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FOREWORD

The need for coordination and linkages of research between various federal and provincial research institutes doing research in agriculture was being felt for a long time. Although a number of experts' groups constituted in the past have studied the problem and made recommendations for improving the system, yet little progress has been made. To examine problems in research management which continue to hamper productivity, research leaders, managers and planners of research were provided a forum to consider constraints in agricultural research and make recommendations for removing the deficiencies and shortcomings.

At the four-day Workshop held at Dongagali during September, 1983, the desired atmosphere and opportunity was provided to the scientists and research managers to debate issues raised in the papers, read during the Workshop and discuss possible improvements. The Workshop ended after making concrete recommendations for a better research system in the country, more effective strategies in coordination and management of research and evolving a research system through which the National Agricultural Research Centre (NARC) at Islamabad could play a role in providing leadership, meeting the research deficiencies of other institutions and providing training in research management. The need for the much-needed documentation and information services was also stressed.

On behalf of the PARC, I would like to thank the USAID for providing the financial assistance for holding the Workshop. Thanks are especially due to the scientists and educators who prepared position papers which focus on important topics and stimulate innovative changes for research system management improvement. I also appreciate the services of all those who helped in organising the Workshop and making it a success.

I sincerely hope that there will be no delay in implementing the recommendations.

May 15, 1984

AMIR MUHAMMED
Chairman, PARC

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1. OPENING REMARKS

Dr. Amir Muhammed*

Ladies and Gentlemen,

I welcome you to this Workshop which has been organised in environments different from those we encounter in our daily life and which are certainly not very conducive to intellectual deliberations of vital issues concerning agricultural research. The Workshop aims at facilitating candid discussions on the gamut of agricultural research system in the country and to suggest measures for further improvements in it. Such exercises are used as effective tool in evolving practical strategies even at global level for improvement in the working of international agricultural research centres. I earnestly hope that the sessions in the Workshop will be productive and offer meaningful perspective of the system for the policy-makers.

The Sixth Five-year Plan envisages a major breakthrough in the agricultural sector. It must not only provide ever-increasing demand for food and fibre in the country but also contribute, at an accelerated rate, foreign exchange to the exchequer. This may involve greater commercialisation of agriculture with accompanying socio-cultural hazards of inequality and unemployment. As such, the agricultural research system, which will provide the required back-up production technologies, needs to be qualitatively reorientated and upgraded to avoid these hazards. There are many missing links in the system at present and unless these links are identified and properly tackled, expecting the system to meet future demands may be unrealistic. I shall illustrate my viewpoint by referring to the current classification of the country into various ecological zones. Such classification is no more adequate to provide a scientific basis for production strategies for various areas of the country. Unless socio-economic factors, demographic patterns and a host of other aspects are also identified and integrated into a new ecological classifications, research policies and operations will continue to be limited in their scope and application. Based on such an ecological classification and on the objective of commercialisation of agriculture, a new package of technology for each zone can be developed to minimize the hazards I referred to earlier.

There is a great deal of confusion at present regarding the need and scope of basic, applied or adaptive research. It is unnecessary as the major aim is to serve the cause of science and country in the best possible manner and there is no conflict between the two. With the limited resources available to us, the research efforts need to be complemented and strengthened rather than duplicated to satisfy personal whims and prestige. The continued enthusiasm and commitment of scientists to research will make productivity rise vertically in the face of shrinking land resources.

The theme of the Workshop is the system and, therefore, a discussion of the areas of research which need to be pursued in the context of future requirements, will be out of place. I shall confine myself to the major facets of the system which need to be examined in the Workshop for the good of the sector. The success of research greatly depends on the place and linkage of research in the education and extension systems, the manpower resources, the training opportunities, the recruitment and salary structure and the provision of support services. The present state of affairs in this regard and the likely solution for removal of difficulties should attract the attention of the participants in the Workshop. I shall only say a few words in passing on these issues.

The linkages of research with education and extension at present suffer from traditional apathy and compartmentalization of pre-research era. Unless the three go hand-in-hand for the achievement of national goals, their efforts may not yield good results. The output of qualified manpower for research and extension should also be characterised by the national priorities in research. So far, a great diversity of objectives, bordering on cross-purposes, has been observed.

The long-term and short-term training facili-

* *Chairman, PARC, Islamabad*

ties available to scientists in Pakistan are limited. Although international donors are showing great keenness in extending all possible assistance, yet the utilization has been unsatisfactory. It is estimated that the present strength of 200 Ph.Ds in the country must be enhanced to 2000 if the challenge of multi-disciplinary research is to be met effectively. An effective system will have to be adopted to achieve the target of high quality manpower.

The scientists have been a depressed class till recently. The Grade and the post-oriented career advancement system offered little opportunity for them to rise high on the ladder. However, efforts at the Federal level succeeded in attracting a different and better treatment to the scientists in the new basic-pay structure. The PARC also provided a fresh air to the talented scientists who were otherwise stuck in the career. Such mobility of expertise within the national requirements needs to be systematised without causing any apprehension to those who cannot make it. Science will not prosper if those who pursue it are not properly cared for and well-provided.

The support services to research such as planning, evaluation, information, personnel administration, laboratory facilities and financial management are some of the areas whose working in the research system should be studied and weaknesses identified for improvement. There is an urgent need to strengthen these facilities with targetted objectives and to integrate them in the agricultural research system.

Ladies and Gentlemen! it is not for the first time that we are deliberating upon the system for making improvements. A number of reports and studies made by international agencies like CIDA, USDA, World Bank, Minnesota group, besides the national teams, are available to offer inspiration. I must add here that all such studies have their own relative validity and, for that matter, we cannot say that the previous efforts were not fruitful. The review of a system is a continuous process and such periodic exercises function as a built-in mechanism for the organic development of the system in the light of changing circumstances. We are not aiming at ideal system but even a few practical results of the Workshop may be worthy step forward in that direction. There is currently an immense goodwill and support available at national as well as international level to make some ambitious moves in the cause of science and research and we shall be failing in our commitment if we let pass this opportunity by default.

I once again warmly welcome you all in this meeting and hope that we shall be able to produce something worthwhile in the ensuing discussions for the benefit of agricultural research and production in the country.

2. ORGANIZATION OF THE WORKSHOP WITH BRIEF BACKGROUND AND PURPOSE

Shahida Akhtar*

Agriculture continues to be the largest single sector of Pakistan's economy. It accounts for 29 percent of Gross Domestic Product (GDP), engages 55 percent of employed labour force and supports directly or indirectly 72 percent of the population for their sustenance. It meets the raw material requirements of the domestic industry to a great extent besides earning 59 percent of foreign exchange for the country. The welfare of the vast majority of the population is largely dependent on efficient harnessing of the agricultural resources.

At present, agricultural research is being carried out by a large number of federal and provincial research institutes, research centres, departments and universities. The Pakistan Agricultural Research Council (PARC) aids, promotes and coordinates agricultural research besides undertaking research at the National Agricultural Research Centre (NARC) and other institutes and arranges training of scientific manpower. It also maintains a reference and research library and provides a number of services to the other federal and provincial research institutes including procurement, testing and distribution of exotic germplasm, scientific literature, equipment and technical assistance. Yet there is an imperative need of strengthening the linkage between PARC and NARC on the one hand and among the other federal and provincial institutions, and universities on the other. Indeed research management which results in more effective generation and dissemination of research to benefit end-users is needed.

Keeping this in view, PARC, with the assistance of USAID, held the four-day Workshop on the National Agricultural Research System on September 1–4, 1983, at Dongagali. The main purpose was to consider the constraints and deficiencies in the national research system and develop strategies which result in strengthening the system and boosting the agricultural production. A small group of eminent scientists, administrators and planners was invited to this Workshop who presented leading papers on important topics of research system.

Dr. Amir Muhammed, Chairman, PARC, inaugurating the Workshop, welcomed the participants and emphasised the need for improvements in research system of Pakistan. Sahibzada Mohammad Ayaz, Chief Agriculture and Joint Secretary (Food & Agriculture Section), Planning and Development Division, presented a lead paper on agriculture in the Sixth Five-year Plan in which he reviewed the performance of the agriculture sector in the Fifth Plan, objectives and strategies of the Sixth Plan, its production targets major proposals and policy issues to achieve its targets.

After the inaugural session, four sessions were held in which leading papers were presented on the following topics:

i) Ecological Zones for Crops and Livestock
ii) Rural Development: Still a needed subject
iii) Fertilizer Research Management System in Pakistan
iv) A Systematic Approach to the Development of Seed Sciences and Technology in Pakistan
v) Engineering Role in Agriculural Research System
vi) Critical Elements of Agricultural Research in Pakistan
vii) Research Planning.
viii) Project Formulation, Monitoring and Evaluation
ix) Financial Administration/Budget Management in PARC
x) Manpower Training
xi) Farm Services
xii) Research Information System for Agriculture in Pakistan
xiii) NARC Development Activities

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During the Workshop, the participants discussed constraints in the existing research system, management of research institutions, manpower improvement, coordination, linkages, evaluation and monitoring of research programmes and budget management. Each Technical Member of PARC or his representative presented a brief on the achievements, constraints, remedies and priorities of research in his respective field. The provincial viewpoint was put forth by the Director-General, Agricultural Research Institute, Tarnab; Director, Agricultural Research Institue, Tandojam and representative of Agricultural Research Institute, Sariab. In the final session, recommendations for the improvement of research system in Pakistan were formulated which form a part of this report.

3. AGRICULTURE IN THE SIXTH FIVE-YEAR PLAN

SAHIBZADA MUHAMMAD AYAZ*

Agriculture is the largest single sector of Pakistan's economy accounting for 29 percent of the Gross Domestic Product (GDP). It employs 55 percent of the labour force and its share in export earning amounts to 70 percent, including processed agricultural products. Although share of agriculture in GDP has declined over the years since Independence, representing high growth rate in industry and infrastructure, yet agriculture itself has maintained a steady pace of development. Since early sixties its rate of growth averaged around four percent which places Pakistan in a group of developing countries which have succeeded in inducing and sustaining high agricultural growth.

FIFTH PLAN PERFORMANCE

The Fifth Plan envisaged an overall annual growth rate of six percent for agriculture. Actual achievement against this is estimated at about 4.4 percent. This is not a mean achievement by any standard, considering that these targets were fixed in the light of maximum range of possibilities. Impressive growth was recorded in the four major crops namely, wheat, rice, sugarcane, and cotton. Similarly, beginning of a rapid growth was witnessed in relatively small poultry sector and selected items in the fruits and vegetables (Tables 1a and 1b). The limited shortfall in crop production compared to Fifth Plan targets arises from a number of factors. Most important among these was the increase in world energy prices which resulted in fertilizer price increase. Inspite of cushioning impact of increase in crop input prices through rationalising output prices, fertilizer consumption increased at a slower pace than visualised in the Plan. World recession was directly responsible for affecting the incentives for export crops, notably cotton and rice. Difficulties were experienced in disposing off exportable surpluses even with the realised growth in output.

Table 1a. Fifth Plan targets and achievements in crop production sector

(million tonnes)

Crop	Fifth Plan targets 1982-83	Achievement 1982-83	Percent achieved
Wheat	13.01	12.34	95
Rice	3.96	3.44	87
Maize	1.22	1.01	83
Others	0.83	0.60	72
Cotton (lint)	0.89	0.82	92
Sugarcane	34.85	32.53	93
Cottonseed	1.78	1.64	92
Traditional oilseeds	0.54	0.42	78
Non-traditional oilseeds	0.19	0.02	11
Pulses	1.14	0.71	62
Vegetables and spices	3.38	2.73	81
Fruits	2.98	2.68	90

Table 1b. Fifth Plan targets and achievements in livestock and fisheries sectors

(million tonnes)

Commodity	Target 1982-83	Estimated production	Percent achieved
Milk	8.8	9.7	109
Meat			
– Beef	0.43	0.46	107
– Mutton	0.50	0.41	82
– Poultry	0.06	0.07	117
Eggs (million No.)	2,650	3,200	121
Fish			
– Marine	0.289	0.272	94
– Inland	0.049	0.060	122

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SIXTH PLAN OBJECTIVES AND STRATEGY

The primary goal of the Sixth Plan in the agricultural field is to ensure that the growth impulses in this sector are institutionalised. This would require improvement in existing supporting services and setting up of new institutions which would ensure an effective linkage of domestic agriculture with the demand for high-value agricultural products in the world market. More specifically the Plan visualises the following broad objectives for the growth in the agriculture sector:

* Move beyond self-sufficiency to export of agricultural commodities, i.e., while maintaining self-sufficiency in wheat and other cereals, to move towards elimination of deficits in milk, pulses, and edible oils and to create exportable surpluses specially in high value commodities such as, fruits, vegetables, poultry, eggs, and meat
* Have more diversified cropping system with more emphasis on high value crops
* Change agricultural production environment from subsistance to commercial farming
* Provide increased employment opportunities and improve well-being of the rural population
* Exploit effectively wood production potential of the forest lands, particularly commercial forests and fish production potential of the inland waters, national coastal waters, and the Exclusive Economic Zone (EEZ) of the sea adjoining our coast.

The strategy conceived for achieving these objectives would broadly consist of the following:

* The growth elements which have produced significant results during the Fifth Plan, i.e., availability of modern inputs (improved seed, fertilizers, pesticides) and technology along with requisite credit facilities will be carried further and improved with a view to cover the farms presently out of their reach and also to optimise their use for maximising farm income.
* Judicious use of existing irrigation facilities has assumed great national significance on account of limited opportunities for any further sizeable expansion. Therefore, on-farm water management practices will be promoted through farmers' associations, their training, and motivation.
* Farm mechanization has emerged as a new growth element for the Sixth Plan period. Opening up import (coupled with gradual local manufacture) of small tractors and small farm machinery, along with continued support of the existing range of farm machinery and implements, would promote intensive farming on all types of farm sizes.
* Extension service would be modernised and its sources would be diversified so that a swift and effective communication is established with the farmers. Advances made during the Fifth Plan period in this regard will be consolidated and extended as needed. New approaches would be experimented which promise higher level of operational efficiency. In order to supplement government efforts, agricultural industry and business enterprises will be encouraged to provide extension service in special crops/commodities of their interest.
* Diversification of agriculture would be achieved by extending system of support prices to high value new crops. Other measures, such as, crop-cattle insurance, innovative agricultural loan programmes, such as, supervised credit, group loans, etc., would also be encouraged to promote investment in the new technologies.
* Main thrust of the agricultural development would be to improve economic conditions of the small farmers who constitute bulk of the farming community of the country. Particular attention would be paid to farmers in the rainfed *(barani)* areas which have lagged behind in benefiting from the agricultural growth achieved so far. Socio-economic institutions, such as, cooperatives, will play a very important role in this regard. Measures designed to harness potential of such institutions for enabling small farmers to better their economic conditions through collective efforts will be given effective support.
* Agriculture will be developed during the

Sixth Plan as an export based industry. Pakistan has only a limited experience of agricultural exports, mainly with cotton and rice. Future growth in agriculture would require a sizeable presence in the world market. This would involve besides, producing a sizeable wheat surplus as insurance for food self-sufficiency, experimentation with a large number of high value crops and commodities, mainly for export markets. Not all of these can be identified in advance. The essential elements are the linkage of domestic agriculture with the world market, cost effectiveness, efficiency of production, concern for quality, arrangements for grading, and a high degree of flexibility and responsiveness to the market signals from abroad. This change in the production environment would trigger investment in food processing and other agro-industries both for the domestic market and exports.

* For the domestic market major emphasis will be on the rapid expansion of oilseeds and protein based crops and commodities for both human consumption and animal feed.
* The Plan includes substantial programmes for exploiting forests and the vast fisheries potential within the bounds of sensible economic, technical, and ecological considerations.

PRODUCTION TARGETS

The following two working groups were constituted by the Planning Commission for indicating agricultural production targets for the Sixth Plan which ensure a growth rate of about five percent per annum for the national account purposes:

1. Working group on food self-sufficiency and maximization of agricultural exports headed by Mr. A. Jamil Nishtar, Chairman, ADBP.
2. Working group on crop targets headed by Mr. Saeed Ahmad Qureshi, former Secretary, Ministry of Food, Agriculture and Cooperatives, Government of Pakistan.

Both these groups examined the existing situation as well as potential, and opportunities, for future growth in the context of overall national needs and the international marketing prospects. The latter mentioned aspect has assumed very high significance on account of our achieving self-sufficiency in all major crops coupled with high cost of production compared to their border prices. Production targets adopted in the Sixth Plan are essentially synthesis of the assessment of these working groups which had examined our comparative advantage and opportunities in great depth. Details of these production targets together with the benchmarks are given in Tables 2a and 2b. These tables reveal that more emphasis will be given to increasing production of oilseed crops (7.3 percent, annual rate of growth for all oilseed crops), vegetables (14.4 percent), fruits (10.2 percent), milk (6 percent), meat (6 percent), poultry (14.9 percent), eggs (13 percent), and fish products (5.2 percent). Production of wood from Government-managed forests is also visualised to increase at the annual rate of 20 percent as a consequence of rationalising forest management systems in conformity with the policy of maximising wood production per unit area. Realisation of these production targets would result in growth rate (value added) of about six percent. This would provide safety cushion of about one percent which will take care of some of the uncertainties inherent in the agricultural production environment.

Most of the additional 1.3 million hectares to be made available for cultivation during the Sixth Plan period will come through improvement in the existing irrigation system by way of remodelling of canals, command area management and land reclamation programmes. Therefore, main effect of this will be by increasing cropping intensities.

Implications of the proposed structural changes in production of the agricultural crops on the cropping pattern are illustrated by Table 3. Due to policy support afforded to wheat in the past, this crop is expected to appropriate significant share (about 18 percent) out of the additional area although its relative position by the end of the Plan is expected to decline slightly. Rice is expected to maintain its share in the cropping pattern due to increased availability of water and lower proposed investment in anti-waterlogging programmes compared to quantum of its threat. No

Table 2a. Sixth Plan targets for crop sector

(million tonnes)

Crop	Computed benchmarks	Estimate 1982-83	Targets 1987-88	Annual percent increase over benchmarks
Wheat	11.80	12.34	1.50	5.6
Rice	3.31	3.44	4.20	4.9
Maize	0.97	1.01	1.38	7.3
Other cereals	0.64	0.68	0.72	2.4
Cotton	0.82	0.82	1.03	4.7
Lint	(4.83)	(4.83)	(6.07)	
Sugarcane	35.00	32.53	40.94	3.2
Cotton seed	1.64	1.64	2.07	4.7
Traditional oilseeds	0.33	0.42	0.44	5.6
Non-traditional oilseeds	0.03	0.02	0.35	64.4
Pulses	0.70	0.71	0.79	2.8
Vegetables and spices	2.61	2.75	5.11	14.4
Fruits	2.20	2.68	3.59	10.2

Figures in parenthesis indicate production of lint in million bales of 375 lbs.

Table 2b. Sixth Plan targets for livestock, fisheries and forestry sectors

(million tonnes)

Commodity	Benchmark 1982-83	Production target 1987-88	Annual percent increase over benchmark
Milk	9.66	12.9	6.0
Meat			
Beef	0.46	0.63	6.0
– Mutton	0.41	0.54	6.1
– Poultry	0.07	0.14	14.9
Eggs (million No.)	3,200	5,900	13
Fish			
– Marine	0.272	0.361	5.8
– Inland	0.060	0.066	1.9
Wood production (Government forest)			
– Timber ('000' m^3)	200	497	20
– Fuel wood ('000' m^3)	480	1,193	20

area increase is visualised for cotton and sugarcane. The entire production increase for these two crops would be realised through productivity increases. However, programme for setting up new sugar mills, and expected increased availability of water will make control of area expansion for sugarcane a very difficult policy objective. Share of vegetables, fruits and oilseed crops is expected to increase. Production increase visualised for these crops will, therefore, come through area expansion as well as productivity increases.

As no mechanism for direct intervention exists for enforcing any particular cropping pattern, the desired changes will be promoted through suitable policy measures, such as, support prices, availability of inputs and machinery, providing improved marketing facilities, research and development back-up, credit, etc. One of the major institutional measures designed for providing effective and continued policy support for ensuring attainment of the desired growth and production target is establishment of national commodity boards for all major exportable commodities.

These policy boards are visualised as broad-based institutions having representation from producers associations, private business and trade, and concerned Government agencies, with adequate specialist secretariat support. Production and marketing environment will be kept under continued surveillance by these boards for early detection of production and marketing problems and initiating action for tackling these.

With the projected growth in agriculture

Table 3. Changes in cropping pattern during the Sixth Plan

Crop	Percentage share in cropped area		Additional area	Percentage of additional area
	Benchmark	1987-88	('000' hectares)	
Wheat	36.25	35.13	240	18.3
Rice	9.95	10.02	146	11.1
Other Grains	9.59	9.52	112	8.6
Total Grains	(55.79)	(54.67)	(498)	(38.0)
Cotton	11.51	10.78	—	—
Oilseeds (excluding cottonseed)	2.85	4.56	393	30.0
Pulses	7.38	7.33	86	6.6
Vegetables, spices and fruits	2.68	3.69	248	18.9
Sugarcane	4.29	4.02	—	—
Others (including fodder)	15.50	14.95	85	6.5
Total:	100.00	100.00	1,310	100.0

For further details (area, total production and yield increases by individual crops) see Annexures I, II and III.

during the Sixth Plan, surpluses in agricultural commodities will emerge for which export markets would have to be identified. The proposed National Commodity Boards will help to establish satisfactory market intelligence system. The working group on food self-sufficiency and maximization of agricultural exports has estimated that Pakistan will have sizeable exportable surpluses of wheat, rice, sugar, fish and poultry. Export potential estimated by this group for food commodities (i.e., excluding cotton and tobacco) will be of the order of 1,718 million U.S. dollars by 1987-88. However, the corresponding estimates incorporated in the draft Sixth Plan for these food commodities is 1,144 million U.S. dollars (Table 4). Irrespective of the precise quantification, which must remain a matter of uncertainty at this stage, the size of agricultural exports will be large if the growth potential of Pakistan agriculture is realised in line with the Sixth Plan strategy.

MAJOR PROPOSALS AND POLICY ISSUES

It has already been explained that Sixth Plan strategy for agriculture envisages setting up of institutions which should ensure quick response of the production systems to the market requirements, domestic as well as internationonal. A beginning in this regard was made during the Fifth Plan period through establishment of the Agricultural Prices Commission and creation of posts of Commissioners for the major crops in the Ministry of Food, Agriculture and Cooperatives. A National Fertilizer Development Centre was also set-up under the Planning Division for providing back-up support for policy analysis of the fertilizer issues.

This process will be carried forward during the Sixth Plan at a much accelerated pace. Establishment of the National Commodity Boards for all exportable commodities will naturally figure among the high priority measures. Another proposed policy measure of great significance is formulation of the National Agriculture Research Plan, a draft of which has already been prepared by the Pakistan Agriculture Research Council (PARC) and circulated for eliciting comments. This plan is intended to guide and focus research attention on nationally high priority researchable areas and problems. PARC will play a pivotal role in formulation and implementation of such a plan.

Other important proposals and policy issues considered important for realization of the growth targets are as follows:

Research

* Increase research effort substantially for developing better technology for the crops which need expansion for local use as well as for export, and for identifying more productive farming systems

* Focusing research effort for increasing crop yields in *barani* areas
* Articulation of institutional mechanisms (National Agricultural Research Plan being one of these) for ensuring coordination in research programmes with a view to avoid duplication and allocating resources in accordance with the national objectives and priorities.

Extension

* Modernising extension service and diversify its sources (promote induction of private sector) for communicating techniques and research prescriptions to farmers, introduce TV system where successful, and remodel extension services by practical training, demonstration and general improvement.

Edible Oil

* Formulating policy which ensures that the country attains self-sufficiency in edible oil in the shortest time, and develop soybean crop through a crash programme into a major oil seed source by comprehensive production oriented measures.

Education

* Giving emphasis to practical training in the agricultural training institutes and developing institutional linkage between agriculture research institutes and the agricultural universities to make higher education in agriculture more responsive to changing environmental conditions and national needs.

Crop Inputs

* Ensuring availability of all production inputs (improved seed, fertilizer, pesticides, weedicides, etc.) commensurate with the production targets
* Optimising use of agricultural inputs with a view to maximising their interactive effects and consequently productivity of land
* Improving input logistics and bringing them within easy reach of the small farmers through effective credit programmes

Table 4. Food commodities export

Crop	1982-83		1987-88			
			Potential as estimated by group on food self-sufficiency and export		Targets as envisaged in the draft Sixth Plan	
	Quantity '000' tonnes	Value million US $	Quantity '000' tonnes	Value million US $	Quantity '000' tonnes	Value million US$
Traditional						
Rice	1,150	306	1,500	600	1,333	471
Fish	19	90	55	236	28	173
Non-traditional						
Wheat	79	15	2,500	500	550	
Sugar	47	12	600	156	200	
Meat	0.02	0.1	13	38		
Fruits and vegetables	160	33	242	68		500
Spices	9	11	38	33		
Miscellaneous		29		87		
		496		1,718		1,144

Miscellaneous include: Eggs, poultry, mollasses, semi-processed and preparation of cereal, animal feed, etc.

* Promoting agricultural mechanization by increasing cropping intensity through large scale introduction of small tractors (below 30 hp range) along with complementary implements, in addition to continuation of the existing programmes for medium-size tractors (45 to 65 hp range) and other types of farm machinery
* As many as 250,000 tractors (mostly of small sizes, below 30 hp range) are planned to be added during the Sixth Plan period compared to addition of 86,700 tractors (entirely of 45—65 hp range) during the Fifth Plan.

Marketing and Storages

* Promotion of private sector institutions for developing and operating marketing infrastructure including establishment of national commodity boards in the public sector for all important agricultural commodities for surveillance and monitoring of market conditions and advising Government on policy issues relating to promotion of internal as well as external trade
* Construction of additional storages for 3.06 million tonnes; 2.15 million tonnes for wheat, 0.66 million tonnes for rice, and 0.25 million tonnes for cotton
* Promoting small-scale agro-based processing and packaging industries in the rural areas through well-designed policy package.

Livestock

* Increasing milk production through encouraging formation of producers' associations for providing services, such as, disease control, input supplies, management advice, etc., and market linkages to help solve production and marketing problems. The Government sector would continue providing services, such as, artificial insemination, disease control, and technical advice but producers' associations would be encouraged to take over some of the responsibilities in this area in order to meet needs of the farmers/livestock owners effectively
* Improving local breeds for milk, meat, and wool production through cross-breeding and selective breeding programmes
* Supporting animal production programmes through research on feeds, animal management, and product marketing
* Increasing meat production by involving farmers in fattening of surplus cattle/buffaloe calves, lambs/kids, and aged/unproductive animals before marketing to increase their carcass weight
* Improving livestock feed availability by increasing feed and fodder production through introduction of improved varieties, recycling of agricultural/industrial wastes and by-products for livestock feeding and better management of rangeland resources
* Existing incentives/concessions provided to livestock industry, such as, income tax exemption, duty-free import of machinery/equipments, import of exotic livestock, parent and grant parent poultry stock on free list, and allotment/lease of state land for livestock farming should continue during the Sixth Plan period
* Continuation of existing policy for encouraging private corporate investment in dairy processing plants
* Abandoning existing policy for import of milk and other dairy products through gradual enhancement of import duty as well as reducing quantity of import permits every year
* Creating a cadre of para-veterinarians among livestock owners for taking care of common ailments of animals
* Complete lifting of price control of livestock products, or permitting fixation of prices according to the grades of such products, or as a policy option of the last resort, there should be no price control on such products which are processed by integrated processing complexes exporting sizeable part of their production
* Existing system of providing free curative treatment to livestock would need review, while vaccination against internal worms may remain a free service, beneficiaries of

other animal health facilities should be made to pay the full charges for treatment of their livestock under a phased programme.

Fisheries

* Providing better marketing system, improved, and mechanised fish catching equipment, and research and training support needed for fisheries development
* Construction of new fish harbours, jetties (for provision of berthing facilities to accommodate large fishing crafts) and on-shore refrigeration/cold storage and processing facilities for getting good quality fish for domestic consumption as well as export
* Encouraging fish and shrimp farming by farmers and private entrepreneurs through provision of support facilities, advisory services, and credit.

Forestry

* Changing low keyed extensive forest management to intensive forest management systems employing improved logging/harvesting methods in order not only to increase wood production but also to enhance employment opportunities for the local population
* Shortening present rotations of northern coniferous forest from 120—150 years down to 60—80 years (i.e., closest to the year where current and average annual rate of growth of forest stands equalise) in order to maximise sustained annual yield from the existing commercial forest area and reducing the gap between supply and demand for weed
* Shift of emphasis for wood production from government owned forest area (which is less than four percent of the total land area) to privately owned lands, with Government's role focussed on promotional, advisory, and supportive activities.

Majority of the foregoing proposals would get implemented through execution of the development projects and programmes already tentatively identified by the Planning Commission in consultation with the concerned agencies of the Federal as well as the Povincial Governments for which provisions have been made in the allocation earmarked for the Agriculture Sector in the Sixth Plan outlays. However, there are many policy proposals which will require action at the Government level by way of reviewing the existing policies or taking such other measures which fall beyond the scope of the development projects. Action on such proposals will be taken by putting up such issues to the competent Government forum (Federal Cabinet or Economic Coordination Committee of the Cabinet) after preparing requisite policy analysis papers. Ministry of Food, Agriculture and Cooperatives, will play the lead role in this regard. Planning and Development Division will, however, watch progress of action in this regard through the institutional mechanism of the Annual Plans.

ANNEXURE-I

CROPWISE AREA TARGETS FOR THE SIXTH PLAN

('000' hectares)

Crop	Area			
	Benchmarks	Target 1987-88	Percent increase	
			Overall	Growth rate
Total foodgrains	10,956	11,454	5	0.9
Wheat	7,120	7,360	3	0.7
Rice	1,954	2,100	7	1.5
Maize	770	818	6	1.2
Other foodgrains	1,112	1,176	6	1.2
Sugarcane	843	843	—	—
Cotton	2,260	2,260	—	—
Rape and mustard	407	451	11	2.1
Sesamum	46	48	4	0.9
Groundnut	56	60	7	1.4
Sunflower	30	145	383	37.0
Safflower	18	50	178	22.7
Soybean	4	200	4,900	118.7
Total oilseeds (excluding cottonseed)	561	954	70	11.2
Gram	1,025	1,112	8	1.6
Other pulses	424	423	—	—
Total pulses	1,449	1,535	6	1.2
Potatoes	44	70	59	9.7
Onion	44	75	70	11.3
Other vegetables and spices	199	312	57	9.4
Tobacco	43	45	5	0.9
Fodder	2,611	2,805	7	1.4
Fruits	239	317	33	5.8

ANNEXURE-II

CROP PRODUCTION TARGETS FOR THE SIXTH PLAN

('000' tonnes)

Crop	Production			
	Benchmarks	Target 1987-88	Percent increase	
			Overall	Growth rate
Total foodgrains	16,712	21,795	30	5.5
Wheat	11,800	15,500	31	5.6
Rice	3,307	4,200	27	4.9
Maize	969	1,380	43	7.3
Other foodgrains	636	715	12	2.4
Sugarcane	35,000	40,935	17	3.2

(Continued.....)

('000' tonnes)

Crop	Production			
	Benchmarks	Target 1987-88	Percent increase	
			Overall	Growth rate
Cotton	821	1,033	26	4.7
Lint	(4,827)	(6,074)		
Cottonseed	1,642	2,066	26	4.7
Rape and mustard	246	322	31	5.5
Sesamum	19	21	11	2.0
Groundnut	67	94	40	7.0
Sunflower	20	108	440	40.0
Safflower	8	26	225	26.6
Soybean	3	216	7,100	135.2
Total oilseed (excluding cottonseed)	363	787	117	16.7
Gram	495	582	18	3.3
Other pulses	199	213	7	1.4
Total pulses	694	795	15	2.8
Potatoes	459	850	85	13.1
Onion	452	800	77	12.1
Other vegetables and spices	1,698	3,455	104	15.3
Tobacco	68	100	47	8.0
Fodder	49,610	56,000	13	2.4
Fruits	2,200	3,585	63	10.2

Figures in parenthesis indicate production of lint in thousand bales of 375 lbs.

ANNEXURE-III

CROP YIELD TARGETS FOR THE SIXTH PLAN

(kg/ha)

Crop	Yield			
	Benchmarks	Target 1987-88	Percent increase	
			Overall	Growth rate
Total foodgrains	1,525	1,903	25	4.5
Wheat	1,657	2,106	27	4.9
Rice	1,692	2,000	18	3.4
Maize	1,258	1,687	34	6.1
Other foodgrains	572	608	6	1.2
Sugarcane	41,500	48,559	17	3.2
Cotton (lint)	363	457	26	4.7
Cottonseed	726	914	26	4.7
Rape and mustard	604	714	18	3.4
Sesamum	413	438	6	1.2
Groundnut	1,196	1,567	31	5.6
Sunflower	667	745	12	2.2
Safflower	444	520	17	3.2

(Continued.....)

(kg/ha)

Crop	Yield			
	Benchmarks	Target 1987-88	Percent increase	
			Overall	Growth rate
Soybean	750	1,080	44	7.6
Total oilseeds (excluding cottonseed)	647	825	28	5.0
Gram	483	523	8	1.6
Other pulses	468	504	8	1.5
Total pulses	479	518	8	1.6
Potatoes	10,432	12,143	16	3.1
Onion	10,273	10,667	4	0.7
Other vegetables and spices	8,535	11,077	30	5.4
Tobacco	1,581	2,222	41	7.1
Fodder	19,000	19,964	5	1.0
Fruits	9,205	11,315	23	4.2

4. ECOLOGICAL ZONES FOR CROPS AND LIVESTOCK

MUHAMMAD ALIM MIAN AND MUHAMMAD RAFIQ*

INTRODUCTION

Pakistan is not ecologically homogeneous for growing of any crop or raising of livestock. A certain crop cannot be grown or a certain kind of livestock cannot be raised as successfully in all parts of its area as in one part, whatever improvements in management may be envisaged. The heterogeneity is due to differences in the environmental characteristics of various parts. In some cases these differences are abrupt while in others they are gradual or diffuse. It is, of course, extremely hard to delimit accurately the areas of homogeneity, i.e., the areas having similar environmental conditions within themselves. Rough delimitation of such areas is nevertheless possible by disaccounting some relatively, unimportant factors. One such areas of ecological homogeneity, the ecological units or zones, are carefully delimited, a sound planning of agricultural development in the country can be ensured.

The definition of 'environmental conditions' that should differentiate the ecological units is rather vague. Whereas it must necessarily include the climatic conditions, hydrology, physiography and kind of soils, the consideration of other factors such as the incidence of diseases and pests, human behaviour and infrastructures should not be excluded. The data on the latter are, however, rarely available in forms that can be specifically related to the delimited units.

Rafiq (in FAO, 1976) identified and delineated 17 'crop ecological zones' in Pakistan (Appendix) on the basis of differences in their climate, physiography and soils. A summary of the characteristics of each zone identified by him is appended herewith, along with a map of 1:7,500,000 scale showing its location and extent.

PARC (1980) recognized 10 'agro-ecological regions' (Figure 1) instead of 17 zones as by Rafiq (in FAO, 1976). The agro-ecological regions are delimited mainly by grouping of the crop ecological zones of the latter. The main objective of grouping was to reduce the number of ecological units for easier handling by high level planners.

SIGNIFICANCE OF ECOLOGICAL ZONATION

The chief objective of ecological zonation is, directly or indirectly, developing agriculture on scientific lines. The underlying principle is that the agricultural or livestock production will be optimum only when a certain crop is grown or livestock is raised under such environmental conditions as are best suited for that purpose. In other words, the growth and development of any kind of crop or livestock have specific requirements which are fully or satisfactorily met only within certain ecological zones. This relationship of crops/livestock with the ecological zones is to be exploited for agricultural development.

ACTIONS REQUIRED

Two important aspects of agricultural development on the basis of ecological zones, are to be considered, viz., (i) agricultural research and (ii) agricultural extension. The actions required to be taken accordingly are discussed below:

Actions Required for Agricultural Research

The agricultural research in many fields is not quite well-planned. The research conducted in certain areas under specific environmental conditions is presumed to be applied to many such areas as are not representative of that. As a result, the crop varieties evolved, the cropping systems proposed and the management practices recommended do not guarantee the expected advance towards increasing the agricultural production. The following actions are needed for

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making the research more effective and useful.

* An agricultural research station or sub-station should be established in each ecological zone. The location of the station should be determined after confirming whether it is quite representative of the zone in all respects. A survey of the location of existing research stations should be made; those unrepresentative of the zone should be reconsidered and where found non-existent, these should be set up.
* An agro-meteorological observatory should be set up at the agricultural research station in each zone. This observatory will provide climatic data directly applicable to the agricultural research being made at that station and will help in studying the year-to-year weather effects on agricultural production.
* The crop varieties evolved at other research stations should be tested at the research station of each zone before recommending them for that zone.
* Research on the requirements of all important crops should be carried out at different research stations. The requirements with respect to soils, climate, irrigation water, management levels, crop growing periods and rotations should particularly be investigated by keeping in view the costs of production and returns.

  The promising crops for each ecological zone should then be redetermined and further research on improvement of their varieties should be continued.
* To facilitate and expedite research on management requirements, different soils of each ecological zone should be grouped into four or five soil families. The most representative soils of each family should then be selected for all kinds of agronomic research. This would help in recognising the constraints in agricultural production which are due to the intrinsic qualities of soils, and in finding out proper solution to the problems.
* The performance of important species of livestock (i.e., sheep, goats, cattle, buffaloes, horses and camels etc.) under grazing from natural vegetation as well as by growing fodders should be carefully studied in each ecological zone to assess the livestock adaptability of the respective zone.
* The potential of different soil families in each ecological zone for grazing or forage production should be assessed. It should be done both under natural and improved grazing conditions in uncultivated areas. Research may also be carried out in cultivated areas to find out soils which would be more profitably used for producing fodders than for growing other crops.
* Research should be done on different species of forage crops, especially with respect to their palatability, growth rates, regeneration and management requirements, in each ecological zone important for livestock production.
* Appropriate range management systems should be evolved to safeguard the natural vegetation of rangelands against degeneration. Research on the use of fertilizers for improvement of rangelands should be made.

Actions Required for Agricultural Extension

To change our traditional arable farming into a modern agricultural production system, one of the basic requirements is to apply the results of research carried out in each ecological zone wisely and strictly by adopting the most suitable crops and cropping systems for different parts of our country. The other actions required in this respect are as follow:

* Government policies should be framed so as to provide necessary advice and incentives to the farmers to grow the most suitable crops in each ecological zone. In some areas, major changes in cropping patterns may be needed. For example, sugarcane is widely grown in Thal doab despite the fact that the ecological classification of that area indicates that growing of groundnuts for vegetable oil production or fodders for livestock

production, and not the sugarcane, would be the most appropriate use. Establishing of proper agro-based industries like oil mills and dairy farms, and not the sugar mills, will be one of the steps that can be taken in that respect.

* The farming systems recommended for each ecological zone should be introduced through model farms and promoted by providing necessary inputs and capital.
* Livestock production may be integrated with arable farming, especially in those ecological zones where livestock production is an important land use. It will help in evolving more efficient and profiting agricultural production systems in the relevant zones.
* Such ecological zones where fodder and feed can be most economically produced for fattening the livestock coming from rangelands should be clearly marked and allowed for that purpose.

SOME RESEARCH PROPOSALS FOR NARC

As the NARC aims at improvement of rainfed farming, it may be worthwhile to give some proposals on its possible areas of research. The following research areas should be included in their programme.

- Performance trails of new crops and crop varieties should be conducted to select the most promising crops for the relevant ecological zone (Rawalpindi zone, particularly for its sub-zone with high rainfall). These trials should be made under all possible and practicable sets of management levels and inputs, with particular emphasis on their growing methods, sowing times, fertilizer application and plant protection measures. The abnormal climatic phenomena if, occurring during the research period, should be carefully noted and interpreted while reporting the results.
- The important soil families should be selected and research should then be made on soil management under the existing as well as the anticipated future resource levels of the farmers. The research should particularly be focussed on tillage practices, drainage and moisture conservation, soil structure improvement, soil erosion control and soil fertility amelioration.
- Research on agronomic as well as climatic requirements of all important crops and their varieties should be carried out. The potential of each soil family should be assessed by keeping in view the requirements of the crops recommended for growing, especially those regarding their rooting habits and water use. This soil-crop relationship should form the basis of further research aiming at increasing the agricultural production from the crops introduced.
- Sub-stations should be established also in the adjoining ecological zones suitable for rainfed farming. The crop trials and related agronomic research should be extended to these sub-zones too.

CROP ECOLOGICAL ZONES

Considering the physiography, climate and soils, the country has been divided into 17 crop ecological zones which are shown in Figure 2. After describing each zone in terms of physiography, climate, soils and drainage, suggestions are given about the most suitable crops and cropping systems. This information would be useful in zoning of crops for realising the production capability of each area. It would also be useful for planners as well as the agricultural scientists. A summary of the recommendations for each zone is given below:

1. Thatta Zone

It covers the Indus delta with clayey and silty soils. Drainage is a problem but clayey soils can become very productive if drainage is provided. The climate is marine sub-tropical.

With proper drainage, the most suitable crops are; coarse rice, sugarcane, summer pulses *(Phaseolus)*, rapeseed, sorghum (fodder) and berseem. Wheat is moderately suitable. Banana, papaya and guava are the suitable fruits.

2. Hyderabad Zone

It covers the frost-free part of the Indus floodplain. The soils are well drained clayey and loamy. The most suitable crops are, sugarcane, maize, soybean, rapeseed, wheat, lentils, sorghum (fodder), alfalfa, berseem and onion. Cotton has moderate suitability on account of disease problems due to high humidity. Among fruits mango and guava are highly suitable but banana and papaya have moderate suitability.

3. Sukkur Zone

It covers the arid part of the Indus plain, with less than 200 mm rainfall, very hot summer and mild but not frostless winter. On account of significant differences in soil drainage, it has been divided into the following two sub-zones.

Multan-Khairpur Sub-zone

It covers the well drained area with clayey and loamy soils. The most suitable crops are cotton, gram, alfalfa, wheat, sorghum (fodder) and onions. Sugarcane, maize and rapeseed have moderate suitability. Dates are highly suitable but mangoes moderately suitable on account of frost-damage.

Jacobabad-Dadu Sub-zone

Having restricted drainage and mainly clayey soils, it is highly suitable for rice, gram, onions and wheat. Sorghum is suitable for water shortage areas. Sugarcane and rapeseed are moderately suitable.

4. Lyallpur Zone

Covering the semi-arid belt (rainfall 200 to 400 mm) of the Indus plain, it has loamy and clayey, well-drained soils. May and June are very hot but dry, and July and August are hot with high humidity.

The most suitable crops are wheat, maize, soybean, berseem and summer pulses *(Phaseolus)*. Sugarcane and cotton have moderate suitability. Citrus, especially kinnu (a mandrain) is highly suitable but mango and guava are moderately suitable.

5. Gujranwala Zone

Covering the sub-humid part (rainfall 400 to 500 mm) of the Indus plain, it has clayey soils with restricted drainage and loamy soils having good drainage. May and June are hot and dry, but July and August are hot and humid. December January and February are also rainy.

For the seasonally poorly drained clayey soils, the most suitable crops are : fine rice *(basmati)*, wheat and berseem; for the well-drained loamy soils maize, soybean, sunflower, groundnuts, wheat, berseem and millets (fodder) are suitable. Gram has moderate suitability on account of

blight. Rust is a problem for wheat, sugarcane has moderate suitability.

6. Peshawar Zone

Covering the Peshawar valley with mild early summer and cold but rainy winter, it has clayey soils in the central part but loamy on the sloping sides. The central part has high incidence of frost while the sloping sides are nearly frost-free.

For the clayey soils with high incidence of frost the suitable crops are; maize, soybean, summer pulses *(Phaseolus)* sugarbeet, berseem and wheat. Pears and peaches are the suitable fruits. For the loamy soils of the nearly frost-free sloping sides maize, soybean, sugarcane, potatoes, tomatoes, summer pulses *(Phaseolus)* and wheat are suitable. Cotton and gram are moderately suitable. Oranges have high suitability.

7. Thal Zone

It has sandy soils, being an area of sand ridges. Small patches of sandy loam cover a small proportion of the area. The climate is arid to semi-arid sub-tropical (rainfall 150 to 350 mm). It has been sub-divided into two sub-zones: (a) with 300 to 350 mm rainfall and (b) 150 to 300 mm rainfall.

In the sub-zone of higher rainfall, the moderately suitable crop under dry farming is gram groundnut is moderately suitable for patches of sandy loam soil. In the lower rainfall sub-zone, gram has low suitability. However, the best use of the area is grazing. The patches of sandy loam soils may be used for fodder production with irrigation from small tubewells.

8. Dera Ismail Khan-Sibi Zone

It is a long strip of piedmont plain on the West bank of the Indus River. It is an arid area which depends upon the storm water of the streams orginating in the Sulaiman mountain range. Two sub-zones have been recognised. These are:

Kacchi Plain Sub-zone

With canal irrigation the clayey soils are suitable for coarse rice, gram, rapeseed and sorghum. Cotton is moderately suitable.

D. I. Khan – D. G. Khan Sub-zone

On loamy soils under torrent-watered cultivation sorghum, millet, gram, wheat and mustard *(taramira)* give poor to moderate yields. With canal irrigation, cotton,sorghum, wheat, gram and alfalfa are the suitable crops.

9. Gujrat Zone

It covers the Himalayan piedmont plain with a gently, continuous slope and receives 500 to 1,000 mm rainfall (70 percent in summer and 30 percent in winter).

For the clayey soils under canal irrigation, the most suitable crops are fine rice, wheat and berseem. Under rainfed cultivation, the suitable crops are groundnut, wheat, rapeseed and pulses *(Phaseolus)* for loamy soils and millet, wheat and rapeseed for clayey soils. Guava is the suitable fruit.

10. Rawalpindi Zone

It covers the sub-humid part (rainfall 500 to 900 mm) of the Potwar upland which has silty soils formed in loess (wind-deposited silt). Under rainfed cultivation, the suitable crops are groundnuts, summer pulses *(Phaseolus)* and wheat for loamy soils, and millet, pulses and wheat for clayey soils. For areas having 750 to 900 mm rainfall, maize and soybean are also suitable. Wheat must be grown in rotation with self-regenerating medicago. The gullied land part may be put under grasses and trees grass may be cut for feeding livestock.

11. Talagang Zone

It is the semi-arid part of the Potwar upland, with 300 to 500 mm rainfall and mainly loamy soils.

The most suitable land use is cattle production by growing sorghum-alfalfa mixture or other suitable forage crops. Crops having moderate suitability are; wheat, mustard *(taramira)* and groundnuts. Wheat in rotation with self-regenerating medicago would be the proper cropping system for this zone.

Gram would be more suitable than wheat if gram blight is controlled. The gullied land is suitable only for regulated grazing.

12. Murree-Swat Zone

It comprises sub-humid and humid (precipitation 500 to 1,400 mm) highlands — 1,000 to 5,000 metres high, with steep slopes of 40 to 100 percent. Only a small proportion of the area has gentle or moderate slopes. The summer is pleasant but winters are cold.

The suitable crops are maize, soybean and vegetables like potato, tomato, cucurbits etc. Apples and pears have moderate suitability, hailstorms in early summer pose a limitation. The major part is suitable for pine forests.

13. Chitral Zone

It is an arid and semi-arid area of high mountains (more than 3,000 m high) with precipitation of 150 to 500 mm.

The main use of this zone should be grazing on steep and shallow soils. Only the deep soils on lower parts of hill slopes and in gently sloping valleys are suitable for wheat and maize at altitudes of 1,600 to 2,000 metres, and only wheat at 2,000 to 2,600 metres altitude. Wheat may be rotated with some legume. Apples, apricots, mulberry and grapes are also suitable.

The ideal use of this zone is grazing, fruit orchards and fodder production for livestock.

14. Quetta — Loralai Zone

It is a mountain area with large, nearly level valleys, and 200 to 300 mm precipitation. The soils in the valleys are deep, highly calcareous loams. The hill slopes are mostly bare; only the lower part has stony and gravelly soils.

As livestock production and irrigated cropping are the two main uses, these should be properly integrated.

Under irrigation, the suitable crops are potato, tomato and other vegetabes as well as wheat. Apples, plums, peaches, apricots and grapes are very suitable.

Under torrent-watered cultivation, wheat, melons and alfalfa are the suitable crops.

In the area of 300 to 400 mm precipitation, the system of growing wheat in rotation with self-regenerating medicago may be tried.

15. Mekran — Jhalawan Zone

It is a plateau, 500 to 1,500 metres high. About half the area comprises hill ranges with steep slopes, but the remaining half if nearly level or gently sloping. The climate arid sub-tropical with 50 to 300 mm rainfall. The soils in the plains are mainly highly calcareous loams.

As the main land use is grazing, cropping should be integrated with livestock production. Torrent-watered areas should be used for fodder production (sorghum, lucerns and grasses). A part of the irrigated area should also be used for growing alfalfa to be used as fresh fodder and hay.

Under irrigation the suitable crops are sorghum, alfalfa and wheat. Under torrent-watered cultivation, mustard *(Eruca sativa)*, wheat and gram are the suitable crops.

16. Tharparkar Zone

It is an area of sand ridges with 200 to 300 mm rainfall occurring mostly in July and August. In summer a south-westerly sea breeze is an important feature of the climate. The soils are very sandy.

It is mainly a cattle raising area, cropping being a subsidiary land use. So proper management of grazing land by regulated grazing and reseeding of suitable grasses and legumes is the priority need of this area. Under dry-farming, millets and guara are the suitable crops. Improved varieties of these crops are needed.

17. Cholistan Zone

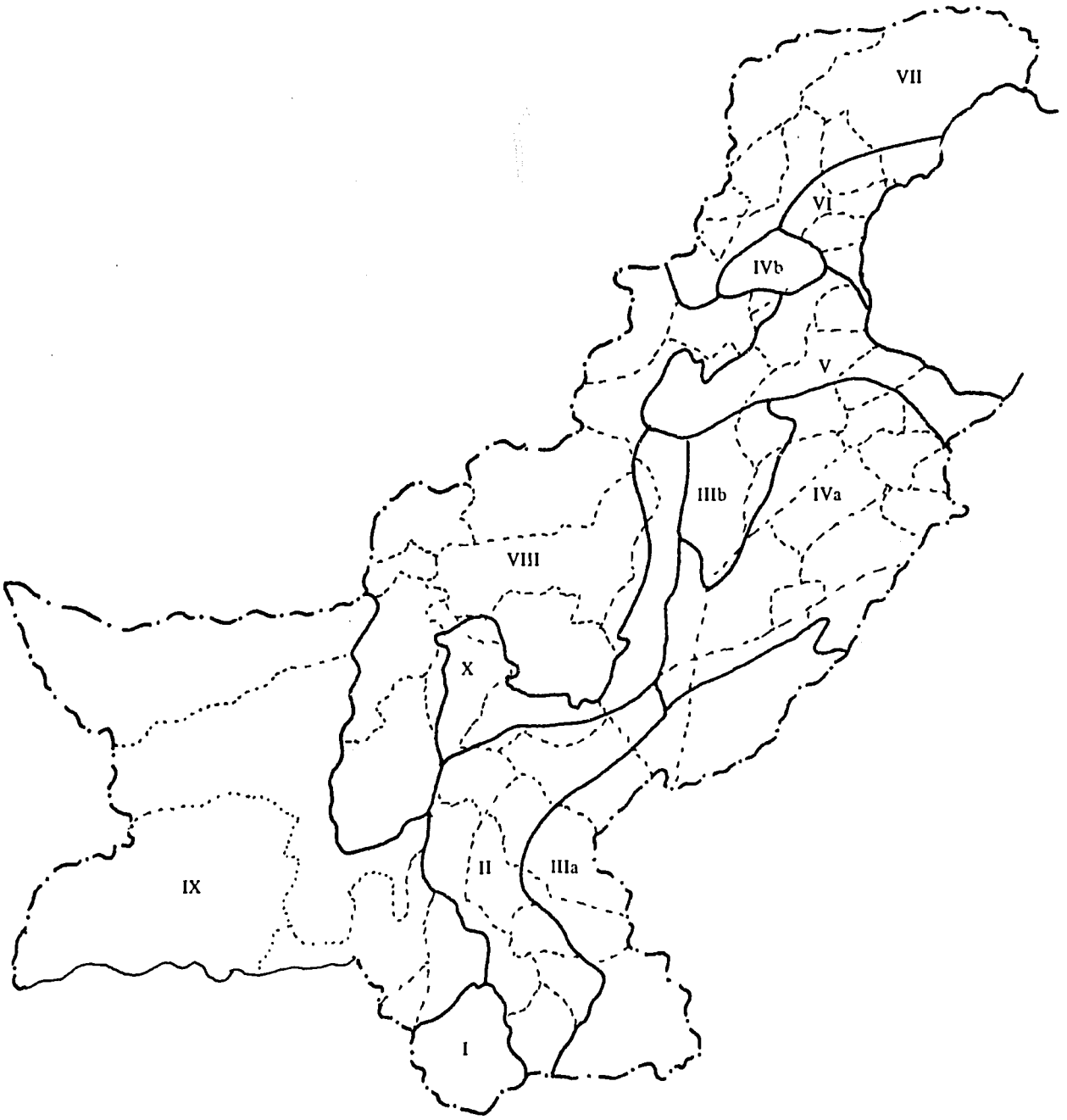
It is an area of sandy ridges, with arid climate. The only land use is seasonal grazing in autumn and winter. The ecological conditions indicate that this area cannot stand grazing for more than two or three months. The livestock production can be increased by production of fodder with canal irrigation in the adjacent area of the Indus plain. The graziers may be allotted irrigated land for this purpose.

REFERENCES

1. FAO. 1976. Crop ecological zones of nine

countries of the near east region. FAO, Rome.

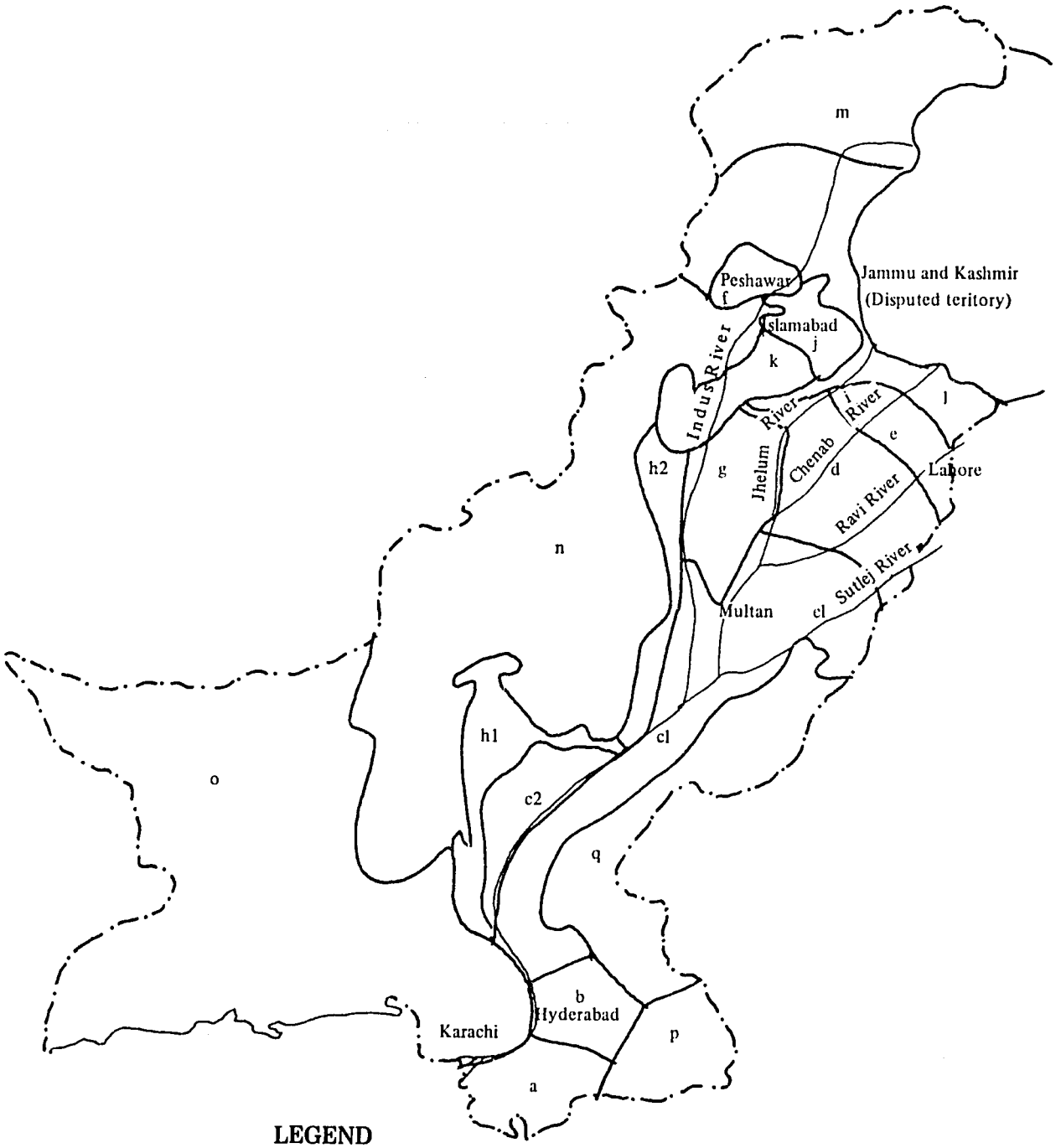
2. PARC. 1980. Agro-ecological regions of Pakistan, PARC, Islamabad.



LEGEND

I	Indus delta	II	Southern irrigated plain	III	Sandy desert (a and b)
IV	Northern irrigated plain (a and b)	V	*Barani* (rainfed) areas	VI	Wet mountains
VII	Northern dry mountains	VIII	Western dry mountains	IX	Dry western plateau
X	Sulaiman piedmont				

Fig. 1. Pakistan agro-ecological zones



LEGEND

ZONES	SUB-ZONES	ZONES
a. Thatta		i. Gujrat
b. Hyderabad		j. Rawalpindi
c. Sukkur	1. Multan-Khairpur	k. Talagang
	2. Jacobabad-Dadu	l. Murree-Swat
d. Lyallpur		m. Chitral
e. Gujranwala		n. Quetta-Loralai
f. Peshawar		o. Mekran-Jhalawan
g. Thal		p. Tharparkar
h. Dera Ismail Khan-Sibi		q. Cholistan
	1. Kachhi plain	
	2. D.I.Khan-D.G.Khan	

Fig. 2. Crop ecological zones

5. A SYSTEMATIC APPROACH TO THE DEVELOPMENT OF SEED SCIENCE AND TECHNOLOGY IN PAKISTAN

IMTIZAJ HUSAIN*

Seed is the key element of agricultural production system. The exploitation of improved varieties through the production and use of quality seed, when combined with complementary inputs such as fertilizers, irrigation and plant protection measures, has the potential for rapidly and substantially increasing crop production. A seed programme capable of providing farmers with good quality seed is essential to a nation's agricultural development.

Seed is not simply a grain planted by a farmer. It is the carrier of genetic potential for higher production. Marketing of good quality seed of improved varieties can trigger change and help in achieving agricultural production objectives. The seed industry covers a broad range of agricultural and business fields in producing high quality seed stocks and delivering them to the ultimate consumer. To produce good quality seed, harvested seed material has to be processed as to eliminate all the unwanted fractions from it.

A major constraint to the full exploitation of the technical break-through in crop production is the inadequate availability of good quality seed to the farmer. This is due to the lack of arrangements for the production of quality seed. However, in the recent years, greater attention is being focused on the multiplication, production and distribution of high quality seed in the country.

HISTORICAL BACKGROUND OF SEED PRODUCTION SYSTEM IN PAKISTAN

The work on seed improvement, multiplication, production and distribution had been in progress since the creation of Pakistan. It has, however, attained gradual refinement with the passage of time.

Uptil 1961, the seed of improved varieties was used to be multiplied and distributed by the Department of Agriculture. The progressive growers used to get its improved variety directly from the breeder and at a number of occasions before the release of the variety. This situation was not obviously congenial to a planned development, hence needed institutionalisation of the system.

On the recommendation of the Food and Agriculture Commission, West Pakistan Agricultural Development Corporation (WPADC) was created in 1961 to look after the development of all the land area comprising Ghulam Mohammad Barrage, Gudu Barrage, Small Dams, Kalabagh and Taunsa Barrages in totality and the seed multiplication, production, distribution and seed testing work formed a major task of this organisation in view of the availability of the requisite infrastructure with the Corporation for performing this function.

The WPADC continued to perform these functions till 1972 when it was dissolved. After its dissolution, its various field functions and the work relating to seed production, multiplication, procurement and distribution was transferred to the Provincial Governments and the Scheme for Seed Certification and Seed Testing was taken over by the Federal Ministry of Food and Agriculture.

In 1973, the Government of Pakistan invited the World Bank to appraise the seed programmes in the country and suggest improvements. As a result of the World Bank's appraisal, a seed industry project was launched in 1976 to produce and make available seeds of improved and adopted varieties of economic crops in the country on scientific lines and help to boost agricultural production.

It was recommended by the World Bank that launching of the seed industry project be preceded with the promulgation of a legislation to control various aspects of seed development. Consequently, Seed Act No. XXIX of 1976 was passed by the National Assembly. This Act envisaged legislative

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provision for controlling and regulating the quality of seeds of crop varieties through setting up the necessary institutional framework for it. As soon as the Seed Act was promulgated, its various components like National Seed Council, Provincial Seed Councils, Provincial Seed Corporations, Seed Certification Agency and a National Seed Registration Agency were established.

PATHWAY OF SEED IMPROVEMENT

A seed improvement programme requires an orderly mechanism for the variety development, its evaluation and release into the seed multiplication and production chain.

The pathway of the seed improvement programme has two main components. Initially, the desirable gene composition in the form of a variety has to be made available through painstaking work of plant breeding. Subsequently, the quality seed of this variety is produced under a scientifically systematised seed multiplication chain passing through various stages of processing requiring a well-knit network of seed technology.

A schematic presentation of the various aspects of cultivar development and release is presented in Figure 1.

The second component dealing with the processing of seed in the processing unit is presented diagramatically in Figure 2.

The different components of the seed production and multiplication chain can work as a well-knit system only after the various agencies concerned with their respective functions take the responsibility of timely accomplishment of their assignments. An effort has been made to identify the agencies in respect of the major activities of the seed production system to help smooth flow of the system as described in Figure 3.

The variety development is being undertaken by the Provincial Agricultural Research Institutes, Agricultural Universities, PARC, PCCC and PAEC in the country. When a variety is developed by the breeder, it is tested by the Variety Evaluation Committee of PARC through coordinated national yield trials for all crops except cotton, (which is the responsibility of PCCC) and also simultaneously by the National Seed Registration Agency for its "distinctness", "uniformity" and "stability" of characters. If a variety successfully completes all these tests, it is then approved by the Provincial Seed Council. The Provincial Council then submit its approved variety along with the necessary data to the National Seed Council for its approval to its inclusion in the seed multiplication programme.

SEED MULTIPLICATION CHAIN

The organisation of a scientifically based seed production system enunciates standardization of all the steps involved in the system originating from the evolution of cultivars and production of their nucleus material to the availability of certified quality seed to the farming community.

PRODUCTION OF PRE-BASIC SEED

Unfortunately, however, it has been noticed with concern that the seed being produced by the breeder at pre-basic stage has failed to attain the prescribed standard. This failure at this initial stage of the seed production system adversely affects the subsequent stages of the seed material and the deterioration in quality is multiplied in serious proportions. The main reason for not achieving the quality in producing pre-basic seed appear to be non-availability of resources with the breeders and their focus of attention to the evolution of new varieties. The principal role of a plant breeder is to produce and test new and improved varieties of crops species rather than the formation of pure stocks. As a result, their concentration is rightly directed to agronomic merits of their creations rather than the attribute that paramount with the seed producers. Thus, with the present organisational set-up, the breeder is neither equipped nor geared to work as seeds-man. This position is obviously of great disadvantage to the establishment of an effective seed industry in the country. The Punjab Seed Corporation (PSC) has, however, made a local arrangement to alleviate this deficiency through making of the necessary arrangement in men and material available for the breeder of a variety within the farming operations of the Corporation. This has helped a great deal in making quality pre-basic seed available to the continual seed generation system of the corporation. The pre-basic seed is further multiplied by the Punjab

Seed Corporation at its own farms to produce basic seed. The basic seed is subsequently multiplied to yield certified seed either within the farms of PSC or with the registered growers of the corporation. A provision of this nature, however, do not exist with the Sind Seed Corporation and, as a result, the seed production chain is not being effectively implemented in that area. The provision of requisite facilities by a seed multiplication agency of the public sector for the production of pre-basic seed is, however not the right answer. For instance, this system is expected to be bogged down with the private sector industry coming to play their part as a competitive business entrepreneur with the public sector. The availability of pre-basic or breeders seed to the private sector agencies is bound to get limited if such a production takes place at the farm of a competitive public sector seed production agency. Therefore, by necessity, production of pre-basic seed has to take place at the level of the breeder and requisite facilities in men and material have to be made available to him so that both public and private sector agencies have equal access to the seed produced by the breeder.

At this stage, an example of the Indian seed industry may be quoted where high quality pre-basic seed is produced in sufficient quantity to meet the entire demand both from the private and the public sector. The three main centres of the seed industry of the northern India, viz., Panthnagar, Ludhiana and Hisar have full-fledged Seed Divisions headed by a Director and attached with the three Universities, i.e., Panthanagar University, Punjab University and Ludhiana University.

Traditionally, the breeder of a variety in Pakistan is also a maintainer of the seed variety. This position should, however, be formalised by notifying the official maintainer, who is the breeder of the said variety as well as the institute responsible for its evolution. In addition to the locally bred varieties, we also have a number of exotic collections and varieties grown commercially in Pakistan. Since the work relating to foreign introductions and maintenance of Germplasm Bank is being handled by the PARC, it would be appropriate to declare the concerned crop commodity coordinator in the PARC as the maintainer of the variety and making the Council responsible for it as an institution. The formalisation of the arrangement will institutionalise the system for a smooth flow of the seed multiplication chain.

SEED QUALITY CONTROL

The pre-basic seed is multiplied by the seed producing agencies on their own farms whereas its subsequent generation classed as 'certified seed' is multiplied by the registered growers who are contracted by the seed producing agencies to do so on their behalf. Irrespective of the class of seed, the quality control is exercised by the Federal Seed Certification Department which has 11 field stations spread over the country as detailed in Figure 4.

In addition to the purity and germination tests that are invariably carried out for all the seed lots, testing the health of the seed also forms an important element of testing. The seed testing conducted by the laboratories is in accordance with the methodology prescribed by the International Seed Testing Association (ISTA) of which, the Department is an accredited member. The main seed testing laboratory of the Department has also been classified by the ISTA as a reference laboratory for seed testing. The monitoring of seed health as a regulatory function of the Department helps in evaluating the status of the seed sample in accordance with the prescribed National Seed Standards and wherever pathogen infection is within the permissible limit, fungicidal dressing of the seed is made compulsory as a condition for certification. The information collected from the seed health tests against seed-borne diseases can be very profitably used by the plant breeders of the agricultural research institutions of the country. For instance, in the process of seed health testing for partial bunt, it has been noted that the occurrence of this infection has started getting momentum recently. It has further been noted that this pathogen is not of consequence in the southern Pakistan upto Rahimyar Khan. The infection starts gaining ground towards north of Rahimyar Khan and it has been found that amongst the recent introductions, varieties like 'WL-711' and 'Sonalika' are apparently susceptible to this disease. Furthermore, recently evolved variety 'Punjab-81' has been found to be badly hit

by the disease. A regular flow of this information to the research institutions can help in manipulating desirable genes for the future varieties.

SEED SCIENCE RESEARCH

The research underway is focused towards the improvement of production of crop species for their present value of utilization viz., food or fibre. The utilization of the crop for seed goes beyond the stage of its normal harvest and, therefore, its growth and development during this period has to be attended to. With the development of seed industry in Pakistan, it has become apparent that research on seed science should receive serious attention so that the production technology is geared towards a profitable enterprise. For instance, a very serious problem in Sind where germination of cottonseed get seriously reduced for its obvious disadvantage to the seed industry has not received the attention of the scientists for the simple reason that this problem neither impedes the quality of lint nor that of oil. On the contrary, lower germination has been seen to increase ginning out turn and, therefore, cotton ginneries seems to be fully contended even if there is a serious loss in the germinability of seed. Additionally, the known problem of brinjal mosaic appears to occur after the normal harvesting time of the crop and is therefore, of no concern to the growers if the crop is raised for table purposes. This disease is, however, of direct concern to the seed producer who has to grow brinjal beyond its harvesting time to raise a seed crop. A number of similar situations need to be identified and corrected through consistent and well-planned research on seed science that has become of importance with the development of seed industry in Pakistan.

MARKETING

Seed production is a highly complex system. As stated earlier, seed industry covers a broad range of biological and commercial fields and unless all the concerned institutions operate effectively and systematically, the chain breaks down with the consequent loss of efforts of a number of institutions who may have put their heart and soul into the work. On the commercial end, marketing forms an important component of the system. The objectives of seed production are not materialised until a sizeable quantity of the produce has been made available to the consumer i.e., the farmer. National agricultural productivity can only be influenced if good quality seed of superior variety is purchased by a large number of farmers.

Efficient seed marketing depends upon the continuous and efficient flow of information like determination of consumers' needs, accumulation of the seed and services, communication of information to and from potential consumers about the seed and services and distribution of seeds to the consumers.

Hitherto the marketing side is not established to the level desired. A number of sale points and their spread is far too inadequate. The marketing organisation has to have a close liaison with the farmers. Seed has to be of high quality of a superior variety, rightly produced and distributed properly. Sales are poor because the communication on the potential buyers is ineffective.

The situation points out to the need for studies to understand it so that an effective institutional arrangement could be formulated for implementation.

SEED ADVISORY SERVICE

In order to have a fairly large clientele of seed consumers, it is imperative to have mechanism which can bridge the gap between the perceived demand of seed and actual demand. This exercise will save time, money, labour and energy.

The Seed Advisory Service will determine the actual demand of seed through forecasting using different methods. It will also organise sales promotional compaigns, distribution efforts and pricing. The proposed advisory service will have a gigantic task to perform to make the farming community seed conscious.

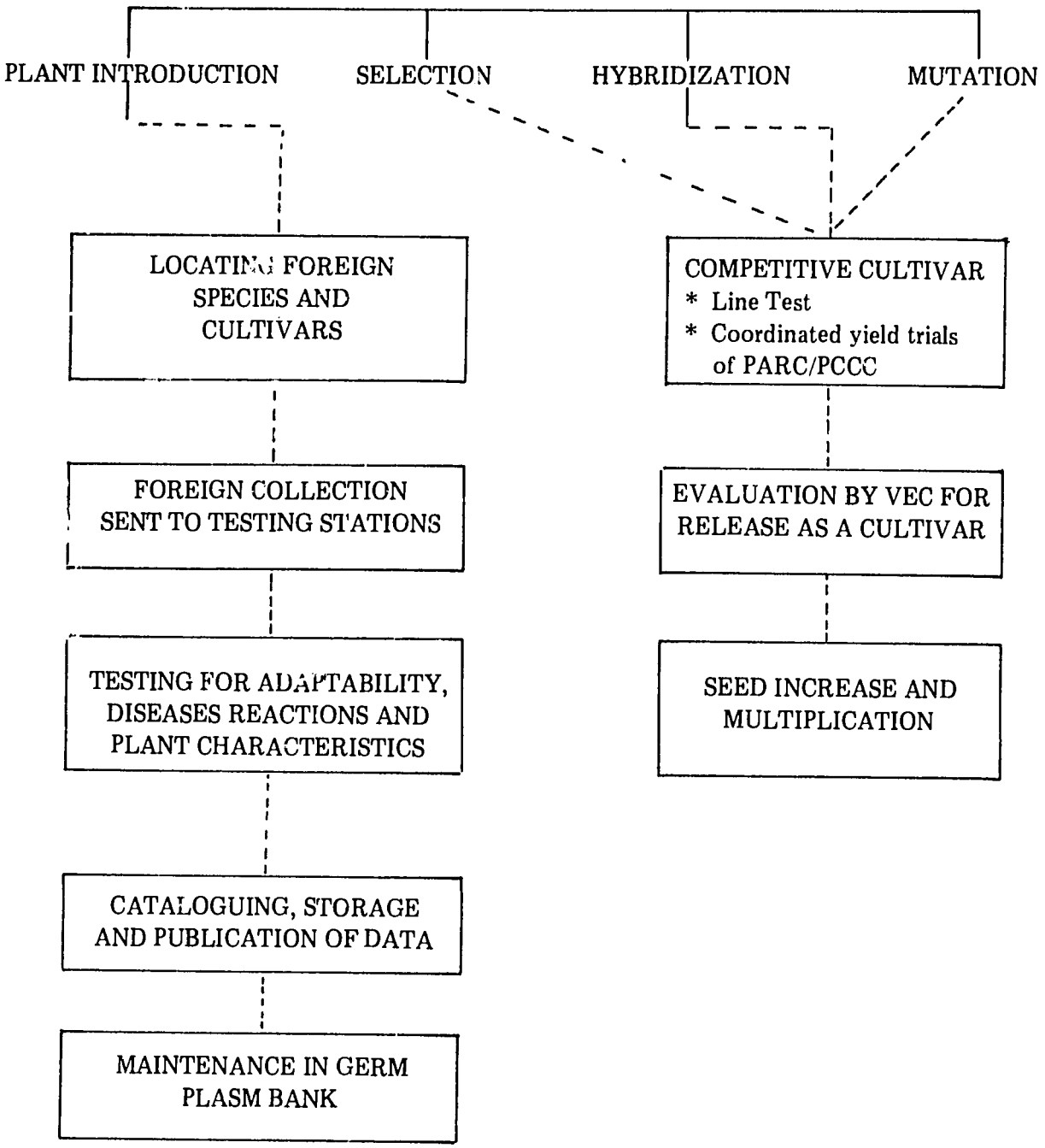

Fig. 1. Cultivar development and release

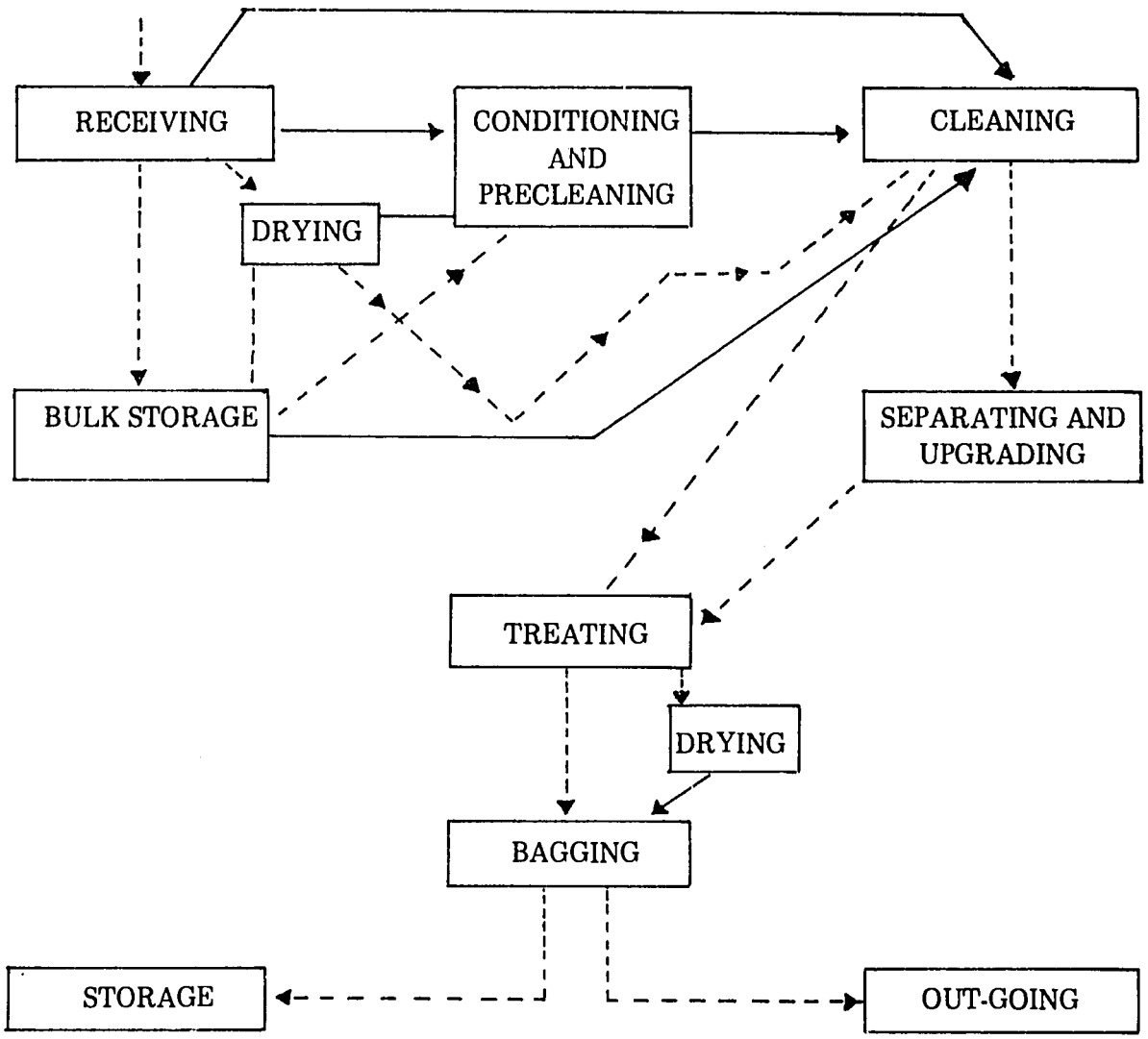

Fig. 2. Basic steps in seed movement through a processing plant

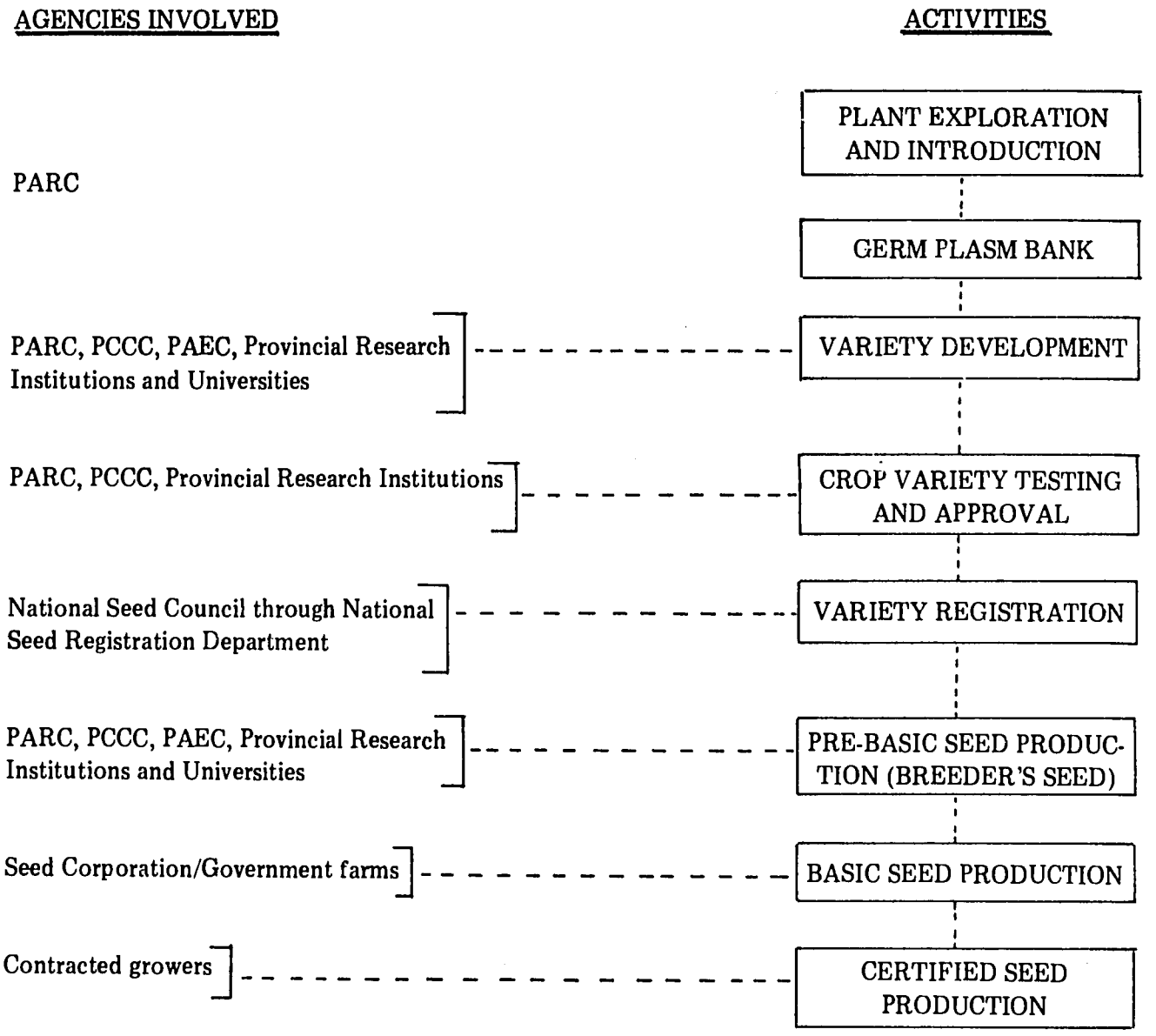

Fig. 3. Agencies responsible for activities essential to development, evaluation and maintenance of improved crop varieties

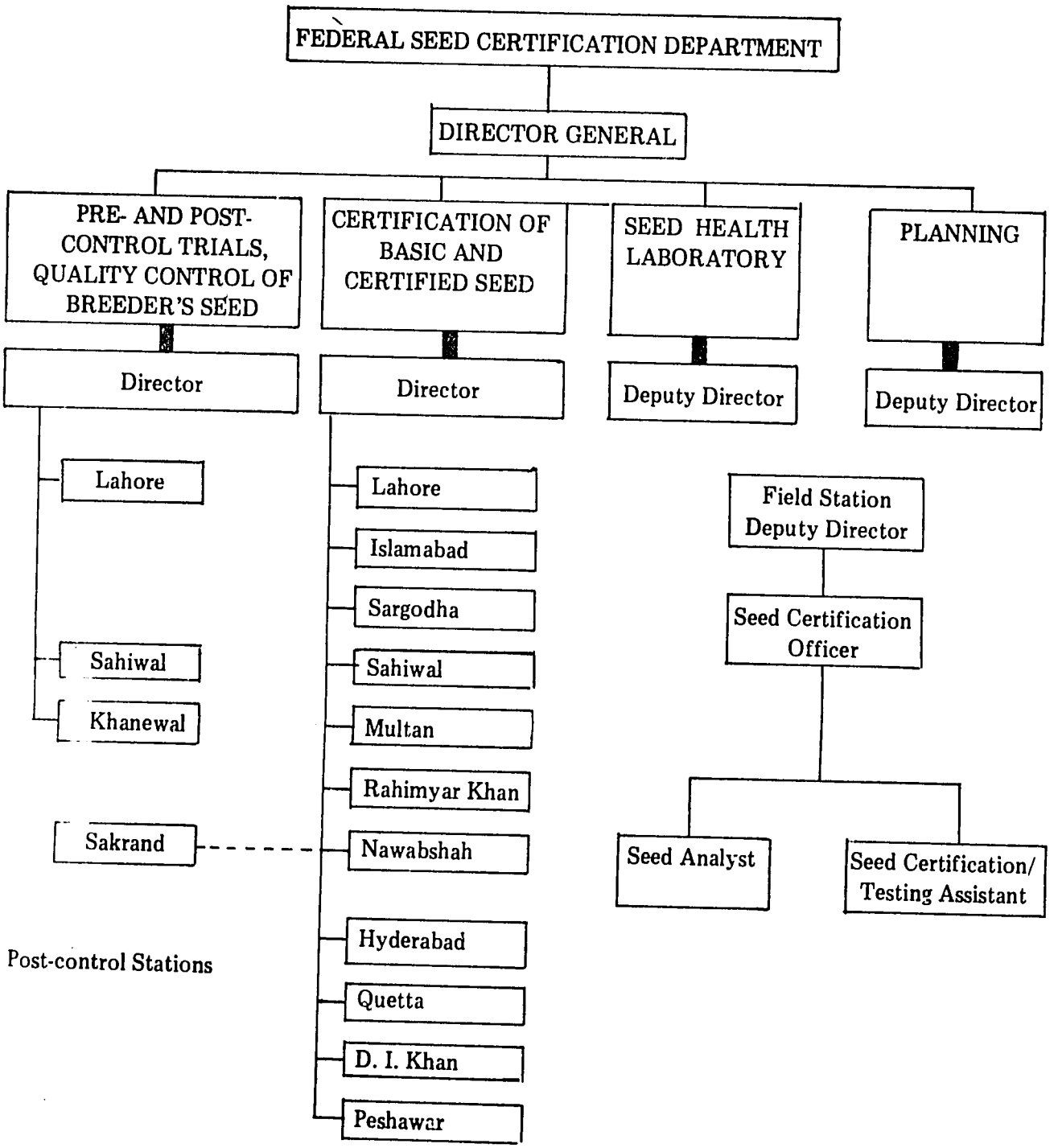

Fig. 4. Organization of the Federal Seed Certification Department (11 field stations)

6. FERTILIZER RESEARCH MANAGEMENT SYSTEM IN PAKISTAN

M. TAHIR SALEEM*

Soil fertility investigations in Pakistan are done primarily at the Provincial research institutes (Tarnab in NWFP, Faisalabad in the Punjab, Tandojam in Sind and Sariab in Baluchistan) and on farmers' fields in all the Provinces. The research at the Provincial research institutes is more basic in nature such as nutrients behaviour in the soil, standardization of methods for assaying status of soil fertility, role of organics in improving soil fertility, etc., while the research trials on farmers' fields have the major objective to develop practical fertilizer recommendations for varying soil and management conditions. Both the approaches are complementary to each other. Specialized research is also carried out at the Atomic Energy Commission's agricultural research centres. The Provincial commodity research stations also include in their programmes fertilizer trials pertaining to the crop under study at the station. Obviously this network of fertilizer research poses problems when perceived as a 'system'.

The 'system' implies inter-dependence between various activities and institutions involved in research and their linkages. The more integrated and well-linked the system, the more efficient and quicker will be the generation of information required for the solution of problems. In view of scarce trained manpower and materials, an in-depth analysis of the system can lead to efficient use of resources. A detailed account of the subject has been given by Saleem et al. (1981). However, some important aspects are briefly dealt with in this paper.

COMPONENTS OF THE SYSTEM

Research Direction

The research direction is set through establishing priorities. Obviously there are always many problems pressing for their solution, but in view of constraints of resources they have to be assigned priorities in the light of national and regional needs. Unless, therefore, the national and regional needs (or priorities) are established and known to both the planners and the scientists, it is difficult to decide the merits of the problem and allocate resources. It is felt that the subject of priorities has been in a state of flux resulting in the lack of research direction.

The research priorities should:

- be based on the gaps identified as a result of critical review of the available up-to-date information;
- reflect national needs and development goals;
- consider the existing socio-economic situation and requirements;
- realistically reflect the material, financial and scientific resources of the country; and
- consider the likelihood and time required for achievements.

Formulation of the Research Plans

The research plans should be based on the established priorities and should clearly define objectives to be achieved within a certain time-limit. The availability of resources and their allocation should also be considered. Conventionally, the plans are discussed biannually in meetings attended by all the concerned specialists. However, these meetings deserve more in-depth and frank discussions in order to refine objectives and to develop the strategy for achieving them.

Monitoring the Implementation of Research Plans

Monitoring provides the necessary feedback on the performance and bottlenecks during the implementation of the research programmes. There

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are no standards set for proper monitoring of the research plans with the result that often the plans are not accomplished on schedule.

Coordination

The lack of coordination leads to duplication of efforts and waste of resources. Coordination among the research activities at various institutions is at two levels: Federal and Provincial. The Pakistan Agricultural Research Council (PARC) is responsible for coordination at the Federal level and the Provincial Agricultural Research Coordination Boards (PARCB) at the Provincial level. The PARCBs are, however, inactive.

Research Environment

A key constraint in the execution of agricultural research in Pakistan is the style and quality of administration. This is in itself a full-fledged subject and a detailed discussion does not come within the purview of this paper.

Evaluation

An evaluation is necessary for the following purposes:

- to justify the expenditure incurred on research and to obtain new allocation;
- to draw valid conclusions;
- to develop future research strategy; and
- to gain useful information for improving the methodology.

There is at present no clearly established system in Pakistan to objectively evaluate the research accomplishments, including fertilizer use.

Training

Fertilizer training of the personnel of various sectors concerned with fertilizer use development in the country is of vital importance for improving crop productivity through the judicious and efficient use of fertilizers. The fertilizer training course has the following objectives:

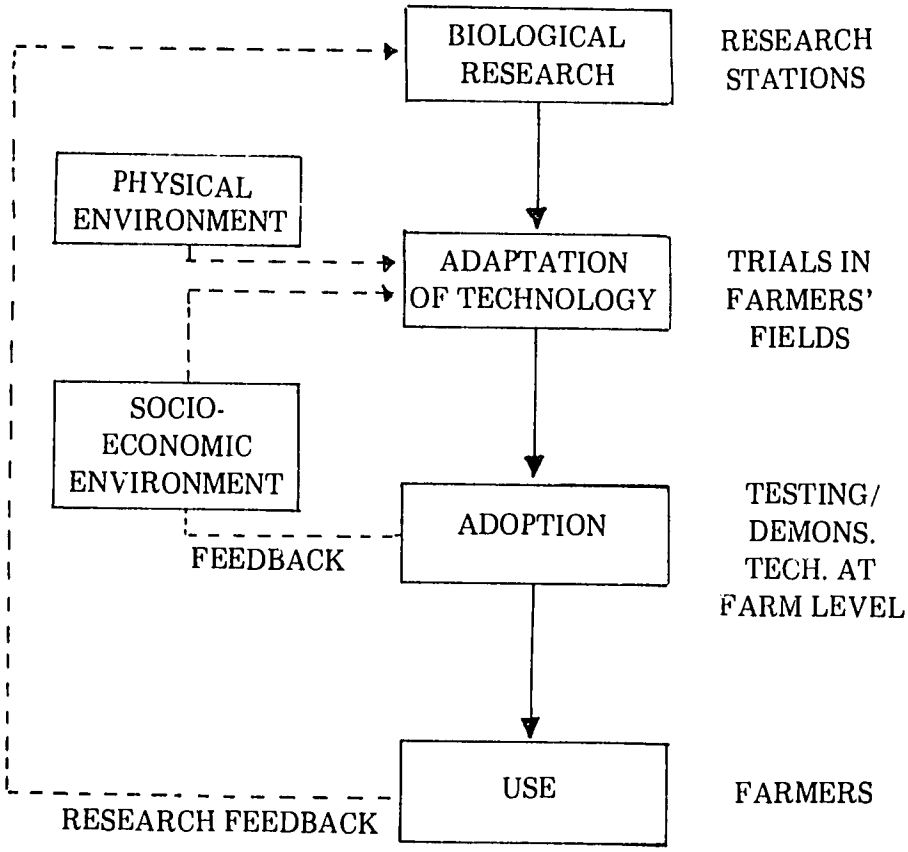
- to provide participants with further knowledge and skills on the efficient use of fertilizers;
- to update knowledge on the various extension techniques to hasten the transfer of fertilizer end-use technology to the farm level;
- to present for discussion and refinement, in the light of local experience, the fertilizer recommendations adjusted to the areas;
- to initiate the development of training materials with respect to fertilizer usage in Pakistan for use by field extension personnel;
- to assess the training needs of and problems faced by the grass-root level field workers and the farming community; and
- to encourage a local follow-up training programme of field staff.

ADOPTION OF TECHNOLOGY AT FARM-LEVEL

The research stations generate technology which is further tested at the farm-level before it reaches the farmers as shown in the figure. Any weak link in this chain is disastrous for sustained increased agricultural productivity. The present over-enthusiasm of the research worker in Pakistan to engage in 'adaptive' and 'operational' research, and his apathy towards basic research which provides rationale to fields results, is, indeed, leading to stagnation and repetitive efforts.

FORMULATION AND RELEASE OF FERTILIZER RECOMMENDATIONS

The subject of fertilizer recommendations has two aspects; the quantity of fertilizer which is location-specific, and the proper agency to extend fertilizer recommendation to the farmer. While the former aspect relates to research (various parameters to be used in tailoring recommendation to a particular site), the latter concerns the methodology– the information-flow from research to the farmer. The recommendations are of little use unless they reach the farmers and they understand



Agricultural technology adoption process

them.

Workshop on fertilizer recommendations was organized by the National Fertilizer Development Centre (NFDC) on May 31—June 1, 1981, in Islamabad. It was attended by 40 participants representing research, extension, mass media, industry and credit. The main objective of the Workshop was to analyse and study the present system for the formulation and dissemination of fertilizer recommendations with a view to suggesting improvements in the system. As a result of the deliberations of the Workshop, the agencies concerned with the formulation of fertilizer recommendations and in the dissemination of fertilizer recommendations were identified. It was recommended to set up special committees at the Provincial and the Federal level. The Provincial Governments have, however, shown little interest.

TASK AHEAD

In his Presidential address entitled Removing Barriers to Crop Productivity at the 1981 annual meeting of the American Society of Agronomy, Olsen (1982) discussed priorities for research which include:

- improved fixation of nitrogen by biological process;
- more efficient use of water and nutrients; and
- yield variability: the factors and interactions which produce maximum yields.

He emphasized that we must work for a long-range understanding of soil fertility in relation to unrealized potential of crops. We must plan thorough study of nutrient cycles and the plant's needs to raise fertility so that soil properties and nutrition are not the factors limiting yield. The Commission on Soil Fertility and Plant Nutrition set up by the International Soil Science Society, (Hera, 1982) recommended research on the efficiency of applied nutrient elements, nutrition of cropping systems rather individual crops and organic recycling. It further recommended that in evaluating nutrition of crops, experiments on cultivators' fields should be preferred and basic information on soil and climate invaribly

collected. This indicates the further thrust of research agreed internationally. FAO (1983) at the Eighth Consultation on the FAO Fertilizer Programme identified biological nitrogen fixation, integrated plant nutrient system, efficiency of plant nutrients, block demonstrations, and interaction of all necessary agronomic factors as the areas requiring attention.

At the national level, however, the priorities identified by Pakistan Agricultural Research Council (PARC, 1983) do not recognize soil fertility as a discipline. Although fertilizer research forms a part of many crops listed for priorities, yet this approach falls short of objectives generally set out in soil fertility investigations. Crop improvement programmes ordinarily always include the fertilizer requirement studies. This, however, cannot substitute complex soil fertility investigations particularly in relation to crop rotations and building up soil fertility status.

Priority areas in soil fertility research are suggested below. These priorities reflect the national fertilizer researchers' views as they were presented (Malik, 1982; Saleem et al., 1979) and discussed at the national workshops.

- Soil test-crop response calibration
- Improving fertilizer recommendations
- Soil testing service
- Increasing efficiency of applied N and P
- Biological nitrogen fixation and improving crop productivity through organic method
- Integrated plant nutrient system
- Long-term field experiments
- Micronutrients
- Soil fertility and plant nutrition in *barani* (rainfed) areas
- Water-plant nutrition management in irrigated areas
- Soil fertility and plant nutrition studies on pulses, oilseeds, vegetables and fruit crops.

REFERENCES

1. FAO, 1983. Recommendations of the Eighth Consultation on the FAO Fertilizer Programme, Colombo, June 28-July 1, 1983.
2. Hera, Ch. 1982. Recommendations of Inter Soil Science Society Commission IV. Soil Fertility and Plant Nutrition. Int. Soc. Soil Sci. Bull. p: 35–36.
3. Malik, D. M. 1982. Future frontlines in soil fertility research. In: Soil Fertility and Fertilizer Use Training Bull. 1: 20-22, National Fertilizer Development Centre, Govt. of Pakistan, Islamabad.
4. Olsen, S. R. 1982. Removing barriers to crop productivity. Agron. J. 74 : 1–4.
5. PARC, 1983. Priorities of research in agriculture. Directorate of Planning and Technical Services, Pakistan Agricultural Research Council, Islamabad.
6. Saleem, M. T. and Bertilsson, G.O B. 1979. Suggested priorities for fertilizer research. National Fertilizer Development Centre, Govt. of Pakistan, Islamabad, Workshop Report p: 169–171.
7. Saleem, M. T.; Bertilsson, G.O.B. and Arnott, G. W. 1981. Management of fertilizer research in Pakistan and suggestions for improvement. Agricultural Administration 8 : 147–158.

7. ENGINEERING ROLE IN AGRICULTURAL RESEARCH IN PAKISTAN

S. IQBAL AHMAD*

The engineering research scientists face the problem of modernising the agricultural production and post-production technologies under severe social, technical and economic contraints. The role of engineers for the development and promotion of manufacturing and use of these technologies with reference to Pakistan are discussed below.

AGRICULTURAL PRODUCTION TECHNOLOGY

There are two major subsectors in agriculture viz., crops and animals.

Crop Production Technology

Engineer scientists have been mainly researching this area in Pakistan. The problems encountered fall into the categories of soil, water input and output management.

The management of soil refers to the manipulation and conservation of soil for healthy plant growth. Soil manipulation includes tillage and levelling. Both of these operations are necessary to ensure proper air and moisture supply to the growing seed and plant. Tillage research under irrigated conditions started a little over five years ago in the Punjab and Sind. The thesis was to study the effect of different tillage techniques on the yield of wheat so that recommendations for proper tillage machinery could be formulated. These experiments concluded disc-harrow to be the best implement for the preparation of seed-bed under irrigated conditions. Due to lack of proliferation of research conclusions and high initial cost, disc-harrow could not be popular tillage implement and in its place cultivator continues to be used by 90 percent of the farmers in Pakistan. FMI is at present conducting tillage research under irrigated and *barani* conditions. The objective is to evaluate and quantify soil characteristics which contribute to increased crop yields. This information can very easily answer the question of suitability of tillage tools and frequency of their use.

Soil conservation means preservation of soil for healthy plant life. The main factors contributing to soil erosion are steep slopes, high rainfall and wind velocities. Potwar plateau regions of Pakistan have all these conditions plus lack of irrigation facilities. Soil conservation research in Pakistan has been focussed on comparative evaluation of different soil and water conservation techniques. The soil conservation techniques studied are terracing, vegetation and afforestation. The water conservation techniques investigated are deep tillage and small dams. The real problem is the reliable long-term hydrological data to predict run-offs. The run-off coupled with land topography determines the conservation structures and the tillage practices. In this regard, FMI is preparing a project to evaluate zero-tillage technique in relation to soil conservation objective. In addition zero-tillage offers considerable savings in energy, labour and time compared to conventional tillage. If FMI project on zero-tillage shows promising results in *barani* areas, the study shall be extended to irrigated areas.

During the last five years, water management programme has expanded to 120 million projects per year. A special cell has been created in the Federal Ministry of Food, Agriculture and Co-operatives to sponsor and coordinate project activities. The Govenments of the Punjab and Sind have initiated water management research under irrigated, and PARC under *barani* conditions. To coordinate and carryout water management research, a sub-station of the International Water Management Institute with headquarters in Sri Lanka, shall be established in near future.

Water management research results have been very well received by the farmers. The standards and specifications for improved watercourses and

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outlets have been formulated and adopted. The farmers using these standards and specifications have saved irrigation water upto 50 percent. A prime requirement of good surface irrigation is precisely levelled land. A variety of implements — tractor operated as well as bullock drawn have been developed for precision land levelling. These implements are now in extension stage.

The proper placement and regulation of inputs, such as seed, fertilizer and pesticides significantly affect the crop yields. The machinery available for the purpose is expensive, and requires precision to manufacture, knowledge and care to operate. The local machines are not only expensive but also lack precision. Research work is underway to develop low-cost efficient and rugged machines for sowing, fertilizer application and spraying. The emphasis is on animal-drawn drill and manually operated fertilizer, broadcaster and sprayer. It is hoped that these machines shall carry price tag, well within the investment range of a common Pakistani farmer.

A good crop is the pride of the farmer. It represents his hard work, investment and is an incentive to continue farming. This warrants that it is to be harvested, threshed and handled with care. By care, it is meant that the losses are minimum and quality is preserved. FMI introduced a harvesting machine in Pakistan two years ago. It has been very popular with the farmers. In 1982-83, nearly 500 units of FMI reapers were manufactured by 15 manufacturers in the country. The performance of FMI reaper has been encouraging since it reduced the harvesting cost per hectare compared to manual from Rs. 400 to Rs. 250 and losses from 15 to 5 percent. In 1983-84, FMI reaper is being further improved and nearly 1,000 units are estimated to be manufactured.

Threshing machines are being produced in Pakistan for the last 20 years. Due to absence of industrial research and development, no improvement could be made. FMI started work on axial flow thresher in 1976 and developed two models. In 1982-83, 25 units of FMI-designed threshers were made by two manufacturers in the country. Although FMI thresher had better performance compared to already made local threshers, but due to high cost it was not very popular. Currently, research work on threshers is underway to improve its cleaning and mechanical efficiency along with cost reduction.

Animal Production Technology

The mechanization of animal production system has been completely overlooked by the engineer scientists in Pakistan, the main reason being that animal production scientists heavily relied on imported equipment and did not feel the need to research on engineering aspects of animal production. The present animal farming practices are inefficient and labour-intensive. Consequently, large animal farm enterprise could not be popular. In an effort to keep the cities clean the Municipal authorities are proposing *Gawala* colonies. This requires careful planning and execution. Only mechanised animal production system is the solution to produce maximum quantity, variety and quality products under tight space, environment and marketing constraints. Engineers have a big role to play in order to mechanize animal production. Farm buildings, forage handling equipment, animal feeding, produce and waste handling equipment need to be researched upon in accordance with the local conditions. This is necessary in order to organize animal farming on business lines and meet the demand of animal products hygienically.

POST-PRODUCTION TECHNOLOGY

The handling, processing and storage of crop-livestock and their products, activities constitute interface between agriculture and food and ensure the availability on year round basis. Unlike the poor man engaged in agriculture, the handling and processing operations are being carried out by affluent class of the country. The equipments and systems used are almost entirely imported.

No special need has been felt so far in undertaking research on handling, processing and storage of agricultural products, the major reason being that the emphasis had been on producing enough to meet the food requirements of the nation. As Pakistan enters into food surplus era, the handling, processing and storage of agricultural products shall gain importance for export reason. The

equipments and systems required cannot be imported continuously for economic, social and technical reasons.

The major area which require immediate research attention is the storage of cereals such as wheat and rice. Pakistan is exporting rice and preparing for wheat. There is not just enough good storage facilities available in the country especially at the farm level. This is the reason responsible for major portion of post-harvest losses. The post-harvest losses of wheat has been estimated to range from 20 to 35 percent. It is, therefore essential to develop design standards and specifications for farm level storage facilities utilizing local materials and skills.

The management of agricultural wastes especially of animal origin is vital from the point of view of energy and hygiene of rural areas. Agriculture has big potential for energy production. Since it is not possible to connect every village of Pakistan to the electric grid, energy from agricultural sources is the only answer. The rural population is already using agricultural sources to meet their energy needs. But they are practising improper methods, resulting in both wastage and pollution of environment. Therefore, it is necessary to research and introduce better agricultural waste management practices.

RESEARCH CONSTRAINTS

The preceding discussion briefly outlines the role of engineers in agricultural research with the sole objective of raising the standard of living of farmers in Pakistan. The majority of Pakistani farmers (74 percent) are small, illiterate and lack mechanical knowledge. Their potential is quite limited. Farm machines often require investments which the small farmers can hardly manage. The economic and technical credibility of a farm machine has to be established before the farmer begins to buy. Such a credibility is jointly established by research scientists and manufacturers.

Due to low investment potential of Pakistani farmers, the farm machinery researchers are under pressure to develop low-cost multi-purpose simple and rugged machines. This is in fact a very difficult proposition. In many cases a multi-disciplinary, approach is essential. For example, a number of improved animal-drawn implements have been developed in the country, but they could not gain popularity with the farmers due to their high power requirements. The majority of the draught animals (oxen) are weak and retire at the age of nine. The solution of the problem is improvements, in both animal-drawn implements and strength/stamina of draught animals. At the National Agricultural Research Centre, a multi-disciplinary research approach has been adopted to look at the problem in its all perspectives.

The economics of farm machinery is very complicated. The major effect of improved farm machines is reflected in better labour productivity rather land productivity. The average Pakistani farmer has not yet learnt to value the time saved as a result of better labour productivity and hence no appreciation for improved farm machines and implements. The situation is not going to stay like this. The young energetic and educated farm labour will continue to move to cities and overseas. The remaining farm labour shall be inadequate to perform farm operations with the help of indigenous farm implements. Therefore, adoption of improved farm machines by Pakistani farmers is inevitable. The question remains, at what rate farm mechanization should proceed. There are varied thoughts. The general consensus is to consider draught animals complimentary to tractors. And steps are to be taken to gradually replace draught animals with mechanical power. The caution is not to effect too much labour displacement and make the farm job interesting and rewarding.

Last of all but not the least, a serious constraint to agricultural engineering research and proliferation is the manpower problem. A large percentage of manpower, being trained locally at great expense, is leaving the country for better employment and educational opportunities. The engineering firms tend not to employ graduate engineers for reason of their practical usefulness. The graduate engineers are inclined towards Government and Semi-Government positions for reasons of job security and less hardwork. At present, there is no significant difference between the financial compensation offered to engineers by the Government and private agencies. The result is that private engineering industry in Pakistan is

without the services of qualified engineers. Pakistan Engineering Council is adopting every possible means to secure employment of graduate engineers by the engineering firms along with upgrading and monitoring the education of graduate engineers. The terms and conditions for employment of engineers are not very favourable either. The advanced educational and training facilities available to engineers in the country are extremely limited. Engineers leaving the country in the pursuit of higher education and training seldom come back and problem of quality manpower shortage remains. Hence there is a strong need to streamline and strengthen the education and training base for engineers in the country.

Due to lack of effective participation by the qualified engineers, the industrial research and development in Pakistan is very minimal. Hence the quality, variety and marketing of products is much below the international standards. The situation is even worse in the case of farm machinery manufacturing. The farmers are not receiving quality machines, warranty cards, operator's manual and after sale service. This is discouraging from user's point of view and is one of the major reason as to why the farmers tend to be contented with their indigenous tools. FMI through its industrial extension activities is pressing upon the farm machinery manufacturers to improve the quality of their products and render after-sale service to the farmers. This is essential to promote farm mechanization in the country.

The engineering research in agriculture, started only five years ago, is progressing well. As the necessary infra-structure develops and the manpower situation improves, the contributions of engineers to agriculture in Pakistan shall be significant.

8. CRITICAL ELEMENTS OF AGRIUCLTURAL RESEARCH IN PAKISTAN

A. WAHID*

The main object of agricultural research is to unearth new knowledge or develop new technology of benefit to the farmers by systematic investigations in a well-planned, closely coordinated and well-integrated manner to substitute knowledge for resources and less expensive and more abundant resources for more expensive or increasingly scarce resources. Its critical elements are discussed briefly in the following lines.**

NEED FOR AGRICULTURAL RESEARCH

1. Exceptionally rapid growth in both economic demand and nutritional requirements for food.
2. More intensive use of land, labour, water, fertilizers, herbicides, pesticides, machinery and equipments, also greater efficiency of resource use output per hectare, per worker and per unit of input.
3. Incentives for higher prices are a burden on development, while those for lower costs are a source of development.
4. Studies made by various scientists reveal a rate of return ranging between 4,000 to 7,000 percent per annum or more.
5. It permits the substitution of knowledge for resources.
6. It facilitates the substitution of less expensive and more abundant resources for more expensive or increasingly scarce resources.
7. It releases the constraints on growth imposed by inelastic resource supplies.
8. It diminishes hunger and ensures economic and political stability.

RESEARCH AND DEVELOPMENT (R&D)

The definition of R&D as a whole, and of three mutually exclusive categories of R&D as internationally agreed upon under the auspices of the Organization for Economic Cooperation and Development (OECD) and set out in the manual of standard practice for surveys of R&D are:

R&D as a Whole

Creative work undertaken on a systematic basis to increase the stock of scientific and technical knowledge and to use this stock of knowledge to devise new practical applications.

Basic Research

Basic research is original investigation undertaken in order to gain new scientific knowledge and understanding. It is not primarily directed towards any specific practical aim or application.

Applied Research

Applied research is also original investigation undertaken to gain new scientific or technical knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental Development

Experimental development is the use of scientific knowledge in order to produce new or substantially improved materials, devices, products, processes, systems or services.

OBJECTIVE OF AGRICULTURAL RESEARCH

Continued agricultural research is necessary for:

- opening the way towards maintaining and improving production resources
- lowering the cost of production

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** *Full text of the article is available with USAID*

- improving quality
- finding newer uses of existing products
- evolving/introducing more profitable species/varieties/strains of plants and animals
- devising new and better methods of growing, processing, distributing and utilizing farm products
- finding ways and means to control weed, insects, pests and diseases of plants and animals
- to reduce wastage in production and to improve transportation, storage and distribution
- anticipating the economic problems involved in farming technology and help farmers to solve them
- anticipating industrial needs and arrange to meet them with adequate and stable supplies of agricultural products.

PLANNING OF RESEARCH

The following procedure is proposed for the formulation of the National Agriculture Research Plan.

1. Policy decisions taken are:
- relative importance to be given to research on food crops, cash crops, oilseed crops, forestry, livestock, and fisheries during the next ten years
- relative weight to be given to basic and applied research

  funds as percentage of the GNP to be allocated for agricultural research

  division of appropriate areas of responsibility between the Federal and the Provincial Government Departments, the universities and other autonomous bodies in carrying out agricultural research programmes
- development of a basis for provincial and Federal cooperation in planning and implementing inter-provincial and international research programmes.

2. Preparation of manual indicating guidelines for the preparation of a National Agricultural Research Plan by PARC and circulation to all concerned.

3. Preparation of tentative research plans in broad outline by each organization (both short-term and long-term) in the light of policy decisions taken by the Federal Provincial Governments.

4. Selection of problem for research in consultation with farmers, extension workers and scientists actively engaged in research keeping in view the work done in the country and elsewhere in the world.

5. Priorities for research to be accorded on the basis of urgency, economic importance, scope and size of problem considering area, people and the units affected, benefit — cost ratio, likelihood of extensive and immediate adoption of research.

6. Submission of tentative research plan by organization to PARC through Agricultural Coordination Boards for critical examination to avoid unnecessary overlapping/wasteful duplication of research efforts and ironing out imperfections if any in consultation with organization concerned.

7. Submission of the modified research plan to the Inter-provincial Coordination Committee for final approval.

8. Undertaking critical review of the implementation of the research plan either annually or biennially and make changes where necessary.

9. Provision of adequate funds to provincial research institutes in the form of additional funds, training facilities, expertise, equipment, scientific information, library and documentation services to strengthen their research capability.

FUNDS FOR AGRICULTURAL RESEARCH

- Contribution of agriculture to GNP (30 percent).
- Contribution of agricultural and agro-based commodities in foreign exchange earnings (80 percent).
- Scope for further development of agriculture (50—200 percent).
- Percentage of population whose welfare is linked with agricultural development directly or indirectly (70 percent).
- Importance of agriculture in maintaining the stability and integrity of the country (next only to defence).

DIVISION OF RESPONSIBILITIES

The functions and the powers of the council under the new Ordinance are reproduced below:

- to undertake, aid, promote and coordinate agricultural research
- to arrange the expeditious utilization of the

research results

- to establish research establishments mainly to fill in the gaps in existing programme of agricultural research
- to arrange the training of high-level scientific manpower in agricultural sciences
- to generate, acquire and disseminate information relating to agriculture
- to establish and maintain a reference and research library
- to establish and promote liaison with foreign as well as international agencies related to agricultural research
- to perform any other functions related to the matters aforesaid.

In discharging its functions, the Council shall be bound by such directives and orders, if any, as may be given to it on any question of policy by the Federal Government which shall be the sole judge as to whether a question is a question of policy.

COORDINATION

The Council should establish a central project cell, whose functions should be to:

*maintain a central record of past projects for the use of research workers and administrators. Information on each project should be somewhat on the following lines:

- title
- justification
- previous work and present outline
- main objectives
- working plans
- personnel engaged in agricultural research and their qualifications
- cooperation with other institutes in the country or abroad

*describe current research programme of the Council, the Federal Government and relate it to that of the Provincial Governments/universities

*maintain a national register of present and future research projects and personnel engaged in agricultural research

*maintain liaison between national and international organizations concerned with agricultural research

*issue a technical bulletin which may, *inter-alia*, contain bibliography on current and projected future research projects information and movement of specialists and on unpublished study material

*ensure close cooperation and exchange of information between research institutes

*answer queries from research workers, advisory committees and public at large

* prepare a catalogue of research institutes engaged in agricultural research and allied subjects

*arrange exchange of research workers and scientific information.

Coordination between agricultural research institutes and agricultural universities can be ensured if:

- senior members of the institutes act as part-time teachers and junior members register with the university for higher degrees
- there is reciprocal membership of institute workers in the various committees/councils of the university and those of senior officers of the university in the Board of Governors and other important committees of the institutes
- there is regular exchange of information
- library and other research facilities are freely available to research workers, teachers and students at the universities and the research institutes on reciprocal basis
- research workers of the institutes established by the PARC are encouraged to spend some years of their service in teaching at an agricultural university while on the pay-roll of the council.

EVALUATION

Critical evaluation of research is necessary to determine :

- whether funds allocated for research are producing economic benefits to justify their use, as compared to other economic activities of the government
- what scientists are doing productive/creative work and deserve accelerated promotion to encourage them and which others whose performance is below standard, should be adjusted elsewhere.
- if there are deficiencies in manpower, equipments, funds and other facilities and how best these could be made up.

9. RESEARCH PLANNING

Ikram-ul-Haq*

Research planning has two distinct phases, namely:

a) establishing the programme which is based on overall national policy and which defines the areas in which research is required, and

b) determining priorities between research projects in accordance with guidelines of the programme.

Research planning is essential if limited means are to be applied as efficiently as possible to the solution of problems considered most important. Planning must be realistic and the resulting programme should be within the limits of the research organization to execute. The institution should have the necessary manpower, infrastructure and facilities to carry out the programme.

Agricultural research must apply itself to solve the problems of the farming community. The programme of research must also be based on the needs of the country as a whole, in accordance with the agricultural policy as formulated at the highest level.

Agricultural research cannot and should not confine itself to the solution of immediate problems that can be achieved in a relatively short time not only it must forecast the problems that may arise as a result of economic or biological developments, but also pioneer new developments and open up new horizons. In other words, it must not only work for future but also have a hand in shaping the future as well. As opposed to short-term planning, long-range research requires stability and continuity. the research worker needs time and peace of mind and, above all, the authorities controlling the purse strings must show understanding of the issues involved and patience for results.

CONTRIBUTION OF RESEARCH TO DEVELOPMENT

Agricultural research has made an important contribution to the well-being of the people of Pakistan. If Pakistan did not have an agricultural research system, the prices at which consumers buy basic foodstuffs would be higher, the incomes of farmers would be lower, the foreign exchange position would be worse, and Government revenue would be lower. Improved wheat varieties have kept the price of wheat down, increased farmers net return and saved precious foreign exchange. Improved cotton varieties have helped in keeping cotton and cotton manufactured products competitive in foreign markets. Increased rice and tobacco production has raised Government revenues through increasing the profits of Government corporations and excise tax revenue, respectively.

The research work (in both the crop and livestock) has had considerable impact on farmers. Local crop breeders played an important role in developing the green revolution wheat varieties and in spreading high yielding rice varieties. They have produced a steady stream of cotton varieties with higher yields and better quality and higher yielding varieties of sugarcane and maize. Recently, there have been important contributions in crop pest control with the reduction of rust in wheat and the introduction of pest surveillance and control systems in cotton and rice. Forestry research has led to the control of certain destructive insects and the introduction of poplar trees which are commercially grown for matches and firewood. Livestock research has had much less impact than crop research. There have been substantial payoff to the research of veterinarians. The incidence of some important diseases has been reduced. Exotic breeds of cattle and village poultry have been introduced with some success. The recent development of an effective system for artificial insemination of buffalo offers the possibility that breeding and progeny testing of buffaloes could have high payoffs.

The provinces which benefited most from past research have clearly been the Punjab and

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Sind. Table 1 shows the percent and area of wheat and rice varieties under new technology by province. This indicates the predominance of Punjab and Sind in these crops. Cotton is the other crop in which substantial progress has been made. This crop is grown only in Sind and the Punjab. There has also been progress in maize, sugarcane and fruit production. The benefits from these crops are more evenly spread throughout the country. Since the Punjab still has a major share of each of these crops and the gains in these crops are probably not as large as in the major crops, it is safe to conclude that the Punjab and then Sind have been the major beneficiaries of crop research. In livestock research, a similar distribution of benefits is probably true. Most of the veterinary research and animal breeding research have been concentrated on improving buffaloes and cattle, rather than sheep and goats which are most important in NWFP and Baluchistan.

Thus there has been a trend in the increase in area and yield of four major crops namely; wheat, rice, cotton and sugarcane in the country over the past five years. Similar trend has been witnessed in maize, barley, tobacco and some minor crops. However, there has been decrease in production of pulses because of the continued failure of chickpea crop over the past three years due to the damage caused by *Aschochyta rabiei*. Research is needed for bringing in new cultivars or breeding blight-resistant varieties for various ecological regions as early as possible to overcome the shortage of pulses. Oilseed is another commodity which needs extensive research because the consumption of oilseeds has been increasing with the improvement in living standards of people, their growing expectations and increase in population without matching increase in production. Besides the conventional crops of rapeseed and mustard which need improvement, new crops such as sunflower, soybean and safflower also need more attention. There is a potential of growing olives in the Northern areas and coconuts in the coastal and adjoining tropical areas. Vegetables and fruits also need attention not only for local consumption but also for exports. Research is neglected in marketing, processing and storage of agricultural commodities. Post-harvest losses also require attention. There is a need for new varieties of crops giving better yields and resistant to pests and diseases not only in major crops but also in oilseeds, pulses, vegetables, fruits another area

Table 1. Provincial population, crop and livestock statistics

	Punjab	Sind	NWFP	Baluchistan
Population 1981 (million)	47	19	11	4
Cultivated area (ha million)	11.5	5.5	2.0	1.4
Wheat HYV area ('000' ha)	4,125	902	486	73
Percent of provinces wheat under HYV	83	88	65	39
Rice HYV area ('000' ha)	317	613	10	25
Percent of provinces rice under HYV	27	82	15	60
Maize total area ('000' ha)	326	24	348	3
Cotton total area ('000' ha)	1,481	598	4	—
Sugarcane ('000' ha)	544	119	93	—
1976 ('000' head)				
Cattle	8,108	2,854	3,000	684
Buffaloes	7,979	1,834	752	33
Sheep	8,037	1,829	3,675	5,057
Goats	7,767	4,237	4,686	4,441

HYV: High Yielding Variety
Source: Government of Pakistan, Agricultural Statistics of Pakistan, 1980, Islamabad, 1981.

which has remained neglected. The twin-menace of water-logging and salinity is still to be tackled. Breeding, feeding, management and marketing of livestock is another neglected area. Reducing calving interval and dry period, early maturing and faster growth rate in cattle, especially in buffaloes, need attention. The technique of artificial insemination in cattle is to be popularised. Improvement in goat and sheep is badly needed. There are problems of periodic gluts and shortages, high cost of feed and diseases in poultry industry which has grown on modern lines mainly with the private effort. Inland and marine fisheries need more attention. There is a whole area of range and watershed management, development of nursery techniques afforestation of dry zone areas, genetic improvement of local tree species, determination of suitability of exotic species under local conditions mechanization in forestry operations, control of insects and fungal diseases etc., need continued attention in research and development. Farm mechanization is coming up rapidly. There were 157,000 tractors in the country during 1981-82. Import of tractors has been indiscriminate and little attention has been given to the manufacture of implements needed for better tillage, sowing and harvesting of crops. Two institutes in farm mechanization research at NARC and Multan are not sufficient to tackle vast problems in this nascent field.

Thus research needs lot of attention in varied areas in crops, animal fish, poultry, soil and water, farm mechanization, forestry, range and watershed management, *barani* (rain-fed) agriculture and the whole field of social sciences: marketing, storage and processing of agricultural products, cropping patterns and intensities problems of small farmers, prices of inputs and farm products, credit, education and health, socio-economic patterns in rural areas also need attention.

SIXTH PLAN

The Sixth Five-year Plan (1983-88) has started from the financial year 1983-84. It provides for a growth rate of 4.9 percent in agriculture during the Plan period. The Plan has listed the following broad objectives for the growth of agriculture sector:

* move beyond self-sufficiency to export of agricultural commodities, i.e., while maintaining self-sufficiency in wheat and other cereals, to move towards elimination of deficits in milk, pulses, and edible oils and to create exportable surpluses specially in high value commodities, such as, fruits, vegetables, poultry, eggs and meat
* have more diversified cropping system with more emphasis on high value crops
* change agricultural production environment from subsistance to commercial farming;
* provide increased employment opportunities and improve well-being of the rural population
* exploit effectively wood production potential of the forest lands, particularly commercial forests and fish production potential of the inland waters national coastal water and the Exclusive Economic Zone (EEZ) of the sea adjoining our coast.

It is hoped that these areas will be given due attention during the Sixth Plan period.

INSTITUTIONAL STRUCTURE

Ever since 1920, agriculture has been a subject which is constitutionally assigned to the Provincial Governments. Thus, agricultural research, education and extension were carried out almost exclusively by the Provincial Governments. In the mid-1920s the Government of British India realized the need for some central body, that would at least make sure that there was communication and coordination of the provincial scientific research. The Indian Council of Agricultural Research (ICAR) was thus established in 1929. After Independence, Pakistan established a Food and Agriculture Council, but this had little power and almost no funds. The Agricultural Research Council (ARC) was formed in mid-1970s. In 1978, the Agricultural Research Council was reconstituted as an autonomous body at Federal level and renamed as Pakistan Agricultural Research Council (PARC) The PARC was given a mandate to work in close coordination with the Ministry of Food and Agriculture, the Provincial Agricultural Departments, agricultural research institutes and agricultural universities. On the basis of a report by the joint World Bank, USAID and CIDA mission, the

Government reconstituted the PARC with a Board of Governors as the policy-making body of the Council and functions redefined as to undertake, aid, promote and coordinate agricultural research, arrange the expeditious utilization of research results, establish research institutions, arrange training of scientific manpower, maintain reference and research library and generate, acquire and disseminate information relating to agriculture.

Pakistan Agricultural Research Council now has the authority to conduct, promote and coordinate agricultural research. It has several research institutions under it, including the National Agricultural Research Centre (NARC), Islamabad, the Arid Zone Research Institute (AZRI), Quetta, the Cereal Diseases Research Institute (CDRI), Murree, the Pesticides Laboratories and the Vetebrate Pest Control Laboratory (VPCL) at Karachi. It still does not include all Federal institutions that do agricultural research. The cotton, tobacco, forestry research institutions the nuclear institutes for agriculture, the land reclamation and water management research which is conducted by the Water and Power Development Authority (WAPDA) and Soil Survey Department are not included in the PARC.

The provincial research institutions remain very strong and independent. Most research is carried out by provincial research institutes. The universities do only a limited amount of research as their time is spent on teaching and students problems. Strong provincial research can have both positive and negative impact on the efficiency of research system. It can help make the research system more responsive to local needs, if there is a system through which farmers can articulate their needs. The negative side is well expressed in the Periera report and applies to the agricultural research system as a whole. It says:

> 'Inter-provincial restrictions act as constraint on agricultural progress and severely reduce the academic opportunities of each of the agricultural universities since they effectively restrict recruitment of staff to those trained in the same province. This is a formula which perpetuates weaknesses as well as strengthens and lends to a somewhat static and complacent outlook.'

The PARC has 40-member Governing Board comprising officials and non-officials, including farmers. The Federal Minister for Food, Agriculture and Cooperatives is the President of the PARC. The Board of Governors has the overall control, direction and suprintendence over the affairs of the Council. There are four technical Members responsible for the management of research in (a) Animal Sciences, including fisheries, (b) Natural Resources, including land and water use, forestry, wildlife and range management. The financial management is looked after by the Member (Finance) who represents the Finance Division of the Council. Besides the Members, the Chairman is assisted by the Secretary, the Director Administration, Chief Planning, Director Training, Director International Liaison and Technical Assistance and Director Information Sciences. These Directorates/Units provide support services not only to the Chairman but also to the Technical Divisions.

CAREPLANS

The PARC has introduced a new system of research planning called the Coordinated Agricultural Research Planning System of Pakistan (CAREPLANS). This system involves the doers of research and users of research results in the planning process. The various steps involved in this system are:

- identification of problems
- according of priorities
- formulation of projects
- evaluation of research projects
- approval of research projects
- assigning of research projects to various institutions
- implementation of research projects
- accomplishment reporting
- accomplishment evaluation.

The CAREPLANS is still at the evolutionary stage. The set of research priorities determined under this system have been used in determining the researchable areas and formulation of projects to solve the problems of farmers. However, the establishment of two important committees, i.e., the Status Review Committees and Technical Planning Committees in the Technical Division is

required to implement the CAREPLANS.

The PARC will be able to carry out effective planning only if it devotes more of its own resources to this task. Increasing the resources and staff of its planning unit will be a step in the right direction. Strengthening the analytical ability of this unit would allow long-term planning and would permit the use of the CAREPLANS procedures. It would also provide the Chairman of the PARC with support that is necessary in his discussions with the Provincial and the Federal Government in seeking cooperation and mustering resources for research.

NATIONAL COORDINATED PROGRAMME

The PARC is financing and executing a number of national coordinating research programmes (NCPs) on selected commodities or problems of national importance which are limiting crop production, animal production and rational utilization of natural resources, or identifying the socio-economic problems related to agriculture. Each coordinated programme consists of a number of research projects, whose objectives directly support the coordinated programme. At present, the following coordinated research programmes are being implemented:

- Wheat, Barley, Triticale
- Sugar Crops
- Oilseeds
- Maize, Sorghum and Millet
- Fodder and Forage
- Improvement in Water Management Control System
- Improvement in Soil and Water Conservation Practices
- Vegetables
- Fruits
- Plant Introduction
- Rice
- Pulses
- Saline Agriculture
- Soil Fertility and Fertilizer Use
- Livestock Feed Resources and Nutrition
- Barani (Rain-fed) Agricultural Research and Development Project
- Productivity, Improvement and Marketing of Potato
- Pest Management
- Consumptive Use of Water
- Honeybee Management

The national coordinated research programmes are important channels for centre-provincial cooperation, collaboration, partnership and complementarity. Their development and execution has and will continue to have major influence in the quality, cordiality and effectiveness of Central/Provincial relations.

National coordinated research programme became popular in developing countries that were struggling to obtain a breakthrough in stagnant agriculture and to overcome staggering food shortages through development and use of appropriate technology to make agriculture more productive and efficient. The concept aims at using available scarce resources, finances and technical manpower to develop viable improved technologies in a selected commodity or area of national concern by using inter-disciplinary teams of scientists located in different agro-climatic and soil conditions, but working together for common goals. A NCP is really a high priority programme to pool and efficiently use the scarce resources of scientific manpower, facilities, and financial inputs and diffuse usable improved technology (suited to local environment) that will cause a marked increase in productivity. In many cases, the new technology will allow producers to move from subsistence to market-oriented agriculture.

The technologies developed by NCPs should be subjected to thorough on-farm testing and evaluation under farmers' conditions to ensure their transferability potential and limitations. For this purpose, research workers have to work closely with extension personnel and both researchers and extentionists must be involved in the intensive on-farm tests. These tests also form the first line of demonstration and facilitate the training of extension workers.

The PARC has arranged the evaluation of a few National Coordinated Programmes to see their strengths and weaknesses and suggest improvements. A team of international scientists from ISNAR has toured the country, visited the research institutes, stations, and universities and interviewed the researchers, Coordinators and Directors of institutes. The report has been received and is being considered.

FEDERAL INSTITUTIONS OTHER THAN PARC

There are a number of Federal research organizations and institutes other than PARC which are involved in agriculture research and development. These are:

* Pakistan Central Cotton Committee with cotton research institutes at Multan and Sakrand, 13 stations, sub-stations and testing centres and an industrial research institute at Karachi.
* Pakistan Tobacco Board with two research stations in Punjab and two in NWFP.
* Pakistan Atomic Energy Commission: three Nuclear Institutes of Agriculture and Biology at Faisalabad (Punjab), Tandojam (Sind) and Peshawar (NWFP).
* Water and Power Development Authority (WAPDA): overall management of Indus Basin Water Resources water-logging and salinity, the Water Quality and Soil Monitoring Directorate at Lahore and Mona Reclamation Experiment Project.
* Pakistan Forest Institute, Peshawar.
* Soil Survey Department, Government of Pakistan.
* Department of Plant Protection, Karachi
* Centre of Excellence in Water Resources Engineering, Lahore.
* Centre of Excellence, Marine Biology, University of Karachi.
* Commonwealth Institute of Biological Control, Rawalpindi.
* Council for Irrigation, Drainage and Flood Control.
* Leather Board.
* Zoological Survey Department, Karachi.
* Directorate of Marine Fisheries Karachi.

All these Federal Institutes are supervised by various Ministeries/Divisions and their research programmes and projects are not coordinated by the Agricultural Research Division. The PARC supports considerable research in most of these institutions through cooperative/coordinated research programmes and individual research projects. However, the annual work plans and research programmes are not dovetailed in the total research system of the country and efforts made by these are isolated, not known to one another nor coordinated by a research agency at the Federal level.

PROVINCIAL AGRICULTURAL RESEARCH INSTITUTIONS

Each province has a major agricultural research institute on crops with sub-stations and centres. There are a number of commodity-oriented institutions which are part of the main provincial institute. Punjab, Sind and NWFP have agricultural universities which are also involved in limited agricultural research programmes. Research on crops is mainly looked after by the Provincial Agriculture Department whereas research on livestock, poultry and fisheries is looked after by the Provincial Department of Livestock, Fisheries, Poultry and Dairy Development. Some research on forestry is carried out by the Provincial Forestry Department. Research on land and water use is carried out by the Provincial Departments of agriculture, irrigation and universities.

To coordinate research at Provincial level, Provincal Research Coordination Boards have been established in all the four provinces. But coordination and linkages between agricultural universities, colleges and research institutes is far from satisfactory. Effective linkages between the PARC/ Agricultural Research Division and Provincial research institutes and universities also need to be established.

PRIORITIES OF RESEARCH

The PARC has gone through a priority setting exercise in agriculture research. A set of priorities of research in different commodities/disciplines was prepared in consultation with the provincial research scientists and extension workers. The set of priorities thus formulated was circulated to various Federal and Provincial agencies involved in agricultural research, production and planning and to the farmers through the provincial extension departments. The revised set of priorities in different commodities and disciplines can form a basis for development of useful research projects in areas of vital interest. This can also help in picking up topics for long range research that may play a vital role in country's development.

TECHNICAL COMMITTEES

For coordination of research, the PARC has appointed technical committees in the following disciplines:

- Crops
- Plant Protection
- Agricultural Economics
- Animal Health and Production
- Fisheries
- Range Management and Forestry
- Land and Water Resources

The technical committees meet twice a year to review the ongoing research projects, make recommendations on the new research proposals formulated by the other Federal and Provincial research institutions and suggest priorities interse projects. The recommendations of the technical committees are considered by the Executive Committee and the Board of Governors of the PARC. The Members and Directors of the PARC also provide guidance and advice in management of research projects. They also frequently visit the institutions in which projects are implemented and offer on-the-spot advice.

RESEARCH PROJECTS

During the year 1982-83, the PARC executed/ funded the following projects.

Source of fund	No. of projects	Allocation (in million Rs.)
Development	14	127.800
PL-480 research grants	87	15.000
Non-development research grants	65	14.986

These projects are being executed in 33 institutions and 6 universities. Thus, the PARC provides funds to the tune of Rs. 50.000 million annually to other Federal and Provincial research institutions and universities for small research projects/programmes to strengthen their research capabilities.

The contribution of agricultural economics research in the development of improved technology and farming systems is very small. The PARC has, therefore, decided to set up one Agricultural Economics Research Unit each at NARC, AARI, Faisalabad, ARI, Tandojam, ARI, Sariab (Quetta) and ARI, Tarnab (Peshawar). The Agricultural Economics Research Units would do on-farm testing of new agricultural technology, identification and measurement of the impact of biological and socio-economic factors restricting crop yields on farmers fields, economics of farm inputs and farm management studies. These units would also assist the scientists in designing experiments and statistical analysis and economic interpretation of experimental data.

LINKAGES

Linkages between research extension and education in Pakistan are very weak. It was not so before 1961 when the Agricultural College and research institute were combined into one and directly placed under the Provincial Agriculture Department. There was free movement of staff between teaching, research and extension and Lyallpur (now Faisalabad) District formed the immediate extension area for the former Agricultural College and Research Institute, Lyallpur. Similar arrangement existed in Sind. However, this critical linkage was broken when the University of Agriculture was established at Faisalabad in 1961. The University was further divorced from agriculture extension as it was placed under the administrative control of the Provincial Education Department. The other two universities set up later in Sind (1977) and NWFP (1981) have similar arrangements. Recently, an effort was made to correct the situation in the Punjab by placing the Agricultural University under the provincial Agriculture Department and by setting up of an Agricultural Research Coordination Board with the Vice-Chancellor of the University as its Chairman. However, the situation still needs improvement.

The universities require access to the research facilities and information at the research institutes for better teaching and for expansion of graduate training opportunities as well as access to the research staff to enhance the breadth of subject-matter specialization. The research institutes need to be able to collaborate with the disciplines and specialities within the universities not represented

in the research institutes. For many universities, a critical mass of faculty members necessary for offering graduate programmes cannot be achieved without joining forces with the research institutes. The growing number of complex research problem areas will require the combined staff breadth of the institutes and universities to successfully cover the problem. Meeting the future manpower needs of trained research agriculturalists is dependent upon strong agricultural universities. Until critical masses of highly qualified staff are avaialbe at the universities, close linkage and coordination between research institutes and universities is needed.

Research/extension linkages are also weak. Researchers do not have close contact with the farmer. They do not have means of mobility. Good research/extension linkages are essential for a smooth flow of information.

Linkages with international institutions such as CIMMYT, IRRI, ICRISAT, CIP and ICARDA are especially important for the exchange of research information, for seed stocks and for training and development of manpower. Genetic material from CIMMYT, IRRI, ICRISAT, CIP and ICARDA are in use at NARC and the provincial research stations. The Cotton Research Institute at Multan is receiving genetic material from FAO. The system of uniform testing of international nurseries is appreciated by the provincial research staff.

The linkages with agro-industry vary a great deal depending on the commodity. Such linkages do exist in cotton and tobacco. These linkages have also helped in pushing research work, providing financial support to research institutions for specific projects and bringing in new genetic material and spreading new technology. Pakistan Tobacco Company (PTC) has provided material for cigarette tobacco. The chemical and fertilizer companies have played an important role in the spread of new varieties of tobacco. The PARC is seeking guidance of the carpet industry regarding the type of wool that it needs. The design of a PTO multi-crop thresher was released to manufacturers by the Farm Machinery Institute of PARC and technical assistance was provided for its fabrication. The Poultry Research Institute in Karachi provides vaccines to the commercial poultry sector. It could play a vital role in judging the productivity of poultry seed stock which is imported in Pakistan. There are, therefore, a number of opportunities for the public sector research institutions to strengthen themselves through close linkage with agro-industry.

RELATIONSHIP BETWEEN PARC, NARC AND PROVINCIAL RESEARCH INSTITUTIONS AND UNIVERSITIES

At present, there is a large number of research institutes, stations, sub-stations, centres and laboratories engaged in agricultural research in the country. These institutes are financed from different sources. They develop their research programmes independently. This creates islands of research cut off from almost every kind of cooperative effort. Coordination at the national level between provinces and the international organizations has to be provided by the PARC. To this effect the Council should set up a Central Project Cell headed by a senior scientist. The functions of this Cell should be to:

i) maintain record of past and present projects for the use of research workers and administrators. Information on each project would be available by title commodity, and research problem area classification, previous work and present outlook, main objectives and methodology, funds expended, personnel engaged and their qualifications, the performing institution, etc.

ii) describe current research programme of the PARC and relate it to that of the other Federal and Provincial institutions and universities

iii) maintain liaison between national and international organizations concerned with agricultural research

iv) maintain a national register of present and future research projects and personnel engaged in agricultural research

v) issue a technical bulletin which may, *inter alia* contain bibliography on current and projected future research projects, information on movements of specialists and on unpublished study materials

vi) ensure close cooperation and exchange

of information between research institutes and universities

vii) answer queries from research workers, advisory committees and public at large

viii) prepare a catalogue of research institutes engaged in agricultural research and allied subjects

ix) arrange exchange of research workers and scientific information.

There is a need for establishing a better linkage between the agricultural universities and colleges and the PARC for research planning and coordination and offering aid to colleges and universities for research programmes. Already the University Grants Commission has accepted the PARC as technical adviser for funding of agriculture research in universities. The relationship should be strengthened and streamlined for better linkages between the agricultural universities, research institutes and the Indian Council of Agricultural Research may be considered for adoption. The first step could be the merger of the agricultural universities and research institutes in the provinces which may be placed under the administrative department of agriculture. The PARC could then coordinate at the national level for providing leadership in development of curriculum, determination of standards and monitoring and evaluation of research. Funding of research in unified provincial institution could also be one of the activities of the PARC. This innovation is necessary to unify the national research system as a well-knit organization to derive the maximum benefits from the meagre resources allocated to agriculture research.

The ECNEC in its meeting held on February 23, 1982, took the following decision:

> "The Agricultural Research Division should spell out the annual work plan for each Federal and Provincial agency engaged in agricultural research, carry out an annual review of the working of each major research organization and submit an annual report to the committee."

To implement this decision, all development schemes on agricultural research formulated by Federal and Provincial institutes/departments and agricultural universities must be submitted to the Planning and Finance Divisions through the Agricultural Research Division (ARD). A committee comprising members from the Federal and Provincial Governments may be set up in the ARD to coordinate and oversee this work.

Necessary support service to this committee and the ARD may be provided by the Planning Unit of the PARC. For this purpose, the Planning Unit may be provided with additional staff and facilities for collection of information, data and reports on prescribed formats, their compilation and analysis and convening meetings of the committees and experts. If necessary, experts not connected with institutions/departments may be engaged on payment of suitable fees for evaluation of reports and assisting in the review.

DEVELOPMENT OF SCIENTIFIC MANPOWER

One of the main constraints, hindering agricultural research and development, is an acute shortage of scientific manpower comprising scientists of high calibre and proven capability to provide research leadership for formulation and implementation of goal-oriented research programmes as well as for testing and modification of research findings to suit large-scale farm application. The available number of trained manpower does not commensurate even with the minimum requirements of the country, keeping in view the large acreage grown under a wide range of diversified field crops, vegetables and fruit trees. Half-hearted efforts have been underway in the past for providing post-graduate education both in the country and abroad but it did not meet the situation because a small number of persons were trained and many out of them were launched a substantive programme of training scientific manpower under various loan agreements with the USAID and the World Bank. This will help, to some extent, in bridging sector-wise and subject-wise gaps in various disciplines within PARC, NARC, the Provincial research institutes and the universities.

Although the proposed higher education and training programme will certainly help in improving the existing situation, it cannot meet the entire requirements of the country because of involvement of a large number of disciplines and research institutes. The following suggestions are given to improve and strengthen the training of scientific

manpower at various levels for accelerating research and agricultural productivity. These suggestions can apply to all the agricultural disciplines

i) to begin with, inventories of qualified scientists, available in different disciplines throughout the country, should be prepared with full information on name, age, qualifications, experience, any outstanding work done, the present type of work being carried out, training and working constraints, suitability for the job, aptitude for research and relations with colleagues, etc. This will help in determining the availability of trained scientific manpower at various levels (professional and technical), training requirements (including higher education, short-term training) as well as in determining the type of courses and the suitable places for higher education/within the country or abroad

ii) the future ten years need of higher education/training sector-wise of new graduates should be determined by taking the following steps:

- selection of the research-minded under-graduate students particularly from under-developed and rural areas on attractive terms, at the agricultural and other universities for guiding them to pursue post-graduate studies in the subjects of their choice at the respective universities leading to M.Sc. and/or Ph.D. degrees. Such selected students should be encouraged through the provision of post-graduate scholarships/stipends or interest-free loans
- selection of young, energetic and enthusiastic research workers at the research institutes and encourage them to pursue post-graduate studies at their institutes, which should be affiliated to the neighbouring universities. Such selected research workers should continue working at the research institutes where they are employed without disturbing their family lives
- selection of young, energetic and enthusiastic research workers who have outshown themselves in their research work for higher education abroad in specialized disciplines to do M.Sc. and/or Ph.D. in selected subjects at suitable universities facilities for which do not exist in Pakistan

iii) establishment of "Research Administration Academy" where people responsible for research administration undergo training to enable them to handle the matters effectively and to make the scientists research minded and dedicated and cooperative to carry out multidisciplinary researches

iv) selection of good research workers for providing research re-orientation, inservice training (short or long-term) abroad or within the country through selected training courses, workshops, visits, seminars or meetings in order to update their knowledge. This will not only provide incentive to the outstanding research workers but will also help improving the research programmes;

v) utilization of the trained manpower in subjects of their training through provision of suitable jobs, promotions and good working facilities including laboratory equipment, field machinery and scientific literature as well as developing cordial and conducive atmosphere for carrying out productive researches

vi) continued follow-up of the trained manpower at various levels through frequent visits and discussions, by a selected group of outstanding scientists in the field of research management in order to keep up the continuity of trained persons and results. This will also include the cooperation and coordination of research workers at institutional and national levels. This follow-up should also include determining the future requirements of the trained manpower for improving their working capabilities, formulating or revising research

programmes and finding out future training and higher education needs of the country as well as recommendations on awards for the good research workers

vii) provision of attractive service conditions and status in the society as well as encouragement to the good research workers through national awards, promotions and citations.

Some fields in which shortage of scientific manpower is obvious are as follows.

* Biometrics and Experimental Design
* Horticulture
* Agricultural Economics
* Plant Pathology
* Computer Science
* Food Technology
* Forestry and Range Management
* Farm Mechanization
* Marketing
* Processing and Storage of Agricultural Commodities
* Farm Systems
* Weed Control
* Repair and Maintenance of Scientific Equipment.

FINANCING

The U.N. World Plan of Action (1971) for the application of science and technology to development recommended for poor developing countries a minimum science and technology (S&T) investment level of one percent of GNP by 1980. Some of the progressive developing countries have since implemented this recommendation whereas in Pakistan the level of research and development/ science and technology (R&D/S & T) spending has unfortunately remained static at about 0.12 percent — 0.2 percent of GNP, which is approximately one-fifth of the minimum acceptable level. It is imperative that this situation be rectified speedily. The Planning Group of Science and Technology for the Sixth Five-year Plan has recommended increased allocations for S&T to achieve the targets of one percent of GNP in as short a time as possible.

A survey carried out by PARC (Table 2) shows the allocation to agricultural research and education during 1980-81:

Thus the total expenditure on agricultural research and education (Federal and Provincial) is about 0.14 percent of the GNP (1980-81). Keeping in view the role of agriculture in country's develop-

Table 2. Allocation to agricultural research and education, 1980-81

(million rupees)

	Development	Recurring	Total
PARC	58.109	19.585	77.694
Other Federal Institutes (PCCC, PFI, Atomic Energy Inst., Soil Survey Dep. etc.)	63.795	105.229	169.024
Punjab (including universities)	35.081	41.336	76.417
Sind (including universities)	9.660	14.289	23.949
NWFP	11.294	6.879	18.173
Baluchistan	2.098	3.237	5.335
Total:	180.037	190.555	370.592

ment, contribution of agriculture to GNP (30 percent), contribution to foreign exchange earnings (80 percent), employment generation (55 percent) and unlimited scope for further development in agriculture, the minimum recommended investment on agricultural research should be of the order of 0.5 percent. The Government should aim at achieving this target by the end of the Sixth Five-year Plan. Based on GNP of 1981-82, the minimum rate of investment on agricultural research at this rate should be Rs. 8,000 million over the Sixth Five-year Plan period (1983-88). To streamline the expenditure on research the following suggestions are made:

* the funds for agricultural research should be allocated to different sectors of agriculture, i.e., crops, livestock, fisheries, forestry and range management, plant protection, soil and water management, farm mechanization etc., according to the determined priorities and to remove the present sectoral imbalances.
* Adequate provision should be made in the Five-year Plan for research institutes and universities keeping in view their needs based on carefully prepared plans and their ability to utilize the same economically and profitably.
* Additional provision should be made for fundamental research in agriculture to be conducted in universities, the National Agricultural Research Centre and some selected Federal institutes.
* Funds for agricultural research should be released on annual rather than the present practice of monthly basis to ensure continuity of seasonal field experimentation.

10. PROJECT FORMULATION, MONITORING AND EVALUATION

M. D. DAWSON*

INTRODUCTION

A research programme designed to meet the needs of the country is the first mark of a successful agricultural research organization. Equally important, however, is to have research programme organized to produce results quickly and efficiently, making the best possible use of available manpower to solve the most urgent problems first.

A management systems approach to project planning and implementation stresses the interaction between sub-systems including intended beneficiaries, improved adaptable technology, supply inputs, field worker training and communication media/material support. Project planners/administrators must develop a systematic approach to involve specialists from all the sub-systems to fit the project goals. Performance and bottlenecks during project implementation are obtained through monitoring and evaluation which provides the necessary feedback to ensure that the project is on schedule and on target.

The scope of this paper is to consider the ingredients necessary to formulate good research projects as well as proposing an effective monitoring and evaluation system. The importance of clearly defined objectives, a well-organized programme which provides for planning and the establishment of priorities are discussed. Attention is also given to the allocation of resources according to priorities and strengthening linkages within programmes and between administrative units. An essential part of the system must be to provide for prompt, effective reporting of research results and for translating them into action on the farm.

PURPOSE

The two-fold purpose of this paper is (i) to establish a process in research programme project formulation, monitoring and evaluation for both the research system and a research centre and (ii) to analyze critical stages in research project implementation while providing recommendations for more productive research.

DEFINITIONS

The hierarchial order of programme, project and experiment used in the context of this paper may be defined as follows:

A programme is a broad but carefully defined plan of an area of research or training. Programmes usually are multi-disciplinary, requiring coordination so that objectives and work are jointly developed and address priorities established by the Government. Each programme statement should include a short title, brief statement of need, a list of objectives against which progress can be measured, a broad outline of work to be done, a list of disciplinary skills and designated programme leader.

A project is a component part of a programme. It is narrow in scope, more specific and detailed in objectives with a work plan that includes who, what, how, when and where for both the given discipline and other cooperating units of the institute.

A project statement should include principal investigator, an outline of the problem to be studied, methodology, a brief on pertinent literature, estimated resource needs (land, labour, facilities and budget) in a time-frame.

An experiment is a component of a project which is carried out in the laboratory or field and in contrast to programmes and projects, often consists of a work plan for a single discipline. Purpose, methodology, treatment variables, design statistical analyses, schedule and principal investigator are given.

Hierarchial relationships between objective, programme, projects and experiments when multi-disciplines (and sometimes a research network) are involved should be established. An

* *Advisor, NARC, Islamabad*

example of such a system using a series of letters and numbers is shown in Table 1.

Table 1. Hierarchial relationships of objectives, programme, project and experiment

Objective:	Develop, evaluate and promote use of improved varieties of crop plants
Programme:	IV. Wheat Improvement
Project A.	Breeding disease resistant varieties of wheat
Sub-project a	
Experiment:	1. Screening test of wheat varieties for resistance to stem rust
Code IV A a 1	
(1.1)	1.1.At NARC/Islamabad
(1.2)	1.2. At NARC/CDRI, Murree
	2. Screening test of wheat varieties for resistance to Leaf Rust
Code IV A a 1	
(2.1)	2.1.At NARC/Islamabad
(2.2)	2.2. On farm of Mr. Sahab Md. Khan

PROGRAMME/PROJECT FORMULATION AND PROPOSAL REVIEW

The PARC national coordinated programmes are well-established in Pakistan. A proposal for initiating such a programme could originate anywhere within an institute, university, management or governing board, directors or research officers. Each institute develops its own research and training programme consisting of numerous projects, some of which may be a component of a coordinated programme.

Project Proposal Format

Project outlines of research proposals take several forms. Annexure I A and I B presents one research proposal format that has wide use. The particular programme, project, experiment/sub-project, project title, project leader and coordination are provided for, together with required subjectmatter content and criteria to be used in evaluation of the project proposal. A work plan summary and activity chart is included as well as a summary budget estimate.

Process of Selection

The research proposal selection procedure will, of course, depend on the funding and administration of the coordinating agency. A research project proposal emerging from NARC as an example, could proceed through the following steps:

STEP 1 : The nature, scope and purpose of the NARC Research Programme would be made known together with research priorities and an initial call for project proposals is made. A prescribed project proposal format would be used by the interested party (Annexure IA).

STEP 2 : Initial submission of the project proposal would be to the convener of the (NARC) appropriate technical work group through the Deputy Director-General, Research. Proposals are screened/priorized and tentatively coded by technical work group. Comments and suggestions received by the reviewers are conveyed to the principal investigator/project leader and revisions, if necessary, are made.

STEP 3 : Successful proposals are presented by the convener of the technical work groups to the NARC Research Committee which scrutinize these for scientific integrity, multi-disciplinary needs, duplication, etc. The Research Committee completes coding and research prioritization and the recommended projects are submitted through NARC finance committee to PARC for technical and funding approval. The NARC finance committee before forwarding to PARC shall examine the budget statements of all research proposals recommended by the research committee to determine source and availability of funds.

STEP 4: PARC approved proposals are returned through the NARC Director-General to the Chairman of the research committee for appropriate

implementation and action as in Step 5.

STEP 5 : Coordinators and project leaders are notified when research proposal is approved and in case of field research a copy of approval is sent to Farm Service and the institute or sector unit head. All research at NARC may be coded as shown in Table 1.

Criteria and Prioritization of Project Proposals

Detailed guidelines for evaluating research project proposals may be developed under the following criteria :

1. Relevance to Sixth-five Year Plan.
2. Priority level established by PARC (based on economic importance, increased productivity, scope of new technology, beneficial impact).
3. Will the proposed project/programme contribute significantly beyond present knowledge to assist solve farm problems which limit food production and net farm income?
4. Will the proposed project/programme focus on generating improved technologies or policy data base to resolve problems identified in specific farming system?
5. Will the proposed project/programme support otherwise non-funded research within the core discipline identified by the funding agency and PARC?
6. Will the proposed project/programme provide likelihood of early success and important findings that increase food/fibre-production, increase net farm income and improve nutrition as indicated in the Pakistan National Agricultural Research Plan?
7. Will the proposed project/programme provides opportunity for inter-institutional coordination and multi-disciplinary participation on station and on farm?
8. Does the proposal reflect capability of proponents to conduct research with resources available?
9. Does the proposal present a reasonable budget and provide prospects for significant accomplishments within the contract research budget constraints and objectives?
10. Does the proposal present with clarity and in prescribed format adequacy of project objectives, soundness of methodology and relevant details?

Application of a prioritized system should not be totally quantitative. It could be tempting to say that only programmes, with A, B and C priorities can be done with funds in sight (given other available resources). Therefore, all D, E and F programme projects would be deferred. Usually, a balanced programme includes a few low priority projects, especially long-term studies.

In summary, it should be emphasized that judgement is essential. The main advantage of having a system is that it ensures periodic, thorough review of priorities and is useful in helping to keep research aimed at the most important and urgent problems as well as encouraging a multi-disciplinary approach while discouraging duplication.

NARC Research Committee*

Project implementation of field experiments requires a strong linkage between scientists and the farm service unit. The farm service director has responsibility for allocation and administration of land, labour, equipment and supplies needed for conducting experiments. The Research Committee (NARC) with Deputy Director-General, Research as Chairman, has authority at Step 5 to request farm service through prescribed procedures, to allocate necessary resources in establishing the field experiment(s).

PROJECT MONITORING

Once a project has been implemented, both technical and budget management monitoring assist the project to keep on target and achieve project objectives.

Objectives of Monitoring

- To feed timely information into the planning and budgeting process to ensure optimal use of resources and to improve planning.
- To identify problems and take immediate remedial action whether of a technical (behind schedule, clearing equipment, etc.), institutional (regulations and

* *The Research Committee of NARC consists of Conveners to each of the technical work group.*

policy), or financial nature.

Effective Monitoring

Basic characteristics of effective monitoring require :

- Responsibility for initial assessment of progress be made at the local level.
- Attainment of project technical and fiscal management targets on schedule.
- A system of checks and balances between institute and agency be maintained.
- Timely corrective action be taken by project managers or other appropriate agencies on the basis of current basic date.

Procedure and Formats

Technical monitoring of research projects will require completion and transmitting of two reports, namely the field evaluation report and annual progress report, both of which are given in Annexure IIA and IIB. The field evaluation will be done by scientists recommended to the Deputy Director-General, Research, by the technical work group conveners and submitted to the Deputy Director-General, Research. Annual progress reports will be completed by the project leader / principal investigator and similarly submitted, together with a quarterly financial report (see Annexure III). The financial data will be provided by the project accountant to the project leader and be included with the field evaluation or annual progress reports.

Information Flow

Besides field evaluation and annual reports, staff conferences, field visits, telephone and correspondence facilitate required information exchange on time to suggest improvements in the project (with target dates).

Maps and bar charts of major activities in progress are continually updated for project participant conferences and aid information flow.

EVALUATION

Components

Systematic project evaluation provides information on the technical effectiveness, the relationship between expenditure and outputs from resource investment and whether the project should be continued, modified or dropped.

Evaluation of project components in terms of objectives is provided in Table 2.

Internal and External Reviews

The purpose of internal and external reviews are to evaluate project performance based on items summarized in Table 2.

Internal project evaluations may initially be as often as annually while external reviews of project may be carried out at longer intervals.

Team members, especially programme coordinators and project leaders/principal investigators, should be active participants in the internal reviews.

At least one of the team should also participate in the external review. Other members of the external review team should be outstanding scientists and agriculturists appointed by PARC/ NARC in concert with the donor agencies.

Project Terminal Report

The terminal report for a given project provides an important input to the evaluation exercise. Annexure IV presents a suggested project terminal report format together with requested supporting material for the report.

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Research that is planned to achieve, within a given time frame, pre-determined objectives compatible with Government-set goals, has the characteristics of a successful project. Good research emulates from carefully prepared and vigorously assessed project proposals and where research is judiciously monitored during implementation. This paper considers a system approach to project planning, implementation monitoring and evaluation. Attention is given to the process and the development of formats for project proposals and their assessment as well as technical and fiscal monitoring and research programme evaluation.

Definitions and hierarchial relationships for programmes, projects, experiments and objectives are provided. The role of technical work groups, Research Committee and linkages between PARC

Table 2. Evaluation of project components

Objective	Input	Output
Intangible objectives	Personnel	Results
	Leadership	Additional information and knowledge
	Personnel development	Commitment and performance
		New technologies and methodologies
Tangible objectives	Physical assets facilities/equipment	Improved products/equipment
		Impact on farmer rural/community
	Operational funds	
	Special services	Special services
	Management of resources	Publications, demonstration trials, farm visitations, field days and training programmes
	Support services	
	Communication channels	Manpower development
	Linkages with agencies	Trained staff and other officials
	Others	Farmers trained
		Briefs to planner and government hierarchy

and the Research Programme of network institutions such as NARC are considered.

Critical stages in the management of research projects from formulation to evaluation, include insufficient attention to performance objectives and work schedules.

RECOMMENDATIONS

*Research organizations should adopt a set of clearly stated objectives to serve as the purposes toward which the research will be directed.

*Formulation of research programmes and projects should be on a multi-disciplinary basis but the scientific integrity of subject-matter disciplines should be maintained in administrative units.

*The differences and the relationships among programmes, projects, objectives and functions must be recognized in organizing and administering institute/centre research. Definitions are given.

*A hierarchial set of defined elements should be adopted that constitute a multi-disciplinary programme, together with a simple system for designating programmes, projects and experiments. A coding of elements at each level is suggested.

*A simple but formal procedure for proposing, drafting, reviewing and approving programmes and projects should be adopted. Suggested procedure and formats are provided. During project review rigorous assessment should result in non-approval of about 20 percent of submitted papers.

*As an aid in planning research programmes and in allocating resources of manpower, facilities and funds, PARC/NARC should develop and adopt a systematic procedure for establishing and reviewing programme/project priorities. Criteria for research project prioritization are suggested.

*Establish at NARC a Research Committee to assist the management board to coordinate approved research programmes/projects and to transmit them to farm service superintendent for land, labour, supplies and equipment allocation. Membership and mandate of the Research Committee are suggested.

*An effective monitoring system should be implemented by the research system to feed timely technical and fiscal information back to planners, coordinators and principal investigators that identify problems and permit remedial action to be taken. Suggested technical and financial management monitoring system formats are provided.

*A programme/project internal and external evaluation system should be established by the research system. A suggested evaluation methodology and criteria are provided, together with terminal project guidelines and follow-up action.

*The PARC should improve information flow systems about new developments for different target audiences. Use of multi-media should be encouraged including publications, reports and bulletins to aid and improve technology transfer.

*Research terminal reports should be assessed. Technical work groups (or technical committees) should scrutinize the reports, request, where necessary, amplification (rewording of points if necessary); and suggest findings which should be packaged for extension to farmers or planners in Government, etc. A suggested format for terminal reports is provided.

ANNEXURE-IA

Research Code: [ ]

PAKISTAN AGRICULTURAL RESEARCH COUNCIL
RESEARCH PROPOSAL

Received at PARC

By Member: _____ Date _____

Programme Title

Project Title

Experiment Title

	Programme	Project	Sub-project/Experiment
Check appropriate box	[ ] Coordinated	[ ]	[ ] Independently implemented

Date commence: Date complete:

Sponsor/Agency

Implementing research station(s)/unit(s) :

Location

Coordinator/project leader :
Designation/title :
Mailing address:

Principal investigator :
Designation/title :
Mailing address :

Signature : Submitted by :
Endorsed by agency head :

To be filled in by PARC

Priority Priority rank

(Continued.....)

PROPOSAL CONTENT

(Detailed writings and completed sheets to be attached).

1. Objectives of proposed work (summarized).
2. Importance and anticipated benefit of proposal
3. Review of related literature (attach bibliography)
4. Plan of work proposed and work plan summary (use format provided)
5. Project personnel (list existing and additional staff needed type and pay scale).
6. Research facilities needed (land, equipment, etc.)
7. Budget estimate (use attached format).

WORK PLAN SUMMARY AND ACTIVITY CHART

Planned Starting Date:	Planned Completion Date:	
Activity No.	Studies on major activities	Duration (months)

BUDGET ESTIMATE

Operational Expenses

Line item	Year 1					Year 2	Year 3	Total
	Quarter							
	1	2	3	4	Total			
A. Establishment Charges								
Basic salary								
Regular allowances								
Other allowances								
B. Repair and Maintenance of Durable Goods								
Transport								
Machinery and equipment								
Furniture and fixture								
Buildings								
Others								
C. Commodities and Services								
Transportation								
Communications								
Utilities								
Stationery								
Printings								
Books and newspapers								
Uniforms and liveries								
Rent and royalties								
Other expenditure								
D. Field Research								
E. Contingencies								
Sub-total:								

(Continued.....)

BUDGET ESTIMATE

Capital Expenses

Line item	Year 1					Year 2	Year 3	Total
	Quarter							
	1	2	3	4	Total			
A. Furniture								
B. Equipment								
C. Motorcycle/Bicycle								
D. Vehicle								
Sub-total								
Grand Total								

ANNEXURE-IIA

PAKISTAN AGRICULTURAL RESEARCH SYSTEM
FIELD EVALUATION REPORT

Prepared by :

Name _____ Date _____

PROJECT IDENTIFICATION DATA
(To be filled in by PARC)

Research for the period
Code 3

Research title :

Implementing agency/research station or unit:
Funding agency :

Research leader/designation:

WORK PLAN SUMMARY

Date planned start : Date actual start :

Date planned completion : Date actual or expected completion :

Total budget : Budget released to date :

A. EVALUATOR'S RATING RECOMMENDATION

1.	Technical achievement	Excellent	Satisfactory	Unsatisfactory
2.	Adherence to schedule	Excellent	Satisfactory	Unsatisfactory
3.	Adherence to budget	Excellent	Satisfactory	Unsatisfactory
	Continue	Integrate	Suspend	Terminate

Further remarks :

Date of field visit :

Persons interviewed: Designation/agency

Evaluator(s) Designation/agency Signature

(Continued.....)

FINDINGS

1. FINANCIAL ASPECT .
   Do expenditures match the approved budget?
   Are quarterly financial reports submitted in time?

2. ADHERENCE TO SCOPE OF WORK AND SCHEDULE
   Did project adhere to planned scope of work and the methodology?
   Is the work in time?
   Are technical reports submitted in time?
   Is the annual progress report submitted in time?

3. TECHNICAL ACHIEVEMENT
   Are the necessary measurements being made?
   Are the experimental methods rigorous?
   Do the results justify any conclusions so far?
   Should the emphasis of the work be changed?

4. FACTORS FOR PROJECT SUCCESS/DEFICIENCIES

ACTION REQUIRED TO IMPROVE PERFORMANCE

Problem/opportunity	Action required	Resource required (if any)

This report will be accomplished and submitted in three copies by an evaluator(s) to be appointed by PARC/NARC—perferably the same person(s) who evaluated the proposal. Field evaluation should be done in the middle of each cropping season, once or twice a year but before preparation of the annual report.

PAKISTAN AGRICULTURAL RESEARCH SYSTEM
ANNUAL PROGRESS REPORT

Prepared by:

Name :- _____ Date : _____

Project identification data

Research for the period
Code

Research title :

Implementing agency/research station or unit :
Funding agency :

Research leader / designation :

WORK PLAN SUMMARY

Date planned start :	Date actual start :
Date planned completion :	Date actual or expected completion :
Total budget :	Budget released to date :
Budget for current year :	Budget released for current year :

ACCOMPLISHMENT AND PLANNED ACTIVITIES
(use additional sheets if needed)

This report will be accomplished annually by research leader and submitted through Deputy Director-General, Research to PARC Member. The financial data will be provided by the project accountant.

(Continued. . . . .)

ANNUAL ACTIVITY SCHEDULE STATUS

Activity No.	Percent completion	Completion		Duration			Problems encountered/ action taken
		Planned	Actual	Planned	Actual	Variance	

ANNEXURE-III

QUARTERLY FINANCIAL REPORT

Research Code: [ ]

For the period _____ to _____, 19 _____

1. Name of Centre/Sub-centre/Institute/Organization: _____
2. Name of Principal Investigator: _____
3. Cost of the Scheme: _____
4. Duration of the Scheme: _____

	From Month		Year		to Month		Year		
	Budget		Amount Released		Expenditure Incurred				
Line item	Current financial year	Current quarter	Financial year (FY) start to date	Project year start to date	Current quarter	Financial year (FY) start to date	Project year start to date	Balance on hand	Remarks
OPERATIONAL EXPENSES: A. Establishment Charges Basic salary Regular allowances Other allowances									
B. Repair and Maintenance of Durable Goods Transport Machinery and equipment Furniture and fixture Buildings Others									
C. Commodities and Services Transportation Communications Utilities Stationery Printings Books and newspapers Uniforms and liveries Rent and royalties Others expenditure									

(Continued. . . .)

D. Field Research								
E. Contingencies								
CAPITAL EXPENSES A. Furniture								
B. Equipment								
C. Motorcycle/ Cycle								
D. Vehicle								
Sub-total								
Grand Total								

Prepared by: _____ Audited by: _____ Concurred by: _____

ANNEXURE-IV

Research Code: [ ]

PAKISTAN AGRICULTURAL RESEARCH SYSTEM
PROJECT TERMINAL REPORT*

Received at PARC

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Location:

Research leader/designation:

Research cooperators (names/designations)

This report submitted by :

_____

Name/signature Date: _____

This report endorsed by PARC or Sector head

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Name/signature Date : _____

ABSTRACT OF REPORT
(outline on next page)

*To be submitted in five copies by Principal Investigator to PARC through Deputy Director-General NARC within 30 days after final data gathering and to the Programme Coordinator in the case of a Coordinated Programme who, in turn, will submit an Integrated Programme report to PARC and NARC within 60 days after programme completion. These reports will be reviewed by PARC and may be returned to the researcher for possible improvement.

REPORT ABSTRACT OUTLINE

1. A Summary Statement of Objectives and Methods.
2. Review of Relevant Literature.
3. Achievements and Contribution Beyond Present Knowledge.
4. Packaged Recommendations for Technology Transfer.
5. Future Proposed Work Plan.

11. FINANCIAL ADMINISTRATION/BUDGET MANAGEMENT IN PARC

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Two special features of finance management in a research organization like PARC may be emphasized at the very outset. The first is that unlike other public corporations, which generate as well as use their own revenue/income, through their activities, PARC like all other research organizations, is primarily a spending body. The nature and scope of its activities are, therefore, necessarily limited by the amount of resources it gets from the Government. Unlike other public corporation, therefore, it has to cut the shape and size of the coat according to the cloth. The former can, of course within limits, decide the shape/ size of the coat first and then go about arranging the necessary cloth. The second feature is that the results of research are not immediately and directly visible and ready for application in the short run. Consequently, unlike other public corporations, whose goods and services are immediately visible and ready for consumption, it is often difficult to convince the funding authorities about the necessity and importance of more funds for a particular or group of research projects/ schemes. In such a situation, the role and goals of the finance management in a research organization like PARC are mainly two:

(1) Arrange and obtain maximum/adéquate funds at the right time.

(2) Ensure the most efficient and productive use of the limited funds with reference to the aims and objectives of the organization.

BACKGROUND AND PRESENT POSITION

According to the Charter of Pakistan Agricultural Research Council (PARC), vide Section 4 of PARC Ordinance, it has the responsibility to plan, undertake, promote and coordinate agricultural research in the country; to arrange expeditious utilization of research results; to arrange training of high level scientific manpower; to generate, acquire and disseminate information relating to agriculture and to do such other needful as are necessary and ancillary thereto. In order to achieve these objectives and strengthen existing agricultural research, the PARC has started research on all the major crops and allied fields in agriculture.

FINANCIAL SYSTEM AND PROCEDURE OF PARC

Sources of Funds

In order to enable PARC to discharge its responsibilities it is provided funds from a number of sources namely:—

- Grant-in-aid from the Government
- PL-480 funds
- Funds from other donor agencies

Grants from the Government

There are two kinds of grants received by PARC from the Government. These are grant-in-aid for current expenditure and grant-in aid for development projects.

The grant-in-aid from the Government for current expenditure is reflected in the revenue budget of the Government and is meant for meeting the current operational cost of the PARC of recurring nature and some research schemes operated by the PARC on a permanent basis. The grant-in-aid for development projects are also reflected in the Government budget for development called the Annual Development Plan (ADP).

PL-480 Funds

A number of projects of the PARC are financed by the Far Eastern Regional Research Office of the US Department of Agriculture (FERRO/USDA). These funds are provided by the FERRO/USDA after scrutiny of the project document of each project according to the pro-

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cedure prescribed by the US Department of Agriculture. Funds for each project are released by the FERRO/USDA on six monthly basis on receipt and scrutiny of the technical and fiscal report of each project. Since Ist July, 1980 the grants from FERRO USDA are received by PARC through the Ministry of Finance as a part of the Government grant. For the same reason the projects financed from PL-480 funds are submitted for scrutiny to the Financial Adviser, Ministry of Food and Agriculture and to the Ministry of Finance for allocation of funds.

Funds from other Donor Agencies

A number of development projects, large and small, are financed partly or entirely by international donor agencies such as USAID, World Bank, CIDA, FAO, UNDP, IDRC etc. Financial aid from these International aid-giving agencies are also reflected in the ADP of the Government and are released as a part of Government grant.

PROJECT FORMULATION AND APPROVAL

Besides doing its own research, PARC also finances a number of research schemes submitted by the Provincial Governments, Federal Government agencies, Provincial research institutes and universities. The schemes which are considered of high priority and technically sound are submitted to the Technical Committee for scrutiny. After clearance by the Technical Committee, these schemes are put upto the Executive Committee of PARC. After approval of the Executive Committee, it is passed onto the Finance Wing of PARC for providing funds for the schemes.

The schemes which are financed by PARC out of current expenditure are provided funds in the PARC's Current Budget. Major projects for which grants are required from the Government and money is to be provided in the Annual Development Plan (ADP) of the Government's Development Budget, the procedure is more elaborate. For every project, a project document is prepared in a prescribed form called PC-I long before the commencement of the financial year and is submitted to the Financial Adviser, Agricultural Research Division. Projects estimated to cost less than Rs. 5 million are approved finally by the Division with the concurrence of its Financial Adviser. Projects which are estimated to cost more than Rs. 5 million are forwarded to the Planning and Development Division for scrutiny. After clearance by the Planning and Development Division the project is submitted to the Central Development Working Party (CDWP). Projects which are estimated to cost upto Rs. 20 million are finally approved by the CDWP but projects which are estimated to cost more than Rs. 20 million are submitted to the Executive Committee of the National Economic Council (ECNEC) for approval. After approval of the project by the competent authority, as indicated above, funds are allocated by the Ministry of Finance in the Annual Development Plan of Government Budget for the coming financial year. The allocations are made by the Priorities Committee and communicated to the PARC, other Government Departments and autonomous bodies two to three months before the commencement of the financial year in order to enable them to plan their activities well in time before the commencement of the financial year on July 1. The grants are released to PARC in monthly instalments and progress reports are submitted to the Planning Division on quarterly basis.

PREPARATION OF BUDGET

Budgeting is a continuous process and its preparation begins well ahead of the year to which it relates. Budget proposals for the establishment and other items of expenditure are invited from the projects and other user Departments well before the commencement of the financial year. On receipt of proposals from the projects and other user Departments, the Budget Wing of the PARC prepares the budget proposals in two parts, one for current expenditure and the other for development expenditure for the Annual Development Plan. The budget proposals for the current and development expenditure are forwarded to the Agricultural Research Division where these are examined by the Financial Adviser of the Ministry. After scrutiny, he passes it onto the Ministry of Finance. The allocation for the current expenditure are made and communicated to the PARC and other Government Departments some time in March and the allocations for development expenditure are made and communicated to PARC and other Government departments and agencies in

April to enable the PARC and other Government departments to prepare their plan of activities and their, own budget for the next financial year commencing from July 1. These allocations are often subjected to substantial cuts by Priorities Committee, the Annual Plan Coordination Committee or NEC. Economy cuts are also applied at the time of announcement of the Federal Budget. On the basis of allocation of funds made by the Ministry of Finance, PARC prepares its current expenditure and Development budget for the next financial year which is submitted to the Executive Committee, and after its clearance, to the Board of Governors of PARC for approval some time in early July. The budget thus approved by the Board of Governors becomes operative from July 1 every year.

PROBLEMS, CONSTRAINTS AND POSSIBLE REMEDIES

Inadequate Funds and Late Releases

Expenditure on agricultural research is one of the best forms of investment with returns around 50 — 700 percent. International standards require at least one percent of GNP for research. This is all the more so because agriculture in Pakistan contributes 30 percent of GNP, 80 percent foreign exchange, supports 70 percent of the population and has prospects of development upto 50—200 percent. Nevertheless, only 0.17 percent of GNP is allocated for research. For 1983-84, as against our demand for Rs. 446.349 million only Rs. 236 million have been allocated. As a result, ongoing and new projects/schemes of PARC are going to be affected very badly. The position in the recent past also has hardly been better. In fact, as indicated in the table below, there has been a progressive decline in allocations for PARC, which is disturbing.

(million Rs.)

	1980-81	1982-82	1982-83	1983-84
Current Expenditure	12.289	47.000	46.706	45.000
Development L.C	57.891	109.102	84.237	58.816

In this content it is strongly felt that:

(a) Adequate funds at least in keeping with the demands/needs of PARC, if not the international standards, relating to research, should be made available regularly in the Annual Budget.

(b) Schemes/projects are prepared with maximum foresight, wisdom and imagination and submitted in time. The cost of each scheme/project should be realistic and minimum to allow for the accommodation of other schemes/projects within the scarce resources.

(c) There should be coordinated research within and outside PARC to avoid wasteful duplication and overlapping of research efforts as well as wastage of scarce resources in terms of financial allocation, trained manpower and costly scientific equipment. In this connection, it is felt that ARD/PARC should be the final authority to decide the nature and extent of research in the agricultural sphere within the country, no matter which Federal/ Provincial Government agency undertakes it. Further, since agricultural productivity and agricultural production and rural development are inter-dependent and first priority is agriculture,. both the Divisions should be brought under one roof/leadership and resources saved thereby should be diverted to agricultural research.

(d) In order to ensure the best utilization of resources, schemes/projects should be selected strictly in order or priority with reference to the aims and objectives of the Sixth Plan PARC.

(e) Release of funds has always been a problem. The funds are received about six to eight weeks after they become due because of a long channel of processing the request for release. Out of a rupee allocation of Rs. 84.237 million for 1982-83, a sum of Rs. 42.942 million, i.e., about 50 percent only of the rupee allocation was released during the first 11 months upto 31-5-1983. This not only seriously hampered the research programmes but also created difficulties in meeting our commitments with the provincial institutes and payment of bills of contractors and suppliers. This greatly

slowed down the construction of NARC. This also gave rise to complaints from the provincial authorities to whom funds could not be released according to the budget allocation and the time schedule given to them. We also defaulted in meeting our commitment with Pak PWD which is executing the construction work of the Arid Zone Research Institute, Quetta. A sum of Rs. 25.376 million was released in June, 1983, and we were only recently able to meet the more pressing demands and released funds to the Principal Investigators of Provincial institutes who sent the expenditure statements. The balance which was not released had to be surrendered. It is, therefore, strongly recommended that the entire budgetted amount should be placed at the disposal of PARC either at the beginning of the financial year or released in two instalments one on July 1, and the next on January 1. If even this is not possible, at least quarterly releases are recommended.

Proper/Full Utilization of Funds

In order to ensure full utilization of funds during the financial year, administrative and financial powers have been delegated very liberally to the concerned officers vide PARC circular No. F. 1-4/82-CS dated 20-12-1982. This decentralization is expected to facilitate speedy and timely completion of projects. At the same time, heavy responsibility falls on the shoulders of sanctioning and spending authorities to use these powers with due care and precautions to avoid losses, wastages, misappropriations and defalcations. In this connection, it is necessary to emphasize the need for close/personal supervision by the spending authorities of execution of projects. Powers should be exercised in such a way as to avoid both excesses and savings.

Regularity of Expenditures

At the end of the financial year, the accounts are audited by the Auditor-General of Pakistan as well as a firm of chartered accountants.

A detailed procedure has been prescribed for submission of claims/bills, their scrutiny, internal audit, payment and accounting vide Administrative Memorandum 300.6, 300.7 and 300.8 issued by the PARC dated July 1, 1980. The accountability controls effected through these documents are intended to ensure that money set aside for a particular purpose is not applied to another purpose, that the limits are not exceeded and that there is no misappropriation or defalcation. These purposes are achieved through the system of pre-audit, post-audit and issue functions of the staff of the Finance Division of PARC. In every system of financial administration, there are controls and counter-controls, but these in themselves do not control expenditures towards an ideal arrangement. It is the content and substance of policy on one hand and skill in management on the other which really determine and control the nature and directions of expenditures.

PARC is a new organization and its financial administration is still in a formative stage. Different rules and regulations are under preparation and staff is still being recruited for different stations. Further, PARC is an autonomous organization and subject to public accountability. In the context of these considerations, resource constraints and public accountability, the need of the hour is financial discipline at all levels of authority and at all stages of work. In this sphere, the position on the ground still leave much to be desired. To quote some recent instances, in one case an open signed cheque was about to be delivered and in the other a cheque for a very large amount was issued in the name of an officer without even his designation. It is, therefore, of the greatest importance that all sanctioning/ spending authorities, while exercising powers under the prescribed system of delegation/discentralization, acquaint themselves with the prescribed accounting system and procedure, and follow the advices/ instructions of the Finance Division of PARC to achieve the objectives in question. The officers and staff of the Finance Division are expected to be equally alert, vigilant and active in these areas. Focus of all concerned should be on the spending of money for the purposes and in the manner prescribed by rules and orders, observance of procedural formalities and maintenance of all books/registers etc of accounts correctly and fully.

Since the scientists and professionals working on a scheme/project are expected to concentrate on research, they need all the support and assistance of the officers and staff of the Finance Division to make their tasks easier.

Problems with Assisted Projects

The projects of the PARC are financed by the Government as well as a number of International donor agencies. Although all financial assistance received from the donor agencies are received through the Government as Government grant, the requirements of the donor agencies have to be fulfilled. Each donor agency has its own requirements and has prescribed its own proforma for financial reports. Information for these financial reports have to be extracted from the accounts prepared by the PARC and submitted to those agencies in the proforma prescribed by them at intervals specified in the agreement with those agencies. In order to meet the requirements, some time parallel sets of accounts have to be prepared by extracting information from PARC's accounts to meet their requirement. Finance Division of PARC has, therefore, to maintain almost parallel books of accounts to meet the requirement of its own budgetary and accounting system and to meet financial requirements of the donor agencies. As more and more donor agencies are coming forward to assist the PARC, additions, alterations and modifications in the accounting and reporting system form a continuous process and there is always room for improvement of the PARC's own financial system and those of the donor agencies.

Computerization of Work

The workload of the Finance and Accounts Department is sharply increasing due to the rapid expansions in PARC activities/ projects and increase in staff. Financial Accounting and budget analysis entail a lot of data handling which is highly time-consuming through manual processing and quite often needful cannot be done within the tight deadlines. As these analytical work have periodical peaks, regular addition in the staff strength would be uneconomical and wasteful. Nor is effective and full evaluation of all expenditures possible through manual efforts. The feasible alternative and practical solution in this sphere is Electronic Data Processing which will greatly facilitate these exercises and other accounting activities, i.e., payroll, inventory control and store accounting etc.

It is a matter of satisfaction that it has now been decided finally to go in for computerization through a powerful micro-computer, which must lead to over-all effectiveness/efficiency of the Finance Division of PARC.

Evaluation of Expenditures

An analytical evaluation of expenditures to ascertain the rate of growth/progress towards achieving the aims and objectives of PARC should be a continuous process. Some efforts in this direction have been made by the Finance and Accounts Division by adding a section on 'Budget by activity' in the Budget book. But more needs to be done in this area. For instance, the question whether major portion of the funds is spent on infra-structure/ facilities for actual research or pay/allowances/honoraria for officers/staff should be a matter of constant review. Preferably, quarterly if not monthly, evaluation of expenditures and physical progress is called for. In this connection, no time limit or deadline or guarantee can be put on the completion or success of a research effort. Some wastages, losses and delay will always be a part of the game, but continuous and regular evaluation would still be necessary to ensure proper and the best utilization of the scarce resources of the Government. It is strongly felt that there should be no insistence on Research just for the sake of Research, irrespective of results. The importance of the role of the scientists/professionals in these areas cannot be exaggerated.

12. MANPOWER TRAINING

G. M. KHATTAK*

An organization is only as good as the quality and education and training of its manpower. For a creative, productive and efficient organization it is essential that it has stringent standards of selection and a good programme of pre-service and in-service training for all levels of its employees. With a high standard of selection, entry can be limited to persons with high intelligence and good education. With adequate pre-service training, the recruits can be taught what is needed for the performance of their duties in addition to what they have learnt in the university. This knowledge can be kept up-to-date through in-service training, which can be utilized to impart skills needed by employees for performing tasks required for progressively higher responsibilities in their careers.

It is essential to emphasize the need for great attention to the quality of the training imparted. Too many of our training institutions are almost empty marble palaces staffed by a few outdated, highly demoralised and disgruntled teachers who have no prospects of promotion in the institution in which they are working and little ability to move to better jobs outside.

PRE-SERVICE TRAINING

Perhaps the most important role of pre-service training is to impart the values of the service for which training is being imparted. Through the personal example of teachers and reiterated emphasis, whenever possible, the recruits are faced again and again with the basic values for which the service stands. I have experience of undergoing pre-service training on two occasions: in the Navy in 1943, and in the Forest Service from 1947 to 1949. From the Navy, I learnt such values as performance beyond the call of duty; and silent work, to keep on working at the limit of your capabilities but not to brag about your achievements. Because of the deep imprint of my naval pre-service training, these two values have become deeply ingrained in my make-up and I am deeply indebted to the Navy for this legacy.

The characteristic traits which training in forestry used to impart were:

- total commitment to the basic principles of forestry so that in your service you do not perform any act which goes contrary to them. Because of this value ingrained in forestry training, foresters generally find themselves in deep trouble during political regimes to whom the concept of values is foreign. But it is because of these values imbibed by most foresters during their pre-service training at the Forest College that we have some of the world's finest coniferous forests still intact despite all pressures working for their destruction,
- another value on which high score is set by forestry pre-service training is physical fitness and the capacity to do hard physical work under all kinds of weather. This is instilled in you by putting you through tough situations. I still remember with nostalgia our 1947 summer tour in Kashmir in which we had to march several miles each day between camp and forest in pouring rain, with a heavy axe on our shoulders, to fell large trees of deodar. And this continued for three weeks. We would be so tired that one day when our tent fell on us in the night, I and Mr. A. K. Khattak, who is now in Iran as Ambassador, had no energy to get up to erect it. So we slept the rest of the night with rain pouring down on us. It was also an essential part of our training that we would pitch and strike tents with our own hands and would also load and unload our luggage and carry it to camp. The mess servants were not allowed to help us in these tasks. This made us tough and removed our shyness in performing physical tasks which is such a characteristic trait of the youth of our country. Though forestry

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training has now become much softer, I still think the idea of putting you through pure hell during training was not a bad one at all. In subsequent life, I have been in several very tough situations when I was tired, cold, hot, hungry and thirsty, but on every occasion I could console myself by comparing the situation with a worse one which I had experienced during training.

With all the defects which have crept in the Forest Service with time and progressive neglect, at least one quality still persists in most members of the service, i.e., the capacity to improvise. You are taught that in forestry you will never get all that you consider pre-requisite for performing a task. Nonetheless you cannot make this an excuse for not performing the task. Perhaps this part of their training has been responsible for the poineering spirit you find in most foresters which has led them into field which are not strictly production forestry, e.g., watershed, grazing and wildlife management.

Pre-requisite for Good Pre-service Training

The most important pre-requisite for good pre-service training is a group of dedicated, diligent, knowledgeable and enthusiastic teachers with high morale and complete faith in the values of their service. With such teachers good training can be imparted with the minimum physical facilities, without them, even the most sophisticated facilities would not suffice.

Where will such teachers be drawn from? Obviously from the concerned professions. At one time the Forest College used to draw its instructors on deputation from the Forest Service. These positions were so highly regarded that even the most competent foresters used to compete hard for them. For example, the Indian Forest College, where I started my pre-service training, had instructors of the calibre of Mr. Muhammad Habib Khan, who has since contributed so richly in such varied capacities to the development of so many provinces of Pakistan.

Since most training institutions have small cadres, it has not been possible for them to create service structures which can offer the same prospects of promotion which are available to the members of the service outside. And this is so inspite of the fact that training institutions must be headed and staffed by the best talent in the country. This has caused a serious drain of talent from training institutions. And worse — the majority of teachers who have decided to stay on are embittered and demoralised and are a negative influence on their trainees. The examples of such dead training institutions with badly depleted staff of very poor quality are numerous. In fact, it would be hard to find even a few viable training institutions in Pakistan today unless they have solved the problem of obtaining quality staff even for limited periods.

Before a training institute is established, it is, therefore, essential to determine what will be the qualifications of the teachers to be employed, what will be their remuneration, what additional facilities will be admissible to them so that they are tempted away from the very satisfying careers in which they are productively engaged, and what will be their future prospects of promotion in case they are to be absorbed permanently in the staff of the institution.

Since our experience of appointing permanent staff for training institutions has been so disappointing, it would be preferable to rotate research workers, field scientists, university teachers and administrators as trainers in training institutions. This would enable the staffing of the training institutions with fresh, enthusiastic trainers who are fully in touch with their professions. Because of the large pool of talent available to them and because of their close contact with every sector of agriculture, and because they are so highly regarded, the PARC is in an ideal position to launch an effective programme of pre- and in-service training in agriculture. Should they do so, this will be their most important contribution to the cause of agriculture in Pakistan.

Need for Pre-service Training

No pre-service training is imparted to graduates in agriculture and animal husbandry because they obtain their degrees in these disciplines from the universities. In forestry, the situation is different. Here, on the lines of the military academies, a selection is first made from amongst applicants possessing degrees in any science

combination, and the selected candidates are then required to undergo a two years course which combines education in Forestry under real-life situations, with training designed to produce a disciplined forester possessing the values which a career in forestry demands.

The question arises: do universities prepare graduates in agriculture and animal husbandry for shouldering their responsibilities in the departments? The answer is no. There was a time when we had teachers in universities who had the ability, time, and inclination to attend to character formation of their charges. Under the current milieu, we cannot even pretend that we are doing so, with the result that most graduates passing out of the universities are incapable of discharging any responsibility. Moreover, their defects cannot be corrected through apprenticeship training either where the graduate fresh from the university is attached for practical training to senior and competent officers for a year or two. This is because such officers are so few and so overburdened with work that they consider such an assignment an imposition. Moreover, the raw graduate of today is generally so ill-disciplined and so ignorant that it is a very unpleasant full-time task to give him a reasonable amount of education and a sense of responsibility through apprenticeship.

Other advantages of in-service training are giving a common outlook on related problems to members of closely allied services and creating *esprit de corps* among them. At present, this is noticeably lacking in agriculture and the members of various services dealing with various aspects of agriculture at the district level frequently do not even know each other and seldom cooperate to solve the problems of the farmer.

A very important objective of pre-service training is socialisation. The universities of today are producing a rough product which must be subjected to a finishing process before they are capable of shouldering important responsibilities in life. This is especially true of agricultural universities which do not even pretend to teach socialisation with the result that their graduates frequently come out with mannerism which is obnoxious in company. Such defects could be pointed out frankly during pre-service training without causing offence, and got corrected. This diagnosis and rectification is generally not possible after the graduates are appointed to responsible positions. Recently, I had the unpleasant experience of helplessly watching one of my teachers continuously plucking his nose when he was being interviewed for selection to the post of Assistant Professor. During pre-service training such mannerism can be pointed out in class, with a brief discourse on why this is not desirable.

Most real life complex problems can only be solved by the cooperation of a number of persons in key positions. This makes it so important to have contacts widely dispersed throughout the country in various walks of life. The process of developing contacts starts at the universities. But in most of our universities, attempts at socialisation have been replaced by politics of violence. So, pre-service training is the only occasion during which the trainees can form lasting friendships, and learn how to make friends throughout life. The most useful collaboration in our country is the collaboration amongst batch-mates in the same pre-service training class. This is true of all services which impart pre-service training.

Course Contents

What should be taught during pre-service training? While the pre-service academy is being planned, a study should be carried out to assess the common shortcomings of young agricultural officers fresh from the university, as they attempt to perform the duties allotted to them. A course should then be designed so that the future graduate is equipped during pre-service training with all the skills and personal attributes which would assist him in performing his duties better. Some suggestions are discussed below:

Mastery of the Subject

Few of today's graduates come out of the universities with an adequate knowledge of their fields, and how this can be used to solve real life problems. The in-service course should offer a concentrated review of the entire field with the objectives of clarifying basic concepts, bringing the knowledge up-to-date, imparting skills of self

study, and teaching practical application of all that has been taught.

Inculcating Qualities of Leadership

Throughout the long years of education in our universities, nowhere is the student taught anything about leadership, and in no position in the university is he required to practice this art. Yet, the day he is posted to his first charge, he is supposed to be a full-fledged leader in agriculture in the community to which he is posted. The result is obvious and we should not be surprised when the young agricultural officer freshly posted to his charge is such a common butt for the farmers' wry jokes. It is, therefore, essential that the pre-service course comprise effective education in leadership, including reading and role playing.

Instilling a Sense of Discipline

Before giving important responsibilities to graduates fresh from the universities, it is essential to put them through a rigorous period of pre-service training during which discipline would become part of their make-up. If this does not happen, the trainee should be required to leave the academy.

Teaching the Ability to Apply the Scientific Method

Few of us, even after long years of education, are able to apply the scientific method in real life, with the result that even as senior officers we are little more than blindfolded buffaloes going round and round a well, thinking we are making great progress, yet staying at the same place all the time. There is great need that we take off our blinkers, blink our eyes, learn where we are, know where we want to go, select the best path to reach there, check our progress *en route*, and make corrections in the direction of our approach should we be straying from our goal.

Improving Human Relations

An agricultural officer is expected to improve agriculture, and agriculture as practised by people. So effective ways of dealing with people is an essential attribute which must be taught to a probationer in agriculture. Even though some universities may be teaching some courses in fields bearing on human relations, the subject is so important that it must again be brought up strongly at the pre-service training, with emphasis on practical application of human relations skills. After an agricultural officer completes his education at the agricultural academy, he should be capable of leaving a deep favourable imprint on any person he meets.

Acquiring Administrative Skills

The major emphasis of pre-service training should be to teach administrative skills to the probationers. Most agricultural universities either do not teach public administration or do not teach it in a manner designed to improve the administrative capabilities of the future agricultural officers. Pre-service training should include an in-depth study of current agricultural administration and should also include exercises in problem analysis and exploring solutions for cases of maladministration.

Imparting Knowledge of Agricultural History, Laws and Policy

So many of the farmers' problems are caused by human institutions that an effective study of the laws bearing on agriculture, the history of various practices in agriculture, and the evolution of agricultural policy, is essential for the understanding of the current state of agriculture, and for making successful innovations. I do not know how much of this is being taught at present in our agricultural universities, but the subject is so important that it will bear repetition at the level of pre-service training when the trainee will shortly be deeply immersed in real life problems requiring a deep knowledge of these subjects.

Improving Knowledge Base

The agricultural officer has to function as the member of a team along with officers of other departments in the Government hierarchy. His success in furthering the cause of agriculture is, therefore, related to his own effectiveness as an

educated person capable of interacting smoothly with other individuals possessing widely different educational backgrounds. He must, therefore, have wide background of varied knowledge and the acquisition of such a background should be spread over the entire duration of the course.

Increasing Creativity

For conceiving and bringing about a change in statusquo, it is essential to possess creativity. Our early upbringing and our entire educational system is generally geared to curb creativity. In the hope that this curbed creativity can again be brought to life, efforts should be made to teach the subject of increasing creativity as a formal discipline, since it is not only important in agricultural research but in every walk of life where improvement is sought over the practices in vogue at present.

The above list is by no means exhaustive. A comprehensive syllabus for the course can be drawn up by a competent team, after studying the agricultural officer functioning in various capacities in the field.

Duration of Training

The duration of pre-service training should be such as to leave a lasting imprint on the trainee. For this reason, courses of a few months' duration are only apologies for pre-service training and are worse than no training because they leave us with a false sense of accomplishing what we are not accomplishing. In my opinion, one year is the right duration for imparting pre-service training. During this period, the students can be exposed to concentrated knowledge, which is focussed effectively on the task of finding solutions to the problems which they are likely to encounter in their careers.

Who Should Teach Pre-service Courses?

The best teacher for a pre-service course is the one who is well known for his personal accomplishments. Only then does the student perk up to listen and imbibe what he is being taught. Since PARC employs the best talent in the field of agriculture and since it can also call on the services of the best talent for this purpose from within and even outside the country, this is yet another argument for starting the pre-service academy for agriculture under the PARC.

Teaching Methods

The teaching methods used in pre-service training should drastically depart from the conventional lecture method so widely used in our education where the teacher either turns his back on the class and starts writing on the blackboard, or starts dictating from his notes. Every teaching session should be a session in creative interaction in which each student is expected to think creatively and to communicate effectively. The teacher's role should be to stimulate discussion, leaving the students as full participants in the process of learning. In addition, the most modern tools of learning should be utilized including slides, films, and videotapes and real life situations.

Learning Materials

Each learning session should be preceded by wide-ranging forays by the trainees into the field to be explored. This will require a good library well supplied with a wide range of current periodicals. An opportunity should also be taken to introduce the students to latest methods in literature.

Field Studies

All aspects of agriculture ultimately concern the field. Field investigations must, therefore, form an essential part of pre-service training. Field investigations must be planned meticulously around the most important current problems of agriculture, and executed under careful supervision. Through carefully selected field trips, the trainees should be given an intimate knowledge of all aspects of agriculture in the country and all other matters which impinge on agriculture.

IN-SERVICE TRAINING

While the main purpose of pre-service training is to provide motivation for starting a career with enthusiasm and some landmarks to guide the trainees through life, the dominant aim of periodic

in-service training is to keep that enthusiasm alive. For the secret of success in any endeavour lies mainly in the intensity of interest which you take in performing it. Though well conducted pre-service training will frequently hone most trainees to a keen edge for high performance, this edge is frequently blunted by the realities of their working environments after training, where they are generally surrounded by indifference and incompetence. It is, therefore, necessary to take them out of their environments into an atmosphere where they can review their performance with a correct perspective.

In-service courses are also a device for remaining abreast of current knowledge, for imparting new skills, for introducing new instrumentation, for focussing attention on a problem requiring a multidisciplinary approach, and for enhancing capabilities for performing tasks of progressively higher responsibility.

Pre-requisities for In-service Training

Physical Facilities

Where adequate facilities exist for a pre-service course, these can also be utilised for organising in-service training.

Faculty

The most important pre-requisite for in-service training is a group of outstanding individuals who can be mustered to conduct it. In fact this is the pre-requisite for organising such a course. The outstanding performance of PARC in this regard is mainly due to its ability to call on a wide array of institutions all over the World for outstanding individuals for teaching the various short courses they have organised so far.

Teaching an In-service Course

More important than even the pre-service training, the emphasis in in-service training should be on stimulating the creative capabilities of the trainees. The routine lecture approach should be shunned as far as possible. A reading list should be circulated in advance and the lecture session used mainly to generate discussion on the main theme in which the participants should be required to participate actively. Each participant should be observed carefully for his initiative and for his capacity to think originally and creatively. Important field problems concerned with the theme should be selected and the group required to investigate various aproaches for solving them. Participants should be given generous opportunities of expressing themselves verbally, in a variety of situations, and also in writing. Every occasion should be utilized to broaden the education of the trainees and to raise their vision.

13. DEVELOPMENT, FUNCTIONS AND ROLE OF THE NATIONAL AGRICULTURAL RESEARCH CENTRE

G.R. SANDHU* AND M. D. DAWSON**

INTRODUCTION

The National Agricultural Research Centre (NARC) was established in response to an accelerated effort to develop Pakistan's agricultural science and technology through a cooperative federal/provincial agricultural research system. The urgent need and importance of such a central research organization with capability to conduct basic and applied research has been indicated by both Government and review missions from abroad.

A committee of experts was set up following the 1947 Food and Agricultural Conference held in Lahore recommended that the Government of Pakistan establish a comprehensive and fully representative Agricultural Research Council. As an interim measure, first a Food and Agriculture Committee was named and this was replaced in 1951 by the Food and Agricultural Council which continued to function until 1964. The Agricultural Research Council was established by Government of Pakistan Notification, November 26, 1964, with a clear mandate and defined membership. In order to achieve tangible and meaningful results through the research network, the Government appointed a Joint Pak-US Agricultural Research Team in 1968 to make critical appraisal and recommend future strategies. As a result of Cabinet approval, the Council was reorganized and the mandate expanded. A second Pak-American Team in 1973 resulted in a loan agreement between Government of Pakistan and USAID which included specific objectives and the establishment of an institutional base.

NARC Established

In response to the Government of Pakistan's request, USAID agreed to provide the project financial and technical support "to strengthen agricultural research capabilities in Pakistan", which was a major recommendation of the review teams. The main feature of this project was the development of National Agricultural Research Centre with necessary facilities for laboratory and field experimentation as well as a reference library on agriculture, a computerised data base for agricultural research, an information system (CRISP) and other support services to undertake high quality research and also assist the provincial research efforts.

In short, NARC emerged in Pakistan during a period when the capability to conduct long-range multi-disciplinary research on major agricultural commodities and other problems remain inadequate at the Federal and Provincial level.

Scope of Paper

Having provided a synopsis of events leading to the emergence of NARC, it is now necessary to examine the status of those components important in the development and growth of the National Agricultural Research Centre. For convenience, components selected for discussion include:

- Purpose, functions of NARC and leadership roles.
- Internal structure and organization
- Manpower, physical plant and the experimental farm
- Programmes in research, training, technology transfer and station development.
- Linkages of NARC: internal and external

PURPOSE, FUNCTIONS AND LEADERSHIP ROLES

The purpose of strengthening an Agricultural Research System through the establishment of NARC was to recognize those areas of nationally important research particularly *barani* areas where research has not been undertaken due to inade-

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** *Advisor, NARC, Islamabad*

quate facilities, manpower and funding constraints. Complex problems of agriculture demand not only a farming system thrust, but also basic research to generate new concepts and knowledge for utilization in various parts of the country. Indeed NARC has a key role to play in agricultural development and in advancing the economic status of Pakistan through strengthening the Agricultural Research System.

Purpose of NARC

As a national centre of research excellence, NARC will conduct mission-oriented, long-range and basic research, with attention to integrate systems research and by providing programme, resource and service support to provincial institutions to strengthen the national agricultural research system.

Functions of NARC

The NARC will have several important facilities for all the scientists in the country. In particular, it will have well-maintained agricultural library a computer-based data centre, a centre for plant introduction and genetic resources, a Farm Machinery Institute and a centralized facility for instrumentation and repair of laboratory equipment. It will also be a focal point for international and national seminars and conferences on different aspects of agricultural research. Frequent training courses will also be organized for agricultural scientists from different parts of the country. The NARC thrusts are aimed to :

* support provincial institutions by conducting fundamental research, providing analytical reference laboratory services and through establishing a germplasm bank.
* give special emphasis to agricultural problems of rainfed areas and selective research under various National Coordinated Programmes.
* provide farming systems thrust to research and training whereby improved technology and methodology are generated and transmitted by multi-disciplinary teams, to different agro-ecological and socio-economic groups.
* develop a Training Institute for technical scientific and management manpower development.
* provide scientific information and data processing facilities.
* provide repair and maintenance services for sophisticated laboratory equipment.
* provide facilities for graduate and post-doctorate research for all scientists to solve complex problems for which their respective institutions are not adequately equipped.

Leadership: Roles and Participation

Leadership involves two elements: the roles of the people who lead and their effects. It includes all those persons who exercise a management or decision-making role within NARC.

First and foremost, leadership among NARC researchers themselves will be encouraged in developing work habits and attitudes that not only raise the intellectual effort but are innovative, practical and make good team work. Problem identification and analysis in the field, followed by sound research methodology to resolve complex farm problems will be featured. Technical competence and social wisdom in the research system are of equal importance.

Moreover, NARC operation's staff and those who support the scientists are vital to NARC success. Here management skills, commitment and a sense of urgency are leadership qualities which will be encouraged among support staff.

Administrative organization based on a sound research management policy, with lines of responsibility and authority clearly identified, will foster leadership and provide for administrative business efficiency. With promotion of officers increasingly based upon performance achievements, NARC administrative leadership will be further advanced.

INTERNAL STRUCTURE AND ORGANIZATION

The organization of NARC is designed to achieve formal and informal distribution of authority and division of labour among component units.

The proposed NARC organizational chart for NARC (Figure 1) should provide for an easy flow of ideas, instructions and transactions up and down the Centre and laterally among the units

that must cooperate to carry out NARC functions and achieve programme purpose. The Director-General would be responsible to the Chairman, PARC.

Initially, NARC administration would be organized into two line groups: research and operations. Each of these in turn would have subsidiary units. The Deputy Director-General of Research has delegated authority to coordinate all research activities. As Chairman of the NARC Research Committee which plans, monitor and evaluates research programmes, the Deputy Director-General (Research) is responsible to the Director-General. The Agricultural Research Section includes the present Institutes and central laboratories at NARC together with Plant Sciences and other research units included with the Natural Resources.

Operations include technical support and administration services (Figure 1) each with six units under appointed Directors or department heads responsible to the Director-General. The management board, chaired by the Director-General would serve as an advisory body in developing policy and ensuring effective management of all administrative and technical support services.

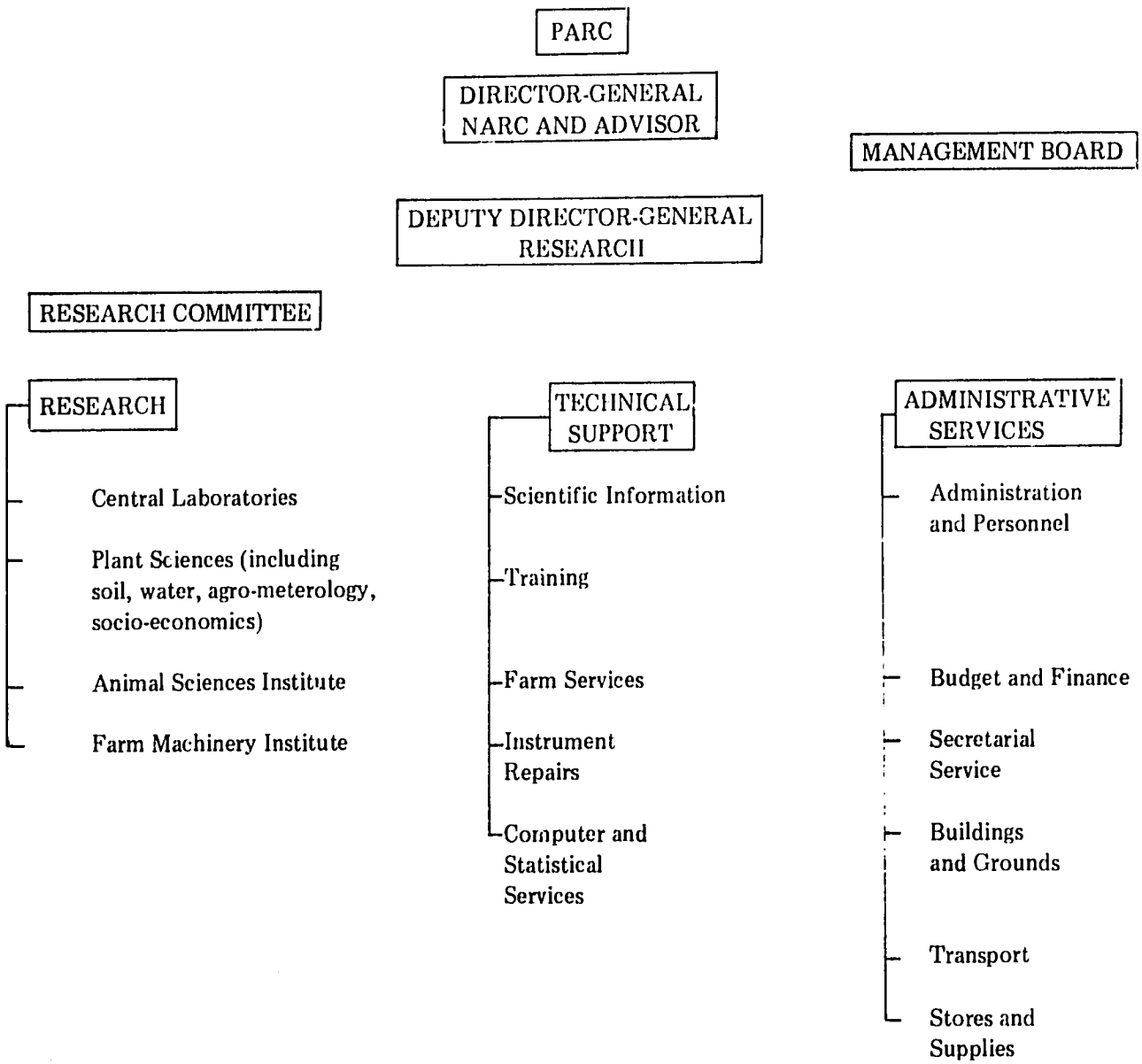

Figure 1. Organizational chart for NARC

Authority Delegation and Control

The proposed organizational chart provides for delegated authority and responsibility yet control is maintained. For instance, Deputy Director-General (Research) provides leadership primarily through the Research Committee and the various NARC technical work groups. Similarly, while control of all operations resides with the Director-General upon actions taken by the management, each Director or unit head of technical support/administrative services has delegated authority to manage effectively. Job descriptions for each management post at NARC have been initiated.

Institute/Laboratory chiefs and heads of research institute or units such as plant protection, soil science, or tissue culture provide supervision over their respective units and laboratories. They are, however, as far as research is concerned, responsible to Deputy Director-General (Research) with control sustained by the Director-General.

In summary, responsibility and authority at NARC will be defined clearly and assigned specifically. Each head of a research section/institute or of a support unit and each programme leader will be thoroughly acquainted with his responsibilities to where he reports, and who reports to him. Yet flexibility will be maintained to assign, promote and allocate skills and capabilities where needed. Programmes and functions at NARC will be distinguished. Line responsibilities are organized according to functional units, while programmes cut across functional units as is shown in Figure 2.

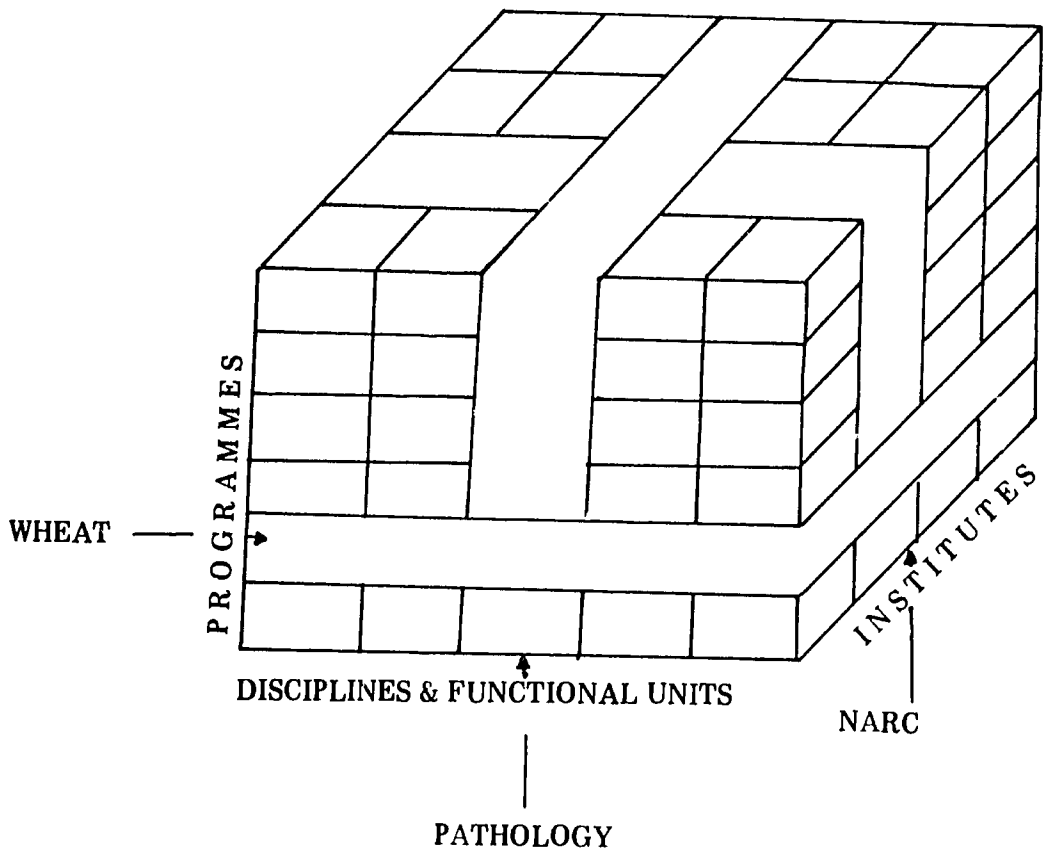

Fig. 2. Three dimensions of programme, functional unit and participating institutes and/or centre

(The 6x5x4 block can be divided into six 5x4 disciplines x institutes programme "Slices", or into five 6x4 programme x institute Disciplines "Slices; or into four 5x6 programme x Discipline institute "Slices").

NARC PROGRAMME

Research

The aim of the research programme is to convert NARC resources into useful products which includes such things as research results, technological information, materials and scientific expertise. Research programmes are designed to fall within the PARC mandate and the stated purpose of the NARC.

Considerable portion of research conducted on the NARC farm originates through the PARC supported national coordinated trials. Other research projects involving selected crops, livestock, farm mechanization and numerous laboratory investigations are carried out on a priority basis by relevant multi-disciplines.

Useful screening trials of cereals, oilseeds, food legumes, vegetables, fruits and fodder/forage crops common to the coordinated programme are conducted at NARC. Some pest management, soil and water management studies have also been initiated. Areas in which research is being conducted by the institutes and laboratories at NARC is shown in the table.

NARC Five-year Research Plan

The research plan will supplement and net supplant the provincial research efforts to resolve farming production storage and marketing constraints under a closely coordinated and well-integrated research system.

Key strategies that guide the development of the NARC five-year research plan (1983—88) and achieve its stated purpose are as follows :

- The NARC will primarily conduct problem/mission-oriented research in areas where provincial research is non-existent or is seriously inadequate to problems of national significance.
- The NARC will also undertake basic, long-range high risk research, the only source of knowledge on the basis of which new advances can be made or new contingencies met as and when they arise.
- The NARC will focus attention to generate site specific tested improved technology for

Areas of research presently conducted at NARC

Plant Sciences	Animal Sciences	Farm Machinery	Central Labs.
— Coordinated varietal improvement and agronomic trials	— Cattle breeding and genetics	— Design and developemnt	— Genetics and cytogenetics
— Barani soil/water management studies	— Animal nutrition	— Testing evaluation	— Tissue culture
— Weed pest and disease studies	— Disease control and prevention	— Mechanization and research	— Pest management
— Long-term cropping system experiments and	— Physiology of reproduction		— Plant diseases
— Long-term fertility trials	— Aquaculture		— Food technology, human nutrition
	— Dairy technology		— Soil physics and chemical analysis
	— Radioimmunoassay		

various *barani* areas and using the Islamabad district as a Model, develop ways and means for its ready adoption by farmers.

- The NARC will emphasise integrative systems research with farming systems thrusts and increased operation efficiency.
- The NARC will provide research support services to provincial research institutes as well to strengthen their research capability to effectively tackle local problems of agricultural production.

Type of research consistent with the above strategies planned at NARC are provided in Annexure I.

Project Proposal, Review and Field Implementation

Research proposals are reviewed by NARC technical work groups and then assessed by the Research Committee according to established format, policy, criteria and procedures. Approved field experiments are transmitted to Farm Service according to prescribed procedures for land and other experimental resource allocations. Provision for research project monitoring and evaluation at NARC is an important research management component implemented recently.

With guidance provided by PARC in developing well-organized and coordinated research programmes and projects with clearly defined objectives and established priorities, NARC is emphasizing the quality of research. Procedures for allocating resources to programmes according to priorities and to connect the research programmes to administrative units have been developed. Yet to emerge, though essential to the system, is to provide for prompt effective reporting of research results and for translating them into action.

Training Institute

The Training Institute facilities consist of a lecture hall, seminar rooms, teaching laboratories, cafeteria and hostel for trainees. The institute organizes short-term training courses for research scientists and extension workers. The training courses and workshop comprise lectures, demonstrations, practical laboratory exercises and field work. The courses are structured to provide the latest knowledge and techniques and are conducted by national and international specialists of repute. A list of training courses and participants and conferences/workshops etc. are presented in Annexure IIA and IIB.

Seminars, Conferences, Workshops

Seminars and Workshops have been conducted at NARC on a variety of topics during the past two years, which, fall into the following three categories:

Science Seminar Committee: The key scientists update results weekly.
Key Theme Symposia: Annually international scientists are to be invited to consider recent accomplishments and the future plans in the subjects as genetic engineering research or agricultural chemistry.
Research Conferences: Specific workshops on topics of high scientific specialisation.

Indeed seminar/workshops serve a useful purpose to inform NARC campus scientists of the breadth and depth of information concepts and methodologies which embrace the entire fields of agricultural and livestock research. There is much opportunity to expand this important multi-disciplinary research activity.

Scientific Information Unit

The lack of research communications is a serious handicap for the scientists in the field of agriculture. PARC/NARC has initiated arrangements to provide the necessary research information to all the research scientists in the country and to keep them abreast of the latest researches abroad. For this purpose, in addition to a well-established library, a computerised service for information storage and retrieval of research is under way for the various agricultural research establishments in the country and abroad.

RESOURCES

Highly qualified and experienced manpower is

the most critical resource in research. Staff positions by advanced degree in each of the agricultural science disciplines is presented in Annexure III.

Only 29 (less than 20 percent) of the NARC staff possess Ph.D. degree. Even more distressing is the virtual absence of well-trained scientists in important fields such as agricultural economics and weed science. Training of staff is of the highest priority.

The NARC support services and administrative staff is presented in Annexure IV. There is no doubt that manpower and in-service training for support staff at NARC should be carefully reviewed. A plan to upgrade support staff competence is being formulated on emergency basis.

Research Farm

The NARC has a research farm extending over 562 ha. Out of this, a block of 20 ha has been precisely levelled and provided with an underground irrigation system. This would be the only area where experiments on irrigated agriculture would be conducted. The rest of the farm has been divided into areas for crop production under rainfed condition. Research and production of forages and livestock under *barani* conditions including improved pasture is planned for about 70 ha. Small areas have also been set aside for seed multiplication and special studies such as the CIDA Barani Research Project.

Annexure V indicates that most of the land development and fencing will be completed within the first quarter of 1984.

Farm operations and services provide the management skills and equipment to service the experimental farm. Indeed, farm service policies and procedures have been developed to assist systematic and effective use of the experimental farm.

LINKAGES AND RELATIONSHIPS

The NARC has an important responsibility to develop linkages with:

- Government planning/finance and expartiate donor agencies,
- Research network institutes and international centres
- Training, extension agencies and the farmer.

Enabling Linkages

It is not enough to generate improved technology alone. Achievements which stem from the research system, deserve to be communicated to the farmers and other potential users through appropriate government officials as well. Pay off from research is vital for a sustained growth in agricultural investment. The demonstration value of NARC will receive emphasis and the socio-economic impact of new technology will be assessed.

Integrated family farming system and component research must be subjected to rigorous cost benefit analysis by a strengthened NARC agricultural economics unit.

PARC/NARC Linkages

By providing resources and facilities for the agricultural research disciplines required to fill in gaps in the country's research system, this mandate given to the Council, is translated in the strategic, tactical, and/or operational research at NARC.

Similarly, back up library, documentation, data processing, repair and maintenance services at NARC, enable the Council to make the National Research System more effective. The NARC Training Institute supplements PARC facilities to provide technical and management training, convene national and international conferences and seminars/workshops aimed at accelerating agricultural production and improving the quality of life in rural areas.

Another NARC/PARC linkage may involve an administrative memorandum between the Chairman, PARC and Director-General, NARC that provides instructions to the Centre concerning manpower, construction, research and/or support services. Apart from the normal PARC monitoring functions the Director-General NARC, would be provided with responsibility and adequate authority to implement the intent of such memos backed

with the resource support needed.

International linkages mean assistance from international experts, training abroad, or exchange of germplasm and other research materials. The activities are carried out or coordinated through NARC/PARC. It is understood that Director-General NARC may proceed directly with international exchanges of germplasm and information provided that (1) PARC is informed and (2) no additional funds or policy matters are involved, in which case approval of PARC/GOP is required.

Research, Extension, Farmer Linkage

A farming system approach provides focus on priority farmer problems. The NARC on-farm trials unit will encourage a strong linkage between research and farmer. Not only can component research or farm machinery design be validated with farmer participation, but entire farming systems may also be studied. Linkages with extension are developed through experimental station, field days, on-farm trials, short course training, workshops and seminars, etc. Extension in the federal area is now the reponsibility of PARC/NARC which provides excellent opportunity to validate research under farm conditions and provide valuable feedback that should guide the future research thrust.

TYPES OF BASIC RESEARCH PROGRAMME EMPHASIS AT NARC LABORATORIES

Soil and Water

Base data for land/water systems analysis and predictive modelling, and programmes to improve management of water resources to minimize plant stress. Impacts of chemicals on agricultural production and the environment. Microbial adaptation and metabolism of pesticides.

Plant Productivity

Acquisition and maintenance of the genetic diversity of plants, beneficial organisms, and pest species; basic studies on genetic engineering and biology of plants, beneficial organisms and pests, fundamental aspects of crop growth. Research programme in chemical weed and insect control.

Animal Productivity

Basic research on improving genetic resistance of animals to diseases and parasites; basic studies on increasing reproductive efficiency; mechanisms of nutrient absorption and synthesis of protein and fat; and integration of efficiency elements of animal production into total management system.

Commodity Conversion and Delivery

Basic mechanisms controlling quality characteristics of marketed products and of means for their genetic and internal control; basic studies on mycotoxin prevention and elimination, basic studies on microbial spoilage agents and pathogen-host associations for preventing contamination: new utilization approaches for exploiting biotechnological advances, adding value, and expanding markets.

Adequate Human Nutrition

Determination of availability of food nutrients and of nutrient requirements for infants, children and adolescents.

Integration of Systems

Assimilation and integration of biological and physical research data into systems for analysing complex interactions of two or more research areas, e.g. animals, plants, and environment.

NARC TRAINING COURSES, DURING 1983

Date	Training course	Participants (with No.)
Jan., 22–27	Managerial Skills Development	Senior Research Officers and Officers from administration, finance—NARC + PARC (15–20).
Feb., 6–10	Training of Mechanics of FMI Developed Reaper	Mechanics (10–15)
Feb., 15–21	Training Course on Beekeeping	Agricultural officers and researchers (30–40)
Feb., 22–24	Training Course on Organic Recycling	Agronomists and soil scientists (15–20)
Feb., 27 – Mar., 1	Training Course on Wheat Pathology	Wheat breeders and pathologists (15–20)
Mar., 3– Apri., 3	Travelling Wheat Seminar	Agronomists, breeders and pathologists (20–30)
Mar., 6–24	Training of Farmers on Operation and Maintenance of FMI Reaper (outside NARC)	Farmers
Mar., 19–25	Travelling Seminar-cum-training Course on Evaluation and Screening of Chickpea Diseases in the Production Areas and Institutes	Agronomists, breeders and pathologists (15–20)
Mar., 27 – Apr., 10	Training Course in Range Management and Forage Production	
Apr., 6–21	Training Course on Farm Maize Research Management	Extensionists and researchers (15–20)
Apr., 19–21	Training Course on Animal Health	Veterinary surgeons and researchers (15–20)
May, 14–24	Training Course on Rice Production	Extensionists and researchers (15–20)
Jul., 24–26	Livestock Feeding Management	Extensionists (15–20)

(Continued)

Aug., 1—4	Problems in Animal Reproduction	Veterinary surgeons
Aug., 7—11	Weed Control in Various Crops	Extensionsists and researchers (20—30)
Sep., 10—Oct., 9	Management of Agricultural Research	Senior Agriculture Research Administrators
Sep., 11—15	Training Course on Rapeseed and Mustard Production	Extensionists and researchers (15—20)
Oct., 9—13	Training Course on Soil Fertility	Extensionists from agricultural department and soil fertility (15—20)
Oct., 24—27	Training Course on Soil and Water Conservation	Researchers and soil conservationists (15—20)
Nov., 20—24	Training Course on Saline Agriculture	Extensionists (15—20)
Dec., 11—15	Seed Production Techniques in Cool Season Vegetable Crops	
Dec., 26—29	Training Course on Agro-Met	Extensionists and researchers (15—20)

CONFERENCES/SEMINARS/SYMPOSIUM/WORKSHOPS

Date	Topic	Participants
Mar., 12–24	Regional Workshop on Least Cost Ration Formulation	30 from different countries
Apr., 2–4	National Seminar on Rice Research and Production	
Apr., 3–5	Technical Meeting of National Experts on Tissue Culture	
Apr., 23–27	National Manpower Development Workshop (Training Needs for the Dairy Sector)	30 heads of departments of private and public sector institutions
July	National Workshop on Manufacturing of Agricultural Machines	
Sep., 4–6	National Symposium and Field Workshop on Maize, Sorghum and Millet	
Oct., 5-6	National Conference on Oilseed Crop	
Dec.	National Conference on Saline Agriculture	

SCIENTIFIC STAFF ACCORDING TO PROGRAMME/INSTITUTE

Programme/Institute	C.S.O.	P.S.O.	S.S.O.	S.O.
Animal Sciences Institute	1	—	4	19
Cereal Diseases Res. Institute	—	1	2	6
Farm Machinery Institute	—	1	2	14
Farm Operations and Services	—	—		1
Fodder and Forage	—	1	2	3
Fruit	—	—	—	2
Food Legumes	—	1	2	6
Honey-bee	—	1	1	3
Maize	—	1	3	5
Food Technology	1	—	—	—
Oilseeds	—	1	5	8
Pest Management	—	1	1	—
Plant Introduction Centre	—	—	1	1
Plant Genetic Resources	—	—	1	3
Rice	1	—	3	3
Soil Science	1	1	2	9
Sugar Crops	—	—	1	2
Tissue Culture	—	—	2	6
Vegetables	—	1	—	2
Water Management	—	—	1	4
Water Measurement	—	—	—	1
Weed Control	—	—	1	1
Wheat, Barley and Triticale	—	1	2	13
Virology	—	1	—	2
Total	4	12	36	114

A SUMMARY OF NARC SUPPORT STAFF
SEPTEMBER, 1983

Category	Number	
1. Director-General's Office		
Liaison Officer	1	
Stenographer	1	
Naib Qasid	2	
Driver	1	
2. Administration Wing		
Administrator	1	
Asstt. Director (Admn.)	1	(On LPR)
Marketing Assistant	1	
Assistant	3	
Stenographer/Typist	2	
U.D.C.	5	
L.D.C.	3	
Driver	2	
Naib Qasid	6	
3. Accounts Branch		
Dy. Director	1	
Accounts Officer	2	
Asstt. Accounts Officer	2	
Assistant	6	
U.D.C.	4	
Naib Qasid	1	
4. Transport Section		
Transport Officer	1	
Assistant	1	
Driver	7	
5. Security Section		
Security Officer	1	
Security Supervisor	1	
Security Guard	9	
6. Landscaping/Nursery		
Dy. Director (Landscaping)	1	
Range Forest Officer	1	
Mali	2	
7. Procurement Section		
Procurement Officer	1	
U.D.C.	1	
Naib Qasid	1	
8. Laboratory Equipment and Maintenance Section		
Dy. Director	1	
Glass Blower	1	
Total	74	

NATIONAL AGRICULTURAL RESEARCH CENTRE STATION DEVELOPMENT NARC ISLAMABAD
(TARGETS AND ACHIEVEMENTS)

S. No.	Works	Target	Achievement	Completion Date	Remarks
1.	Roads	33 km	24 km	30–12–1983	
2.	Land shaping	71 HA	47 HA	30–12–1983	
3.	Drains (surface)	8 km	5.5 km	30–12–1983	
4.	Drain (sub-surface)	1.2 km	1.2 km		
5.	Irrigation channels (surface)	4.5 km	3.5 km	Complete	
6.	Irrigation channels (sub-surface)	1.5 km	1.5 km	30–12–1983	
7.	Reservoirs	2 Nos.	2 Nos.	30–12–1983	
8.	Fencing	15 km	0.5 km	February 1983	It was temporarily held up for want of a decision from the court and now for want of labour.
9.	Implement shed	1 No.	i. Estimate for 4.79 lakh sanctioned ii. All the procurement of material complete iii. Work awarded to contractor		

14. FARM SERVICES

D. J. MINEHART*

On a research station that is devoted to agriculture there are usually a number of laboratories manned by research scientists who seldom see the end-result of their experimentation – a bumper crop for the farmer. In fact, many of them are hardly conversant with farmers or their problems.

There is, however, one laboratory that duplicates the farmers' conditions and that is the field. This is the basic laboratory on any agricultural research station. All other research is incidental and supplementary to the final testing of the various research hypotheses on the farm land. If it does not generate a higher yield to the farmer then it hasn't a great deal of rationale for its funding by the Government exchequer. The proof of the validity of research is the yield.

On many of the research stations in Pakistan, there seems to be lack of agronomic trials and research, or simply a duplication of those carried out for the past several decades. The key to research is true professionalism. This is characterised by good training, good tools, good working conditions, and by a commitment to the goal of all agricultural researchers, valid research results that benefit the farmer. This is the final use of the research – sowing the crop and reaping the harvest.

A research scientist should not be expected to be conversant with all the tools and implements that can be used to till the land, prepare the seedbed, sow the crop, keep it weed-free, apply the fertilizer and the water, and harvest the crop. Obviously, with every crop, there are special implements with which the researcher may have some experience and which he has operated to varying degrees. Few, if any, are experienced beyond this point. Even so, most researchers will tell the farm service people to give them a certain implement with no indication of what is to be done. By the same token requests come for irrigation with no valid, scientific reason for the irrigation except the surface is dry. To most of the research staff, farm services are simply the supplying of tools to the researchers. It is this approach with its resultant mismanagement that renders much of the research effort dubious.

The farm services division of an experiment station should be able to plan for the ensuing crop while one is being raised. Proper rotations can be fitted in, fertilizer use monitored and recorded so that the man doing research work on that plot the following year has a full history of the treatments that could affect the yield or behaviour of his experiment. At most stations, this is not being done at present since there is no appreciation of the problem. Most researchers would like a permanent assignment of land that they could manage unhindered by any other programmes or needs. This, of course, is not possible in a multidisciplinary research centre. Programme aims and intentions change almost annually. While there is enough land when a station is new to assign land, it is obvious that it must change in a few years. For that reason, it is good to begin the proper programme from the start.

Farm services run the entire gamut of farming. For the purposes of this presentation, we will confine it to the following areas :

- Land allocation
- Land preparation
- Sowing
- Chemical application ; fertilizer, weedicides and pesticides
- Inter-tillage
- Irrigation
- Harvesting
- Storage
- Equipment procurement and maintenance
- Labour

LAND ALLOCATION

It is essential that the farm operations staff

* *Consultant, NARC, Islamabad*

know well in advance what crop operations are planned for each season. They are the only people who are aware of tentative principal occupiers of any piece of land and thus know when it will be occupied for its present basic assigned purpose. For instance, if it has been assigned for experimental wheat plots during *rabi*, it must be vacated by October 10 to 15, must not have any large or irregular dosages of fertilizer and must not be cut up, impairing large-scale plot work.

While allocating land for the coming *rabi* crop, the farm services look ahead to next year's *kharif* crop. That is why they insist that they must know the long range plans of each group of researchers. It gives them time to plan all of the operations as well as ample time to carry them out. In that way, the land will be ready on time and it will be in good condition. It is terribly disconcerting to have people come around after the rains and ask them to get the land prepared immediately. With rains throwing off any attempts at scheduling it sometimes takes weeks to prepare land and even that is miserably done.

On a medium to large research centre, it is dangerous to allot land to programmes for more than three years. There is a tendency to set up small kingdoms and before long landscaping, flower and tree planting, small buildings and other permanent fixtures start appearing. Admittedly, there will be some of this, where horticulture is concerned but only with fruit tree plantings. In the interest of the centre, it is better to rotate the land so that there will be no complaints about who has good soil, better water facilities, closer accommodation to the buildings, etc. Everyone is treated the same over a period of time.

Every year there must be a review of the allotment of land along with its record of use, and changes made where the land is either too much or too little. In other words, allotments are not to be sacred nor inviolate.

In this regard, it might be noted that normally it is not possible to allot land to any programme in a contiguous block. The precision cropped area at most centres is also the precision levelled area and crops that will be demanding irrigation will be assigned to this area while *barani* crops will be outside that area. It has only been in this part of the world that the idea of crop-oriented farms still holds forth. It is being breached now and while there is a tendency to set up wheat blocks, maize blocks, vegetable blocks, etc., the concept is loosing ground as one looks at the new research centres. Crop rotations, heterogeneity of soils, patterns of drainage, availability of irrigation all are more important to the researcher than the continued occupancy of a piece of land. This bodes well for the research programme.

LAND PREPARATION

There is always a problem with the preparation of land on a newly developed station. Land shaping, land smoothing, ditch and road realignment, and irrigation water—all pose problems during the initial years. Deep cuts and deep fills cause aberrations in crop yields for a few years when the land is coming into shape. There is a tendency to think that all hard spots are permanent and are the result of incompetent preparatory measures. No amount of explanation will satisfy some of the researchers who feel that all that is needed is to cultivate the land with a field cultivator and drag a *sohaga* over it.

Primary tillage, or its absence is one of the greatest impediments to crop production in Pakistan. The field cultivator with its semi-rounded chisel goes to a depth of four to six inches and leaves a hard pan where the chisel compacts the soil. Carrying out this operation over a number of years develop a layer that is nearly impenetrable to the root system of any crop. Confining 90 percent of the roots to the top 10 percent of the root zone creates a major problem in production.

Proper land preparation is more than just deep tillage which should vary from 15–30 cm just to prevent any development of plough pan. It should be done with a plough that is sharp and properly designed so as to minimize the tendency to form a pan. It is in the secondary operations that so much misunderstanding takes place. This should be the final seed-bed preparation. Unfortunately, on most research farms that is not the case.

A belated ploughing, when the land is too wet or too dry, may leave a mess in the field that no implement can set right. This tends to be more the rule, than the exception. It points to the need for proper planning for timely operations.

A disc-harrow is usually adequate for secondary tillage. There is some clod breaking but essentially all that is done is some re-arrangement of the soil particles so that more of the smaller ones are on the surface presenting a better seedbed. This is adequate for machine planting. Usually nothing more needs to be done. If the proper planning has gone into the operation, the fertilizer is spread between the ploughing and harrowing. On land that has been levelled and is to be irrigated there may be need for the use of the land plane. Since this is a packing operation, normally the land planer can be used in place of the disc and a spike tooth harrow used to rough up the ground surface prior to planting.

It is hoped that in the near future the idea prevalent in Pakistan that a dry, loose, and friable seed-bed is best can be changed. This is true for the labourers who pull hand-drawn markers and *desi* drills across the plots. Unfortunately, it is very unscientific. Nearly all seeds call for a moist, firm seed-bed. It is not possible with a field cultivator and *sohaga* to give this type of bed. The result is a comedy of errors as the land is prepared.

Suffice it to say, that if there is proper lead time given to the farm services people, the land can be prepared properly so that a good seed-bed awaits the researcher. It requires the cooperation of both the researcher and the farm operators.

SOWING

What constitutes a good seed-bed? The first criterion is that the soil should be suitable to the crop grown. The second is that moisture should be available not only to germinate the seed but to sustain the plant until the soil water is replenished or the roots have gone down to more available water. I have mentioned nothing about aeration or fertility since at this initial stage it is not so important. Once the plant takes root then nutrients become important. Studies made in the Great Plains of the US under minimum tillage and limited water supply have lent some credibility to the statements that aeration is not as important as was once believed.

Given a smooth seed-bed with an adequate amount of moisture, well packed to eliminate any premature drying of the soil due to air pockets, what is the best way to handle it?

At the start, let us admit that there does exist a rationale for hand-planting. If you have a small handful of seeds and your plot is only one row less than a metre long you can hardly justify machine planting. If your row is over 3 m long there is good equipment, even hand pushed, that can do so much better a job of planting than can a person who is dropping seed into a small furrow.

Most stations now have self-propelled drills and planters that make simple work out of this operation. There are mounted planters that fit on the tractor and there are small manually-operated drills that can put in single row or multiple rows. They space the rows evenly and distribute the seed evenly in rows. Every crop grown on our research farms can be and should be planted mechanically. It is the best example of the absolute superiority of machine over man.

Improper row spacing causes all kinds of problems in cultivation. Rows should be spaced based on the cultivation equipment that is available. Insofar as possible, on any research station, row width should be standardized whether it be at 60 cm or 75 cm but it should be the same for all row crops. Plant population can be controlled by the plant to plant distance in the rows.

Seed rates are far too high on most plantings in Pakistan. This is especially true for small seeded crops such as mustard, rape, berseem, lucerne, etc. A properly adjusted drill can put the correct seed rate in the soil and eliminate most of the tedious job of thinning the crop. On berseem and lucerne there is seldom any thinning done and yields of both these crops are terribly low since the high plant populations are conducive to stems and not leaves.

One more point must be mentioned. During *kharif*, monsoon rains create drainage problems. Therefore, rows should be planted on ridges with the slope so that drainage is effected on all crops. During *rabi*, if the crop is to be irrigated at all, the rows again should be planted on ridges. In that eventuality, all irrigation is done in furrows precluding standing water around the crops. Suffice it to say that all row crops then should be planted on ridges or beds on all research stations. It is a practice with which our researchers must be familiar.

APPLICATION OF CHEMICALS

This is primarily the responsibility of the researcher. He determines as to what type of fertilizer is needed, how much it is needed and when to apply it. The same holds true in case of pesticides and insecticides. The latter two usually need specialized plot equipment which is available to the various programmes. On some stations, all equipment is commonly used and the farm service operations people take the lead in carrying out the various operations when requested by the programmes. Again, rates of application are, determined by the researcher while the responsibility for doing it correctly rests with the farm service staff.

This is perhaps the least understood and the most mismanaged aspect of farm operations. The handling of farm chemicals and their proper distribution on land and crops is a science. Therefore, a station must have a farm chemicals specialist on its staff. There are too few of them in the country. Simple operations such as spreading fertilizer are botched by broadcasting by hand. There is no way that one can get a uniform application of fertilizer when it is done by hand. Even the rotary broadcaster is misused as the distance between tractor runs, is seldom calculated and the normal procedure is to keep running the spreader over the land until it runs out of fertilizer. Uniformity under these conditions is also impossible. Equipment can be calibrated, speed can be controlled, and one pass over the land should be sufficient.

Weedicides and pesticides, if applied properly, can be very effective. Inappropriate amounts, poorly calibrated machines, incorrect PTO speeds, fluctuating pressures and careless handling of chemicals—all contribute to an ineffective application of agricultural chemicals. Hardier strains of insects and increased weed populations are the only result.

INTER-TILLAGE

Primarily, inter-tillage consists of labourers and *kirpans*. Care is taken not to kill the weeds but to take the foliage for fodder and allow a re-growth of weeds. Much has been said in this regard by many weed control specialists. At least 30 percent and perhaps as much as 80 percent increases in *kharif* yield can be attained if weeds are properly controlled.

The least expensive way to check the weeds is through inter-tillage or cultivation of row crops. The only effective way to do this is through mechanical means. A bullock-drawn cultivator, a hand-pushed one, or a tractor-drawn cultivator can eliminate 80 to 90 percent of the weeds between rows. The secret is uniformly spaced rows and spaced wide enough so that equipment can be moved between the rows. Again the minimum spacing should be 60 cm with the optimum being 75 cm. Tractors can move through the latter without the risk of running over the crop. The operator can spend more time watching his cultivator and less time watching tractor's wheels.

The use of a lister cultivator to hill up the crop on the last cultivation is recommended. This covers weeds, adds stability to the plant and gives a furrow for late season irrigation.

IRRIGATION

Perhaps more experiments in Pakistan are rendered unreliable due to irrigation than any other single practice. No one can tell whether one gave 10 or 100 cm of water to the crop; there are experiments reported with 20 cm of water, or 30 cm and even more given as the amount that was applied. Such precision is impossible at nearly all research centres.

At NARC, there is only one organization, the Land and Water Resources Unit, that has even the slightest idea of how many acre-inches, or square metre-centimetres of water were applied to a given area but they gave it up as a useless experiment since it was obvious to them that there was no uniformity of water application on any plot. Ten centimetres applied to a plot using cut throat flumes to measure could be achieved. Unfortunately the lack of levelling gave 2.5 to 5.0 cm on the high side of the plot and 12.5 to 15 cm on the low side. Less than half the plot got judicious irrigation. Reporting results from that kind of research is not worth the effort nor the paper.

Another problem is that the research scientist is satisfied when he sees water going into his plot. He then returns to his office or catches the bus home leaving his experiment at the mercy of a field

assistant and some labourers. The field assistant soon leaves the place, (it makes little difference as he was doing nothing as he knew nothing about the job). So, the experiment which is the entire annual output of the research scientist is under the care of untrained, indifferent labourers. It is appalling when some of these experiments are subsequently reported and printed. When a labourer stands in the field with a shovel and throws water on dry spots so as to dupe the experimenter it is utter folly to say the plot was irrigated. Such a plot is not even watered.

A third problem is over-irrigation. Nearly every researcher scuffs the surface of the soil with his shoe so as to know how his plants are suffering. Every week to 10 days from germination to harvest he must have water on his crop. No matter how much water is in the root zone, no matter if there has been 75 cm of monsoon rain with no consumptive use of more than 35 to 50 cm, they must irrigate. They shout in indignation if anyone questions the crop's need for water.

Undoubtedly, no facet of agriculture is less properly managed than the application of water. And none influences the results of experiments as much as water. Even deficiencies of soil may be overcome with judicious applications of soil amendments, but if water is not judiciously applied the rest is wasted. Recognizing this interaction of the soil-plant-water relationship, most scientists relegate the application of water to untrained persons with about the same concern as they have for the potted plants that adorn their doorstep or footpaths.

It is hoped that the NARC would hold a series of seminars and training sessions over the next year for teaching the science of irrigation to agriculturists. There is little doubt that the mismanaged application of water introduces a major error into nearly all agricultural research. It is high time to rectify this error.

It is suggested that on experiment stations there should be a small, trained cadre of irrigators under an irrigation engineer who should determine the necessity for irrigation, set up water regimes for the crops, work out the correct methodology and ensure that the right amount of water is applied at the appropriate times. This is of paramount importance when the irrigation itself is one of the variables in the experiment. As scientists, researchers must dispel the mentality of three, four or five irrigations or normal irrigations. It is a most unscientific approach and is one of the causes of the salinization and water-logging of vast areas of Pakistan.

Farm services should supply water for irrigation but it must be on a par with the same scientific endeavour that goes into seed selection, planting methods, choices and rates of soil amendments, and analyzing the results.

HARVESTING

Many changes have been made in some of the crop disciplines in harvesting of the crops. The most radical and certainly one that can and should enhance accuracy is the process of mechanization. This is qualified since incorrectly adjusted harvesters lose and break seeds causing errors to creep into results. A combine that leaves a high percentage of the seed unthreshed due to an incorrect concave cylinder adjustment is less useful than the bullocks on the threshing floor. Or a combine that drops a high percentage of the seed in front of the cutter bar is of no value to a researcher. Cutting too high, providing too much wind and blowing away the seed, separation sieves not properly set, and weeds choking the cylinder all cause seed losses that are inexplicable to the scientist who thought he had a good crop standing in the field.

Since many of the individual crop disciplines have purchased their own combines or threshers they feel that they have no need to call on the farm services division for assistance. This affects only a small percentage of the crops harvested. Even then, supplemental assistance is needed in handling border rows and bulk plantings. Also, there is always the problem of adjustment of the harvesters, repair of broken parts, etc.

The remainder of the researchers must call on the farm services division to assist them in their harvest operations. For this purpose it is essential to have at least an agricultural engineer on the staff who, in addition to his work, is conversant in adjustment of harvesters and threshers. Few agronomists in Pakistan are trained in the use and adjustment of farm machinery. A good farm services organization should have all the necessary

harvesting equipment including mowers, threshers, combines, and forage harvesting equipment plus the manpower to maintain and operate the equipment.

STORAGE

One of the important aspects of farm services is to maintain an effective store of farm inputs such as seed for bulk plantings, fertilizer in the kinds and amounts that will satisfy both the researchers and the seed multipliers, pesticides and weedicides in basic amounts plus the many tools that are needed to perform the hand labour jobs on the farm.

Storage of farm machinery, particularly large specialized equipment, should be the responsibility of farm services. Small equipment such as cleaners, single head threshers, dusters and treaters, scales, etc., should be under the care of the people who use them.

In addition to the farm inputs, the farm services division must provide for storage of the harvested crops and see that these are properly labelled and treated. Small samples would be under the control of the individual crop disciplines even though the storage may be centralized. The use of assigned areas, bins and shelves should be a part of the operations.

Bulk seed should be cleaned by the Farm Services Division before being treated and stored. Unused seed from the programmes should also be turned over to the Farm Services Section and the seed handled properly for eventual disposition whether destroyed, sold or planted out the following year.

EQUIPMENT PROCUREMENT AND MAINTENANCE

One of the major functions of farm services is to see that the proper equipment is on hand to do the work necessary in running a research centre. The number of tractors, their horsepower, their attachments and options, and their necessary fast moving spares should be ascertained. Properly trained operators backstopped by good mechanics are essential. Training should be imparted to these people at regular intervals so that the operators and mechanics are kept up-to-date on new trends and technology.

The proper farm machinery is of vital importance and at this point input is needed from the various programmes. Basic machinery such as ploughs, discs, harrows, field cultivators, and grain drills are normally on hand. Most good research centers have a rotovator. Some have a few harvesters of various types.

From that point on specialization is the order of business. Land planes, scrapers, ditchers, border ridgers furrow ploughs and bed formers are essential where irrigation is done. Corn planters, vegetable hoppers, varied seed plates, row crop cultivators, thinners, and rotary cutters are needed wherever row crops are planted. Deep furrow grain drills, mowers, forage equipment, pumps, sprinkler irrigation systems, gated pipes, combines, threshing machines, rotary hoes, spike toothed harrows, reversible ploughs—all these things are needed by various programmes. There is more that can be added to the list if one considers rice, sugarcane, groundnuts, tobacco, cotton and other specialized crops. Again, the input from the crop disciplines is essential in order that new and useful equipment is made available to the researcher.

As was mentioned under tractors, a well trained workshop staff is essential to maintain this huge assortment of machinery. Good tools, used by trained mechanics and fitters, are necessary. In order to find these men it will be essential to adjust salaries. In the western world, a good mechanic earns more than most college graduates. He is simply more important and is paid on that basis. Poorly trained mechanics even with good tools at hand will assure that equipment is out of use when needed most. On a research farm that factor can be the difference between valid research results and a lost year or a lost programme.

LABOUR

The last input from farm services is manpower. On most research stations, the programmes hire their own labourers. In some programmes, there is permanent labour force with a fluctuating roster during peak seasons.

There have been a number of attempts on the part of most research coordinators to have a common pool of labour. Apparently, it has had some rather unspectacular results in Pakistan with

unions causing all sorts of troubles. Decentralization has weakened this facet and most research coordinators feel that pooling of labour is not in the interests of the research station.

One problem must be taken into account and that is the uniformity of hours and the regulation of overtime pay. This may become scandalous and create many problems in regard to labour utilization.

There is a tendency to have too many labourers on most farms. Mechanization can eliminate 50 to 60 percent of the total labour and the jobs will be done more effectively as well as more efficiently. Much of the antiquated research methodology in this country stems from the myth of the superiority of hand labour. It is self-aggrandizing and self-fulfilling. And the labourer continue to dictate the method of soil preparation, the method of planting, the inter-tillage, the irrigation, and the harvesting of the experimental plots. Until these are put in the hands of the research scientists, who can call on an effective and efficient farm service division, research efforts in Pakistan are going to remain dismal.

15. RESEARCH INFORMATION SYSTEM FOR AGRICULTURE IN PAKISTAN

ANWAR ALI CHAUDHRY*

INTRODUCTION

Within the theme of agricultural research system I wish to open my discourse with a very pertinent quotation from Loeb (1923) regarding library's place in research. "Real discoveries are actually made in the library and subsequently tested out in the laboratory. A new discovery is a new combination of old ideas and those combinations are most likely to occur in the mind of the scientist not when he is handling material things but he is brooding over thoughts of other men and thinking them himself. In those hours of profound reflections, the new combinations may occur to him and then he goes to the laboratory to verify or disprove. The library remains the great essential to discovery". An important corollary to this assertion is the creativity of the scientist has a positive correlation with the volume of information imbibed by him.

The scientific potential of a country can be adjudged by four parameters, namely, the supply of manpower; the supply of scientific information; technical and financial resources, and the form and organization of the system (Doborov, 1968). The supply of scientific information is of paramount importance because science can also be defined as a process that uses information to create new information.

IMPORTANCE OF INFORMATION

In this age of science and technology, information is an important national resource for development, but as against other resources it is not scarce. The contribution of agricultural information to national economy can be well estimated from two examples: from 1960 to 1970 it has led to 100 percent rise of rubber yields in Malaysian small holdings (Thomas, 1970) and 20 percent rise of rice yields in the Philippines (FAO,1971). It is also estimated that due to non-availability of relevant information in time unintentionally duplicated research accounts for over ten percent of the expenditure on research and development even in countries with good information services (Penna, 1970). The proportion of this wastage will, inevitably, be much higher in countries with less developed information system.

INFORMATION EXPLOSION

Individually, we are becoming relatively more ignorant with each passing day because the rapid developments in science leave an individual groping far behind. This is explained by Lukasiewiez 1972, very aptly, "We may thus define a 'man's degree of grasp' as the ratio of information the human intellect is capable of retaining and handling to the total volume of information available, and the 'degree of ignorance' as the analogous ratio involving all the remaining information (beyond a man's grasp)". According to Price (1971) the scientific information is being doubled every ten years. The maxim of 'publish or perish' has inevitably transformed the problem of 'information explosion' into 'literature explosion' through repetitive reproduction of the existing information. According to Bourgeois (1956) out of 100 technical articles only 8 made a really original contribution to learning and research. A physician or medical researcher would take some 55 centuries to read just one year's output of literature in his field (Saunders, 1980) which is indicative of absolute inability of a scientist to read or even glance through the new literature.

To help the scientists, worried of being burried under the mass of ever-increasing literature, a new specialization, called information science, came into existence. Information science is that

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branch of knowledge which investigates the properties and behaviour of information, the factors governing the information flow and means of processing information for optimum accessibility and usability.

INFORMATION NEEDS OF RESEARCH SCIENTISTS

The information that the scientists use can be classified into three types: i) the current information that is needed for research planning, (ii) the on-going information that is required to sustain the research progress, and (iii) the in-depth information that is necessary to thoroughly test the results and evaluate their worth in the light of other research in the field. According to UNESCO (1976) estimates, scientists spend 60—80 percent of their time on information handling and processing. Here the information scientist proves of immense help to save the time of the scientist by sifting the grain from the chaff. In this regard, another UNESCO study (1974) concluded, "A well-managed national information system will provide information: selected on the basis of the users' requirements; presented in a consolidated form (most of the time a state-of-the-art review, for example, will present the information of the primary publications in usually less than one-tenth of the space). The sum of these two operations will allow the users of a well-managed national system to receive the same information in less than ten percent of the time required before. . ."

The efficiency of the scientist is adversely affected if he is separated for some time from the library. In a survey of agricultural libraries in developing countries, Parker and Carabelli (1970) found, "The young research workers, who have recently returned from intensive overseas advanced training in their field of specialization, stated that after six months of separation from a good library they feel that they became 'rusty' and that their efficiency is affected."

Much of the brain-drain from the developing countries can be explained by the fact that the scientists have limited access to information, pertaining to their subject interests in their own countries. Nobel Laureate, Dr. Abdus Salam (1981) stated his painful experience of making a hard choice between "either to remain in physics or in Pakistan". Such an experience is not specific with Dr. Abdus Salam. Penna (1970), as well, concluded, "Good library and documentation services are necessary if the services of research workers of high quality are to be retained. One reason given by research workers for moving from less- to more-developed countries is the greater accessibility and quality of library and information services. The provision of good library services will help to stem this brain-drain."

HISTORY OF SCIENTIFIC INFORMATION IN PAKISTAN

Pakistan has been very late to appreciate the importance of scientific information in agricultural research. At national level, the necessity of meeting the information needs of agricultural researchers was, for the first time, realised in 1973 when a Documentation Centre was established in Agricultural Research Council (now Pakistan Agricultural Research Council). With the expansion of its activities and commitments, the Documentation Centre was transformed into the Directorate of Scientific Information in 1977. However, no comprehensive effort could be initiated to build a national system of scientific information. Even today, the infrastructure of research information in the country is very rudimentary. Except in Punjab, where a full-fledged Directorate of Agricultural Information had been created in 1978, in all other provinces any formal structure is almost non-existent. In NWFP, however, Bureau of Agricultural Information has been created very recently.

In 1976, a joint IDRC/UNDP Mission visited Pakistan to study and advise on the organization of National Scientific Information System. The Mission proposed the networking of the available information resources of the country. PASTIC was assigned the role of coordinating the national network termed PakSTI Network in all the scientific disciplines. Unluckily, due to some administrative constraints this concept could not be developed further. Pakistan Agricultural Research Council was designated the National Focal Point for agriculture in the PakSTI Network.

NATIONAL INFORMATION SYSTEM

A national information system is a coordinated network of libraries, documentation and information centres, aimed at optimum utilization

of information resources, through putting everyone, regardless of his affiliation or location, within the reach of a branch of this network. Presently, no such system exists in Pakistan in any field of science.

For creating a research information system what is envisaged, is a sort of federation of many scattered existing libraries information centres in the first phase and establishing new centres for neglected disciplines in the second. This type of resource sharing amongst the libraries is the trend of the day because of the growing inability of any single library, in developing countries with severe stringency of financial resources, to procure all important information, due to rapidly rising cost of printed word.

In Pakistan, the information services are facing the following major constraints:

- insufficient reading stocks
- low number of journal subscriptions
- insufficient funds
- shortage of trained manpower
- lack of cooperation, resulting in wastage on duplicate procurement by even neighbouring libraries
- absence of Union Catalogue of Books and Union List of Journals, limiting resource sharing and inter-library loaning
- absence of coordination, leading to adoption of independent storage and retrieval systems, without consideration of mutual compatibility.

All these constraints can be broadly divided into three categories namely, shortage of manpower and material resources; absence of national inventory of library holdings, and absence of coordination in procurement, processing and use of information.

To make up these inadequacies there is an urgent need for creating a national network of cooperating libraries, without disturbing their status and administrative set-up. The links among different nodes of the network will be based on:

- common objectives
- shared knowledge of the operations of all participating libraries
- compatibility among those operations
- practical working arrangements for collaborative efforts to increase and accelerate information flow
- each participant, while maintaining liberty of action, has access to several other sources in the network, thereby facilitating better information services to the users.

NETWORK STRATEGY

There are many kinds of library networks out of which following are the important ones.

Non-directed Network

It is totally decentralized structure in which all the participating institutions or nodes can communicate directly with one another (Figure 1). The formula for calculating the number of communication links is $C = N\left(\frac{N-1}{2}\right)$, where, C represents the communication links and N the number of nodes in the network.

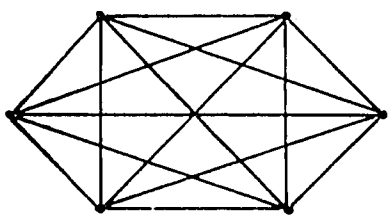

Fig. 1. Non-directed network

Directed Network

It is a centralized structure in which the nodes are linked indirectly through a switching centre (Figure 2). The formula for calculating the number of communication links is $C = N-1$.

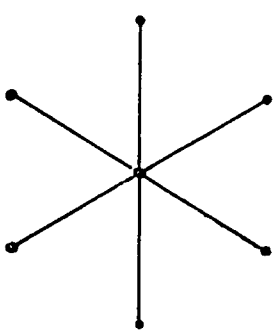

Fig. 2. Directed network

Composite Network

It is an interface of two or more directed networks, in which a number of nodes are connected to a common switching centre, as in directed network and all switching centres, in turn are connected to each other as in non-directed network (Figure 3).

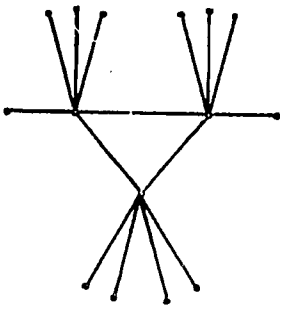

Fig. 3. Composite network

Keeping in view the geographic concentration of our agricultural research and academic institutions at a few locations like Faisalabad, Lahore, Rawalpindi/Islamabad, Peshawar, Hyderabad, Karachi and Quetta, the composite type of network seems most suitable. In this network, one switching centre (coordinating unit) may be established at each of the forementioned locations, having the non-directed network of local institutions. These switching centres can form a directed network with National Focal Point (PARC). The tentative configuration of the proposed national network is shown in Figure 4.

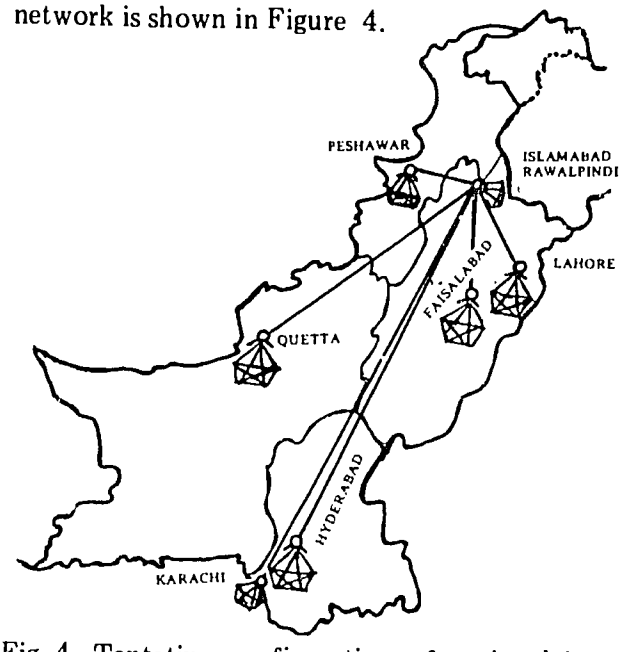

Fig. 4. Tentative configuration of national information network for agriculture

Due to concentration of generators and users of research information (research workers), the first preference should be given to research institutions while designating the coordinating units.

PREREQUISITES AND PRODUCTS OF CO-OPERATIVE NETWORKING

National Inventory of Information Resources

For any sound planning, the knowledge of the existing resources is a necessary prerequisite. Unfortunately, no such survey has been conducted for the agricultural libraries and information services in Pakistan. There are hardly two or three studies as thesis requirements for Master's degree in Library Science. These, too, were not comprehensive in scope and coverage.

As a first step in cooperative working, a detailed survey of existing resources should be undertaken to identify the gap in the present infrastructure and thereafter an appropriate strategy be evolved to plug these gaps. The items in this survey would include the total library holdings, the storage and retrieval systems, budget, technical and non-technical staff, journal subscription, etc.

Union Catalogue of Books and Union List of Journals

Union catalogue or union list is a joint catalogue, listing the holdings of more than one library. The major advantages of the union catalogue include:

- ease in locating the documents which results in increased utilization through inter-library loaning
- encouragement of research through easy access to required information
- identification of overall gaps and duplication in coverage of specific subjects thus facilitating cooperative acquisition.

However, to build a union catalogue, the holdings of individual libraries must be processed (classified and catalogued) while in many cases, much of the stocks are unprocessed, mainly due to

shortage of trained manpower. In the beginning only those libraries may be included in the network whose holdings are processed.

The libraries where the holdings are not processed, the librarians are trapped in a vicious circle of time wastage. In the absence of a catalogue they spend most of their time in locating the references, again finding very little time for processing the backlog and the new arrivals. The situation can be helped by establishing a pool of a few professionals who can be seconded for specific periods to different institutions on request.

Cooperative Acquisition

Rapidly rising cost of publications is pressing hard to avoid unnecessary duplicate procurement. To ease this squeeze due to paucity of funds we have to resort to cooperative acquisition, especially in case of expensive and little used publications, at least by libraries having the geographic proximity. Presently there is no such consideration and at one time in Rawalpindi/Islamabad three libraries were subscribing to the most expensive periodical, 'Chemical Abstracts' for which one subscription costs about 0.11 million rupees.

In the present age of rapid communication, the emphasis has shifted from books to journals. It would, therefore, be advisable to spend library budgets proportionately on the procurement of journals and books near the ratio, 4:1 to approximately match the contribution of journals and books in the dissemination of new knowledge. As our major emphasis would be on journals we can find what percentage of the most important journals can be procured with the present overall allocations for the procurement of journals. In 1976 the IDRC/UNDP Mission (PSF, 1976) estimated that Pakistan is spending about 0.5 million dollars per annum on procurement of journals and in the same amount it can procure 10 percent of the most important journals through cooperative acquisition.

There is a tendency to concentration of the really important literature in a very limited group of 'star' Journals. Brown (1956) found that in chemistry, 90 percent of references lead back to only 37 percent of the periodicals. An empirical index to the importance of information is usually considered to be the number of times a piece of information is cited in other sources, and many tools such as 'Science Citation Index', are helpful to identify this.

National Data Base

It is an open-ended inventory of all the documents published in the country. It is essential to identify, locate and use the nationally produced, and naturally most relevant information, besides enabling participation in international exchange of information through systems like AGRIS (International Information System for Agricultural Sciences and Technology) of FAO in which PARC is presently participating as National Liaison Office. Number one problem in the establishment of National Data Base is the inability to know what is being published. As a consequence of this difficulty, one cannot approach confidently to any library or agency where he can find comprehensive collection of all national documents published on agriculture. The solution to this problem is the bibliographic control through assigning specific number to every document published on agriculture in the counry. Provincial Agricultural Information Agencies can take this role. Nothing should be published unless document number has been got assigned from the concerned agency. To have at least one copy of every document published in the country, National Repository on Agricultue should be designated which would require every publisher to submit one copy of each publication. These arrangements will also facilitate the compilation of National Bibliography of Agriculture.

CURRENT AWARENESS SERVICE

Among current awareness service, SDI (Selective Dissemination of Information) is the most important one. It means notifying to the individuals the bibliographic details of documents which are likely to be of specific interest to them. The SDI service is an inevitable outcome of information explosion. Manual SDI service is, however, most time-consuming and costly affair. It is cost-effective when computerised. PARC is in the process of establishing the SDI service, firstly on a level to meet the subject interests of specialised groups/institutions which later on can be expanded to reach the individual scientists. Hopefully, the

service will become operative during the next calendar year. Other tools of current awareness are 'contents of current journals', 'fresh arrivals',etc.

INTERNATIONAL LINKAGE AND DOCUMENT DELIVERY SERVICE

For access to the world store of information, international linkages should be fostered. Many international data bases such as AGRIS, AGRICOLA, CAB are offering bibliographic services worldwide. However, after getting the bibliography on a particular subject, the next most difficult step is the procurement of required documents, especially from abroad because of constraints of foreign exchange payments, high copying costs, long turn-out time, etc. A document of 10 pages or part thereof costs about 50—60 rupees, if procured from abroad and the average turn-out time is more than eight weeks. It has been observed that many times the document being imported, is present in one of the local libraries but absence of union catalogues and union list of Journals makes it impossible to locate. Recently, PARC has started a bibliographic service based on the computerised searches of AGRIS Data Base.

MANPOWER DEVELOPMENT IN INFORMATION SCIENCE

Selecting, searching and sifting information from a large mass of literature on any subject has become a specialization in itself. It has been estimated that an information scientist qualified also in the subject takes half the time than the ordinary librarian in searching the required technical information. To serve the research scientists with exactitude and precision, we need to train enough number of subject matter specialists in information science so that they turn out to be really competent supporting arm to the research scientists. In fact, the scientist will resort to the information man only if he believes that by referring the problem to him it will be easier for him to obtain the requisite information. The famous Weinberg Report (1963) made a very correct diagnosis of the situation in stating, "The anomalies of our information system have conditioned some scientists to active resistance to being informed".

This resistance can only be overcome if the information scientist can serve the research scientist so efficiently that he is made to realise that the information scientist is not only meeting information needs of the scientist but can also guide him to seek what he should have to pursue for his work more effectively. Besides providing a strong support arm to the research scientist, the information scientist performs a number of other useful functions too. He specializes in abstract writing and compilation of review articles. All these functions require a strong subject background. In view of these important roles which the information scientist is called upon to play in the field of research he is considered equally important as the research scientist. Unluckily in Pakistan due to lack of career incentives, scientists could not be attracted to the information service. This situation needs urgent rectification.

Research information system can be established on sound lines only if the persons with good subject background are inducted in this field. However, to attract and retain talent from amongst the scientists in information science, provision of career opportunities equivalent to their colleagues in research would be an essential prerequisite. In U.K., this recognition to information scientist was given as early as 1948 when the Royal Society Scientific Information Conference (21 June — 2 July, 1948) declared the information scientist as equivalent colleague of research scientist, working in the library instead of laboratory.

I will finsish my paper with a very relevant quotation from Muzaffar Hussain (1981). "The position of agricultural information system can be likened to the heart which pumps the life blood into the entire body keeping it alive and function properly. It is but obvious that a feeble heart can build only a feeble body."

REFERENCES

1. Abdus Salam. 1981. Renaissance of sciences in Arab and Islamic lands. The Pakistan Times May 8.
2. Bourgeois, P. 1956. L' avenia du periodique scientifique Libri. 7:71.
3. Brown C. M. 1956.Scientific serial (A.C.R.L. Monograph No. 16).
4. Doborov, G.M. 1968. Decision making in

national science policy, London: J.A. Churchill Ltd.
5. FAO. 1971. Production yearbook. Rome: FAO 25: 75.
6. Leob, J. 1923. Library's place in research. Ex Libris. 1(74). Abstr. in "Special libraries." 14 (179).
7. Luckasiewiez, J. 1972 .The ignorance explosion — a contribution to study of confrontation of man with the complexity of science — based society and environment. Transac NY Academy of Sciences: 373—391.
8. Muzaffar Hussain. 1980. Evolution of agriccultural information system in Pakistan and its impact on the farmers to increase farm productivity. Proc. Semin. Agric. Information to Master Development Manila, Philippines.
9. Pakistan Science Foundation .1976. Scientific and technical information in Pakistan: Report of a joint IDRC/UNDP Mission.
10. Parker, D. and Carabelli, A. 1970. Guide for an agricultural library survey for developing countries. New Jersey: Scarecrow.
11. Penna, C. V. 1970. The planning of library and documentation services. Paris: UNESCO.
12. Price, Derek de Solla. 1971. Science since Babylon. New Haven: Yale University Press.
13. Saunders, W. L. 1980. Information, the 'unscarce' resource: Proc. Aslib and Library Association Joint Conference on the National Provision and Use of Information, Sheffield. p. 1—12.
14. Thomas, P. O. 1970. Malaysian NR in the seventies: a forecast of production trends. Planter's Bulietin No. 110.
15. UNESCO. 1974. National issues for policymakers: the consolidation of information. Paris: UNESCO.
16. UNESCO. 1976. Consolidating information for development: some practical implications of policy makers. Paris: UNESCO.
17. Weinberg, A. 1963. Science, government and information: report of the President's Science Advisory Committee. Washington, D.C.: The White House.

16. ACTIVITIES OF PARC'S TECHNICAL DIVISIONS

16.1. CROP SCIENCES DIVISION

The Crop Sciences Division of PARC oversees the planning and coordination of crop production and protection research and provides the necessary technical backstopping.

Crops are vital to the country's economy as sources of food, feed and forage, industrial raw material, and export commodities. Therefore, a sustained development in their production is important to the process of development of country's economy.

Such a development is attainable either through expanding acreage (by cultivating new areas or practising more intensive cropping) or through increasing yields per acre by adopting improved production technology.

As crop production in the country occurs over a wide range of agro-ecological and socio-economic environments, therefore, its development through either of the above means would require an appropriate production technology suited to each of these environments and its effective dissemination to the farmers.

The Crop Sciences Division, while performing its role in planning and coordination of crops research in the country, ensures that research programmes are appropriately oriented towards achieving these objectives.

The predominant mechanism of planning and coordination of crops research is through National Coordinated Programmes. Such programmes have been organized on all major crops and disciplines such as wheat, rice, maize and millets, pulses, oilseeds, sugarcane, vegetables, fruits, plant genetic resources, weed science and plant pathology. Though the specific objectives at the micro-level would vary from one programme to another, at the macro-level, these aim at developing suitable crop varieties to fit into various agro-ecological and socio-economic situations, and appropriate production and protection practices to ensure an optimum return from input resources.

These National Coordinated Programmes implemented by PARC, in collaboration with the federal and provincial research institutes, have effectively strengthened the capabilities of various component units in terms of trained manpower, research material and field and laboratory equipment. Besides, these have provided a mechanism for joint problem identification, programme planning and monitoring and evaluation. These programmes have also helped in avoiding duplication in research efforts and consequently a judicious use of scarce manpower and material resources available for agricultural development in the country. As a result expanded germplasm, to provide gene sources for desirable traits have been established. Regular planning and evaluation meetings among the scientists of various institutions and travelling seminars during the crop season have led to a more frequent inter-provincial transfer of research material and exchange of ideas and information to their mutual benefits. These efforts have resulted in the evolution of more productive varieties of wheat, rice, grain legumes and oilseeds, to fit into various agro-ecological conditions and cropping systems in the country.

This Division also monitors the implementation of a number of contractual research projects which cover several areas of major significance. A total of 67 schemes are under implementation at the present moment in various institutions including universities. These schemes are reviewed by competent references and are cleared by the Technical Committees before funds are actually committed.

PARC is currently in the process of establishing SZARC at Sujjawal, which would ultimately develop into a national sugarcane breeding station and research centre for tropical fruits.

Through the Plant Genetic Resources Unit and Plant Introduction Centre, the Division is persuing quite vigorously, collection, maintenance and distribution of field and horticultural crops germplasm and introduction of new plant

species for cultivation. A number of expeditions have been mounted in the past in the Northern areas of the country to tap the in-country genetic reservoir.

Tissue culture is a new technology for production of disease-free seed in several plant species and for faster plant propagation. The Tissue Culture Laboratory established at NARC has successfully adapted this technology for production of virus-free potato seed, which would easily increase the productivity by about 30 percent. Techniques are also being perfected for propagation of date-palm and inducing salt tolerance in rice through tissue culture.

In the area of soil science, a programme is being implemented to increase fertilizer use efficiency and useful preliminary results have been obtained which would lead to formulation of more appropriate recommendations for fertilizer application. Studies on micronutrients deficiency and clay-mineralogy are also in progress.

The Crop Diseases Research Institute (CDRI) of PARC has provided a nationwide service for identification of disease organisms and effective screening of crop breeding materials for resistance. This has contributed to the development of several varieties with stable resistance and has safeguarded against an outbreak of serious epidemics in wheat. The activities of this Institute have been expanded to cover all major crops.

The severity of nematode infestation in our fields and horticultural crops has only recently been recognized. The PARC has funded the establishment of a Nematological Research Laboratory at Karachi which has successfully developed measures for control of this pest in sugarcane and citrus orchards.

Biological control of insect pests has a lot of appeal, being an economical and less hazardous technique. PARC has recently become a partner in the management of Commonwealth Institute of Biological Control, located in Rawalpindi, and has initiated the process of application of the control technology available with the institute. Work has already been taken up on control of sugarcane pyrilla in NWFP and pink bollworm of cotton, in Multan.

The vertebrate pests, including wild boar, rodents and birds do a great damage to crops. Vertebrate Pest Control Laboratory at Karachi has successfully developed a number of control measures and have carried out extension demonstration for the farmers and training course for the extension staff.

Enormous losses occur after the crop harvest due to several reasons. Efforts have been made to develop appropriate procedures to prevent such losses including the development of suitable post-harvest handling equipment and protectants derived from indigenous material. Procedures have been developed both for village level storage as well as large-scale commercial storage. The research activity in this area is mainly located at the Grain Storage Research Laboratory, Karachi. Currently, two projects one dealing with commercial bulk storage and the other with the farm level storage losses, are under implementation in this Division.

With the expanding use of herbicides and pesticides, it has become necessary to research on the residual toxicity in plants and storage stability of pesticides. The Pesticides Research Laboratory at Karachi, besides acting as Government Analytical Laboratory for pesticide registration has developed an extensive programme of research on these topics.

The Crop Sciences Division has a significant role to play in the process of varietal release of crops. After the new candidate varieties have been evaluated through the National Uniform Variety Trials, the data are evaluated by the Variety Evaluation Committee under the chairmanship of Member (Crop Sciences), for clearance of varieties for release.

16.2. NATURAL RESOURCES DIVISION

LAND AND WATER RESOURCES

Agricultural production depends on land and water, adequate resources of which, are available in Pakistan. But, the development of both the resources is, however, necessary. Pakistan, being basically an arid country, has more difficulties in developing water resources than land resources, because water development needs a much higher investment than land development.

Out of a total of 79.61 million hectares (mha) area of Pakistan, only 34.84 mha is reserved for culturable land, about 11.93 mha is kept as culturable wasteland and 2.76 mha is under forest. This leaves only 20.15 mha available for cultivation. Within the cultivated area, about 14.32 and 5.83 mha is under irrigated and rainfed conditions, respectively (Agric. Statistics, 1981).

The annual average flow available in rivers of Indus basin is of the order of 17.5 million hectare meters (mhm). The total annual diversion to the canal system is of the order of 12.9 mhm (Agric. Statistics, 1981). The delivery and application efficiencies in the canal command area indicated a net sub-system efficiency of 45 percent. This leaves only 6.2 mhm available for crop consumptive use. However, the contribution of rainfall is estimated at about 1.65 mhm.

Problems and Constraints

- Uncertain river flow and erratic rainfall distribution
- Shortage of surface irrigation water and storage reservoirs
- Water delivery losses in irrigation system
- Water-logging and salinity
- Poor quality of groundwater
- Soil erosion (wind/water)
- Productivity limitations due to variability in land form and soil type
- Low soil fertility

Research Programmes

Ongoing Project

The present research thrust includes on-farm water management studies, soil fertility, agronomic technology and soil survey implementation.

Achievements

* Consumptive use of water for wheat, maize, sugarcane and cotton was determined for different agro-ecological zones and climatic analogues were developed to transfer this data to other areas.
* Micronutrient status maps were developed for zinc, manganese, iron, and boron.
* Low-cost lining materials were developed for earthen watercourse.
* Land development methods and equipments were developed to conserve rain moisture in *barani* areas and to reclaim gully eroded lands for multiple land use.
* Status reports for tubewell irrigation in various districts of the Punjab were prepared with the recommended management practices.
* Surveys were made to assess the availability of organic wastes for the preparation of organic manures and procedures were developed for the preparation of organic manures.

RANGE MANAGEMENT AND FORESTRY

The importance of the management of the wildlands stems primarily from the need to preserve an environment in which people can live and practice a sustained and profitable agriculture. Other benefits to be derived from the improvement and management of these resources are increased products and conservation of soil and water.

Out of 79.61 mha, the area under forests is 2.76 mha whereas the area of productive forests is only 1.5 percent of the total land area. About 70 percent of the total area (57.06 mha) is classified as rangelands and livestock grazing constitutes the biggest land use in the country. The percentage share of forestry is 8.17 and 0.56 percent in GNP and agriculture, respectively. The northern and north-western mountains have a total catchment area of 74,770 m^2 and are of vital importance to the irrigation system of the country. In addition to the Government forests, trees grown on farmlands are an important source of income to the farmers, as the trees planted around the farmland provide 40.3 percent timber and 16.26 million cubic metres of firewood. The yield per unit of productive forests is 0.3 m^3/ha/year, whereas the yield of productive forests in other countries under similar ecological conditions is 3—5 and 10—20 m^3/ha/year in temperate and tropical forests, respectively.

Problems and Constraints

- Socio-economic problems and pressure of population to meet their domestic needs of fuelwood, forage and other products.
- Limited and small area under productive forests.
- Slow-growing tree species and out-dated management system.
- Inability to utilize arid, saline and water-logged land and other problems.
- Inability to utilize the potential of farmland to grow trees in conjunction with crops and in woodlots.
- Defective and wasteful methods of felling, sawing, logging and extraction of timber.
- Shortage of genetically selected and tested planting stock of superior quality.
- Denudation of mountain slopes by cuttting and removal of trees and vegetation cover.
- Cultivation of steep slopes and wrong agricultural practices leading to soil erosion.
- Uncontrolled and heavy grazing.
- Unscientific and uncontrolled grazing practices.

Research Programmes

Ongoing Projects

These include studies in forest soils, silver culture integrated use of rangelands, forestry bi-products, tea and bee culture and sericulture.

Achievements

* Regeneration techniques of juniper forests have been determined and methods for raising plantations in the nursery and field planting have been established.
* Inferior quality woods like, Tamarix, Salvadora, Juniperus, Prosopis and Parrottia have been found suitable for board production.
* Yield of resin from pine trees can be doubled by the application of 40 percent sulphuric acid and in conjunction with American bark hack methods.
* Local species of poplar (i.e., *Populus ciliata, P. euphratica* and *P. alba)* can be economically used for construction work, wooden shoes, furniture, body-building of trucks and buses in addition to their conventional use in match industry and sports goods.
* With proper spacings (1.5 m x 1.5 m) and quantity of water (6′ delta) eucalyptus and hybrid poplar can yield up to 245 ft^3 of wood annually.

16.3. ANIMAL SCIENCES DIVISION

Livestock sector occupies an important place in the economy of Pakistan. It contributes in multiple ways to the economy of Pakistan through providing (i) milk and milk products for human consumption, (ii) meat, (iii) raw materials for industries such as hides, skins, wool etc., (iv) draft power for cultivating land, transportation and carrying out work operation, (v) cowdung for manure and fuel, (vi) better utilization of farm labour throughout the year and (vii) profitable utilization of arid and semi-arid areas of Pakistan. The capital value of livestock resource amounts to Rs. 62 billion. Livestock sector provides regular cash income to 40 percent of the population in Pakistan, it contributes 30 percent of agriculture GDP, and 23 percent of all exports. Livestock provides approximately 80—85 percent of the draught power needed for soil cultivation. The annual value of livestock products is much higher than that of other agricultural commodities. For example, the value of only one of these products, i.e., milk @ Rs. 120 per 40 kg almost equals the combined value of wheat, rice, sugarcane and cotton, as indicated in Table 1.

In respect of foreign exchange earnings, livestock and their products constitute the second highest source of earnings.

There is a large scope for further development of livestock production which can be increased at least by 50 percent through improved feeding, management, disease control and breeding. For example, meat production potential can be increased a great deal through measures proposed in Table 2.

Table 1. Annual value of major agricultural commodities vis-a-vis milk (1981)

Commodity	Production ('000' tonnes)	Average price (Rs./40 kg)	Value (million rupees)
Wheat	11,475	58.00	16,638
Rice paddy	3,120	65.00	5,070
Cottonseed ('000' bales)	4,201	150.00	1,371
Sugarcane	32,359	9.00	7,280
Total milk	9,195	120.00	27,585

Table 2. Meat production potential

	Percentage increase in liveweight			
Measures	Sheep	Goat	Cattle	Buffalo
Better health	5	6	3	3
Higher weaning weight	42	25	—	—
Twin birth	27	16	—	—
Fattening	55	55	66	55
Rearing male calves	—	—	—	250

The loss due to late age at first calving (48 months instead of 28 months) and longer calving interval (18 months instead of 12 months) in buffaloes comes to over Rs. 1.6 million per annum. If only 10 percent of this loss could be prevented in five years' time, it would make a substantial contribution to GDP as well as improve the status of nutrition of the people.

Proper utilization of agricultural/industrial wastes in animal feed can add an estimated 15.6 million litres of milk equivalent and 1.9 million kg of beef equivalent, which will help reduce the burden of import of dry milk powder and increase the per capita availability of meat.

In spite of the large contribution of the livestock sector to the national economy, it has not received the financial support and backing it deserves. The allocations made to this sub-sector during the successive plan periods reveal a grim picture (Table 3).

It would be seen that funds allocated to the livestock sector are proportionately far less compared to its size and the potential for development.

In order to promote harmonious growth of agriculture it is essential that the existing imbalances in the allocations to the various sectors should be removed. Animal agriculture should receive its due share. In fact, crop and livestock production are complementary and mutually beneficial and a balanced combination of the two is required for optimal growth.

It is encouraging that more recently there has been some appreciation of the importance of livestock. However, there is yet no obvious reflection of this in the financial allocations.

In the R&D area, the Pakistan Agricultural Research Council, since its re-organization as an autonomous body in 1981, has started building up the long neglected discipline of animal sciences. An Animal Sciences Institute has been established in the National Agricultural Research Centre, Islamabad. Research is being conducted in the following areas:

Animal nutrition, breeding and genetics; Animal reproduction; Animal health and Dairy technoiogy.

In addition, a number of projects in livestock sector are being supported by the PARC at other centres. Some of these are listed below:

1. Studies on rinderpest like disease prevalent in livestock at Landhi Cattle Colony.
2. Cross-breeding of the AIS with the Sahiwal breed and comparative studies on production performance and adaptability of the pregnancy.
3. Studies on the causes of infertility in male Nili/Ravi buffalo.
4. Study on the production performance and adaptability of cross-bred cows under the sub-tropical environmental conditions of the Punjab.
5. Evaluation of nutrient requirement of layer strains of poultry under local climatic conditions.

Table 3. Allocations made by the Planning Commission

Sector	First Plan	Second Plan	Third Plan	Fourth Plan	Fifth Plan	% increase Fifth Plan over First Plan
Crops	403.41	303.00	2,839.54	4,016.45	10,416.40	2,484
Livestock	113.82	124.00	147.77	175.00	1,201.00	953
Forestry	90.10	134.00	257.31	230.90	953.10	958
Fisheries	34.92	46.00	169.94	133.47	411.00	1,074

6. Poultry performance testing and research.
7. Studies on Degnala disease in cattle and buffaloes.
8. Coordinated Research Project on sheep and wool.

Newly Approved Schemes

1. Preparation of pelleted Newcastle Disease Vaccine

2. Antihelminthic evaluation of indigenous medicinal plants for veterinary usage

3. Study of mycoplasmosis and its complications in poultry

4. Studies of genetic and environmental factors influencing the performance of buffaloes and identification of buffalo bull mothers for the production of progeny tested bulls to improve the production performance of rural buffaloes in Punjab

5. Studies on the venereal and non-venereal infectious diseases causing reproductive problems in buffalo

PARC also organized a number of symposia and workshops in important areas of livestock production relevant to the needs of Pakistan. Some of recent events are listed below:

- International Seminar on Sheep and Wool Research, Production and Development,. March 14–16, 1982, Islamabad.
- Symposium on Dairy Development in Pakistan, October 4, 1982, Islamabad.
- National Meeting on Animal Power in Pakistan, February 28, 1983, Islamabad.
- FAO Workshop on Least Cost Ration Formulation March 12–24, 1983 at National Agricultural Research Centre, Islamabad.

16.4. SOCIAL SCIENCES DIVISION

The role of Social Sciences Division of the PARC has been manifold,. Firstly, its efforts have been directed to identify national priority areas of research in the Social Sciences sector of agricultural research. Secondly, planning and designing of research projects according to the priorities fixed at national level. Thirdly, it has been acting as coordinating agency for the execution of the research projects which are being implemented in collaboration with different research institutions in the country. Fourthly, the scientists in the Division are engaged in conducting short-term socio-economic surveys, results of which are of utmost importance to the national economy.

The following is a brief review of the various research activities undertaken by the Division.

Identification of Priority Research Areas

In order to conduct research into problems of economics, nationally important priority areas of research were identified in consultation with scientists of repute a report on this aspect was prepared. The Technical Committee approved the research areas of priority proposed by the Social Sciences Division, identified under different disciplines of social sciences,i.e., agricultural economics, credit, marketing and production economics etc.

The new proposals include:

a) Supply and demand projections of selected agricultural commodities in Pakistan.

b) Study on the transfer of resources between agricultural and non-agricultural sectors.

c) Study on the linkages between agricultural education, research and extension.

d) Developing scientific methodology for estimating acreage and production of oilseeds, pulses and potatoes.

Domestic Resources Cost

The major objective of this project was to study the comparative advantage of producing rice varieties ('Basmati' and 'IRRI-6') in Pakistan using domestic resource cost methodology along with analysis of pricing and production policies in the country. The study utilized national level production, prices and costs data for analysis.

The study revealed clear advantage in producing 'Basmati' over 'IRRI-6' due to higher export price of 'Basmati'. It was also revealed that more input costs were needed for growing the later variety, suggesting inter-crop substitution between 'Basmati' and 'IRRI-6'. However, because of limited data the results apply more to the Punjab than Sind province where 'Basmati' is a major crop.

Study of Cropping Patterns in Various Ecological Regions of Pakistan

The primary focus of the project was to study existing cropping patterns, and to design and suggest more profitable cropping patterns for various ecological regions of the country according to the physical and socio-economic resources available in the area and making them compatible with the national objective of achieving food self-sufficiency, high nutritional and employment level. Agencies involved were University of Agriculture, Faisalabad; Applied Economic Research Centre, Karachi; Institute of Economic Studies, Peshawar and Agricultural Research Institute, Quetta.

On-farm Yield Constraints Research in Selected Areas of Pakistan

The project aimed at identifying biological and socio-economic factors responsible for keeping the farm yields of major crops (rice, wheat, maize,

etc.) low as compared with the potential yields.

The project conducted 183 experiments on major crops like wheat, rice, maize, and groundnut in different provinces. Wheat experimental data from the Punjab indicated the existence of a substantial yield gap (3,077 kg/ha) and that low use of fertilizer and improved wheat seed accounted for more than 87 percent of the yield gap.

Cooperative Research Programme on 'On-Farm Management Studies in Different Agro-ecological Regions in Pakistan

Existing farm resources, management practices, types of farming systems and estimate of the cost of production/net benefits to farmers from different farm enterprises are under study. Collaborating institutions are the Sind Agriculture University, Tandojam; Applied Economic Research Centre, Karachi and University of Karachi, Karachi. These institutions are working out the detailed plan to initiate and execute the study in all the provinces. The planned duration of the project is five years with an estimated cost of about two million rupees.

Evaluation of Existing Agricultural Extension Services in Punjab

The objective is to identify the communication system used by researchers, the extension workers and the level of feedback to the research from the field. The project also aims at identifying field difficulties faced by researchers and extension workers in effectively communicating the research findings to the farming community.

Economic Analysis of Small Animal Farming in Sind Province

The objective is to investigate the economic performance of sheep and goat farms in Sind and examine the existing infrastructure.

Food Distribution System

A short-term project to examine the food distribution system comprising a network of ration depots in the urban areas was initiated to identify the urban beneficiaries of the food rationing system belonging to different income groups and the costs to the Government on account of subsidizing food distribution through rationing system.

Wheat flour and sugar were the major food items supplied to urban consumers through rationing system. The survey results showed that lower income groups of consumers (with income up to Rs. 1,000 p.m.) derived more benefits from rationing than the high income consumers (with income up to Rs. 1,500 p.m.) However, the distribution was causing a large subsidy to the Government and that the likely black-marketing/hoarding of wheat flour as a result of reducing ration coverage could be minimized by releasing Government stocks in the open market. The Division organized a world food conference on the "Issues of Food Distribution in the Developing Countries of the World".

Wheat Situation Survey

The Social Sciences Division undertakes quick field surveys as a regular feature to provide estimates of crop condition to the Government. A Wheat Situation Survey was conducted in the Punjab province, the major wheat-growing area of Pakistan. As many as 1,301 farmers in irrigated as well as *barani* districts were interviewed. The crop survey indicated that the crop condition was normal in the irrigated areas as reported by more than 86 percent of the survey farmers. The crop condition was reported less satisfactory in *barani* areas due to delayed sowing caused by long dry spell. The fertilizer use, however, was reported to have increased.

Agricultural Productivity Maximization Project

The objective was to increase productivity of *rabi* crops such as wheat and rape/mustard. The field team established 61 wheat and 24 rape/mustard trials to introduce new technology in the district. To encourage the use of improved technology 225,500 kg of 'Lyp-73' variety of wheat and 18,500 bags of (urea and DAP) fertilizers were distributed to farmers free of cost. Interest-free farm credit amounting to more than Rs. 1.7 million was also distributed through cooperative

and commercial banks to remove financial constraints of farmers.

Investment in Agricultural Research

A study was initiated to determine the total research outlay for different activities within the PARC and the output of the research projects in order to arrive at returns to investment of research in agriculture.

Training of Scientists

The Social Sciences Division holds different training programmes in connection with the different research projects being implemented in the country as well as for institution which could be potentially related to the current research training programmes for federal and provincial research personnel. These programmes include:

- Methodology for conducting on-farm yield constraints research programme.
- Training in experimental design to the biological scientist of NARC.

International Seminars, Conferences and Symposia

The Social Sciences Division has also been arranging international seminars and symposia on important issues. These are listed below:

a) International Food Conference was sponsored jointly by the PARC and American Universities Field Staff.

b) International seminar on 'On-farm Yield Constraints Research' was sponsored jointly by PARC and the Ford Foundation.

c) A symposium on Agricultural Extension was sponsored by PARC.

d) World Food Day was celebrated on October 16, 1981 in collaboration with FAO.

Limitations

The availability of trained and experienced manpower has been a major constraint to conduct Social Sciences Research.

17. RECOMMENDATIONS

INTRODUCTION

The most appropriate agricultural research system for Pakistan is a federal/provincial/co-operative one which ensures optimum utilization of scarce resources such as manpower, material and finance. The aim of agricultural research system is to minimize waste, maximize human efforts and productivity per unit investment and operate as a harmonious unit to effectively solve national, regional and local agricultural problems which constitute serious constraints in agricultural progress. This will include resolution of production, processing and marketing constraints.

I. RESEARCH COORDINATION, PLANS AND REVIEWS

An Assessment of the Research System Nature, Scope and Thrust

In the past, Pakistan has benefitted much from specific packaged technology such as seeds and fertility etc., but future agricultural progress must place more focus on many packages which benefit entire rural communities. Technology transfer must be assessed more in economic terms and PARC should adopt a role which catalyses change in farming systems and support services. This will require a new thrust to research and development planned with strong provincial participation and the appearance of new blood that sets a progressive agriculture on a sustained basis under sound management.

1. RECOMMENDATION

The PARC should, with the help of its own staff and provincial representatives, undertake a comprehensive self-examination of the direction and its present and projected R&D programme as well as other research support activities in the light of several agricultural research review reports prepared by various scientists/international organizations in the recent past and provide recommendations for future research organization and intensification of research efforts where need is greatest, under capable management.

PARC Research Programme, Planning and Review Board

In developing a National Agricultural Research Plan, establishing priorities, making research allocations and providing an effective monitoring/evaluation system which maximizes resources and minimizes duplication, PARC has a most important role to play. A body consisting of provincial and federal senior scientists responsible to the Governing Board of PARC to plan, coordinate and review programmes is needed.

2. RECOMMENDATIONS

That PARC urgently establish a high-level technical advisory standing programme planning and review board to assist in coordinating national planning, resource allocation and programme monitoring/evaluation as well as to plan system manpower and facility needs.

That PARC should formulate a prospective research plan in cooperation with provincial and federal agencies.

Additional Information Needed for Ecological Zones

To date, ecological zones and sub-zones are based primarily on climate, physiography and soil data. Additional demographic and socio-economic information that includes land size and ownership patterns, cultural characteristics, populations, peculiar skills, markets and transport should also be included. Ecological sub-zone grouping could then be of greater potential use.

3. RECOMMENDATION

That PARC initiate strategies and arrange to undertake needed research which establishes ecological zone/sub-zones based on socio-economic and cultural factors including demography in addition to climate, water resources and soil descriptions.

Lead Institutes and Selected Commodity Research Specialization

Considerable potential exists in Pakistan to

develop existing agricultural research facilities. Moreover, ecological zones/provinces each have agro-ecological as well as socio-economic features which distinctly equip them for conducting research on certain commodities. Therefore, to maximize resource use in Pakistan and at the same time achieve a high level of scientific and technological performance, upgrading (where necessary creating) National Institute would be appropriate to generate urgently needed improved site-specific technology.

4. RECOMMENDATION

That PARC working with appropriate Government agencies upgrade or if necessary create, in different ecological zones/provinces, lead experimental stations that are linked with a network of provincial institutes/stations. Initially, the following lead institutes are proposed.

1. Poultry Research Institute, Karachi.
2. Sugarcane Research Institute, Sind.
3. Wheat Research Institute, Faisalabad.
4. Rice Research Institute, Kala Shah Kaku, Lahore.
5. Cereal Crop Research Institute, Pirsabak.
6. Horticultural Research Institute, Quetta.

Case Studies that Characterise Project Impact

Case studies conducted in Pakistan of carefully selected successful projects where farmers have adopted improved technology to identify the elements of success would be helpful. In contrast, studies of project failures, where research has not been adopted, should provide valuable information. Together such studies would provide researchers, planners and agencies with needed information in the generation and transfer of technology strategies for future thrusts.

5. RECOMMENDATION

That PARC should assist in initiating a series of case studies on selected successful projects to identify elements of success and a project failure, sites to articulate components associated with success of or failure, including defining any production management and market constraints.

Research Prioritization and Monitoring

With limited capable manpower and resources for conducting research, persistent major food production, marketing and research system management constraints, there is urgent need for improved research project prioritization, monitoring and evaluation systems to avoid past mistakes and conduct research on more profitable lines.

6. RECOMMENDATION

Effective research project proposals monitoring and critical evaluation require that carefully considered formats and detailed procedures be urgently established for the research system by PARC.

Technology Transfer

Until the linkages between research extension and education/instruction are strengthened, the rate of technology transfer to the farmer and effective research as well as training will be constrained. Merging agricultural research institutes and agricultural universities would go far in optimizing the use of scarce resources, strengthening institutional linkages and accelerating agricultural development. Problems of equating institute/university staff posts in such merger should be articulated and strategies urgently identified to mutually resolve position/salary problems in an equitable way.

7. RECOMMENDATION

Provincial agricultural research institutes and agricultural universities should be merged to optimize resource use and manpower for agricultural education research and extension education.

Area Defined Operational Research with Holistic Approach

While in the past research planning and development programmes have depended largely on commodity projects, such as wheat, with emphasis on available improved seed or fertilizer, sustained productivity increase will depend more on totality of research and development involving rural people in marketing, transport and resource service activities.

8. RECOMMENDATION

Research planning and project implementation should give more attention to the totality of research development with more farmer and rural community participation in area defined operational research.

II. INTEGRATING ELEMENTS

Forage, Fodder and Studies in Animal Nutrition

There is urgent need for the feed and livestock research/extension components to be better integrated. The provinces deserve to examine the present system aimed at increasing collaboration among fodder, forage and livestock scientists and managers. Furthermore, with rangelands managed through forestry, livestock and optimal utilization of rangelands should be studied and strategies formulated to involve vast outlying areas of Pakistan.

9. RECOMMENDATION

The PARC should urgently improve the integration of forage, fodder and pasture research with the livestock research programme and strengthen the research system to encourage the optimal use of forest and rangelands and identify constraints in use of range and forest lands with recommended remedial action.

Assessment of Soil Fertility Research and Soil Survey Interpretation

Soil fertility and management research remains one of the weak programmes in the research system yet it is vital in generating technology for optimizing production and improved net farm income. Pakistan does not fully utilize soil survey maps and inventories. Urgent need exists for soil survey interpretations, including its use in expanding soil fertilizer, research focus and utilization. Consistent fertilizer recommendations from researchers and extension for the farmer depend on closer coordination among provincial and federal agencies.

10. RECOMMENDATION

Fertilizer research should be critically reviewed and a renewed thrust initiated. PARC should develop a capability to provide soil survey interpretation for ready utilization in rural development, programmes, including the extrapolation of site specific fertilizer recommendations and articulate strategies to package consistent fertilizer recommendations appropriate for given crops on recognized benchmark soils.

Seed Certification Linkages with Seed Technology/Marketing Research

An important constraint to accelerate increase in production is due to inferior seed. The Department of Seed Certification could provide invaluable assistance to the research system by participating in joint seed processing, storage and marketing research projects.

11. RECOMMENDATION

The PARC should organize a seed research unit and programme with excellence in conducting and coordinating research in seed technology/and marketing and establish close coordination and linkages with Departments of Seed Certification and Seed Corporation.

III. MANAGEMENT, TRAINING AND SUPPORT SERVICE

Farm Mechanization and Repair Services

Increased productivity per unit time, per unit area and per capita is needed by way of systematically planned farm mechanization so that local manufacturing, repair/maintenance services provide employment and reduce the rural urban drift.

12. RECOMMENDATION

An accelerated effort is needed to increase research, training and development in farm mechanization which encourages local manufacturing and repair/maintenance services, especially in rural areas.

Laboratory and Library Service

Ready access to recent journals/scientific literature, facilities for data processing or repair/maintenance of laboratory equipment are research system services that often constrain research productivity.

13. RECOMMENDATION

The PARC/NARC urgently provide for establishing documentation with a library service and information flow system or the research network together with a capability to provide for data processing as well as laboratory repair/maintenance service.

Management Training and Improved Agronomic Skills

It is widely agreed within Pakistan and abroad that lack of well-trained committed scientists and support staff under effective management and administration constitute a major constraint in the entire research extension and agricultural education system. There is an urgency for a number of immediate steps to be taken to improve research, extension support staff and management performance.

14. RECOMMENDATIONS

The PARC should establish an agricultural education unit to work in close cooperation with the University Grant Commission to assist them in improvement of agricultural education, quality and performance of scientists and support staff and thereby enhance the efficiency of the entire research system.

The PARC further develop and strengthen the capability in farming system management to upgrade management skills and provide a programme of in-service training of scientists, especially new recruits.

The PARC/NARC develop a programme to instruct agricultural scientists in the basic agronomic/water management skills and techniques in field plot experimentation.

IV. CAREER ADVANCEMENT

Personnel Performance

An important incentive to ensure research productivity is to recognize scientific and support staff performance and commitment to excellence. Promotion at all levels in the research system, therefore, should be based on performance criteria and assessment rather than merely on seniority.

15. RECOMMENDATION

The PARC develop together with realistic criteria, procedures and a system which rewards excellence and discourages mediocrity of performance at all levels in the research system.

Optimizing Human Resources

Frequently, Government bodies such as the Planning Commission are required to make important decisions with too little technical expertise on their staff. The research system possesses many able and experienced scientists and technicians whose expertise might be called upon by these Government agencies.

16. RECOMMENDATION

Government agencies such as the the Planning Commission should be encouraged to invariably utilize in policy and in the decision-making process relating to Agricultural R&D, the services of competent scientists/technocrats from the Agricultural Research System.

18. APPENDICES

18.1. PROGRAMME

SEPTEMBER 1, 1983

INAUGURAL SESSION

0900—0930 Registration of participants

Chairman : Dr. Amir Muhammed, Secretary Agricultural Research Division and Chairman, PARC

0930—0935 Recitation from the Holy Quran

0935—0950 Introductory Remarks by Dr. Amir Muhammed

0950—1030 Agriculture in the Sixth Five Year Plan (lead paper),
Sahibzada Mohammad Ayaz, Joint Secretary (F&A), Planning & Development Division, Government of Pakistan, Islamabad

1030—1100 Tea

WORKSHOP SESSIONS

SESSION I
Research Base for Agriculture

Moderator: Dr. Haleem-ul-Hasnain, Member (Animal Sciences), PARC

1115—1215 Ecological Zones for Crops and Livestock (lead paper)
Dr. Alim Mian Director, Soil Survey of Pakistan, Lahore

1215—1315 Rural Development still a needed subject (lead paper)
Dr. Hussain Malik, Chairman, Department of Economics, Quaid-e-Azam University, Islamabad

1315—1430 Lunch

SESSION II
Inputs for Crop Production

Moderator: Mian Mumtaz Ali, Vice Chancellor, University of Agriculture, Faisalabad

1430—1530 A Systematic Approach to the Development of Seed Science and Technology in Pakistan (lead paper)
Dr. Imtizaj Hussain, Director-General, Federal Seed Certification Department, Government of Pakistan, Islamabad

1530—1630 Fertilizer Research and Development in Pakistan (lead paper)
Mr. M. Tahir Saleem, Dy. Chief, National Fertilizer Centre, Islamabad

1630—1700 Tea

1700—1800 Engineering Role in Agricultural Research in Pakistan (lead paper)
Dr. S. Iqbal Ahmad, Project Director, Farm Machinery Institute NARC, Islamabad

SEPTEMBER, 2, 1983

SESSION III
Agricultural Research System in Pakistan

Moderator: Dr. Haleem-ul-Hasnain, Member, (Animal Sciences), PARC

0900—1000 Critical Elements in Agricultural Research System in Pakistan (lead paper)
Dr. A. Wahid, Consultant

1000—1100 Research Planning (lead paper)
Mr. Ikram-ul-Haq, Director (Planning), PARC

1100—1130 Tea

SESSION IV
Achievements/Constraints/Remedies and Priorities of Research

Moderator: Dr. Amir Muhammed, Chairman, PARC

1130—1300 Brief on Programmes of PARC

- Representative of Member (Social Sciences), PARC
- Dr. Ch. M. Yousaf, Member (Crops Sciences), PARC
- Dr. Haleem-ul-Hasnain, Member (Animal Sciences), PARC
- Representative of Member (Natural Resources), PARC

1300—1500 Lunch and Prayer

1500—1800 Hike and Picnic

SEPTEMBER 3, 1983

SESSION V
Research Management and Manpower Training

Moderator: Dr. G. M. Khattak, Chairman, University Grants Commission

0800—0900 Project Formulation, Monitoring and Evaluation (lead paper)
Mr. M. D. Dawson, Adviser, NARC

0900–1000 Finanical Administration / Budget Management in Pakistan Agricultural Research Council (lead paper)
Syed Sohail Ahmad, Member (Finance), PARC

1000–1100 Manpower Training (lead paper)
Dr. G. M. Khattak, Chairman, University Grants Commission

1100–1130 Tea

SESSION VI
Support Services and NARC Development

Moderator: Dr. Amir Muhammed, Chairman, PARC

1130–1230 NARC Development Activities (lead paper)
Dr. G. R. Sandhu, Director-General, NARC

1230–1330 Farm Services (lead paper)
Mr. D. J. Minehart, Consultant, NARC

1330–1500 Lunch

1500–1600 Research Information System for Agriculture in Pakistan (lead paper)
Mr. Anwar Ali Chaudhry, Director (Scientific Information), PARC

1600–1630 Tea

SESSION VII
Provincial Agricultural Research Views and Perspectives

Moderator: Dr. Amir Muhammed, Chairman, PARC

1630–1930

- Syed Ahmad Pasha Jagirdar, Director ARI, Tandojam
- Mr. M. Saddiq, Director-General, ARI, Tarnab
- Mr. Saddiq Achekzai, Potato Botanist, ARI, Sariab, Quetta

SEPTEMBER 4, 1983

SESSION VIII
Formulation of Recommendation

0900–1100

- Dr. Haleem-ul-Hasnain, Member (Animal Sciences), PARC
- Mr. M. D. Dawson, Adviser, NARC

— Mr. Ikram-ul-Haq, Director (Planning), PARC

— Dr. A. Wahid, Consultant USAID

CONCLUDING SESSION

Chairman : Dr. Amir Muhammed, Secretary, Agricultural Research Division and Chairman, PARC

1100—1200 Presentation of Recommendations by Mr. S. M. Ismail, Secretary, PARC

1200—1230 Concluding Remarks by Dr. Amir Muhammed

18.2 ORGANIZING COMMITTEE

1. Dr. G. R. Sandhu,
   Director-General,
   National Agricultural Research Centre, Islamabad

2. Dr. M. D. Dawson,
   Adviser,
   National Agricultural Research Centre, Islamabad

3. Mr. Ikram-ul-Haq,
   Director (Planning),
   Pakistan Agricultural Research Council, Islamabad

4. Mr. S. M. Ismail,
   Secretary,
   Pakistan Agricultural Research Council, Islamabad

5. Miss Shahida Akhtar,
   Deputy Chief (Planning),
   Pakistan Agricultural Research Council, Islamabad

18.3. PARTICIPANTS

1. Dr. Amir Muhammed,
   Chairman, PARC,
   Islamabad.

2. Sahibzada Muhammed Ayaz,
   Joint Secretary,
   Planning & Development Division,
   Islamabad.

3. Dr. G. M. Khattak,
   Chairman,
   University Grants Commission,
   Islamabad.

4. Mian Mumtaz Ali,
   Vice-Chancellor,
   University of Agriculture,
   Faisalabad.

5. Dr. Imtizaj Hussain,
   Director-General,
   Federal Seed Certification Dep.,
   Islamabad.

6. Mr. M. Siddiq,
   Director-General,
   Agricultural Research Institute,
   Tarnab, Peshawar.

7. Syed Ahmed Pasha Jagirdar,
   Director,
   Agricultural Research Institute,
   Tandojam.

8. Mr. Allen. C. Hankins
   Chief Agriculture &
   Rural Development Division,
   USAID Mission,
   Islamabad.

9. Mr. M. D. Dawson,
   Adviser NARC,
   Islamabad.

10. Dr. Douglas Butchart,
    Agricultural Officer,
    USAID,
    Islamabad.

11. Mr. D. G. Minehart,
    USAID
    Islamabad.

12. Dr. D. R. Phillips,
    Barani Agricultural Research &
    Development,
    PARC, Islamabad.

13. Mr. Peter R. Hobbs,
    CIMMYT Wheat Agronomist,
    CIMMYT,
    Islamabad.

14. Mr. Derer Byerlee
    CIMMYT, Scientist

15. Dr. M. A. Hussain Malik,
    Professor,
    Quaid-i-Azam University,
    Islamabad.

16. Dr. Haleem-ul-Hasnain,
    Member (Animal Sciences), PARC
    Islamabad.

17. Dr. M. Yousaf Chaudhry,
    Member (Crop Sciences), PARC,
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18. Dr. G. R. Sandhu,
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19. Mr. Ikram-ul-Haq,
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20. Dr. A. Wahid,
USAID Consultant,
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21. Mr. M. Amjad Virk,
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22. Mr. S. M. Ismail,
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23. Mr. Tahir Saleem,
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NFDC,
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24. Muhammed Alim Mian,
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Soil Survey of Pakistan,
Lahore.

25. Mr. Anwar Ali Chaudhry,
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26. Dr. S. Iqbal Ahmed,
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27. Mr. Mohammed Sadiq Achakzai,
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29. Dr. Shamshad,
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30. Mr. Shahid Ahmed,
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31. Mr. Anjum Amin,
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