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International Center for Agricultural Research in the Dry Areas

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RESEARCH REPORT

No. 23

A STRATEGIC PLAN
FOR THE
PARC ARID ZONE RESEARCH INSTITUTE
1990-2000

by

J.D.H. Keatinge, B. Roidar Khan,
D.J. Rees, R.S. Aro, and C. Talug

November 1988

THE MART/AZR PROJECT

HIGH ELEVATION RESEARCH IN PAKISTAN

Pakistan Agricultural Research Council

ARID ZONE RESEARCH INSTITUTE

Brewery Road, Quetta, Pakistan.

MART/AZR PROJECT RESEARCH REPORTS

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The project contract is implemented by the International Center for Agricultural Research in the Dry Areas (ICARDA) and Colorado State University (CSU) at the Pakistan Agricultural Research Council's Arid Zone Research Institute (AZRI).

This Institute has responsibility for undertaking dryland agricultural research in all provinces in Pakistan through its headquarters in Quetta, Baluchistan and its sub-stations at D.I. Khan (NWFP), Umerkot (Sind) and Bahawalpur (Punjab)

The principal objective of the MART/AZR Project is the institutional support and development of AZRI in the period 1985-1989. This series of research reports outlines the joint research findings of the MART/AZR Project and AZRI. It will encompass a broad range of subjects within the sphere of dryland agricultural research and is aimed at researchers, extension workers and agricultural policy-makers concerned with the development of the resource-poor, arid areas of West Asia and the Middle East.

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A STRATEGIC PLAN

FOR THE

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by

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DECEMBER 1988

PART A GENERAL RECOMMENDATIONS

HISTORY

The Pakistan Agricultural Research Council (PARC) established the Arid Zone Research Institute in the 1974-75 financial year with its headquarters at Quetta, Baluchistan and with a single sub-station in each of the three other provinces of Pakistan (Executive Committee of the National Economic Council - ECNEC - case no. 41/3/71 & 78/5/73). The building phase in Quetta was not sufficiently advanced until 1980 to permit research work to begin and buildings at the sub-stations were completed in the period 1985-87.

In the period 1981-84 research work at AZRI was facilitated by technical assistance from the International Center for Agricultural Research in the Dry Areas (ICARDA) principally through the provision of improved cereal and food legume germplasm.

In the last four years 1985-88, under financial sponsorship from USAID, PARC and ICARDA/CSU have combined to develop the technical and human research resources of the Institute as part of the Management of Agricultural Resources and Technology project (MART - PC1 December 1984).

CURRENT INSTITUTIONAL STATUS

After a period of relative stagnation in the early 1980's the Institute has developed rapidly at its headquarters location in Quetta but little progress has been made at the sub-stations in provinces other than Baluchistan. At Quetta, following a large scale investment in buildings, equipment, and personnel resources by PARC through the MART project, the nucleus of a functional research institute now exists. Trained manpower remains a constraint to independent operation, but assuming continued training support in the medium term, by 1994 the Institute will possess the maturity of resources capable of leading research in rainfed agricultural research in the dry areas of Pakistan. At the sub-stations the current token presence is likely to continue unless a major injection of funds and trained personnel is forthcoming.

AZRI'S SCIENTIFIC, GEO-POLITICAL AND ECOLOGICAL MANDATE

The Institute's ecological mandate encompasses the arid (<150 mm rain p.a.) and semi - arid areas of Pakistan (<350 mm rain p.a.) which constitute approximately eighty - five percent of the country's land mass. A substantial proportion of this land (14M ha) is presently served by canal and other sources of irrigation and thus does not fall within AZRI's sphere of responsibility. However, at least fifty percent of the geographic area of the country (40M ha) is nominally serviced by research from the Institute. This land area is subdivided into two major ecological sub-divisions: upland temperate cool deserts (upland Baluchistan, upland NWFP and dry mountainous areas - Gilgit, Hunza etc.) and sub-tropical hot deserts (Tharparkar, Cholistan, Thal, S. Baluchistan). Though the land area in question is very large, it is likely that less than ten percent of Pakistan's population are resident in these areas. Also, it can be assumed that this section of the population form one of the lowest income groups in the country.

The scientific mandate of the Institute incorporates the need to investigate the present constraints to agricultural productivity in dry areas where the potential for irrigation is either undeveloped or does not exist. Also the design and testing of suitable solutions to overcome these constraints. Additionally, to consider the social and economic acceptability of proposed technological innovations and to develop suitable methods for the rapid and effective dissemination of new agricultural information. The attainment of solutions to problems, in the scope of this mandate, have to be sought within the context of maintaining the self-sustainability of biological systems and should not impose the possibility of further environmental degradation in the fragile environments typical of the arid zones in Pakistan.

The political reality of being a federal government agency to date has required AZRI to have representative substations in each of the provinces of Pakistan. Hence AZRI has its principal research activities in Baluchistan and subsiduary efforts at its substations at Umerkot in Sind (serving the Tharparkar desert), at Bahawalpur in the Punjab (serving the Cholistan desert), and at Dera Ismael Khan in the North West Frontier Province (serving the Thal desert area and other dryland agricultural areas such as Waziristan, DI Khan to Bannu etc.).

This very broad mandate under which the Institute operates currently was ratified by the Government of Pakistan (ECNEC) when AZRI's budget was transferred from the development to the non-development side in 1986.

AZRI'S PAST EXPENDITURE AND FUTURE BUDGET PROJECTIONS

The Institute's budget was placed on the non-development side at the start of the 1986-87 financial year after major PARC-funded capital developments had been completed. Since that time actual annual expenditure has been somewhat over eight million rupees per annum (Table 1) with PARC's contribution increasing substantially in the 1987-88 financial year. MART/AZR funds do make a substantial contribution to AZRI's budget, providing at least 50% of operational funding. At present the ratio of PARC operational funds to total PARC funds is projected to fall from 37% in 1986-87 to 23.6% in 1988-89 due to increasing salary costs and a larger establishment. This is clearly an unhealthy trend and a solution is needed by which the ratio of operational to total funds could be brought closer to a minimum of 30%

Table 1. PARC and MART/AZR project expenditure at AZRI

YEAR	TOTAL EXPEND M Rs.	PARC EXPEND M Rs.	MART EXPEND M Rs.	PARC SALARIES M Rs.	PARC OPERATNL M Rs.	MART OPERATNL M Rs.
86-87	8.6	4.7	3.9	2.7	1.7	2.0
87-88	8.2	5.9	2.3	4.0	1.9	2.0
Est. 88-89	7.9	5.7	2.3	4.2	1.3	2.0

In addition to MART rupee expenditure approximately US$ 0.75M per year has been spent on technical assistance costs in the period 1986-89 and $ 0.4M has been spent on non-expendable imported commodities. No attempt has been made to estimate depreciation costs for commodities.

WHAT CAN AZRI ACHIEVE WITHIN ITS PRESENT AND FORECAST BUDGET IN TERMS OF ITS RESEARCH MANDATE?

To date AZRI's operations have largely been performed in the upland areas of Baluchistan (approx. 8M ha). Experimental locations range from Loralai to Khuzdar districts which principally have a temperate semi-arid climate. The radius of operation is determined by a pragmatic limit of experimental sites being not more than six hours by road from headquarters, but with survey and plant collection operations extending over a still wider area. The present complement of scientific staff at the

headquarters of the Institute (approx. 28 members grade 16 and above) implies that even with a restriction of activities to upland Baluchistan there remain fewer than four scientists per one million hectares of land.

It is evident that the Institute's research resources are spread extremely thinly in Baluchistan and additional help cannot be expected from the provincial research agencies, with which AZRI is currently collaborating, as their resources are at present even less abundant. If the additional contribution to AZRI's operational expenditure from MART project sources is removed the intensity and scope of research activities would have to be reduced. However, this would not necessarily imply a reduction in the the geographic area of operation as this is necessary to effectively span the ecological range of conditions found in upland Baluchistan. Reduction in emphasis on crop agronomy, crop germplasm evaluation and agricultural extension would probably need to take place and a reduction in staff complement would have to occur. Nevertheless the Arid Zone Research Institute, though smaller and with narrower objectives, would remain a viable research unit.

Given the fine margin of resources at the headquarters location and the need to target funds to achieve the critical mass which can allow research credibility, it is not surprising that with only very limited resources (less than 10% of total budget allocation) that research efforts at the sub-stations outside of Baluchistan are token in nature. This situation is likely to remain the case unless AZRI's budget were to increase by 100% and in this case substantial impact could only be expected in one other major geographic zone such as Tharparkar. Investment in alternative areas more akin ecologically to AZRI's current expertise such as eastern Baluchistan (Zhob-Barkhan) and Waziristan (NWFP) would be a much more efficient use of research resources. According to an FAO classification (Rafiq, 1976)* the uplands areas of Baluchistan and western NWFP form a single ecological unit. In addition, redistribution of budget currently expended on sub-station activities and personnel could be vital in the preservation of headquarters operational activities if MART funds were no longer to be available.

*Rafiq, M. (1976). Crop ecological zones of nine countries of the near east region. FAO, Rome 119pp.

THE RECOMMENDATIONS OF THE REPORT OF THE NATIONAL COMMISSION ON AGRICULTURE - 1988: POTENTIAL IMPLEMENTATION BY AZRI.

The Commission has recognised, with the current population growth rate of 3% per annum and the virtual exhaustion of opportunities for expansion of surface water supplies for irrigation with resultant limitations on expansion of cropped area, that rainfed areas will be a primary target for expanded production. Furthermore, the intention of bringing about a major transformation in the productivity of the livestock sector, to meet the growing demands for meat and milk and to contribute to the well being of less developed areas, places a major demand on arid areas, marginal for cropping, but suitable for livestock production.

The main cause of poor livestock production to date is identified as being inadequate animal nutrition. Major feed sources such as the 51% of total land area (60% being in Baluchistan) which is under rangeland vegetation have had their potential productivity seriously eroded by overgrazing. The Commission recommends that livestock holders need to be encouraged to adopt improved methods of animal husbandry, promote productivity per animal rather than increase current numbers and to increase the quantity and nutritional quality of animal feeds. Conservation of rangeland resources is stressed in association with attempts to regenerate range feed supplies through better grazing management and reseeding with grasses and dual purpose shrubs and trees. The creation of a Watersheds and Arid Land Development Authority (WALDA) and separate range development agencies for Baluchistan and NWFP to promote appropriate research and coordinate federal and provincial entities responsible for watershed management, arid lands, barani areas and rangelands is recommended. This will be a substantial step forward in an area where coordination is presently ineffective.

Crop improvement recommendations, particularly suited to semi-arid zones include higher production of forage and fodder crops for animal feed, a 25% increase in pulse production and the need for rapid development of climatically adapted rust resistant wheat cultivars. These recommendations in dry areas are necessarily linked to previous recommendations on promoting livestock feed as the major pulse crops in the dry areas (chickpeas and lentils) and wheat are essentially "dual purpose" producing either high value green grazing in winter or valuable post harvest residues as well as a grain crop for human consumption.

MAXIMISING AZRI'S COMPARATIVE ADVANTAGE IN CERTAIN AREAS OF AGRICULTURAL RESEARCH IN PAKISTAN IN THE CONTEXT OF THE COMMISSION'S REPORT AND THE SEVENTH DEVELOPMENT PLAN

The Institute headquarters at Quetta is centrally located in the major livestock production zone from range and marginal cropland in Baluchistan. Its substations in other provinces are also located close to major, but potentially less productive, hot desert ranges.

Current major research and training thrusts in Baluchistan include improved management of small ruminants, conservation and improvement of range derived animal feed resources, introduction of adapted forage crops for marginal environments, improvement of dual purpose pulse and breadwheat production and promoting economic security for disadvantaged rural communities.

A substantial data base on the agricultural community of upland Baluchistan and its output has been collected and collated in the past five years. Reports specifically include: Range-livestock production constraints; dryland arable farming systems; techniques for improving water use efficiency; household agricultural production; the role of women in agricultural development; community profiles; the incidence of internal and external parasites in sheep; meteorological probability analysis for rainfall and temperature events; and a compilation of secondary agricultural statistics. Comparable data for other AZRI mandate areas of Pakistan are essentially lacking.

Research results from upland Baluchistan have indicated that potential improvements in livestock management, range rehabilitation and forage crop introduction are already feasible and the scope for further successful interventions deriving from research output is good though no estimate of the potential adoption rate for interventions can yet be made. However, by the very unpredictable nature of the environment, it should be recognised that the research and extension process is slower in output, when compared with initial research efforts in the past into irrigated crop production. Rates of return to research analyses suggest that research into livestock management will have a more substantial payoff than crop production research in Baluchistan. This latter area would improve considerably in return if water harvesting techniques can be made more efficient, thus rendering crop production more reliable, particularly in annual sown forages such as barley and vetch. Water harvesting research will also substantially assist the introduction of more productive range vegetation in rehabilitation schemes and in this regard there is a substantial linkage between the agronomy and range rehabilitation programs. The development of perennial shrub fodder banks on marginal crop land is a clear example

of where this interaction of disciplines would be most important. AZRI has recognised the considerable importance of research into effective pricing and marketing strategies for livestock and of forming a genuine understanding of what might motivate current livestock owners to adopt improved practices of management. Failure to address such issues in an integrated fashion clearly puts at risk the value of any improved physical or biological strategies that will be the output of AZRI's research effort in the next decade.

In the light of the current status of agriculture in Pakistan and AZRI's present scope of expertise it seems logical that AZRI should continue to invest its resources in attempting to improve the output of the small ruminant livestock sector. This should continue to take place principally in upland Baluchistan and if additional resources become available then AZRI's geographic focus should expand within the limitations of its present zone of ecological expertise. This would imply expansion into the similar ecological conditions of eastern Baluchistan and Waziristan and would most conveniently be serviced from its existing sub-station at DI Khan. AZRI could then assume the role of the basic research organization servicing the proposed range development agencies for Baluchistan and NWFP and the associated sections of provincial forestry departments would adopt an applied research and extension brief.

The Institute's substations at Bahawalpur(Punjab) and Umerkot(Sind) are also recommended along with DI Khan for upgrading in the Commission's report. It seems that these stations cannot be adequately coordinated or supplied with funds from AZRI headquarters in Quetta and therefore their role might be more profitably absorbed by other organisations as is suggested in the Commission's report. For example, the proposed arid zone research department of Islamia University of Bahawalpur could be given the current responsibilities of the Bahawalpur sub-station and thus avoiding what is currently overlapping mandates. Likewise the Commission's proposal for a Sind provincial government (or possibly Tandojam university) research station for arid areas, specifically emphasizing camel research, could takeover the existing facilities and responsibilities of the AZRI sub-station at Umerkot. Additional responsibility for crop research could be undertaken by the proposed barani institute at Mithi and other locations in Tharparkar.

Allowing AZRI to narrow its mandate focus in this fashion would greatly assist the viability of the Institute and enable it to have a more certain and better defined impact on the Agricultural sector of the Pakistani economy.

THE STRENGTHS AND RESOURCES OF ICARDA/CSU IN ASSISTANCE TO AZRI AND ITS PRESENT MANDATE.

The International Center for Agricultural Research in the Dry Areas (ICARDA) has been mandated regional responsibility for the countries of the Middle East and West Asia by the Consultative Group for International Agricultural Research (CGIAR). Pakistan is one of the largest countries in this region not only in geographic area but also in population. In consequence, ICARDA has a principal interest in assisting the Pakistan Agricultural Research Council in its agricultural research role. In particular, this would include the areas of Pakistan having a mediterranean climate such as upland Baluchistan and NWFP. AZRI is therefore an institute of special interest to ICARDA as is exemplified by its continuing contact since the inception of AZRI.

The forthcoming strategic and medium term plans of ICARDA highlight expertise and expanded work in forage crop production and livestock management with the latter area pinpointed for major personnel growth. Marginal land improvement is a growing area of ICARDA speciality while traditional strengths in food legume, cereal improvement and farm resource management remain in place. ICARDA is well placed to continue its collegial relationship with AZRI.

Colorado State university also has a longterm record of research assistance to Pakistan, particularly in the areas of rangeland improvement. The strength of its research and training programs in the fields of range and livestock management has been essentially complementary to that of ICARDA and together both institutions have provided AZRI with the support envisaged by PARC in its 1984 PC1.

RECOMMENDATIONS FOR THE NEXT DECADE 1990-2000

AZRI's mandate

Within the limitations of AZRI's current budget and assuming a 15% real growth in financial support per year it remains unproductive for the Institute to retain its sub-station activities in hot desert areas of the Sind and the Punjab. Therefore, the mandate of the Institute should be narrowed to incorporate solely those areas of Pakistan with a cool, semi-arid temperate climate. Emphasis should remain on those areas where the potential for irrigation is either undeveloped or does not exist. Investigation of the constraints to agricultural productivity will emphasise livestock productivity and the availability of improved sources of livestock nutrition. The need to consider evaluating the economic and social acceptability of technological solutions to identified constraints should be

retained, as should the preference for working with disadvantaged rural communities, and ensuring the maintenance of sustainable agricultural systems. These systems in the main will be agro-pastoral in nature.

In summary therefore AZRI's mandate will be:

1) To provide research support for the arid and semi-arid areas of Pakistan (<350mm of rain p.a.) with a principal focus in areas with cool semi-arid temperate climates.

2) Emphasis will be placed on those areas where the potential for controlled irrigation is either undeveloped or does not exist.

3) Constraints to agricultural productivity will be addressed where economic factors can be shown to have demonstrable importance or where conservation issues are considered to be central to the sustainability of ecological systems.

4) The economic and social acceptability and appropriate means for agricultural extension, of AZRI generated technologies will be examined.

5) The research problems of disadvantaged rural communities will be addressed as a priority.

AZRI's future research thrusts

The Institute will follow the recommendations of the National Commission on Agriculture and will emphasise improving the economic value of livestock offtake from small ruminants. The principal constraint to be addressed will be deficiencies in quantity, quality and timing of the availability of livestock feed. This will incorporate studies on improved livestock management, rangeland grazing management, rangeland rehabilitation including the introduction of new range plants, the introduction of new forage crops into dryland arable cropping systems and improved production of cereal and food legume crop residues in mixed arable-livestock enterprises with improved methods of water harvesting. Research emphasis will tend to reflect the large imbalance in the current ratio between rangeland area and area suitable for arable crop development.

AZRI's future geographic range of activities

While present budgetary constraints remain, AZRI's principal area of focus should remain upland Baluchistan but efforts should be made to extend activities, initially at least, as far as the more productive grazing areas near

Zhob. Further support to the DI Khan sub-station would facilitate this eastward trend and in due course would permit work to extend into Waziristan, NWFP. This would then incorporate the majority of Pakistan's land area that experiences a semi-arid continental mediterranean climate which is currently an ecological zone that is a good deal less productive than it might be.

AZRI's federal character

The withdrawal of direct AZRI activities in the Sind and the Punjab might suggest that AZRI's federal character, to some extent, would be invalidated. This is not the case as AZRI would be acting directly in both Baluchistan and NWFP with a further possible sphere of operations in Gilgit, Hunza etc. Furthermore, experimentation in livestock management techniques, methodology of water harvesting etc. would have direct relevance to other arid livestock production areas such as Tharparkar and Cholistan without experimentation actually occurring in those areas. Clearly, AZRI would become part of a larger network of institutes working in arid zone areas and cross fertilization of ideas and research results will have a synergistic effect on research output. It is therefore important that AZRI retain its federal character to assist it in its larger coordinative role.

AZRI's research administrative structure

In line with AZRI's proposed shift of emphasis it would be appropriate to re-organise the research groups in which AZRI is currently operating. The current range/livestock group would be split to form two new groups but of enlarged size. The range group would absorb some of the strength of the germplasm evaluation group and expand activities in the introduction of perennial species. The agronomy section would be retained, but would be amalgamated with the remainder of the germplasm group, to form a crop production group in which use of water harvesting techniques would be a major focus. The agricultural extension/communication group would cease to exist and their role would be absorbed by the other groups and cooperating provincial agencies. The agricultural economics/ farming systems group would be retained but would emphasize livestock production economics. The current establishment might initially be reduced somewhat to permit further funds to be used for operational expenditure.

PART B OUTLINE RESEARCH PROPOSALS

It is assumed in this section of the plan that the principal objective of the Institute's research program is to respond to the national need to increase output from the livestock sector without increasing numbers of breeding animals. A supporting assumption is that any significant increase in livestock products will come principally from two categories of land resources: rangelands and lands considered to be marginal for cropping. Unfortunately, many of the latter areas are in reality rangelands which have been unwisely tilled in the hope of producing crops despite critical limitations of climate and soils. This example of inappropriate land use serves as a reminder that increases in livestock outputs must be pursued under the constraint that the biological sustainability of the proposed systems can be achieved.

The Section will be sub-divided by use of the proposed new research groupings for AZRI; but these sub-divisions are for administrative convenience only and the entire research approach of the Institute should be seen as forming an integrated program.

LIVESTOCK MANAGEMENT

Improvement in the quantity and quality of forage available to ruminants, especially during critical periods in the annual production cycles, will be the main focus of research. Both sheep and goats will be studied, but there will be a preferential emphasis on sheep due to their proportionally greater numbers in the ecological zone of emphasis (for example provisional figures for 1986 in Baluchistan show 11.1M sheep and 7.3M goats). Range forage plant introductions and various fodder production technologies will be studied under other sections of AZRI's integrated program. The emphasis in the Livestock Management area will be on defining and quantifying the relationships between different and variable forage sources and key animal production parameters. This will initially be restricted to local breeds to examine to what extent their genetic potential and genetic variability can be exploited. Studies will include not only feeding trials to compare animal responses to different forages, but also examination of improved livestock management strategies such as innovative uses of introduced forage plants in flushing and supplemental feeding pastures, the use of mineral/protein/energy blocks on rangelands, allocation of dams' milk to offspring and family, and alternative breeding

schedules. The relationships between livestock diseases and parasites to fertility, mortality and productivity of grazing animals will also be important aspects of the research effort under this section.

Livestock research will be carried out with AZRI animals, as currently practiced, at the two present outlying stations (Tomagh and Zarchi) and the Animal Nutrition Unit at Quetta. It is planned that cooperative research with local livestock owners, in which they furnish and manage their own animals, should be the main approach used at a new proposed research center in Zhob District. This will provide a natural transition for AZRI from the more conventional research station and researcher-managed experimentation to a coordination of researcher- and farmer-managed studies.

RANGE MANAGEMENT

The main areas of research activity in this section, in approximately reverse order of priority, will be grazing studies, range rehabilitation and range forage plantations. The first category will include study of vegetation responses to different grazing systems and seasons of use, animal responses to different stocking densities, and livestock grazing preferences for different range plants and will act as baseline studies for estimates of current rangeland carrying capacity and potential vegetational productivity. Range rehabilitation studies will focus on testing of potentially adapted perennial grasses and transplanting of forage shrubs into rangelands. These interventions will be tested in most cases in conjunction with land treatment practices, such as ripping, contouring, and micro-catchments to increase infiltration and soil moisture storage. Range/marginal crop land forage shrub plantations will utilize the demonstrated potential of adapted species, such as fourwing saltbush, to evaluate the feasibility of establishing large-scale fodder reserves and improved pastures to supplement natural grazing feed sources. Plantations on sailaba, occasionally flooded sites, and into existing range vegetation, will be studied as part of this effort. Forage and fuelwood dryland forestry research is also planned.

Cooperative research with local farmers at present and proposed field locations will be an important aspect of the range forage program. Farmers will be involved in the production of shrub and tree seedlings, and the establishment of test and demonstration plantations. Rangelands controlled by local farmers, either individually or communally, will be included in the grazing studies, in coordination with forage plantations and livestock management studies discussed earlier. These topics are

broken down here for convenience of presentation, whereas actually they will be dealt with in an integrated systems approach, including additionally, agronomic and economic inputs.

An integrated resource management approach (IRMA), based on the physical unit of the watershed, will be proposed for at least one of the research areas. The new location proposed for Zhob District would be a good choice for this. Under the IRMA/watershed scheme a drainage basin would be selected for a comprehensive, coordinated set of studies which would include rangeland and livestock management, animal health, crop production, applied hydrology, socio-economic analyses, and extension components. The results of this watershed-based effort would extrapolate to other areas in Baluchistan having similar ecological characteristics.

CROP PRODUCTION

The new crop production group at the Institute which is to be formed from an amalgamation of the present agronomy group with the bulk of the germplasm evaluation group will have the consistent production of forage and dual purpose crops as its principal research thrust. Even though the proportion of land cropped under dryland conditions is very much smaller than the area of rangelands, for research purposes they will be considered of equal importance, as their potential for improved output of additional animal feed is substantial. This research thrust will include traditional and new forage crops such as barley and *Vicia* sp. and current staple food crops such as wheat and lentils. At present farmers only grow small quantities of forage crops as they have a strong preference for food crops because of domestic food security needs and as such breadwheat research will need to continue a) to accord with current farmer preferences b) to investigate whether forage crops are economically and socially acceptable, wheat being the control treatment and c) to determine how forage crops will be most appropriately fitted into present farmer rotations in substitution, or in sequence, with wheat.

New disease and cold resistant cultivars of forage and dual purpose crops will be tested for winter planting with early winter green grazing being an important additional consideration. Rate of establishment of a grazeable stand in spring time for "early bite" and leaf retention, animal palatability, non-shattering pods, hay making quality, lodging characteristics, protein content and forage/seed ratio will be important considerations at harvest. For spring planting optional cultivars will be required that

combine frost resistance at the seedling stage with earliness of maturity and an ability to set seed under severely moisture limiting conditions. Reliability of animal feed output will be the major goal.

Current water harvesting trials indicate a substantial potential for improved yields and reliability. Such experiments will continue to be a major focus of the crop improvement group's research effort. Alternative approaches will be investigated and may include artificial slope increases, dispersal treatment of catchment surfaces, other catchment sealing treatments such as waxing, soil cement, cement lining and asphalt lining etc. The need for, and appropriate design of, spillways in local and improved catchment systems will be an important new area of investigation.

Economic evaluation of new systems of improved water harvesting will depend upon the resultant increased and more reliable crop production. The range of agronomic factors previously investigated, tillage, fertilizers, new cultivars, weed control etc. will have to be assessed under these less moisture limiting conditions to determine appropriate technological recommendations to maximise profitability and consistency of output.

Further research work on agroclimatic issues will be required, to support the crop improvement research program, as the acute variability of physical environmental factors in both space and time in Baluchistan must be well understood before recommendations for changes in the farming system can be made with any confidence.

Some basic research may also be required on elements of crop physiological responses to high and low air temperatures stresses. This would be designed to safeguard expectation of improved productivity from unexpected environmentally induced crop failures, which can be common, where crops are being grown close to their physiological limits as is often the case in upland Baluchistan.

AGRICULTURAL ECONOMICS

In AZRI's integrated research program the agricultural economics group play the major role in technology and impact evaluation and the subsequent identification of new constraints to production. In the period 1985-88 a substantial data base has been created on the livestock and crop farming systems of upland Baluchistan. From this information base it has been possible to determine the major constraints to productivity in quantified terms. The rates of return to research in alleviating these constraints are

being considered and the implications for future research policies will be included in new and continuing research proposals mainly from AZRI's livestock management, range management and crop production research groups.

Technology evaluation will continue to be a major thrust of the agricultural economics group and the criteria of assessment will remain as previously a) technical feasibility in the field, b) economic profitability and risk evaluation, c) the suitability of the fit of the technology in the system, and d) socio-cultural considerations. Risk evaluation will be an area of increased effort as more and more reliable data are generated by the other AZRI research groups.

Macrosocio-economic issues will also receive further emphasis in the coming decade. Government and institutional policies that affect technology adoption such as marketing, agricultural and consumer subsidies, exchange rate policy, product and input pricing policies, transportation, tariffs, energy pricing and development strategies, for arid areas all could be suitable subjects for AZRI research. This will ensure that integrated biological and social policies can be devised which will have the highest chances of substantially improving livestock output.

Agricultural economic research is needed in the field of livestock management, as it will be an important factor in demonstrating to policy makers and livestock owners of the value of the grazing resources in Baluchistan. These resources are currently extremely undervalued and the likelihood of considerable social change exists in these areas, if and when, a transition in attitude occurs from "subsistence" maintenance of livestock to the active management of livestock offtake which is recommended by the National Agricultural Commission. This may be a period of difficulty for livestock owners and farmers, particularly for livestock owners practising seasonal migration, and research is needed at this time to ensure that the transition is made as painlessly as possible.

PART C MANPOWER DEVELOPMENT PLAN

By the end of the MART project period 1985-89, the Institute's ability to fulfill its mandated responsibilities will be greatly improved. However, considerable further investment in the development of human resources is still needed to ensure AZRI's longterm viability and its ability to assist the GOP achieve its longterm agricultural projections for the arid and semi-arid regions of the country.

In the past AZRI's training program has been a judicious mixture of local workshops, in-house english language training, on-the-job training with expatriate advisers, short term training either overseas or at local institutions and long term training overseas. It seems to be entirely justifiable to continue with such a mixture which has been, in the main, a successful formula for upgrading the Institute's staff capability.

LOCAL WORKSHOPS

The series of local workshops (approximately 5 a year) which have been held at the Institute since 1985 have been successful principally in two major ways. Firstly, the workshops have been used to impart specific required skills to AZRI and provincial government scientists which can then be further refined through on-the-job training. Secondly, they have been a major vehicle with which AZRI has developed working linkages and credibility with provincial government scientists and agricultural administrators.

It is therefore recommended that sufficient funding be provided in the future to maintain this ongoing series of skill transfer workshops and where necessary outside talents should be imported to provide state of the art instruction in research skills.

ENGLISH LANGUAGE TRAINING

At the start of the MART project phase, English language training was not emphasized as part of the brief for institutional development of AZRI. The need for an emphasis on this area of training became apparent when, in 1985, no AZRI candidates were capable of achieving a qualifying TOEFL score in English language that would have

permitted them to be considered for longterm higher degree training in the USA. Steps were taken therefore to provide in-house English language training. This took several forms:

1) Final preparation of candidates to achieve qualifying TOEFL scores.

2) Boosting candidates TOEFL scores to enable them to reach the minimum qualifying standard for admission to intensive training at CIELS Islamabad.

3) Improving oral communication skills for candidates at TOEFL scores as low as 350 to enable them to take better advantage of other training opportunities.

4) To improve the level of scientific writing to accelerate the publication of AZRI research findings.

5) Improving skills of oral presentation of scientific results to allow the Institute's research program to have the impact which it merited.

It is evident that the English language training program has been a successful addition to AZRI's institutional development. In particular, the pool of talent available for consideration for longterm training opportunities has been considerably expanded and the quality of scientific writing has been improved, with impressive results in some cases. However, weakness in English language skills remains as a longterm problem at AZRI and is exacerbated by additional recruitment of Baluchistan residents which is currently the preferred source of new personnel. If AZRI is to continue to develop its human resources to match its research program and available research facilities it is vital that English language training, in all its aspects, is continued at AZRI for the forseeable future. Expansion in this area, to assist collaborating provincial scientists, is one methodology by which goodwill between institutions can be further developed.

ON-THE-JOB TRAINING

The value of this aspect of AZRI's training program has tended to be grossly undervalued by observers of the Institute's development. Perhaps, the undemonstrative and gradual nature of this type of training is the cause of it being undervalued. However, it has been clearly evident over the last four years that the presence of experienced advisory staff working in a daily hands-on collaborative mode has been of tremendous benefit to AZRI's scientific staff. This type of informal training environment is not

replaceable. By preparation of staff it goes a long way to ensuring that full benefits are gained from other types of training. The Institute is currently refocusing its research program towards areas where the availability of experienced Pakistani scientists is particularly limited, i.e., small ruminant management, range improvement, water harvesting agronomy and agricultural economics. It is essential that steps be taken to ensure that AZRI has available the necessary experienced support in the next five years to provide the Institute's staff with a level of on-the-job training comparable to that which they have previously received.

LONGTERM HIGHER DEGREE LEVEL TRAINING

Higher degree training abroad is an expensive investment. AZRI has not yet received much benefit from its current program of longterm training but initial signs indicate that this benefit could be substantial and long lasting. Four staff members of the Institute are currently on long term degree training programs in the USA. Three more candidates have been nominated by PARC and will commence their training in 1989.

Where possible, AZRI's training program has been designed to permit staff members to undertake their thesis research on projects of importance to AZRI and usually at AZRI. Joint visits of senior advisers from US universities have been encouraged and from the single example of a longterm trainee returning to do thesis work at AZRI, it is clear that the whole Institute has benefited from fresh views, enthusiasm and commitment to research.

In the MART phase of the Institute's development the lack of provision of senior counterparts to expatriate advisers from PARC has been a problem. The only viable solution to this problem appears to be to take a long view and, through longterm training of current AZRI staff, to enrich the pool of experienced well-trained senior personnel. It must be recognised in the next decade that not all AZRI longterm trainees will continue to serve at AZRI but will be promoted to more senior positions in either the provincial or federal research system. It is therefore of critical importance to AZRI that the pipeline of staff being selected and assigned for longterm training continues to flow undiminished.

Specifically, it is recommended that in the next five years PARC should allocate at least ten longterm training positions for scientists concerned with arid zone studies. AZRI's proposed reorganisation of structure is an appropriate framework in which to assess the needs for further trained staff. The agricultural economics group is

the weakest at AZRI with an SO currently being the senior member. As this is a serious area of national weakness at least two long term training positions should be reserved for this discipline. Water harvesting is a new area of speciality for AZRI and spans the disciplinary divides between agronomy, soil science and watershed management. Better trained personnel will be urgently needed to fulfill AZRI's proposed expansion of research effort in this area. Two positions should be allocated to this area. Rangeland improvement is again a broadly-based multidisciplinary science with minimal representation at senior level in Pakistan agricultural research. Range improvement is a central theme of the National Agricultural Commission's report and therefore of AZRI's research program. Additional trained people will be required and at least two positions should be allocated to this field. Livestock production is of course the key to AZRI's research effort and is the area in which AZRI's principal contribution to national economic development will be felt. Two positions in small ruminant management will be a major advantage in ensuring AZRI research has the necessary impact. Of the ten longterm training positions requested at least two should be committed to AZRI without formal ties. Several areas could be considered in future as areas of demand for longterm training for the Institute's staff. Examples include biometrics, library studies, science writing and agricultural extension. It would be unwise to neglect to be flexible in allocating longterm training positions as foresight in this area can only be less than perfect.

SHORT TERM TRAINING AND PARTICIPATION IN OVERSEAS WORKSHOPS

This aspect of AZRI's training has been quite unsuccessful to date largely as a result of opportunities being missed due to inherent problems of ICARDA, USAID, PARC and GOP bureaucracy. Nevertheless, it is a valuable training mode and funds should be committed to its continuation. However, it is strongly recommended that steps be taken now to ensure that the previous wastage of opportunities is not repeated. Suggestions on how this might be brought about are as follows:

1) PARC should clearly delineate the eligibility of AZRI staff for short term training where possible. Rules should be amended to allow the most junior staff to be sent for short term training courses; as these scientists are most in need of, and benefit most from, this type of training. The need for a highly complex series of application forms including requirements for longterm bonds should be re-evaluated. A clear timetable for the deadline on nominations for the following year should replace the

present ad hoc system and if valuable training opportunities can be created after this deadline, sufficient flexibility should be present in the system to not hinder the departure of a nominated candidate.

2) PARC should give a clear ruling on the eligibility rules for longterm training nomination of AZRI staff and how or whether this eligibility is compromised by either short or medium term non-degree training.

3) PARC should streamline its clearance process and its procedure to fulfill GOP requirements for nomination and clearance for the attendance of overseas workshops.

4) PARC/USAID/ICARDA should develop a joint policy for the support of expatriate advisers for a minimum of one overseas workshop per adviser per year in the company of their counterparts or appropriate national scientists.

PART D CAPITAL EXPENDITURE

Forecasting specific needs for capital expenditure for a ten year period is a necessarily imprecise science. However, certain items of capital expenditure are requirements in the near future if AZRI is to maintain and expand its research program. These include:-

Computers

The AZRI scientific staff are all computer literate at present and the Institute's research program is dependent on this premise. The present complement of 6 IBM AT and 3 COMPAQ portable computers are barely adequate for present staff needs. Furthermore, these machines will be approaching the end of their useful lives in late 1989 as premature ageing is a consequence of the electrical and atmospheric environment to which they are exposed in Quetta.

AZRI's administrative staff have not yet made the transition to computerization owing to competition for machine time from scientists. It is inappropriate that this situation is allowed to continue if AZRI is to be a leading PARC institute in 2000 AD.

AZRI's library is also uncomputerized and this will have to be changed in the immediate future.

It is therefore recommended that AZRI procure at least twelve new computers of the capacity of their current IBM AT machines plus two truly portable computers for use in outreach locations. This will include peripheral hardware items such as UPS systems, voltage stabilizers etc and several high quality printers.

Vehicles

The Institute was provided with a fleet of 15 vehicles under the MART project in 1985. By 1990 many of these vehicles will be reaching the end of their cost effective working life and therefore should be disposed of and replaced. Replacement vehicles should all have, as robust a make-up as possible, as Baluchistan's roads cause extreme wear and tear rates. Four wheel drive capacity is essential and a versatile arrangement is highly desirable. Vehicles of the Toyota landcruiser double cabin pick up type should be the mainstream vehicle. One additional large, optional panel sided or flat bed, truck should be included to permit easy movement of livestock and heavy agricultural equipment.

Agricultural Machinery

Continuity of agronomic and germplasm evaluation work will require two self-propelled and/or tractor drawn plot planters of the Hege/Wintersteiger type and two plot scale combine harvesters. A further heavy emphasis on water harvesting techniques at both an agronomic and range improvement scale will require the purchase of a small sized bulldozer and possibly other landshaping equipment. A robust range seeder will be required if large scale reseeding operations are contemplated. A truckmounted power auger may also be required for range shrub seedling and tree planting on a demonstration scale. AZRI's current tractor pool is presently in reasonable condition but will require replacement in the period beyond 1992.

Photocopiers

These are an essential part of modern office facilities. AZRI currently has five units and they receive heavy use due to production of scientific papers, reports etc. They will all need replacement in the next 1-3 years. Life expectancy of such machines in Quetta is short owing to irregular electrical current and poor local maintenance support.

DI Khan Substation

The Institute's current area of potential expansion into eastern Baluchistan and southern NWFP will be most conveniently serviced from the DI Khan substation. Where possible work will be performed in a collaborative or farmer managed nature but nevertheless some development of facilities at Zhob, DI Khan and somewhere in Waziristan will be called for. Capital expenditure can be seen to be needed but cannot be specified at this time.

Laboratory Equipment

The major expenditure on laboratory furniture and equipment which was invested at AZRI will continue to have active life in the next decade. Additional laboratory equipment will be needed to service new or expanded areas of AZRI research such as in livestock management and nutrition, improved water management etc.

This list must not be considered to be comprehensive but rather a detailing of presently obvious and forecastable needs. A flexible approach to capital expenditure estimates must be retained in future if AZRI research is not to be seriously impeded.