm from farmers. For others, it means also collecting wild relatives of cultivated species. Pakistan is known to be a fertile source for collection of wild relatives of some crops. Present and proposed collections are aimed at chickpea, lintel, faba bean, barley, oats, maize, millet, sorghum, fruits, vegetables, medicinal plants and forages. PGR collects in collaboration with the International Board for Plant Genetic Resources (IBPGR) and shares its collections with IBPGR and with other international

institutions. The PGR sector report proposes that a technical advisory committee be established on each crop to guide its work on collection and evaluation of germplasm. It suggests that each committee include the coordinator for the commodity and a crop specialist from each province.

#### Recommendations for Plant Introduction and Germplasm Resources

(a) Review the objectives and management procedures followed by the two units. Consider the modifications each group has proposed and how they might be applied or modified. Consider the desirability of merging the two sections into one that would handle all the needed functions in an integrated manner.

(b) In making these determinations examine procedures followed in other countries and invite IBPGR to comment. The objective of these units is to foster the use of needed germplasm and not to serve a regulatory role. Appropriate attention to phytosanitary standards is essential, but procedures that un-necessary delay germplasm transfer and utilization should be avoided.

### 12. Nutrition and Food

The nutrition and food unit was established at NARC to provide support to other units, particularly the plant breeders to help them select for good nutritional quality and for cooking and eating characteristics that will meet with good market acceptance. Nutrition and food has the further mandate to strengthen linkages with other institutions, both national and international, in the areas of food and nutrition and to collaborate with them in dealing with problems of mutual concern. The unit will also provide analytical service to scientists working in provincial institutions.

Current work. Projects presently underway deal with wheat (10 projects), food legumes (7 projects), oil seeds (6 projects) and with pesticide residues in Pakistani cooked diets. Within the wheat group lines from uniform yield trials are screened for nutritional value and for quality for bread and chapattis. Other experiments deal with these same quality characteristics as affected by (a) season and location of planting, (b) sprouting of the grain (c) method of fertilizer placement, (d) sowing date and (e) by microbial infection during storage. Other studies relate to extending and/or enriching wheat flour with potato flour or soybean flour, to maximizing flour yield from commercial wheat varieties and to the effect of different salts on quality of wheat dough.

Within grain legume studies are ones aimed at determining the effects of fertilizer rates, planting date, Rhizobium inoculation and similar factors on legume quality. Flatulence factors in food legumes are studied as is the effect of

processing on the tannin content of several legumes.

With oil seeds, two projects are listed which relate fertilizers to oil and/or meal quality and one attempted to relate quality to production environment. Uniform yield trials with ground nuts and with soybeans are screened for oil content and quality.

Proposed work. In discussing program foci for the balance of the century the Nutrition and Food sector program statement lists eleven titles, many of which are quite broad as follows: (1) Nutritional quality and consumer acceptance of cereals, legumes and oilseeds, (2) Effect of production environment on the nutritional quality of cereals, legumes and oil seeds, (3) the toxic effect of nitrate, nitrite and nitrosamine of common foods (4) Improvement of bread quality and extension of wheat flour with other flours, (5) Effect of storage on nutritional quality of cereals, legumes, oilseeds and their products (6) Development of food products from inexpensive raw materials (7) Monitoring and evaluation of pesticide residues in cooked foods (8) Effect of national agricultural policies on the nutritional status of the population (9) Effect of processing on the quality of cereals, legumes, oilseeds and vegetables, (10) Quality evaluation of vegetables and fruits (11) Nutritional evaluation of diets in different agro-ecological zones.

Recommendations for Nutrition and Food. This unit has important things to contribute to NARC but the range of subjects to be studied must be kept within manageable limits. The current schedule of proposed work should be reviewed carefully as regards priorities. It is apparent, for example, that the role of fertilizer placement in wheat quality is less important than genetic factors. It should have lower priority. At the same time the basic role or mandate for this section needs to be articulated. Specific recommendations are as follows:

(a) Name this division the Department of Food Technology and Nutrition. (This change may already have been made for both forms are noted in the Sector Program Statement. Specify that its role shall first of all be to support the commodity research units of NARC and to fulfill NARC's responsibilities to the National Coordinated Commodity Programs.

(b) Focus primarily on food technology, particularly food quality, aspects. Wheat quality for making bread and chapattis are examples. Provide strong service support to all national commodity programs giving particular attention to ones such as wheat where the NARC unit can be particularly beneficial. Undertake similar work for lesser commodities as they are emphasized at NARC. Nutrition per se is notoriously under-rated in the market place if the commodity is of poor eating quality as judged by the consumer. Breed for good nutritional characters but not to the exclusion of consumer acceptance.

(c) Do not invite a regulatory role for this unit in areas such as pesticide residues. Work closely with the entomology group and the commodity programs and be alert to residue problems that may arise in their work but regulatory work is best done outside of a research entity and will prove distracting if accepted as a role for NARC.

(d) Collaborate closely with food processing research units elsewhere in Pakistan. Work with these entities and with NARC units in developing national integrated production, postharvest and marketing systems. Fruits and vegetables should be included as a near term priority because of their value in nutrition and because of their perishable nature.

(e) Participate in all NARC planning activities which relate to nutrition to ensure that nutritional aspects are taken into account. Work with social scientists to educate the public on nutritional concerns and to influence the production and consumption of foods of high nutritional value.

### 13. Associated Activities and Research Support

There is a group of directorates, institutes, sections, and units at NARC which do not have research as their primary mandate. Nevertheless, these units are essential for, or highly complementary to, research activities at NARC. Although somewhat outside the core of the development of a NARC research master plan, successful implementation of any research plan will (to a substantial degree) hinge upon effective functioning of units such as the library, the computing and statistics unit, etc. Beyond this, these units are essential for the implementation of the NARC mandate for information transfer.

#### a. Scientific Information and Publications

The Directorate of Scientific Information and Publications has two major purposes. One is to keep the agricultural scientist, planners, policy makers and farmers updated on the latest R&D developments in their areas of interest. The other is to publish research results in the form of journals, reports, monographs, books, bulletins, newsletters, etc., and to disseminate these publications to the concerned clientele group.

The directorate clearly has a very broad responsibility in the area of collection, storage, and dissemination of information. It currently has a wide range of activities, and it proposes even more for the future. Its plans show a good grasp of the shift which is taking place in information technology from hardcopy to electronic copy. Although NARC Scientific Information and Publications may already have the best agricultural library in Pakistan, the unit will clearly be the pre-eminent agricultural library if even a portion of the proposed plans are implemented over the next decade.

## Recommendations for Scientific Information and Publications

(a) The directorate is vigorous in providing timely information to scientists and others by taking advantage of the latest technology. However, it is not inconceivable that information technology may be running ahead of those whom it is intended to benefit. Therefore, it is recommended that. A strong effort be made (a) to train scientists in the effective use of information services and (b) to monitor the extent to which use is made of these services.

(b) It appears that the plans for the next 12 years are too ambitious to allow complete implementation. Priorities will have to be set. No priorities are recommended here, as the Scientific Information and Publications Directorate currently has a consultant with strong credentials in information science. The consultant's recommendations should be taken account by the directorate when completing its report for inclusion in the NARC research master plan.

### b. Computers and Statistics Section

The mandate for the Computer and Statistics Section is to (a) to enhance the quality and credibility of research conducted at NARC by helping NARC researchers to use statistically sound, feasible and efficient research strategies; (b) to provide statistical and biometrical training to NARC scientists; and (c) to provide computer services in the form of consultations, training and programming to scientists of NARC. The Computer and Statistics Section proposes to provide enhanced services under each of the three objectives. It calls for an increase in the number scientists in the section from the present two to a total of eight during the planning period. The proposed staff increase is not unreasonable. However, only one scientist is recommended for the computer unit (currently no one with the section is trained in computer science). That is insufficient.

### Recommendations for the Computer and Statistics Section

It is questionable if the statistics section and the computer section should remain combined now that capabilities in statistics and computing have been established. Separation would point out the need for specialized expertise in computing and would encourage the development of a broader knowledge of computer applications. Current computer applications appear to be limited to statistical applications. Tools such as spreadsheets, simulation, optimization etc., which should be available to NARC scientists, can at present not be dealt with at the NARC computer section.

### c. Training

The mandate for the NARC Training Unit derives from the overall NARC mandate. It charges the institute (a) to provide

opportunities for acquiring knowledge and skills in improved agricultural production technology, management and communication; (b) to develop expertise in problem identification and in developing alternative strategies to solve problems of food and fiber production, marketing, and processing; and (c) to strengthen the links between farmers, extensionists, and research workers by providing an environment conducive for dialogue, planning and implementing projects that accelerate the transfer of technology and increase productivity. To accomplish these objectives, short courses of varying duration, conferences, etc. are organized. In addition to organizing training courses, the unit conducts research related to measurement of learning styles and evaluation of effectiveness of teaching.

The training unit proposes an expanded program including introduction of career development courses, instituting a set of regularly taught courses, designing courses on research management, establishment of an autotutorial laboratory, establishment of a computerized database, among others. To accomplish this, the Training Unit projects a need of 444 scientist-years to the year 2000. Of those, 288 are allocated for "evaluation" and 144 for "data-base computer." Twelve scientist-years (or one scientist per year) are slated for the international regional training center.

#### Recommendations for the Training Unit

(a) It is evident that the Training Unit will have to set priorities, as an expansion by 37 scientists per year is obviously not feasible in the foreseeable future. Further, 288 scientist-years for evaluation and 144 scientist-years for database computers appear unnecessary. This should not detract from the fundamental importance of the Training Unit to the overall mandate of NARC.

(b) The training unit had the benefit of a consultant during September, 1988. The consultant's recommendations should be taken into account by the unit when completing its report for inclusion in the NARC Research Master Plan.

#### d. Technology Transfer

The Technology Transfer Unit has responsibility for what is commonly referred to as "extension" in the Islamabad Capital Territory. Its objectives are broad and encompass essentially all aspects of agriculture (including family consumption and marketing) in the I.C.T. The Technology Transfer Unit provides an excellent outlet for research results from NARC, and to some degree the research master plan must take into consideration the information needs of the Technology Transfer Unit. However, because of the national mandate for NARC, these needs cannot be a major determinant of the research master plan. As a result, the Technology Transfer Unit, to be effective, will also draw heavily on other information sources.

## Recommendations for Technology Transfer

(a) The presence of a Technology Transfer Unit at NARC provides valuable feedback about usefulness of research results and needs for research. NARC researchers should take advantage of this opportunity through organized procedures, such as monthly and quarterly seminars, joint projects with staff from the Technology Transfer Unit, etc.

(b) The Technology Transfer Unit has proposed major programs for the next 12 years. Estimated manpower needs for implementation of these plans are 2,368 man years (or 197 persons per year). As this program lies outside the research mission of NARC, no evaluation of the appropriateness of the proposed programs was undertaken and no recommendations are made.

### III. COMPLETING THE MASTER PLAN

#### A. RECOMMENDATIONS OF AUG 25, 1988

The original plan of action for the finalization of the Master Plan was based on the assumption that the modified reports requested from each NARC program, institute or research group would serve as the basic units of the final plan. Each statement would include tables which indicated research objectives, staff and funding needs, and priorities among subjects. Unfortunately these statements were disappointing in that there were wide variations in how the format and content was interpreted by different scientists. Many reports omitted some tables and/or interpreted them in different ways. There were also wide differences in how much growth in staff and funds different units proposed. For these reasons substantial revisions are needed before finalizing the plan. This section will offer some suggestions on the subject.

##### 1. Calendar of events.

The symposium which is expected to serve an important function in the dialogue leading to finalization of the plan has been unavoidably postponed. We recommend that it be rescheduled for the beginning of October and that the consultants' report, labeled "Preliminary", be circulated to all symposium participants. Some of the material in the report will suggest ways of modifying the sector statements for the plan; they may also prompt the participants to modify their symposium statements. After the symposium the scientists should be in a better position to prepare their final statements and the management should have a clearer understanding of how they wish to move on certain policy issues. With these various considerations in mind the following schedule is suggested:

- o Distribute consultants' report to participants. Aug 30.
- o Convene the Master Plan Symposium..... Oct 2-4
- o Policy decisions by NARC management..... Oct 1-15
- o Final Master Plan components from research..... Nov 1 units.
- o Editing of Master Plan..... Nov 1-30
- o Final Master Plan to printer..... Dec 1

##### 2. Policy Decisions by NARC Management

After reviewing the "Consultants' Report on the Research Master Plan for the National Agricultural Research Centre" and after conclusion of the symposium on the NARC research master plan it will be necessary for NARC management to make several

policy decisions. These decisions are needed if the researcher, group leaders, unit leaders and institute directors are expected to provide final drafts of research plans for their respective units. The consultants have directly and indirectly identified a number of issues and given recommendations throughout this report. These decisions and the consultants recommendations are summarized below for emphasis and for ease of reference.

a. The NARC Mandate. In order to prepare a Master Plan it is essential that there be a clear statement of the organization's mandate. As noted in the introduction of this report, the original statement as given in the PC-1 has been somewhat modified principally by certain additions. While these changes pose no particular problems, and while in fact an institution's orientation should evolve over time, it is recommended that NARC review and re-confirm the mandate statement before the Master Plan is finalized.

b. Funding Policy. The report of the National Commission on Agriculture recommends that funds for agricultural research increase annually by 15 percent through the end of the current Five-Year Plan and by 10 percent annually thereafter through the year 2000. The report also recommends that operating, maintenance, etc. funds for agricultural research organizations be increased until they represent 40 percent of total budget, with personnel costs representing 60 percent (presently, personnel costs are 90 percent of total budget at NARC). Two policy decisions are necessary regarding funding:

1. Will the strategy be to translate future funding increases into personnel positions or will initial increases be used to increase available operating funds until they have reached 40 percent (or some other specified percentage) of total funds?

2. Should the projected fund increases cited in the NCA report (15 percent per annum during the seventh five year plan and 10 percent thereafter) be accepted as a realistic expectation for NARC? It should be noted that the NCA specifically favored increasing the share of federal research funds to be channeled to the provinces. It is recommended that the proportion of operating funds be increased before new positions are granted. It is further recommended that the research master plan contain two tiers of projects. Priority I are those projects which will be pursued if no additional positions are forthcoming throughout the planning period; priority two are those projects which will be pursued only if additional positions can be funded. A maximum annual increase of 10 percent should be used for planning purposes.

c. National Program Coordinators. Most of the coordinators of national programs are currently located at NARC. This causes certain management difficulties as well as some ambiguity with respect to what the NARC research program actually consists of. This is particularly true for commodities for which the provinces

have well established programs.

It is recommended that all national coordination activities be clearly identified. Those which include substantial provincial activities should be managed as separate from the NARC research program. Newer coordinated programs may use dual leadership until a critical mass exists at NARC and substantial activities have developed in the provinces.

d. Sub-units of NARC. In reviewing the documents which we have referred to as "sector program statements" the existence at NARC of an array of organization sub-units which are variously called institutes, programs, projects or working groups has become evident. Some appear to be temporary while others are permanent. Some clearly have more authority and independence than others. It is recommended that NARC management review this situation and make appropriate adjustments. The recommendations on this subject given in the management review, referred to as the "Khattak Report", particularly as regards the designation of institutes or departments appear highly relevant. It is recommended that the final Master Plan be based on a management structure that will be largely in place throughout the plan period.

e. Research Program Gaps. Although NARC has an agricultural economics unit, it is so inadequately staffed and the field is so important that urgent attention is recommended. Annex 5 provides detailed information as to how this might be accomplished and what initial research thrusts should be.

f. Research Emphasis on Certain Crops. The planning process described in chapter I and the analyses performed at the beginning of chapter II suggest that because of its mandate, its resources (both human and physical), its existing research base, lack of research done elsewhere, and emerging significance of hitherto relatively unimportant crops in Pakistan, NARC has a comparative advantage in emphasizing research on certain crops. These include sorghum, millet, pulses, oilseeds, vegetables, and fodder crops.

It is recommended that these crops be recognized as thrust programs of NARC.

g. Research Emphasis on Certain Types of Livestock. The planning process results in the conclusion that NARC should emphasize research dealing with buffalo, sheep and fish. For buffalo emphasis would be on nutrition and health, for sheep it would also include crossbreeding to improve wool quality and quantity. It is further recommended that research on large animals be restricted to nutrition and health.

h. Reconfirmation of Farming Systems Emphasis. A farming systems thrust has been part of the NARC mandate from the beginning. As a NARC research master plan for the coming 12 years is being finalized, it is appropriate that the commitment to this direction of research be reconfirmed.

i. Emphasis on Inter-Disciplinary Research. One of the unique characteristics - and strengths - of NARC is that it has practically all agricultural disciplines represented at its Center. No other research organization (save universities, where little research is being done) in Pakistan can make this claim. This very desirable situation makes it possible for NARC scientists to address complex interdisciplinary agricultural production and development issues. An interdisciplinary approach, bringing to bear both basic and applied sciences simultaneously, is frequently more effective and has often greater impact than a single disciplinary approach to problems.

NARC already has a good record of interdisciplinary cooperation. However, much improvement is still possible in this regard, as a review of the prepared sector papers and discussions with scientists will quickly reveal. It is, therefore, recommended that NARC explicitly state its policy in support of interdisciplinary cooperation whenever possible and that a management structure be established to encourage such research cooperation.

B. RECOMMENDATIONS OF OCTOBER 5, 1988

1. Calendar of Events.

The scientific staff of NARC has had a number of opportunities to interact with others regarding their plans for research in the years from the present until the end of the century. Interactions have taken place within the NARC staff, between the staff and the management of NARC and PARC, between the staff and the consultants and between the staff and provincial researchers and administrators. This has permitted them to modify and adjust their proposed activities as related to the Master Plan. The net result is a set of documents that is substantially closer to a plan ready for editing and printing. To bring the planning exercise to completion the following schedule is suggested:

- o Policy decisions of NARC Management... Oct 5 to 15
- o Finalization of Master Plan components  
from research units..... Oct 1 to 31
- o Editing of Master Plan..... Nov 1 to 30
- o Final Master Plan to Printer..... Dec 1

2. Policy decisions by NARC management

In the Aug 25, 1988 "Preliminary" version of the report a group of 9 issues requiring decisions of NARC management were listed. These have been discussed with NARC and decisions have been reached or soon will be. It is important that decisions be reached within the timeframe given above. In addition the following two groups of decisions will be necessary in order for

a Master Plan to be finalized.

a. Priorities between programs. The scientists of NARC are highly tuned to the need for modifications of programs. They recognize that funding levels will not permit all programs to develop as broadly and as rapidly as they might wish. In discussions with the consultants they have indicated their recognition of this reality but they have generally been less willing to accept fully the recommendations of the consultants regarding specific priorities. It is up to the management to say which programs will expand, which will contract and which will continue the same. The recommendations of the consultants are summarized in Table 1 and are given in some detail with each set of recommendations for the sector programs.

b. Priorities within programs. The individual sector statements of NARC scientists have become increasingly specific as regards priorities within programs as the planning process has continued. However most still list priority work on a larger scale than will be feasible within expected funding. Not all require decisions to be made at this time but a review by management and an expression of willingness to provide financial and other support at given levels within each unit is necessary before the Master Plan can be made realistic.

### 3. Other actions and issues.

a. Recommendations for next steps. On Aug 25, 1988 a statement entitled "Recommendations for next steps to complete the NARC Research Master Plan" was prepared by the consultants and delivered to the Director General. This was prepared partially in response to the terms of reference and partially to respond to requests from NARC and MART officers. It was prepared too late to be included in the preliminary report and is reproduced herein as Annex 6. It should be considered an integral part of the report.

As of Oct 5 these recommendations still have validity and might be referred to in scheduling actions for completion before Nov 1. In reacting to these it is recommended that NARC officers take full account of recommendations regarding making sector statements explicit, and realistic in size as dictated by funding. They should be clearly prioritized taking into account recommendations by the consultants, by symposium participants and by NARC and PARC management.

b. The NARC Mandate. The consultants were expected to "scrutinize the comments and suggestions given by PARC and NARC scientists relative to the NARC mandate and to assist in writing a revised mandate".

Relatively few comments were received in writing but a number of verbal expressions of opinion were volunteered by NARC officers. It appears that most NARC personnel are satisfied with the mandate as it stands. Some have suggested considerably more detail but others have cautioned that too much detail may prove

restrictive. The consultants feel that the mandate is one that can serve in its present form for the next five years and probably beyond. It is sufficiently specific to give focus to the organization yet open enough to allow a fair amount of flexibility. If it appears that more precise positions should be stated on specific points it might be desirable for PARC to issue operational guidelines from time to time. These could take care of existing points of concern and would be less binding than the mandate. The same PARC officials could modify the guidelines as necessary.

c. The NARC organizational scheme. The terms of reference for the consultants called for them to "prepare an updated organizational scheme for NARC". Before this could be accomplished we were shown a revision of the same thing which was prepared by Drs. Abdul Wahid and Bill C. Wright. This is reproduced as Annex 13. In the view of the consultants this plan is logical and could be used. It might be desirable to have it reviewed in greater depth by the consultant who is studying the Management Review report which was prepared under the leadership of Dr. G. M. Khattak.

d. Chapters I and II of the Master Plan. The consultants were asked to review the first two chapters of the Master Plan document which were prepared by the writing committee. This was done and the views conveyed to the writers. It was agreed that with some amount of editing these chapters would constitute an appropriate introduction to the Master Plan.

A N N E X E S

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**Terms of Reference\***  
**of**  
**NARC Master Plan Consultant**

The goal of this consultancy is to prepare a set of procedures to be followed in completing the Master Plan. A draft of this report must be completed at the end of the first consultancy. In developing these procedures and developing the draft, the consultants would work with the NARC Director General and his staff and the MART Project specialists to accomplish the following:

1. Review the current outline for the Master Plan and suggest improvements.
2. Review the analysis of the Master Plan questionnaire and its interpretation and suggest ways it can be analyzed further. Conduct further interviews with NARC staff as necessary.
3. Review and comment on NARC sector statements and oral presentations related to the Master Plan with particular regard to recommendations for future research programs, priorities for research, and requirements for staff, funding, and physical facilities. Identify sector programs that are incomplete or need help to complete their research programs. To the extent feasible the comments should include suggestions/recommendations regarding priorities, (a) among programs and, (b) within programs.
4. Review proposed procedures for use in setting research priorities, and in determining the level of staff and funding required to accomplish the most urgent priorities. This will be used by research sectors to assess their research programs and sharpen their focus regarding priorities and level of funding. Suggest modifications/or alternatives to these procedures as appropriate.
5. Review the plans for completing the Master Plan and suggest ways to improve these plans, assess the needs and make suggestions for additional ST consultants to help complete this Master Plan.
6. Prepare sections of the Master Plan as required to compliment components prepared by NARC officers et. al. and assist in the compilation of a draft report.

**\*Modified 8/12/88 following discussions with Bill C. Wright and M.D. Dawson.**

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## NARC SECTOR REVIEW DOCUMENTS

Consultant No.	Title	Indicated Author
1.	Animal Breeding, Genetics, Reproductive Physiology, Embryo Transfer, Meat & Dairy Science and Poultry performance testing.	Animal Sciences Inst. Dr. Waheed Ahmed
2.	Animal Breeding (Revised)	--
3.	Reproductive Physiology (Revised)	--
4.	Embryo transfer (Revised)	--
5.	Meat Production (Revised)	--
6.	Dairy technology (Revised)	--
7.	Animal Health	Dr. Ashiq H. Cheema
8.	Animal Health (Revised)	--
9.	Animal Nutrition	Dr. Amanat Ali
10.	Animal Nutrition (Revised)	--
11.	Sheep & Wool	Mr. M. A. Naqvi
12.	Sheep & Wool (Revised)	--
13.	Poultry Performance Testing	--
14.	Fisheries	Dr. Nasim Akhtar
15.	Fisheries (Revised)	
16.	Agricultural Economics	Mr. Ikram Saeed
17.	Apiculture	Mr. Rafiq Ahmed
18.	Sericulture	---"/Mr. Riaz Khalid
19.	Land Resources	Mr. M. Sharif Zia
20.	Land Resources (Revised)	Mr. M. Sharif Zia
21.	Water Resources	Dr. Shahid Ahmed
22.	Water Resources (Revised)	Dr. Shahid Ahmed
23.	Range Management & Forestry	Dr. Noor Mohammad

24.	BARD	Dr. Mumtaz Ahmed
		<b>Fodder &amp; Cereals</b>
25.	Fodder	Mr. Banaras Bhatti
26.	Maize	Dr. M. Aslam
27.	Rice	Dr. M. Ashraf
28.	Sorghum & Millet	Mr. Abdul Shakoor
29.	Wheat, Barley & Triticale	Dr. N. I. Hashmi
		<b>Pulses &amp; Oilseeds</b>
30.	Pulses	Mr. M. Bashir
31.	Oilseeds	Mr. M. Aslam
		<b>Crop Protection</b>
32.	CDRI	Dr. M. Aslam
33.	CDRI (Revised)	Dr. M. Aslam
34.	Entomology	Dr. C. Inayatullah
35.	Entomology (Revised)	Dr. C. Inayatullah
36.	Virology	Dr. S. M. Mughal
37.	Weeds	Dr. Rashid A. Shad
38.	Weeds (Revised)	Dr. Rashid A. Shad
		<b>Farm Mechanization</b>
39.	Farm Machinery Institute	Dr. S. Iqbal Ahmed
		<b>Horticulture &amp; Special Crops</b>
40.	Horticulture	Dr. Daud Ahmed Khan
41.	Sugar Crops	Dr. Ahmed Mustafa Khan
42.	Potato	Dr. S. M. Mughal
43.	Tissue Culture	Dr. Azra Quraishi
44.	Tissue Culture (Revised)	Dr. Azra Quraishi
45.	Cytogenetics	Dr. H.I.T. Khawaja

- |   |  |
|---|--|
| 46. Nutrition & Food Quality  | Dr. M. Akmal Khan                              |
| 47. Plant Genetic Resources   | Mr. Rashid Anwar                               |
| 48. Plant Introduction Center   | Dr. Zahoor Ahmed                               |
|   | <b>Socio-economic/Support Services</b>         |
| 49. Computer & Statistics   | Mr. Naseer Alam                                |
| 50. Technology Transfer Unit (TTU)  | Mr. Khalid Masood/Taj<br>Mohammad Khan         |
| 51. Training Institute  | Dr. M. S. K. Rana                              |
| 52. Scientific Information Unit   | Malik Mushtaq Ahmed                            |
| 53. Strategies, Objectives, Thrusts<br>and Programs                         | Dr. Abdus Salam Akhtar/<br>Dr. M. D. Dawson    |
| 54. Farming Systems Research<br>Program Objectives and Project<br>Titles    | FSR Coordinator and<br>Associates              |
| 55. Fodder Research Program,<br>Project Titles and Objectives<br>(Revised). | Mr. M. Banaras Bhatti,<br>Coordinator (Fodder) |

**PERSONS MET OR INTERVIEWED BY THE CONSULTANTS**  
(August 6-25, 1988)

Mr. Sartaj Aziz, Minister for Food & Agriculture  
 Dr. Amir Muhammed, Chairman PARC  
 Dr. Abdus Salam Akhtar, Director General, NARC  
 Mr. Harry Dickherber, ARD, USAID  
 Dr. Bill C. Wright, COP MART  
 Dr. Curtis Nissly, ARD, MART  
 Dr. Abdul Wahid, ARD, USAID  
 Dr. N.I. Hashmi, Convenor Writing Team  
 Dr. M. Yousaf Chaudhry, Member (CS)  
 Dr. G. R. Sandhu, Member (SS)  
 Mr. Manzoor Ahmed, Consultant (Coordination)  
 Dr. N. I. Hashmi, Convenor Writing Team

M. Asif Khan	Horticulture
Zahoor Ahmed	Plant Introduction
Rashid Anwar	Plant Genetic Resources
Azra Quraishi	Tissue Culture
Karim Bakhsh Malik	Sugar Crops
Mohammad Aslam	Oilseeds
Riaz Khalid Siddiqui	Sericulture
Rafiq Ahmed	Honeybee
Parvaiz A. Naeem	Remote Sensing
Rashid A. Shad	Weed Sciences
M. Sarwar	Training Institute
Dr. M. Ashraf	Coordinator (Rice)
Dr. N.I. Hashmi	Coordinator (Wheat, Barley & Triticale)

Dr. M. Qasim Chatha	Crop Maximization Program
Dr. M. Aslam	Coordinator (Maize)
Mr. Abdul Shakoor	Coordinator (Sorghum & Millet)
Dr. Iftikhar Rana	Food Technology
Mr. M. Banaras Bhatti	Coordinator (Fodder)
Dr. Shahid Ahmed	Water Resources
Dr. A. Rashid	Soils
Mr. M. Sharif Zia	Soils
Mr. Taj Mohammad Khan	Technology Transfer Unit (TTU)
Mr. M. A. Naqvi	Coordinator (Sheep & Wool)
Dr. Ashiq H. Cheema	Director (Animal Health)
Dr. M. Afzal	Animal Sciences Institute
Dr. Amanat Ali	Animal Nutrition
Dr. Nasim Akhtar	Fisheries
Mr. Abdur Rab	SO Fisheries
Dr. Jaque Millette	BARD
Dr. Ozair Chaudhry	Member Writing Team
Dr. M. Akmal Khan	DDG/Analytical Services
Mr. Naseer Alam	Computer & Stat.
Mr. Zafar Hameed Hashmi	Lab Equipment & Maintenance
Dr. Ch. Inayatullah	Entomology
Mr. Khalid Masood	Technology Transfer Unit (TTU)
Mr. Masood Amjad Rana	Oilseed Coordinator
Dr. Abdul Majid	FSR National Coordinator
Mr. Manzoor Ali	Director Ag. Economics, PARC
Mr. Harry Dickherber, ARD, USAID	
Dr. Curtis Nissly, ARD, USAID	
Dr. Jim Miller - Consultant (Architect)	

## AGRICULTURAL ECONOMICS RESEARCH UNIT

### A. CURRENT PROGRAM

#### 1. AERU at NARC

The Agricultural Economics Research Unit (AERU) at NARC was established in February 1984. The unit was provided with the following mandate:

a. to perceive on-farm problems and translate them into research priorities for the respective recommendation domains.

b. to determine socio-economic and ecological viability of the technologies released by the research station, to identify farm level constraints to adaptation and in the process specify requirements for technology redesign and highlight areas for policy interventions;

c. to evaluate social benefits and costs of new technologies through introducing a multi-disciplinary approach with respect to problem identification, and to suggest strategies for achieving goals.

d. to arrange training workshops/symposia/conferences in order to assist biological and social scientists in understanding concepts and analyses of experimental data, and

e. to conduct macro-level studies of specific commodities. To date, the AERU has produced ten reports, dealing primarily with costs of production and farm level technology assessment. Much of the research was conducted jointly with biological scientists. The AERU also carried out farm seminars/ workshops.

The present staff contingent of the AERU at NARC consists of one senior scientific officer and three scientific officers. The operating budget in 1987/88 was 68,500 rupees, down from 242,000 rupees only two years earlier.

#### 2. AERU's in the Provinces

PARC has set up AERU's in each of the provinces. Specifically, AERU's exist in provincial Agricultural Research Institutes at Faisalabad, Tandojam, Tarnab and Quetta. These units will not be considered as an integral part of the NARC research master plan. They are mentioned here nevertheless (a) because they represent a unique arrangement and (b) because they need to be kept in mind due to the excellent linkage opportunity these provincial AERU's offer between NARC and the provinces.

## B. PROPOSED PROGRAM

The scientists of the AERU at NARC have proposed a much expanded program and somewhat expanded role for implementation under the research master plan through the year 2000. The proposed problems for research analysis range widely from technology assessment to demand and supply analysis for commodities and inputs, from commodity marketing to household economics, from dynamics of technical change to crop insurance, and from foreign exchange earnings analysis to agricultural credit policies.

The scientists also propose workshop on topics such as research methodology, farming systems approach to research and extension, land use planning, project planning, forecasting, survey statistics and methods, and agricultural modeling, among others.

It is envisioned that collaborative research projects receive 40 percent of the available manpower resources, social science specific research will receive 30 percent, and 15 percent of the scientific manpower resources will be devoted to training workshops, seminars, and conferences. The remainder (fifteen percent) of the manpower resources is expected to go to research management and administrative assignments.

The afore described program is proposed to be carried out with an expanded manpower as follows:

Chief Scientific Officer	1
Principal Scientific Officer	2
Senior Scientific Officer	6
Scientific Officer	12

## C. ASSESSMENT AND RECOMMENDATIONS

### 1. Assessment

The AERU at NARC is one of the smallest units at NARC. Its staff comprises about one percent of the center's scientific manpower, and its 1987-88 operating budget was less than one-half of one percent of the center's total operating budget. It is questionable whether such a small unit can be a viable entity. This is particularly so because past and projected demands by other NARC research units for economic analysis and collaborative research far outstrips available resources. The scientists of the AERU clearly recognize the discrepancy between the demand for their services and the availability of existing resources. It is for this reason that they recommend that scientist manpower be increased from four to 21 scientists. Although it may not be possible to increase the number of scientists in the AERU to this recommended level immediately, any significant increase will be an important step towards establishing a viable agricultural economics unit at NARC and towards meeting some of demand for economic analysis expressed by other NARC units. However, even

increases upto the recommended levels will fall short of making it possible for the AERU to undertake all the research it proposes to undertake during the next twelve years.

Whereas research conducted to date by the AERU was confined largely to collaborative cost of production and descriptive studies, the proposed future research program proposes a much wider scope of work. With the information provided in the sector paper it is not possible to assess exactly what the manpower needed would be to carry out the proposed research. The primary reason for this is that the sector paper is silent, for instance, regarding which or how many commodities and inputs will be considered in the proposed research program. But even if relatively few commodities and few inputs are considered, a large amount of manpower (larger than proposed) will be needed to accomplish what is proposed. It does not appear to be necessary for the AERU to conduct research on all commodities and on all inputs. In fact, it may be inappropriate to do so. It is logical for the AERU to concentrate on those commodities (and related inputs) which are emphasized by other NARC research units.

The proposed research program is not only very general, and as a result potentially very broad and all inclusive with respect to commodities and inputs, it is equally general with respect to studies at the macro-level. Further, it is not clear that the proposed macro level studies have relevance and a relationship to the proposed micro level studies. Also, some of the proposed research at the macro level (e.g., issues of foreign exchange earnings, subsidy policies, etc.) is likely to duplicate research efforts which are or should more appropriately be carried out by other agencies.

The AERU proposes a modestly ambitious program for courses and workshops over the next 12 years. The proposed training program raises questions not so much with the quantity of the proposed training as it does with its nature. In particular, the proposed training program calls, on the one hand, for training in areas in which the AERU does not propose to conduct research (e.g. land use planning, project planning) and in areas (e.g., survey statistics and methods) where other units at NARC are likely to be able to provide superior training.

The AERU at NARC has made no comment as to its intended role vis-a-vis the four AERU's in the provinces.

## 2. Recommendations

a. The need for enhanced economic analysis at NARC: There is increasing awareness and understanding in a growing number of government agencies of the usefulness of socio-economic analysis in the agricultural and economic development process. Similarly, agricultural scientists in Pakistan, and particularly at NARC, recognize the need for a socio-economic assessment of the technologies potentially deriving from new research findings and appreciate the value of socio-economic analysis in guiding

research. This is clearly indicated by the fact that NARC biological scientists frequently identify socio-economic analysis as an integral part of their proposed research programs over the next 12-years.

The supply of well-trained and experienced social scientists in Pakistan is not large. Further, the capacity of the universities to train agricultural social scientists has not improved over the past decade, and in some cases has weakened further (Goldman, 12). On the positive side, through PARC leadership five AERU's were established at NARC and in each of the provinces. Also, a small but growing number of well-trained agricultural economists are returning to Pakistan.

By any measure, the social science activities at NARC are too limited in size and scope and are poorly positioned. In other words, the absence of a quantitatively and qualitatively strong social science program at NARC represents a "gap" in the research program at NARC. It is, therefore, recommended that the social science program be substantially elevated both with respect to size and status. The growing recognition of the value of social science research in agricultural development by policy makers and scientists alike, the favorable experience with the AERU's in the provinces, the small but growing number of well trained returning agricultural economists, and the development of a research master plan for NARC all combine to make the development of a strong social science research component an item of the highest and urgent priority.

The development of a strong social science research component could proceed in phases as follows:

a. Every effort should be made to fill the vacant position of Member (Social Sciences), PARC, as soon as possible. It is understood that a Member (Social Sciences) has already been designated, so that this step is likely to be concluded soon.

b. Under the leadership of the D.G., NARC, and in cooperation with the Member (Social Sciences), steps should immediately be taken to fill the senior position (Chief Scientific Officer level) of the AERU.

c. Also under the leadership of the D.G., NARC, and in cooperation with the Member (Social Sciences), the AERU should be upgraded to the same status as other research units at NARC.<sup>1/</sup>

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1/ This recommendation is based on the consultants' understanding that elsewhere a committee of consultants has recommended an administrative structure of comparable and equal administrative units (specifically, departments), and that the committee's recommendation is receiving favorable consideration.

d. The Member (Social Sciences), the D.G., NARC, and the Chief Scientific Officer, AEI, should jointly determine the number of additional positions that will be approved. In a research center of the size of NARC an agricultural economics contingent of the size (21 scientists) proposed in the AERU sector paper is not unreasonable. However, it may not be realistic to expect that such an increase can be achieved quickly. Hence, it is recommended that the proposed size (of 21 scientists) for the AEI be viewed as a general target for the year 2000. However, a firm action target should be set for increasing the size of the AEI over the next three years. It is recommended that the increase should be at least, four scientists per year in each of the next three years.

e. At least one third of the twelve proposed and approved additional positions of the new AEI should be filled within one year; the second third should be filled by the end of the second year and the last third by the end of the third year.

b. Research Program: General: It is recommended that the AEI develop its research program around the following four general areas:

- i) economic analysis of alternative technologies;
- ii) disciplinary economic analysis;
- iii) data bank development and maintenance, and
- iv) research management

The general areas are listed in descending order of priority (as far as development of a research plan is concerned), and each one will be discussed in turn below.

c. Research Program: Economic analysis of alternative technologies: This rubric contains research of the type conducted to date by the AERU at NARC, that is to say, this type of research attends to the economic evaluation of new knowledge and technology developed by the institute (and/or other institutes). In the past, this type of research was conducted by the AERU almost to the exclusion of any other research and resulted in research reports such as "Wheat in the Rice Based Farming System of the Punjab", "Weed Problems and Weedicide Use", "Wheat Production Practices and Technological Issues", etc. The choice of these research projects was a prudent one, and it is recommended that this type of research continue to occupy a major role in the AEI's research portfolio. Two changes are recommended, however. The first is that the research effort devoted to knowledge and technology evaluation be reduced from nearly 100 percent in the past to about 50 percent of total research effort over the next 12 years. Second, it is recommended that the economic evaluations of new technologies be shifted away from commodities such as rice, wheat, sugarcane, maize, etc. (where NARC is likely to have relatively less on-going biological and agronomic research and where provincial institutes are expected to have comparative advantage) to projected areas of emphasis at NARC, namely, oilseeds, pulses, vegetables, land and

water management, farming systems, livestock, etc. The number of potential research projects, all being cooperative with other scientists at NARC, is still too large to be all accomplished by the enlarged AEI. However, within the guidelines above, a highly productive research portfolio with explicitly identified priorities can be assembled.

d. Research Program: Disciplinary Economic Analysis: This category contains two distinctly different but complementary activities. The first of these deals with research (and professional improvement) in methodology and theory. A modest level of activities in this area is essential if the economic staff is to continue to be able to bring the best social science capacity to bear on social science research relevant to the Institute's mandate. The second category of research deals with an extension of research on the evaluation of new technologies and attempts to provide consensus regarding likely structural changes in agriculture as a result of changes in technology, income, etc. For example, researchers should attempt to measure the relative economic payoff to alternative biological, technical and policy strategies from removing farming systems constraints to increasing oilseeds production. This is an important (and complex) areas for analysis, since a comparative advantage based import substitution program could be a major source of economic growth. Similar questions can be asked with respect to vegetables, livestock, dairy products, and fodder, among others.

It should be emphasized that all examples stated above build on research which is recommended for scientists in other Institutes at NARC, which is recommended for AEI scientists in (2.c) above, and which falls into areas of primary emphasis for NARC.

It is recommended that about 30 percent of total research effort be devoted to this type of research.

e. Research Program: Data Bank Development and Maintenance: A data bank is to an economist what a gene bank is to the plant breeder. Therefore, the AEI should devote modest effort (say, 10 percent of total research effort) to the establishment and maintenance of an economic data bank. Such a data bank should not duplicate what is already available elsewhere, but a mechanism should be developed which assures, first, that the AEI is knowledgeable about other data depositories and, second, has the capability to access existing data bases elsewhere quickly and with reasonable effort. However, the AEI at NARC should concentrate its effort on establishing the country's premier data bank in the areas of NARC's research emphasis, namely, oilseeds, vegetables, etc. as indicated previously or as eventually specified in the NARC research master plan.

f. Research: Research Management: Social scientists at agricultural research institutes are frequently cast in the role of program analysts with the responsibility of working with the D.G.'s office on issues of program analysis and planning. Social

science skills are highly relevant to the process of research management and research resource allocation. While a strong case can in general be made for engaging social scientists in this type of activity, it is considered premature to involve the AEI in this activity at this time, at least not early on in the 12-year planning period. The AEI should be allowed and encouraged to mature by conducting research in the previously mentioned areas before engaging in management research issues.

g. Transfer of knowledge: Like other scientists, social scientists have a responsibility to transfer research results to those who have need for them and will use them in their decision making process. It is, therefore, recommended, that the AEI devote about 10 percent of its effort to transfer of knowledge. It is further recommended that the topics for seminars (workshops, courses, etc.) conducted by the the AEI be confined to or at least highly complementary to its research activities. It does not appear to be a prudent use of resources for the AEI to teach statistical methods, particularly as a statistical unit exists at NARC.

h. Linkages: The AERU of NARC has an excellent record of linkages, within NARC as well as with many agencies outside NARC. These excellent linkages should continue to be nurtured. Of particular relevance and importance is the existence of AERU's in the provinces. Their existence provides an unusual opportunity for collaboration, for example, in the development of common methodology, parallel studies on costs of production, evaluations of technologies in a range of agro-ecological zones, structure of data bases etc. Such cooperation will increase the scope of research, decrease cost of research, and will provide research results which are more useful both at the micro level and for further analysis at the macro level.

i. Social Sciences Vs. Economics in Agriculture: Throughout this section the terms "social sciences" and "economics" were used interchangeably. Of course, while economics belongs to the social sciences, social sciences in the usual sense of the term is far broader than economics and includes such fields as sociology, political science, anthropology, etc. The reason for confining the meaning of social sciences to economics alone in the afore discussion is simply a matter of practicality and priority. Specifically, it is recommended that for the planning period under consideration development of a social science research component be confined to the development of an effective AEI. At a later date, other social science components, such as rural sociology, may be added. This strategy is recommended for practical reasons. As a small agricultural economics component already exists (as do AERU's in the provinces), it appears that strengthening and maturation of the economics component has a better chance of success than the introduction of several social science components simultaneously. The scientists at the AEI are, however, encouraged to establish linkages with institutions with rural sociologists, anthropologists etc. This approach will assure at least a minimal consideration of broader social science

issues as part of NARC research. This may suffice until a broader social science research component can be formally introduced at NARC.

**RECOMMENDATIONS  
for  
NEXT STEPS  
to  
COMPLETE NARC RESEARCH MASTER PLAN**

(An Elaboration on "Completing the Master Plan" as Presented in  
the Consultant's Report on the Research Master Plan for the  
National Agricultural Research Centre)

1. The preliminary but rather complete Consultants' Report will be submitted to the appropriate authorities on or around August 25, 199. Unless significant difficulties are detected in the report, it is expected that copies of the report will be distributed to scientists of NARC around August 30, 1988. 1/ In case significant difficulties are detected in the report, it is expected that a synopsis of the report, containing its salient features, will be distributed.

The report (or its synopsis) will provide the scientists with an overview of the entire NARC research program as it now exists, with the research program proposed by the scientists for the next 12 years, with comments and recommendations by the consultants, with suggestions regarding prioritization of research, and with various other information. This overview will be a valuable and essential basis for the scientists to rethink their recommendations and programs, to prepare for the symposium, and subsequently to provide their final submissions for the Research Master Plan.

2. Beginning around September 1, 1988, preparation of presentations for the symposium should begin. This is envisioned to be a three-step process:

a. The first step is for the scientists to review the consultants' report (or a synopsis thereof) and to familiarize themselves with its content, particularly as it relates to the scientist's subject matter area. The scientist does not have to agree with the consultants' observations and recommendations, but he should have clearly articulated reasons for disagreement as well as provide his own recommendations to put in place of the consultants' recommendations that he might be rejecting.

b. The second step is for one individual (or a small number of individuals) to confer with each program leader, group leader, etc. in order to aa. discuss the consultants' report as it pertains to the respective subject matter area, bb. complete a summary table of the proposed research plan through the year 2000, cc. outline the content and format for the upcoming symposium.

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1/Copies of the report may also be submitted to other attendees of the symposium. This will depend on how the usefulness of the Report will be viewed for this purpose, on logistics, and on other considerations.

In order to assure continuity, at least one individual should be present at all the meetings with scientists, group leaders, etc. Others may be brought in as required.

It is suggested that a reasonably uniform format be used for the summary table of the proposed research plan and for the presentations at the symposium. A recommended format is provided in Annex I. Needless to say, individual circumstances may require deviation from the proposed format. However, it is hoped that no major and frequent deviations are necessary.

Scientists may, at this point in time have the impression that a great deal of additional work is being asked of them. This is not the case if the situation is handled properly. Towards that end, it is recommended that the summary table be first set up on a computer (either with a spread sheet program or a data base program). Forms for each scientist, unit, group leader, etc. can then be printed out prior to the meeting, and the required information can then be relatively easily and quickly filled in (conversely, the information could be typed in the computer directly during the meeting. This approach has the advantage that sums of FTE and budgets are automatically developed and consequences of certain priority decisions can quickly be evaluated). As much of the information is already available from previous background work by the scientists, this exercise should not be very time consuming.

It is strongly recommended that the summary table be organized using computers as indicated above. This will make it immeasurably easier to make changes and to produce a variety of summary tables which will be needed for inclusion in the master plan document.

3. The Master Plan Symposium is planned to be convened on October 2-, 1988. Although it may require some revisions, the symposium program has been developed and is ready for implementation.

4. It is expected that certain policy decisions (see III.B Policy Decisions by NARC management, Consultants' Report) will be made by October 15, 1988. The NARC scientists will then be in a position to prepare their final reports for submission to the Research Master Plan. They will, at that time, be in a position to take into account the policy decisions by NARC management, the great amount of work they have done previously, the recommendations in the consultants' report, and the comments received at the symposium. The scientists should make their submission to the Research Master Plan by November 1.

5. After all the components have been received by the D.G., NARC or his designee, the components will have to be reviewed by NARC management for consistency, completeness, etc. It is well possible that some decisions will have to be made regarding increases or decreases in programs above and beyond those

recommended by the scientists. These decisions should be made by October 15, 1988, and should be conveyed to the scientists as soon as possible.

6. Although certain decisions regarding the final composition of the Research Master Plan will not be made until October 1, 1988, editing of the components submitted by the scientists can commence as soon as these components are received. All components should be received by November 1, 1988.

7. December 1, 1988, is the target date for the final draft of the Research Master Plan to go to the printer.

**ANNEX I**

**PROPOSED OUTLINE  
for  
SECTOR PAPERS  
for the  
SYMPOSIUM  
and the  
NARC RESEARCH MASTER PLAN**

- A. Statement of Problem
- B. Goals, Objectives, Mandate of the Unit (institute, etc.)
- C. Current Program
  - a. Research
  - b. Technology transfer
  - c. Resources
  - d. Other
- D. Proposed Program
  - a. Research
  - b. Technology transfer
  - c. Resources
  - d. Other
  - e. Relationship of program to NARC mandate, National Agricultural Research Plan, NCA report, etc.
  - f. Criteria used in selecting the above program

NOTE: This section will include the summary table (attached)
- E. Linkages and Relationships
  - a. Provincial centers
  - b. Other Pakistan centers
  - c. International centers
  - d. Other
- F. Other

Table \_\_\_\_\_. Research Planning, NARC, 1988

Directorate, Institute, Unit ID: \_\_\_\_\_ Number of Scientists in unit at present \_\_\_\_\_ Unit's Operating Budget in 18/88 (000 Rs)

Project			Scientific Manpower Requirements (FTE)						Operating Funds (000 Rs)/p.a.			Lab Space, Eqpt requirements	
Number	Description	Priority	From Own Unit			From Other Units				1989/92	199/9	1997/20	(Item per line, 20 char.per line)
			1989/92	1993/96	1997/20	1989/92	ID	1993/96	ID				

LETTER OF TRANSMITTAL

MEMORANDUM

Date : August 24, 1988

To : Dr. Abdus Salam Akhtar, DG NARC  
Dr. Murray D. Dawson

From : A. Colin McClung and Ludwig Eisgruber

Sub : Consultants Report; NARC Research Master Plan

In accordance with prior discussions we are submitting herewith a document entitled "Consultants' Report on the Research Master Plan for the National Agricultural Research Centre". The document bears a designation "Preliminary" together with an explanatory note. It is our suggestion that after reviewing the report you may wish to forward copies of it to your staff for use as they finalize their statements for inclusion in the Research Master Plan.

You will note that there are a few sections yet to be written, including especially one the Chairman requested on management and organizational structure. We regret this but time was too short. We will complete these and add them when we return to Pakistan for the Oct 2- Symposium.

We request that all concerned give us their comments so that we may improve the quality and usefulness of the final documents. We wish to propose that we come to Islamabad a few days before the Symposium with the intent, among other things, to react to comments and finalize the document.

Thank you for all the support you have given us in this task. Rest assured that we remain enthusiastic about this assignment and look forward to further association with yourselves and all the others at NARC.

---

A. Colin McClung

Ludwig M. Eisgruber

9/28/88

Terms of Reference  
of the second  
NARC Master Plan Consultancy

The consultants will work with the NARC Director General and his staff and the MART Project specialists to accomplish the following:

1. Meet with small working groups of NARC scientists and/or with individual scientists prior to the Master Plan Symposium. Review with the the Master Plan documents which have been prepared in anticipation of the Symposium and which are intended as sector statements for the Master Plan. Give particular attention to priorities within programs.
2. scrutinize the comments and suggestions given by PARC and NARC scientists relative to the NARC mandate and assist in writing a revised NARC mandate.
3. Prepare an updated organization scheme for NARC which shows lines of authority as well as internal and external linkages.
4. Participate in the Master Plan Symposium and provide comments/recommendations regarding priorities (a) among the programs and (b) within programs.
5. Review the plans for completing the Master Plan and suggest ways to improve these plans, assess the needs and made suggestions for additional short-term consultants to help complete this Master Plan.
6. Finalize a written report covering both consultancies.

## NARC MASTER RESEARCH PLAN SYMPOSIUM PROGRAM

October 2, 1988

## Inaugural Session

0900	Arrival of the Chief Guest
0902	Visit to Exhibition
0910	Recitation from Holy Quran
0915	Welcome and Introductory Remarks by DG NARC
0925	Purpose, Scope and Need of Master Research Plan by Consultants Drs. McClung and Eisgruber
0945	Chairman's Address - Genesis of National Agricultural Research System
1015	Inaugural Address by Chief Guest
1035	Tea Break

## FIRST SESSION

## CHAIRMAN

Dr. M. Yousaf Chaudhri  
Member (Plant Sciences)

1100	Cereal Crops (TWG)	Dr. M. Qasim Chatha, Director, CMP.
1200	Crop and Environment Protection (TWG)	Dr. M. Aslam, Director, CDRI
1300	Lunch/Prayer Break	
1345	Horticulture, Sugar and Special Crops Group	Dr. Daud A. Khan, Consultant, Hort.
1430	- Pulses	Mr. M. Bashir, Coordinator (Pulses)
	- Oilseeds	Dr. M. Aslam, Coordinator (Oilseeds)
1520	Tea Break	
1535	General Discussion	
1635	Session Chairman's Summary	Dr. M. Yousaf Chaudhri
1705	Adjourn	

October , 1988

## SECOND SESSION

## CHAIRMAN

Dr. G. R. Sandhu  
Member (Natural Resources)

0830	Soil Resources Group	Dr. M. Salim, PSO, Soils
0900	Water Resources	Dr. Shahid Ahmed, PSO, Water
0930	Tea Break	
0945	Environment and Forestry	Dr. Noor Mohammad, Director, WSM
1015	Barani Agriculture	Dr. Mumtaz Ahmed,

1045	Honey Bee and Sericulture Group	P.D. BARD Dr. Rafiq Ahmed, CSO (NR)
1115	General Discussion Session Chairman's Summary	Dr. G. R. Sandhu

### THIRD SESSION

#### CHAIRMAN

**Dr. M. Yousaf Chaudhri**  
**Member (Social Sciences)**

1215	- Farming Systems Research	Dr. A. Majid. Coordinator, FSR
	- Fodder Crops	M. H. Bhatti, Coordinator (Forage)
	- Forage Crops	Dr. Noor Mohammad, Director, WSM
1305	Socio-Economics Technology Transfer	Director Agri. Economics
1330	General Discussion Session Chairman	Dr. M. Yousaf Chaudhri
1400	Lunch	

### FOURTH SESSION

#### CHAIRMAN

**Dr. Abdus Salam Akhtar**  
**Member (Animal Sciences)**

1445	Livestock/Poultry	Ashiq H. Cheema, Director, ASI
	Fisheries	Dr. Nasim, Dy. Director (Fisheries)
1545	General Discussion Session Chairman's Summary	Dr. Abdus Salam Akhtar
1645	Adjourn	

### FIFTH SESSION

#### RESEARCH SUPPORT SERVICES

#### CHAIRMAN

**Dr. Abdus Salam Akhtar**  
**Director General, NARC**

0810	Agricultural Mechanization	Dr. S. Iqbal Ahmed, Director (FMI)
0830	Germplasm Evaluation/ Dissemination	Rashid Anwar, PSO, PGR
0850	Crop Diseases/Pest Diagnosis Services	Dr. M. Aslam, Director (CDRI)
0910	General Discussion	
0940	Analytical Services	Dr. M. Akmal, D.D.G., NARC
1000	Repair and Maintenance	Dr. Z.H. Hashmi, Dy. Director (LEM)
1020	General Discussion	

1050	Tea Break	
1105	Statistical Services	Mr. Naseer Alam, SSO (CS)
1125	Lib/Scientific Information	Mushtaq A. Malik, Director (SIU)
1145	AV Communications	Dr. Anwar Hassan, Director AVU
1205	Training	Dr. M.S. Khan Rana, Director Trg. Instt.
1225	General Discussion	
1305	Session Chairman's Summary	Dr. Abdus Salam Akhtar, DG, NARC
1315	Adjourn	

**SIXTH SESSION**  
**CHAIRMAN**  
**Dr. Amir Muhammed**  
**Chairman, PARC**

1400	Comments	Consultants Colin McClung and Ludwig Eisgruber
1430	Concluding Remarks	Dr. Amir Muhammed, Chairman, PARC
1445	Adjourn	

### INVENTORY AND PROJECTIONS OF FINANCIAL AND PERSONNEL RESOURCES

As a result of "Recommendations for next steps to complete NARC Research Master Plan" (see Annex-6), NARC and MART staff had, by September 25, 1988, accumulated data on the current (1988/89) staffing and operational budget levels for the various units. This information was collected for 49 units (see Table A.10.3). Information on average monthly salaries, including benefits and allowances, for all employee categories was also collected.

Early during the September 25 - October 5, 1988, consultancy, the consultants processed these data and distributed copies of the resulting reports (Tables A.10.1-A.10.) to the respective unit/program leaders.

The data source and basis for making projections are as follows:

1. The information on number of staff in the respective units comes from the units themselves (see Tables A.10.2 and A.10.5).
2. The operational budget information also comes from the accounts section, etc. (see Tables A.10.2 and A.10.5).
3. A uniform salary scale has been applied to all positions. (See Table A.10.1 for the uniform salary scales and Tables A.10.2 and A.10.5) for resulting staff costs.
4. In making projections, an annual increase of 15 percent of the total budget through 1992/93 was assumed (in line with NCA recommendations); 10 percent thereafter.
5. The target of 40 percent of total budget for operational funds and 60 percent of total budget for staff costs was taken into account. Thereafter, in making the projections no additional staff were calculated until this ratio (40/60) was achieved. In either case, staff salaries were increased by three percent per annum.
6. In cases where units had an initial position of more than 40 percent of total budget in operational funds, the projections were made under the assumption that additional personnel would be hired immediately and the operational budget reduced accordingly. Thus, in these cases the "additional operational funds available over the previous year" are a negative figure. Projections were made for NARC as a whole (see Table A.10.) and for each of 49 units (see Table A.10.6) for an example of a projection for a unit, in this case the pulses research unit).

In examining projections (Tables A.10.4 and A.10.6), the following considerations should be kept in mind:

1. While the projected budget increases are based on NCA recommendations, there is no guarantee that these projected increases will materialize. Even if such increases materialize at the national level, NARC may receive more or lesser funds.
2. The 40/60 ratio of operational to staff funds in an "ideal" or "target". For some units/disciplines a ratio of 0/60 may be satisfactory for effectively carrying out their research programs.
3. Although projections were carried out using the same assumptions and decision rules for all units, budget will clearly not grow by the same rate for all units. In fact, the process of developing a research master plan is to a substantial degree undertaken to ascertain which units should grow faster, which should grow slower, and which should not grow at all or even decrease.
4. While there are differences from unit to unit, most units will not have funds to hire additional staff for several years to come, given the assumptions and decision rules used in the projection. This is also true for NARC as a whole. Thus, if some units are to be expanded rapidly, as is recommended, other will stay at their current levels or even decrease.
5. Finally, the NARC Summary Tables (Tables A.10.2 - A.10.4) are incomplete in as much as they do not include information on such components as the accounts section, costs of building maintenance, etc.

TABLE A.10.1: AVERAGE MONTHLY SALARIES, NARC, 1988/89

RANK/DESIGNATION	BASIC SALARY	SR.POST ALLWCE.	ENTRTMT. ALLWCE.	ORDERLY ALLWCE.	HSE.RENT ALLWCE.	CONVEYCE. ALLWCE.	WASH ALLWCE.	DUSTING ALLWCE.	MEDICAL ALLWCE.	RESEARCH ALLWCE.	PENSION	TOTAL SALARY
CSD	5800	200	400	800	3250	305	0	0	500	800	520	12575
PSO	4950	0	0	0	3000	305			345	800	495	9895
SSD	3685	0	0	0	2250	305			345	737	368	7690
SD	2995	0	0	0	2250	305			259	599	300	6708
ASD	2128	0	0	0	1500	305			259	435	212	4839
BS-18	3685	0	0	0	2250	305			345	0	368	6953
BS-17	2995	0	0	0	2250	305			259	0	300	6109
BS-16	2128	0	0	0	1500	108			259	0	212	4207
BS-15	1875	0	0	0	524	108			115	0	187	2809
BS-14	1740	0	0	0	495	108			115	0	174	2632
BS-13	1615	0	0	0	466	108			86	0	161	2436
BS-12	1490	0	0	0	437	108			86	0	149	2270
BS-11	1370	0	0	0	410	108			86	9	137	2111
BS-10	1290	0	0	0	392	108			86	0	129	2005
BS- 9	1210	0	0	0	374	76			86	0	121	1867
BS- 8	1130	0	0	0	356	76			86	0	113	1761
BS- 7	1040	0	0	0	338	76			69	0	104	1627
BS- 6	1005	0	0	0	326	76			69	0	100	1576
BS- 5	950	0	0	0	315	76			69	0	95	1505
BS- 4	895	0	0	0	304	76			69	0	90	1434
BS- 3	840	0	0	0	293	76			69	0	84	1362
BS- 2	785	0	0	0	281	76	21	25	69	0	78	1335
BS- 1	730	0	0	0	217	76	24	25	69	0	73	1214

TABLE A.10.2: A SUMMARY OF STAFF, STAFF COSTS  
AND OPERATIONAL BUDGET, RESEARCH PROGRAMS  
N A R C, 1988/89

RANK/ CATEGORY	BELOW PH.D.	Ph.D.	Total	STAFF COSTS
CSO	1	5	6	995400
PSO	11	22	33	4314420
SSO	53	24	77	7537560
SO	201	4	205	16573680
ASO	22	0	22	1277496
BS-18	1	0	1	83436
BS-17	2	0	2	146616
BS-16	19	0	19	959196
BS-15	19	0	19	640452
BS-14	6	0	6	189504
BS-13	0	0	0	0
BS-12	21	0	21	572040
BS-11	33	0	33	835956
BS-10	10	0	10	240600
BS- 9	2	0	2	44808
BS- 8	28	0	28	591696
BS- 7	28	0	28	546672
BS- 6	27	0	27	510624
BS- 5	97	0	97	1751820
BS- 4	37	0	37	636696
BS- 3	0	0	0	0
BS- 2	12	0	12	192240
BS- 1	204	0	204	2971872
XXXXXXXXX	0	0		
TOTAL			889	41612784
OP. BUDGET	15473057			

TABLE A.10.3: SUMMARY OF STAFF COSTS AND OPERATIONAL FUNDS, RESEARCH PROGRAMS, NARC, (1988/89)

UNIT/INSTITUTE/DEPARTMENT	STAFF COSTS	OPRTL. FUNDS	TOTAL FUNDS
LAND RESOURCES	3268224	197166	3465390
WHEAT, BARLEY, TRITICALE	1709472	316000	2025472
MAIZE	689784	198000	887784
RICE	1704600	393000	2097600
SORGHUM & MILLET	344136	173000	517136
FODDER	498732	64000	562732
PULSES	1507176	207000	1714176
OILSEEDS (CONVTL.)	415824	0	415824
VEGETABLES	583956	238000	821956
FRUIT	822492	135000	957492
FSR	31584	0	31584
SUGAR	205584	76000	281584
PGR	370908	30000	400908
PIC	262164	63000	325164
OILSEEDS (NON-CONVENTIONAL)	671076	268000	939076
CDRI	2411724	630000	3041724
VIROLOGY	648180	72000	720180
ENTOMOLOGY	1881312	132000	2013312
WEEDS	877284	94000	971284
AGROMETEOROLOGY	277188	16000	293188
IRRIGATION & WATER MANAGEMENT	679200	138000	817200
SOIL & WATER CONSERVATION	1327656	301500	1629156
AGRO-FORESTRY	47196	61000	108196
FORAGE & PASTURE	896976	80000	976976
REMOTE SENSING & ECOLOGY	409728	51000	460728
TISSUE CULTURE	884436	100000	984436
FOOD TECHNOLOGY	1000872	134000	1134872
APICULTURE	768876	120000	888876
SERICULTURE	121416	48000	169416
ANIMAL SCIENCE (MAIN)	474168	460000	934168
ANIMAL BREEDING & GENETICS	271272	103111	374383
REPRODUCTIVE PHYSIOLOGY	428832	162639	591471
EMBRYO TRANSFER	414264	157324	571588
MEAT PRODUCTION	217236	82914	300150
DAIRY TECHNOLOGY	277128	105237	382365
FARM	1721304	120000	1841304
POULTRY	269952	286000	555952
ANIMAL NUTRITION	1178232	320000	1498232
FISHERIES	680064	306000	986064
SHEEP & WOOL	364128	137000	501128
ANIMAL HEALTH	1186668	197166	1383834
SCIENTIFIC INFORMATION UNIT	1136592	1331000	2467592
COMPUTER & STATISTICS	354120	147000	501120
TRAINING INSTITUTE	939780	146000	1085780
TECHNOLOGY TRANSFER	552084	296000	848084
AERU	409788	78000	487788
F.M.I.	2893632	980000	3873632
LAB EQUIPMENT & MAINTENANCE	577992	305000	882992
CENTRAL STORES	351036	0	351036
TOTAL:	40016028	10056057	50072085
			50072085

TABLE A.10.4: PROJECTIONS OF FUNDS AVAILABLE FOR STAFF COSTS AND OPERATION FUNDS,  
NARC RESEARCH PROGRAMS, 1988/89 - 1999/2000

BUDGET ITEM	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/20
	(IN MILLIONS)											
1. STAFF COSTS	42	43	44	51	59	65	71	78	86	95	104	115
2. OPERATIONAL BUDGET	14	21	30	34	39	43	47	52	57	63	69	76
3. TOTAL BUDGET	56	64	74	85	98	108	119	130	144	158	174	191
4. STAFF COSTS/TOTAL	0.74	0.67	0.60	0.60	0.60	0.30	0.60	0.60	0.60	0.60	0.60	0.60
5. OPRTS.BUDGET/TOTAL	0.26	0.33	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
6. AVLBLE.FOR STAFF INCR.*	0	0	0	5	6	4	5	5	5	6	7	7
7. AVLBLE.FOR OPR. INCR.*	0	7	8	4	5	4	4	5	5	6	6	7

\*OVER PREVIOUS YEAR

TABLE A.10.5: STAFF COSTS, AND OPERATIONAL BUDGET, PULSES RESEARCH PROGRAM, NARC, 1988/89

RANK / CATEGORY	BELOW PH.D.	Ph.D.	Total	STAFF COSTS
CSO	0	0	0	0
PSO	2	0	2	237480
SSO	2	1	3	294840
SO	9	0	9	724464
ASO	0	0	0	0
BS-18	0	0	0	0
BS-17	0	0	0	0
BS-16	0	0	0	0
BS-15	0	0	0	0
BS-14	0	0	0	0
BS-13	0	0	0	0
BS-12	1	0	1	27240
BS-11	1	0	1	25332
BS-10	0	0	0	0
BS- 9	0	0	0	0
BS- 8	2	0	2	42264
BS- 7	0	0	0	0
BS- 6	3	0	3	56736
BS- 5	1	0	1	18060
BS- 4	3	0	3	51624
BS- 3	0	0	0	0
BS- 2	0	0	0	0
BS- 1	2	0	2	29136
XXXXXXXXX				
TOTAL			27	1507176
OP.BUDGET	207000			

TABLE A.10.6: PROJECTION OF FUNDS AVAILABLE FOR STAFF COSTS AND OPERATIONAL FUNDS, PULSES RESEARCH PROGRAM, NARC, 1988/89 - 1999/2000

BUDGET ITEM	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/20
1. STAFF COSTS	1507176	1552391	1598963	1646932	1798853	1978749	2176624	2394286	2633715	2897086	3186795	3505475
2. OPERATIONAL BUDGET	207000	418911	668035	960116	1199242	1319166	1451083	1596191	1755810	1931391	2124530	2336983
3. TOTAL BUDGET	1714176	1971302	2266998	2607047	2998105	3297915	3627706	3990477	4389525	4828477	5311325	5842458
4. STAFF COSTS/TOTAL	0.88	0.79	0.71	0.63	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
5. OPRTS.BUDGET/TOTAL	0.12	0.21	0.29	0.37	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
6. AVLBLE.FOR STAFF INCR.*	0	0	0	0	102523	125920	138512	152364	167600	184360	202796	223076
7. AVLBLE.FOR OPR. INCR.*	0	211911	249124	292081	239126	115924	131917	145108	159619	175581	193139	212453

\*OVER PREVIOUS YEAR

**PERSONS MET OR INTERVIEWED**  
(September 25 - October 6, 1988)

Dr. C. A. Ozair (Member Writing Team)	Plant Protection Group
Dr. A. Jabar	SSO, Entomology
Dr. Iftikhar Rana	Food Nutrition
Dr. Azra Qureshi	Tissue Culture
Dr. Muzaffar A. Khan (Member Writing Team)	
Shahid Ahmed	PSO (Water)
Dr. Noor Mohammad	SSO (Forage)
Dr. Rafiq Ahmed	CSO, NR
Riaz Khalid Siddiqui	SSO, Sericulture
Dr. Abdul Majid	Farming Systems
Mohammad Aslam	Coordinator (Maize)
M. Qasim Chatha	PD (CMP)
Zahoor Ahmed	SSO, PIC
Rashid Anwar	PSO, PGR
Abdul Shakoor	Coord (Sorghum & Millet)
Masood A. Rana	Coord (N.C) Oilseeds
Ahmed Bakhsh Malik	SO (Pulses)
Naeem I. Hashmi	National Coord (Wheat, Barley and Triticale)
M. Ashraf	Coord (Vegetables)
Ulfat N. Khan	Animal Sciences (Breeding and Genetics)
Dr. M. Afzal	ASI (Health)
Nasim Ahmed	SO (Rep. Phy), ASI
S. Arshad Hussain	SO, ASI

Dr. Amanat Ali	SSO (Animal Nutrition)
Izhar H. Akhtar	SO (Dairy Technology)
Dr. Nasim Akhtar	Dy. Director (Fisheries)
Dr. Ashiq H. Cheema	CSO (AHI)
Mr. Harry Dickherber	USAID
Dr. Curtis Nissly	USAID
Dr. Abdul Wahid	USAID
Dr. Bill C. Wright	MART/Winrock
Dr. Murray D. Dawson	MART/Winrock

**Deletions, Modifications and Additions**

The preliminary version of this report submitted to the Director General of NARC was edited to correct typographical, grammatical and other errors and to improve structure and readability. In addition there were several substantive changes which should be called to the readers attention as follows:

1. A foreword was added on pages I and II just after the title page.
2. A summary was added on pages VI to IX.
3. Comments on the scope of work were removed from Section I. They are mentioned in the foreword and detailed in the Annex I and VIII.
4. In section I.C.2 additional detail was given on funding assumptions. Annex X was added on the subject.
5. In section II.A.1.a. wording was added to clarify a recommendation that the BARD project not be included in the Master Plan as such but that its components be built into the regular structure of NARC.
6. In Section II.A.2. Agroforestry was deleted as a "gap" in recognition of the fact that the Range Management of NARC is charged with work on Agroforestry. This is also recognized in Section II.
7. Section II. B. 12 was added on "Nutrition and Food".

Proposed Organizational Structure for WARC

