

THE MART/AZR PROJECT

HIGH ELEVATION RESEARCH IN PAKISTAN



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ARID ZONE RESEARCH INSTITUTE

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**GUIDING AZRI INTO THE 21ST CENTURY -
STRATEGIC PLANNING OPTIONS
FOR THE NEXT DECADE**

by

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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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SUMMARY

The status of the Arid Zone Research Institute by the year 1990 is presented in the context of its historical and budgetary development. The role of the first phase of the MART/AZR project in the institutional development of AZRI and the formulation of its current research priorities and areas of geographical emphasis is discussed. The need for a further support phase from outside agencies is stressed in order to ensure that the major advances in institutional capability evident in the period 1985-90 are maintained.

The question of whether the Arid Zone Research Institute is to fulfill its extremely comprehensive national mandate is raised, and the concomitant need for further geographical expansion of effort, personnel and resources is outlined. Options are presented from which policy selections can be made which could guide the Institute's research policy in the next decade. These options are based on scientific, logistical and political considerations but maintain the Institute's basic philosophy of a multidisciplinary systems approach necessary for providing workable solutions to the agricultural problems of the dry areas of Pakistan.

If no substantial expansion of the Institute's resources is contemplated in the next decade, a research policy option is presented which largely maintains the current position in Upland Baluchistan with continuity of token efforts in the other provinces of Pakistan.

OBJECTIVES

The Pakistan Agricultural Research Council's Arid Zone Research Institute (AZRI) was established by the Federal government in the financial year 1974-75 with the responsibility of undertaking research in all aspects of non-irrigated agriculture to assist farming communities in the dry regions of Pakistan. However, with the impact of increasing population pressure and the recognition of inequalities in regional development, the need for research into determining the agricultural potential of more marginal areas has been recognised. AZRI's role and objectives

within the Pakistan Agricultural Research Council's national research strategy are therefore threefold namely:

(a) To establish an effective research capability to address the problems associated with the agricultural development of the arid areas of Pakistan where the potential for irrigation is either undeveloped, or does not exist.

(b) To investigate the present constraints to agricultural productivity in dry areas and to design and test suitable solutions to overcome these constraints.

(c) To consider the economic and social acceptability of proposed technological innovations and to develop suitable methods for the rapid and effective dissemination of new agricultural information.

Finally, the attainment of these objectives has 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 arid zones in Pakistan.

HISTORY

In the period 1974-1981 the budget allocated to AZRI was in the region of 2 million rupees annually. In the year 1980-81 work on the main headquarters building was largely completed and a research program was initiated. In general this was constrained by budgetary and vehicle considerations to a 3 hour radius from Quetta and on-station efforts at the substations, none of which had a purpose built office on station. In this period, initial contacts were made with ICARDA (Cereals and Food Legume Improvement programs) and a small scale germplasm evaluation and agronomic effort was started. Survey work on livestock in various areas of Baluchistan were also launched.

In 1982, the first formal approaches were made to USAID by PARC and ICARDA with a view to funding a project to help develop AZRI institutionally. During the period in which this project proposal was reaching maturity (1982-1985) AZRI's budget increased substantially from 2 to close to 14 million rupees, the bulk of which was used for the construction of a 24 unit staff housing colony at the HQ site and the construction of offices cum resthouses at the substations. The operational budget also increased by approximately 100% up to a maximum 2.1 rupees in 1983-84 which was coincident with an expanded on-farm trial network in upland Baluchistan largely concerned with agronomy and germplasm evaluation. The numbers of scientific staff also increased to a total complement of approximately thirty scientists.

THE MART/AZR PROJECT PERIOD 1985-89

In May 1985 the USAID funded MART/AZR project was initiated with ICARDA and Colorado State University being the implementation agents. The principal objective of the project was to assist in the institutional development of AZRI through the provision of a resident team of five scientists, initiation of a research program, equipment supply and training.

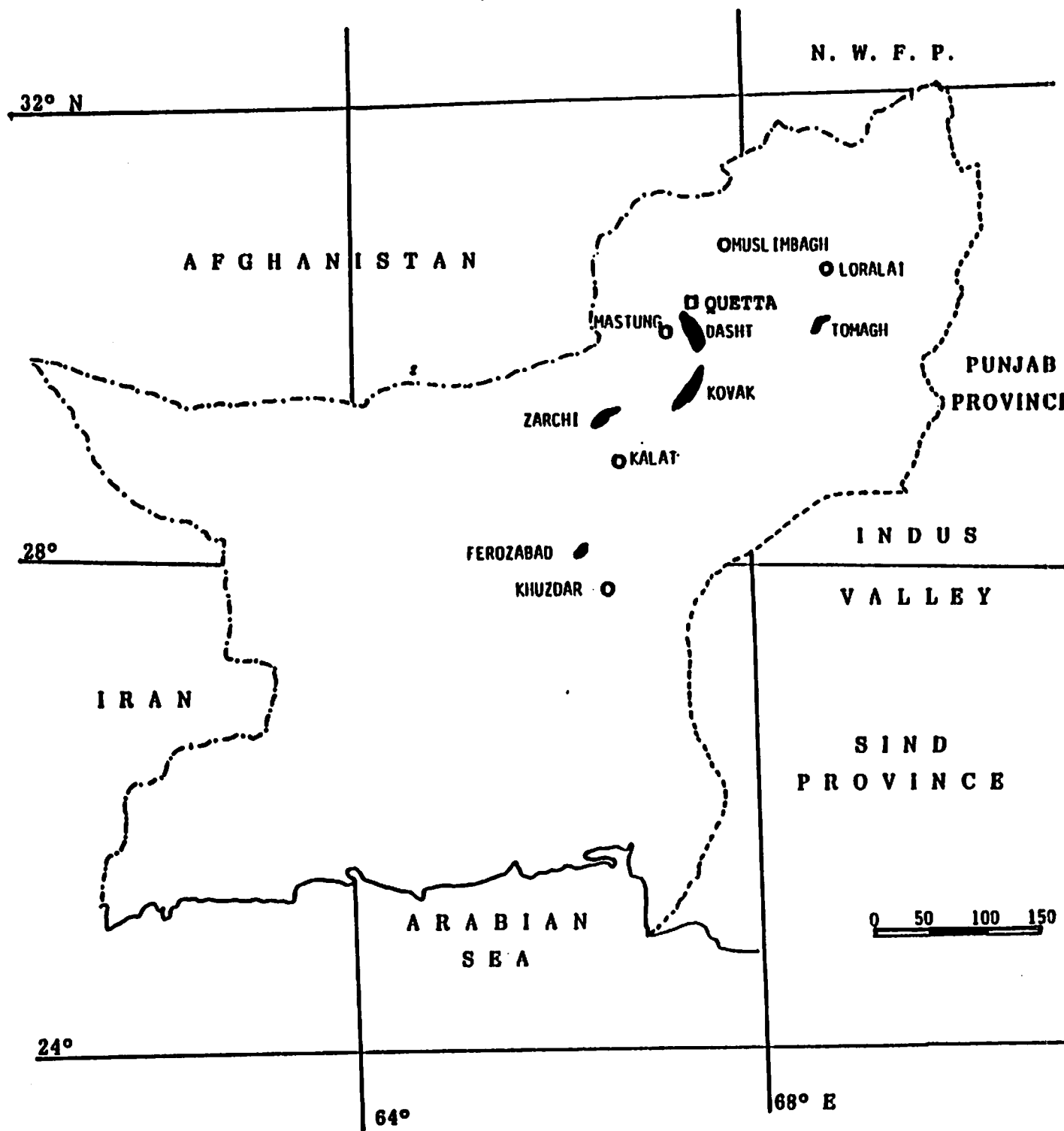
This team has been in residence for three 12-month cropping seasons to date and the institutional development of AZRI has largely been achieved within the guidelines and timing of the MART/AZR contract. Unfortunately, in the shift of AZRI's budget from the development line item in PARC's budget to that of non-development (1986) a substantial fall in budgetary allocation occurred, particularly in the area of operational expenditure. Thus in 1985-86, the last development year, a budget of 11.5 m rupees was expended with 1.7 m rupees being allocated to operational costs. This was further supplemented by an expenditure of approximately 2.1 m rupees for research operating expenses contributed by the MART/AZR project.

In contrast in 1986-87, the first year of non-development, budgetary expenditure was reduced to 4.3 m rupees with 1.3 m rupees operational costs. This was fortunately buffered by a further input from MART/AZR of approximately 4.9 m rupees for research operational expenditure and laboratory development.

In the 1985-86 season, research activities at AZRI increased by approximately 250% and this increasing trend continued in the 1986-87 season. By mid 1987 AZRI's research effort was in top gear and could have been rated as an effort five to ten times greater than in 1984-85. However, the major emphasis of research activities in the MART/AZR period has been directed to the upland environment of Baluchistan and this has resulted in only token research efforts by AZRI at its substations in other provinces (see Figure 1).

The rationale for the reduction in the AZRI non-development budget was that the budget estimate is calculated by the GOP on a formula related to previous operational and salary expenditure. This formula was unable to take into account the increased operational commitment of AZRI and thus a considerable reduction was experienced. Any increase in a non-development budget can generally only include small inflationary increases without special justification to the GOP. This is a lengthy process and was not completed in time for the 1987-88 budget. As a result this was set at 4.8 m rupees.

FIGURE 1. MART/AZR PROJECT EXPERIMENTAL SITES IN BALUCHISTAN PROVINCE, PAKISTAN



However, projected expenditure is likely to be at least 5.5 m rupees with the addition of special PARC reserve funds. Furthermore, the addition of MART/AZR funds of approximately 2.5 m rupees will meet the shortfall in operational expenditure. In the 1988-89 budget, which has been to date promised in full, a considerable improvement has been achieved following special case pleading to the GOP and PARC. A figure of 9.7 m rupees is projected with major increases in operational line items. This budget level is now expected to be maintained with an estimate of 10.2 m forecast for 1989-90. However, it is expected that in the last two years of the MART/AZR project an increasing proportion of operational costs will be absorbed by AZRI instead of MART/AZR. At the same time that this transfer of the cost of operational activities is underway, it is envisaged that research activities will not increase substantially over that of the 1986-87 level. In fact these efforts may be reduced in size as more longterm trainees are sent to the USA and personnel resources become more limiting at AZRI. In consequence, the present strategy of dedicating the bulk of AZRI's resources to its headquarters environs in upland Baluchistan, to ensure a visible impact and thus credibility in the eyes of the government of Baluchistan and its research agencies, is planned to continue.

THE STATUS OF AZRI IN 1990

In 1985, at the time of the start of the MART/AZR project, it was conceived that for each of the expatriate scientists resident at AZRI senior Pakistani counterparts would be available to be joint research group leaders. These counterparts were intended to permit the expatriates to adopt an advisory role in the development and execution of the research plan. This situation was not achieved in 1985 as only two senior counterparts were available and by 1990 this situation will only have improved marginally. The major constraint to PARC in fulfilling this commitment has been lack of appropriately trained manpower willing to be resident in Quetta.

In substitution to this preferred policy, the MART/AZR team have adopted a role which involves a greater degree of participation in the research process than was previously imagined, and that senior counterparts would only be forthcoming through the return of AZRI sponsored long term trainees. Unfortunately, the pool of candidates available for immediate despatch for long term training at AZRI was almost non-existent. Most staff members were poorly trained and had second quality academic records. This was and is a continuing problem for potential candidates from rural Sind and Baluchistan. The level of english language ability was extremely poor and an intensive training effort has taken place in the MART/AZR period to rectify this problem. The lack of choice of potential long

term trainees has therefore resulted in a much slower despatch rate than was previously envisaged in the contract. In 1990 therefore only the first two long term trainees out of a possible 5 - 10 will have returned to take up service at AZRI. Furthermore, it is unrealistic to presume that a freshly returned MSc or PhD level scientist can immediately take over the running of a multidisciplinary research group of up to eight scientists.

It is clear therefore, that under the current MART/AZR contract time schedule a period of inadequate support to AZRI will occur in the 1990-95 period; awaiting the return and gathering of local experience of AZRI's trained pool of senior scientists. Furthermore, as these scientists are not necessarily committed to AZRI for the remainder of their careers, (an undesirable concept anyway) a continuing program of longterm training will be required for AZRI's recently recruited high quality local staff to ensure that they remain either in AZRI or at least in the provincial government research arm associated with dryland agriculture.

Physical support at AZRI will be required on a continuing basis post 1990. The present vehicle fleet will be adequate until that period but will be largely worn out by 1990. The proportion of off-road or rough road driving in Baluchistan severely curtails the active working life of vehicles even when effective running maintenance is performed. The useful life expectancy of AZRI's computer hardware can be projected also only till 1990 as the dusty environment, coupled with poor quality power supply, is "ageing" the computers very quickly. However, laboratory equipment will still be in good condition and AZRI's laboratory development in the first MART phase will be a major continuing asset. Specialist mechanized plot scale seeding equipment is presently the major omission from AZRI's agricultural machinery pool and further additions to support specialist livestock research programs will also be required. The livestock management discipline was least well supplied under the MART major equipment purchase for AZRI. This was largely the result of having no specialist livestock scientist available at senior level at AZRI or MART/AZR. Proposals to include an additional expatriate livestock scientist with "sleeping" MART/AZR funds were rejected by USAID in late 1987.

One of the major visible successes of the MART/AZR project has been its local training effort. This has achieved two major objectives: firstly, it has provided AZRI junior staff with a range of skill oriented training workshops which have much improved their research capabilities; and secondly, by making such workshops open to cooperating provincial agencies, much better inter-institutional collaboration has resulted. This had been an identified area of great weakness for AZRI in the past and

by 1990 will be relegated to a historical problem. AZRI in this period will be well established as a catalytic research agency, for all joint research agency efforts in Baluchistan, in the area of dryland agriculture and its extension.

FUTURE RESEARCH PRIORITY AREAS

It is certain that by 1990 AZRI will be regarded as a credible research institute in upland Baluchistan. However, this credibility will not extend to its substations. With a core staff of about 30 scientists and a mandate to improve all aspects of dryland agricultural productivity (ranges, livestock, crops, extension etc.) AZRI has a full time job merely restricting itself to operations in upland Baluchistan and maintaining a "presence" in the other provinces. This is exacerbated by the very low investment in dryland agricultural research by the Government of Baluchistan.

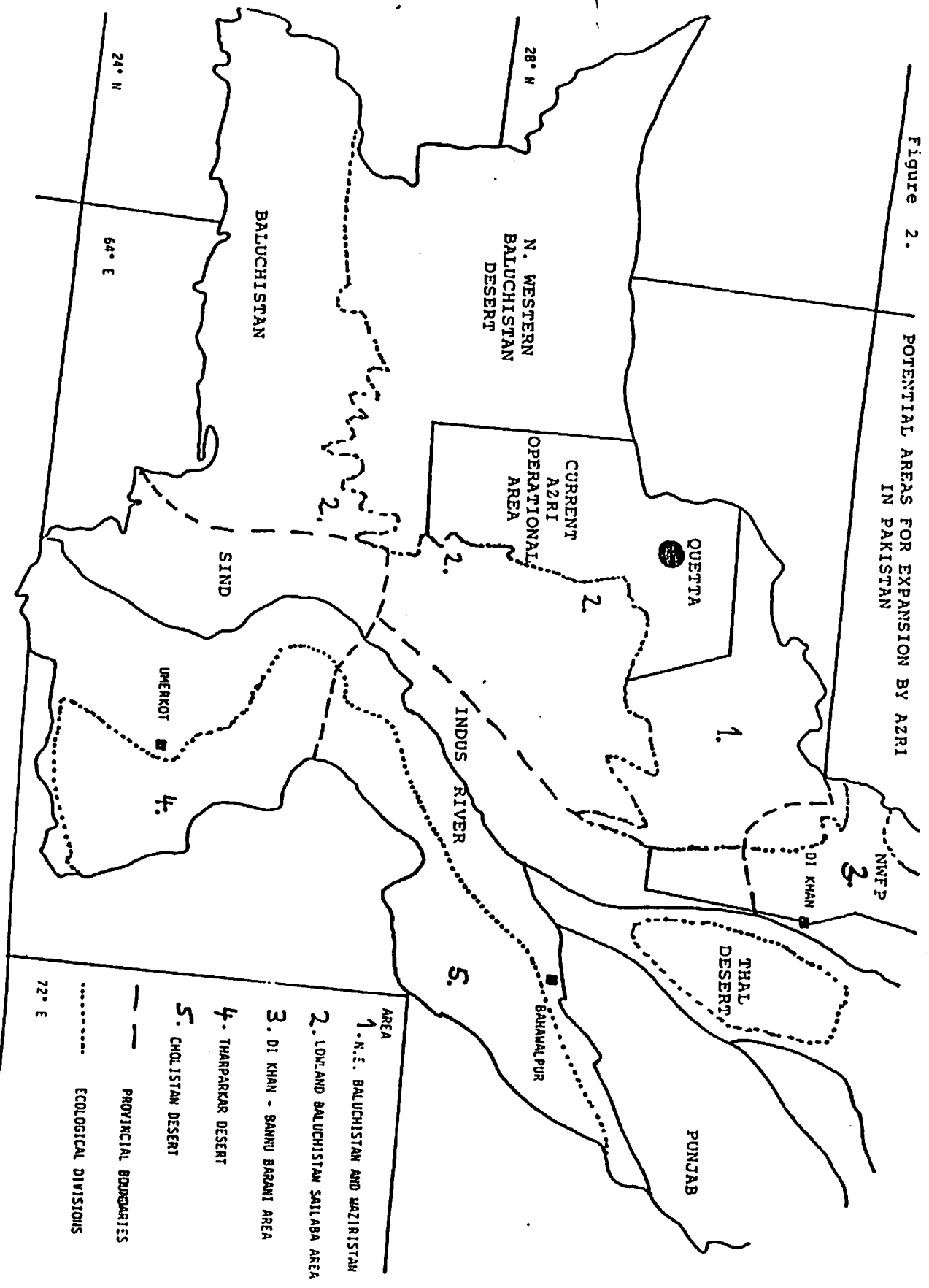
However, AZRI has come under considerable pressure over the last two years in particular to pay more attention to its efforts at the substations, particularly in the hot deserts of Tharparkar and Cholistan. It seems evident that AZRI will eventually develop the expertise to perform research in hot desert areas; but at present possesses neither the available manpower nor financial resources to tackle these huge, intransigent problem areas with any chance of performing a productive role.

If it is assumed that AZRI will not receive additional manpower or budget then its strategy will likely be to maintain efforts in upland Baluchistan with possibly the development of initial survey activities to determine what might be possible in one of the hot deserts. Further expansion of efforts or transfer of staff to the substations would compromise the progress AZRI has made to date.

If it is assumed that through a continued training program at AZRI additional trained staff, and resources to support them, are provided by PARC then AZRI seems to have at least six potential alternatives for expansion (see Figure 2):

(1) At present AZRI research activities are restricted by logistical considerations to areas west of Loralai. A large, and not dissimilar area ecologically, to our present area of focus is Eastern Baluchistan (Zhob-Barkhan) and south-western NWFP (Waziristan). From the D.I. Khan Substation this area could be conveniently included in AZRI's research scope with additional resources but without major difficulties in transference of AZRI research technology.

Figure 2. POTENTIAL AREAS FOR EXPANSION BY AZRI IN PAKISTAN



AREA

- 1. N.E. BALUCHISTAN AND WAZIRISTAN
- 2. LOWLAND BALUCHISTAN SAILABA AREA
- 3. DI KHAN - BANNU BARANI AREA
- 4. THARPARKAR DESERT
- 5. CHOLISTAN DESERT

— PROVINCIAL BOUNDARIES

..... ECOLOGICAL DIVISIONS

72° E

24° N

64° E

28° N

N. WESTERN
BALUCHISTAN
DESERT

BALUCHISTAN

CURRENT
AZRI
OPERATIONAL
AREA

QUETTA

SINDH

UMERKOT

INDUS RIVER

BAHAWAL PUR

THAL
DESERT

PUNJAB

NWFP

DI KHAN

(2) To complement the present ongoing program on livestock and sailaba agriculture in Baluchistan, AZRI could encompass other low elevation areas in southern and western Baluchistan. A major cropping area presently being ignored by AZRI is sailaba production in the Sibi and Uthal areas of Baluchistan. In addition, with the transhumant system of livestock management presently being practiced in upland Baluchistan; to effectively study the whole system would require inclusion of the lowland plain areas of S. Baluchistan and N. Sind where livestock overwinters. Furthermore, the complete absence of present research activities on an important major ruminant and draft animal - the camel - is an area in which AZRI could very usefully provide expertise directly applicable to all provinces of Pakistan.

Justification for this non-federal spread of research activity would be a problem for AZRI. However, Baluchistan is Pakistan's most disadvantaged province and efficient use would be made of AZRI's physical resources.

(3) In direct contrast, AZRI and ICARDA have considerable expertise in the area of germplasm selection and agronomy for dryland cropping. AZRI's D.I. Khan substation is located in a major area in the Frontier in which dryland wheat and food legumes are grown. This area between D.I. Khan and Bannu has light textured soils and low and variable rainfall. In this marginal cropping area the provincial government invests only a few resources as better, wetter dryland cropping areas exist. However, as population pressure increases these drier areas will be forced to become more productive. Research is needed now to ensure that this can occur successfully. The serious epiphytotic outbreak of *Ascochyta* blight in the Frontier and other associated barani areas of the Punjab destroyed the food legume crops, particularly chickpeas, in the early years of the decade. This may well happen again and the search for truly disease resistant and drought tolerant chickpeas still has a long way to go. Furthermore, a potential replacement crop for chickpea such as lentil is much under-researched in arid areas. AZRI could assist in this area but PARC must then clearly establish the boundaries of responsibility between AZRI and BARD (Barani Agricultural Research and Development project). There is presently an overlap in responsibilities in this area between these two special projects.

(4) The present long duration drought being experienced by the Tharparkar desert has engendered a powerful political pressure for AZRI to adopt an active and hopefully effective presence in this hot, arid subtropical area. The large numbers of ruminants which use this desert range are of economic importance to the GOP but the system is probably intimately linked with the irrigated crop

residues of the Sind. As a result if AZRI is to start work in this huge area of negligible infrastructure, a considerable investment in survey effort must be made initially. Only minor emphasis could be placed on crop alternatives as the environment is too dry other than for adventitious basin cropping. Range grass and perennial shrub germplasm evaluation and agronomy would be a possible "high visibility" area for AZRI but the sub-tropical nature of the environment would require consideration of a completely new range of species for which AZRI at present only has very limited experience. Considerable training of manpower would therefore be required and a substantial investment in new vehicles and machinery would be required. Trying to service the Tharparkar substation from Quetta would be very inefficient as it takes two days to travel between these points.

(5) The comments mentioned for Tharparkar are also relevant to another potential hot desert research area, the Cholistan desert in the Punjab. Political pressure is also substantial to assist this area. However, it is a considerable distance from Quetta and might be more effectively serviced from an Islamabad-, Lahore- or Multan-based research agency. However, if AZRI were to invest resources in either Tharparkar or Cholistan the research findings would have a considerable degree of cross-fertility as these areas are representative of a single major ecological unit.

(6) The last alternative which is AZRI's present policy is to attempt to work in all areas. The magnitude of the problems in these areas suggests that continuing this policy would make little more impact than at present unless resources were to quadruple.

However, if AZRI were prepared to specialize in a single component of the hot desert problem, such as the introduction of forage grasses or shrubs, then it would be possible to be somewhat more effective than at present. This approach is in direct contrast to AZRI's present systems perspective.

AZRI is now faced with decisions that will fundamentally influence its future research direction, its national impact and possibly its survival. Positive achievements have occurred as a result of the partnership between AZRI and MART/AZR. The developing maturity of AZRI is still in a vulnerable state and should be protected for at least a further five year period. Additionally, overexpansion of research targets may be counterproductive immediately but through a concentrated long term training program, AZRI could become the conduit by which suitably experienced dryland research scientists can be fed into the Pakistani research system to permit an expanded effort. If

political pressures on AZRI are to be relieved it is clear that additional time and resources are both needed. However, a start can be made in 1990, to adopt a longterm research strategy that can be successfully implemented by AZRI in the period up to and into the twenty-first century. It is to be hoped that this will make a major contribution to improving the agricultural productivity of the dry areas of Pakistan.

FUTURE RESEARCH PROPOSALS (1990-2000)

(1) GERMPLASM EVALUATION GROUP

In the previous five year phase (1985-89) the germplasm group's efforts have been centered on the ecological diversity found in the geographic area of upland Baluchistan encompassed by Khuzdar, Kalat, Quetta, Muslimbagh and Loralai (See Figure 1. on page 4.)

In order to maximise the transferability of the experience and genetic material derived from the 1985-89 phase and if AZRI Germplasm is to expand its efforts, then it should do so to areas where the environmental change is as small as possible. This "gradualistic" philosophy of expansion may not accord with AZRI's politically inspired research priorities. Therefore optional scenarios are presented based upon potential loci of effort and projected available resources.

Assumption - >50% expansion of current resources

Option A

In order to minimise ecologically engendered changes in crop species, the most logical new area of expansion for the AZRI germplasm group should be eastern Baluchistan (Zhob-Barkhan) and the southern highlands of NWFP (Waziristan). These areas would be most conveniently serviced from both the AZRI HQ Quetta and the DI Khan Substation and the additional lowland barani area D.I. Khan-Bannu could also be included. Crops to be studied would place a continuing emphasis on winter planted breadwheat, barley, forage legumes but would expand emphasis on food legumes as both kabuli chickpeas and lentils are better suited to these somewhat warmer environments.

Option B

If AZRI's investment of research effort into water harvesting techniques pays off with readily transferable technologies to the sailaba areas of southern and central Baluchistan (Sibi, Dadhar, Wad, Bela, etc.) it would be necessary to implement evaluation of more sub-tropical crop species, as well as continuity with wheat, food legumes,

etc. but with a shift from long maturity cold tolerant types to shorter duration, more heat resistant types. This option would have the pragmatic advantage of being serviced from AZRI HQ Quetta in conjunction with ARI Sariab and the Baluchistan Extension Department.

Option C

If AZRI's wider mandate is to be fulfilled, greater attention needs to be paid to hot desert areas such as Tharparkar (Sind), Cholistan and Thal (Punjab). In this case the chief mode by which the AZRI germplasm could contribute would be through further cooperation with the AZRI range group. This would include further testing of perennial grasses and legumes, forage shrubs and dual purpose trees (forage and fuel) for potential testing under actual hot desert conditions. AZRI's expertise in this type of area is presently very undeveloped and pre-training with initiation of a larger scale program in the 1995-2000 phase would seem to be the most realistic approach. At present, the Tharparkar area would be the logistical area of choice for further AZRI efforts in hot deserts as AZRI buildings have been constructed on the edge of the desert. Transport constraints "in-desert" would have to be eliminated before much productive effort could be made.

Option D

Evidently it would be possible for AZRI's germplasm group to adopt a mixed option: with a small effort being made in the environments covered by Options A, B and C. However, this raises the issue of the minimum investment of resources which could make a measurable impact. If our present assumption of a greater than 50% expansion of resources is further increased to beyond 100% a mixed option might become feasible. For example, the group could encompass the present area of upland Baluchistan with some expansion towards Zhob and to initiate work in Tharparkar or additional resources could be concentrated at D.I. Khan to service Zhob, Waziristan, Bannu and the Thal desert. This latter solution at least has the political merit of including 3 provinces of Pakistan in AZRI's research thrusts.

Assumption - No real expansion of resources beyond what is the likely status in 1990

Given this assumption AZRI's proposals for expansion of the germplasm evaluation group activities would be placed in severe jeopardy. Its current productive role in upland Baluchistan would be maintained. Research over the decade 1990-2000 would underpin and complement the efforts of the provincial Agricultural Research Institute at Sariab. Their efforts are presently heavily biased towards irrigated

agriculture and are lacking a formal barani agricultural research wing. Furthermore, continued expansion of efforts in the perennial forage and dual purpose tree area will assist the present activities of the provincial livestock and forestry departments and will enable AZRI to maintain its valuable role of catalytic coordinator between a wide range of provincial departments.

Efforts at sub-stations would have to continue to take place on a very small scale - food legume research at D.I. Khan would be possibly the most rewarding area, followed by perennial grasses and browse shrubs for Tharparkar.

(2) AGRONOMY GROUP

In the previous five years (1985-89) the agronomy group's main geographical target area has included the main upland production area in Baluchistan of barani cropping namely Khuzdar and Kalat districts. Initial diagnostic agronomy trials have indicated that (a) upland Baluchistan is extremely marginal for crop production without effective water harvesting and (b) interventions such as new varieties, fertilizers, herbicides and tillage practices can increase biological production but are not often economically sound interventions. However, even though the rainfall in most of upland Baluchistan is not sufficient to produce good, reliable crop yields alone, it is in the range in which most workers consider water harvesting to be practical and effective.

Assumption - >50% expansion of current resources

Current water harvesting research trials indicate a potential for improved yields and reliability. It is evident that this area of research is fundamental to AZRI's work and should be pursued for at least the next decade. Possible alternatives are: (a) artificially increase slopes to 3%; (b) NaCl dispersal treatment of catchment surfaces; (c) wax treatment of catchment surfaces; (d) other catchment treatments (soil cement, cement lining, asphalt lining). All these alternatives require increased inputs and so have not been selected for initial testing, but do offer the possibility of considerably increased water harvesting and large increases in yields and reliability. The possibility of improving the local technology of water spreading ("sailaba") should also be considered.

Given increased water availability to crops, responses to fertilizer, variety, tillage, rotations, etc. are likely to be increased, suggesting that appropriate agronomic practices for crops grown with water harvesting will need to be developed. Widespread testing of "improved" varieties arising from the AZRI germplasm group will also be required,

as will the development of appropriate agronomic practices for these new varieties. The traditional animal drawn seeder and plough is heavy and difficult to use and does not control seed rate. No tractor-drawn planter that ridges the soil and plants into the furrow is commercially available. Harvesting is done by hand. Threshing is the most labour-demanding activity and is usually done by hand or with animal-assisted power, although commercial threshers are available. All of these topics require research attention.

A range of crops are grown in rainfed conditions in upland Baluchistan and some order of priority should be assigned to these.

Livestock is an important industry in potential target areas for AZRI expansion and so considerable further emphasis should be given to the agronomy of fodder crops. However, farmers currently grow mainly wheat as a dual purpose crop and so this should not be neglected.

Summer crops such as sorghum, maize and mung offer a useful alternative to farmers if rainfall timings are inappropriate for winter/spring crops. Observations have indicated that generally very poor yields are obtained. Improvements could be obtained by introducing new short season varieties, treatment against loose smut (*Ustilago*), stem-borer and research into appropriate seed rates for arid areas.

Irrigated crop and fodder production is currently not being addressed by AZRI because provincial research institutes mainly focus on these issues. This does not necessarily preclude AZRI's involvement in specific irrigation topics, particularly in an integrated fashion with the range/livestock unit.

Agrometeorological and crop physiological studies are also the proper concern of an Arid Zone Research Institute. The possibility of establishing a specific section for this type of study should be considered. Such a section could consider topics such as: rainfall/run-off studies in cropped fields, rangelands and in treated catchment areas; plant water relations of new varieties in comparison to local landraces, the effects of agronomic practices on plant water and nutrient relations; the effects of low and high temperature stresses on plants; definition and refining of crop-climate models for arid areas.

The AZRI agronomy group's research effort is somewhat less constrained by environmental considerations than the germplasm group. Nevertheless, expansion into the areas of eastern Baluchistan/south-western NWFP, and central/southern

Baluchistan would have considerably more potential than agronomic research in the hot deserts of Pakistan. In these latter areas only environmentally determined opportunism would be an acceptable form of husbandry - improved agronomy is unlikely to play much of a role in improving such high risk systems unless some supplementary irrigation water is available.

Assumption - No real expansion of resources beyond what is the likely status in 1990

AZRI's principal focus will be on water harvesting techniques but the agronomic packages designed around improved water availability would have to become a secondary issue. Crop physiological and agrometeorological studies, being labour intensive for scientists would also be downplayed in emphasis. Winter forage crops would remain the principal crop focus and some expansion into summer forage crops would be a new secondary priority. Geographically the AZRI agronomy group would largely be restricted to upland Baluchistan with D.I. Khan as a secondary area of potential expansion.

3. RANGE LIVESTOCK GROUP

The long-term goals of the group should remain essentially the same as they have been in the 1985-89 period namely:

To facilitate and conduct research applied to improvement of livestock production in the arid zones of Pakistan. Economic aims are to be achieved in the context of sound resource management on a sustained yield basis. Thus, the long-term research strategy for the group should reflect not only the desire for greater animal offtake from rangelands, but also the need to conserve and improve the natural resource base which supports this production.

Research areas which should receive the greatest effort include:

(1) Improvement in quantity and quality of range forage available during critical phases in the annual production cycle of small ruminants;

(2) Relationship of livestock diseases and parasites to fertility, mortality and productivity of grazing animals;

(3) Introduction of improved livestock management techniques, in addition to feeding and prophylactic health care for small ruminants;

(4) Evaluation of the constraints, potentials and needs of large-scale camel production in Pakistan.

By 1990 a solid foundation should be in place, and a core of relevant information should be available to support an expanded program in range-livestock research. Three strategy options for the next decade are discussed below, based on the assumption of a greater-than-50 percent increase in funding for this part of the AZRI operation. Some aspects of the proposed options would require considerably more than a 50-percent increase in funding. Cost estimates are not attempted here; but conceptual frameworks for expansion and key specifics of the options are presented for further evaluation.

The expansion strategies can be classified in two ways, by subject areas to be emphasized, and by geographical areas to be added. Subject areas covered under items 1, 2, and 3, above would be included in the research programs at any new locations, and would therefore expand in level of effort as geographical expansion occurred.

Problems associated with providing a yearlong supply of nutritious forage, whether from rangelands or from off-range sources, are basic to all regions where livestock are produced. The specific range research questions posed by this challenge will vary from place to place, but often involve one or both of the two topics, grazing management and range rehabilitation. Under some circumstances the former can be the means to the latter, therefore, these are not always mutually exclusive subjects. However, for practical purposes, given the aridity and grazing pressures in most of Baluchistan, the concepts of grazing management, i.e., control of numbers and kinds of livestock, and season of range use, and that of range rehabilitation, i.e., introduction of new range plants, mechanical treatments and other forage production interventions, can be treated as separate research areas.

The relationships between animal production and animal health, as affected by diseases and parasites, would be studied at all locations. There are a number of other related areas which do not fall conveniently under the headings of animal nutrition or animal health, which can be considered as livestock management techniques. Any expansion of AZRI range livestock activities would include additional work in all of these livestock management subject areas.

Item 4, camel production research, would become a new subject area for AZRI and would be included on only one or two of the new locations, or at Umerkot. A probable first choice for a camel study area in Baluchistan would be

southeastern Kharan District. A second camel study area could be located in eastern Chagai District.

The geographical approach to strategy options presents a more complicated and controversial problem. Three geographical options are discussed, and serve as the primary framework for this projection. Subject areas are relegated to secondary status, because, with the exception of camel research, these would remain essentially constant regardless of where the work is done. Differences in subject area emphasis among the geographical options would reflect local variations in such factors as vegetation conditions, health problems and livestock management practices.

Option A "Baluchistan Option"

All range-livestock work would be confined to Baluchistan. Present field research stations in Loralai and Kalat districts maintained, with basically the same research objectives. These include grazing management, range rehabilitation, forage reserves, small ruminant nutrition and productivity, and livestock diseases and parasites. animal nutrition unit and range germplasm work at AZRI headquarters, Quetta, continues with moderate increases in levels of effort.

New field research stations will be added in Zhob, Kharan, and Chagai districts. The Zhob station, located in a higher precipitation zone than either of the first two field stations, conducts a similar research program, as above. The Kharan and Chagai stations include camel production research, along with appropriate studies on range and small ruminant management.

The research program at Maslakh Range area in Pishin District is re-activated in cooperation with the Baluchistan Forest and Livestock Departments. This action is naturally contingent upon assurances of safe working conditions in the Maslakh area, a status which could occur by 1989. AZRI would provide impetus, advice, and coordination for the establishment of an integrated, cooperative range-livestock development and demonstration center. The new Maslakh program should actively involve, not only key provincial departments, but also local farmers and livestock owners who use the rangelands of this area. Local participation in the re-activated development project is a vital element from the beginning of the process. Testing and demonstration of practical range and livestock production interventions, using an agro-pastoral systems approach, provide the focus for the effort.

All stations participate in an expanded research program on selection and introduction of forage and fuelwood trees.

Proposed allocation of funding, by districts or sites:

Quetta	15	percent
Loralai	15	"
Kalat	15	"
Zhob	15	"
Kharan	15	"
Chagai	10	"
Pishin	15	"

Option B "Baluchistan + Tharparkar Option"

This option maintains the level of effort of the present range-livestock program in Baluchistan, based in Loralai and Kalat districts, plus the headquarters at Quetta. Expansion involves a major increase in the work based at the Umerkot substation, serving the Tharparkar desert region, and the addition of field stations in southeastern Kharan District and Zhob District. The Kharan site and the Umarkot substation become the bases for a new camel production research program. The new Kharan and Zhob stations also carry out full programs of range and small ruminant studies parallel to those underway in Loralai and Kalat districts.

Range-livestock work is suspended at the Bahawalpur substation, serving the Cholistan desert, and at the D. I. Khan substation near the Thal desert. The expanded effort in the Tharparkar partially satisfies the demand for increased AZRI attention to problems of the hot deserts.

Proposed allocation of funding, by districts or sites:

Quetta	15	percent
Loralai	15	"
Kalat	15	"
Zhob	15	"
Kharan	15	"
Umerkot	25	"

Option C "National Option"

The range-livestock program in Baluchistan remains at about the same level of effort, with some chance for trade-off adjustments among the three present sites. The substations at Umerkot, Bahawalpur and D.I. Khan get a substantial boost in range-livestock programs, thus

establishing a strong commitment by AZRI to working in the hot desert regions.

Geographical expansion carries with it a concomitant increase in diversity of research areas and scientific expertise. Staffing requirements for the three hot desert stations are met from new recruitment and permanent postings to Umerkot, Bahawalpur and D.I. Khan, rather than by transfers or field trips from Quetta.

The range management program includes more emphasis on selection and introduction of woody species for production of forage and fuelwood in hot deserts. Forage grass testing expands to include a wide variety of warm-season species. Livestock management research includes a major effort on camel production constraints and production methods, and broadens the small ruminant work with new breeds of sheep and goats adapted to the hot deserts. The livestock health program includes new surveys of diseases and parasites, and development of technologies for mobile veterinary services in the hot deserts.

Proposed allocation of funding, by districts or sites:

Quetta	40 percent*
Umarkot	25 "
Bahawalpur	20 "
D. I. Khan	15 "

* Includes Loralai and Kalat

(4) FARMING SYSTEMS / ECONOMICS GROUP

The future program of work for the Farming Systems/Economics (FS/Econ) group at AZRI will continue to be in the two areas of: (1) descriptive, diagnostic and information gathering and (2) technology evaluation. Descriptive and diagnostic informal and formal surveys are carried out at AZRI to (1) describe the current farming systems and (2) to understand the major agricultural production and marketing constraints and priority problems faced by farmers. This information is used by all AZRI researchers in the design of the AZRI research program.

By the end of the first phase of the MART/AZR project, substantial baseline data will have been collected for those locations that AZRI now works in. However, there must be a continual commitment to descriptive and diagnostic work because: (1) the farming systems of Baluchistan and the sub-station areas are dynamic and will see a rapid change

over the next two decades - the farming systems will be influenced by interventions from AZRI and other research institutions and by outside economic and social forces and this information is crucial to the design of an on-going research program, and (2) AZRI will be involved in research at new locations within Baluchistan and the sub-station areas that require initial base-line data and diagnostics.

The technology evaluation criteria for the AZRI research program in the future will continue to be: (1) technical feasibility in the field, (2) economic profitability and risk evaluation, (3) the fit of the technology in the farming system and (4) socio-cultural considerations.

The FS/Econ. program to date has focused mainly on economic budgeting with some attention to risk evaluation and the fit of the intervention. As AZRI matures as an institution with better and more reliable data and as the calibre of the FS/Econ staff increases through higher degree training, more attention will be given to risk evaluation and the fit of the technology within the farming system. Future technology evaluation will include extensive use of the MSTAT risk analysis program and whole farm modeling.

Also, as the AZRI research program matures, some of the FS/Econ resources can be devoted to those macro-socioeconomic issues which have an effect on technology adoption. Government and institutional policies and programs that affect technology adoption such as marketing, agricultural and consumer subsidies, exchange rate policy, product and input pricing policies, transportation, tariffs and energy pricing could be areas of research.

Much of the descriptive, diagnostic and technology evaluation work to be done by the FS/Econ group over the next two decades depends on the scale and direction of the joint AZRI research program. If the AZRI research program remains at the present scale, the current complement of six FS/Econ staff is sufficient. This is provided that two of the six are at the Ph.D. level with experience and that the remaining four have good MSc. degrees. If there is an expansion of 50% in the research program, then two more positions are required - one at the Ph.D. level and one at the MSc. level especially if research is to also include macro socio-economic issues. There also needs to be a rationalization of the workload of the staff if each sub-station area is to receive attention. At least one economist's time must be dedicated to each sub-station with backup from AZRI headquarters.

If AZRI is to become more effective in the area of descriptive and diagnostic work, regardless of any expanded

effort, it must also have a rural sociologist as a member of the FSR/Econ. group. Such a person can help the economists and biological scientists with descriptive and diagnostic work as well as with technology evaluation, especially with defining the socio-cultural criteria for the adoption of interventions.

(5) EXTENSION GROUP

In the period 1985-89 the AZRI extension group was in a formative phase. Extension for poor, arid areas is presently a much under-researched science. Thus, methodological development has been one of the group's principal functions. In the next 10 years phase the role of AZRI's extension group will evolve to become mainstream dissemination of AZRI generated technologies through provincial extension agencies. This will require expansion of the group's role in multi-location verification trials for both crops and livestock and the activation of further involvement by the provincial extension agencies and mass media. At present this wider scale verification would be limited by personnel resources and expansion of this group will be a pre-requisite if AZRI is to make effective impact in the next decade. Dependent on the availability of trained staff not only will emphasis be on adoption of innovations, but also on the monitoring, diffusion and impact of AZRI generated technologies. Additionally, research in hot deserts will require constraint surveys as conditions are different from upland Baluchistan but it is recognised that extension group skills are more readily transferable than those of the germplasm or agronomy groups.

The development of AZRI's media production and audio-visual unit will assist provincial extension services and mass media by producing "ready packaged materials" for immediate use for extension and will help produce specialized training materials for AZRI's other research groups. Over the next decade the level of activity of the audio-visual unit will grow in conjunction with AZRI's other research efforts. This will require not only investment in equipment, but also most importantly, in human resource development. Audio-visual materials require a wide range of skills and AZRI must invest now in developing a pool of trained personnel to ensure timely and effective dissemination of AZRI generated technologies to dryland farming communities.

A major "unfinished" and on-going task for AZRI's extension group will be the development of AZRI's resource center for dryland agricultural information. Distribution and dissemination rather than mere collection of material will be the watchword of the resource center. An effective information void on dryland agriculture in Pakistan faced

AZRI in 1985. Clearly this was a false impression but gathering, checking, collating and publishing the information in an efficient form is a very large and time-consuming task. Furthermore, gaining relevant information for other arid areas of the world to assist AZRI research activities in an efficient manner is a sophisticated process requiring high grade editorial skills. Such skills have yet to be developed and additionally the hardware of information technology is also currently lacking awaiting rationalization with other PARC information resource centers. Clearly, therefore, a setting-up process of the resource center will consume the first few years of the projected decade but would be mature after 1995.

TRAINING STRATEGIC PLAN 1990-2000

After the 1985-1990 phase of initial development at AZRI staff training will remain a most important priority. Scientists of all disciplines trained in agriculture suitable for arid zones remain rare in Pakistan particularly in the areas of rangeland management, water harvesting agronomy, agricultural extension and farming systems/economics research. A coordinated approach to AZRI's plans for expansion with plans for obtaining the skilled manpower required to translate AZRI's goals into reality is an essential prerequisite to the success of the Institute's work.

Long Term Training

AZRI is seeking to develop a cadre of scientific talent to provide the expertise for its desired expansion into other dry environments. By 1989 six AZRI scientists will be on higher degree training funded by the MART project. However, there will be a continued need to build up AZRI's staff resources and to provide the incentive of further training to enable AZRI to recruit talented scientists, preferably with rural backgrounds from arid areas. In Table 1, it is estimated that provision of 2.5-3 long term training positions per year for the next ten years will be the minimum requirement with which AZRI can genuinely attempt an expanded research role in its "federal all provinces context". This level of training will require a coordinated recruitment policy to be established as soon as possible to ensure that sufficient quality candidates meeting GOP time of service qualifications and USAID TOEF requirements can be provided "in house".

Table 1. Long term training positions for the next decade

RANGE	LIVESTOCK	ECON	EXT	GERM	AGRON	
MART higher degree staff trained abroad by 1990	2	1	1	-	1	1
Additional trained requirement by 1995	3	2	2	3	2	2
Additional trained requirement by 2000	3	3	2	2	1	2
TOTAL ADDITIONAL POSITIONS (27)	6	5	4	5	3	4

Short Term Training

In parallel to AZRI's needs for long term training exists AZRI's requirements for short term training. This may take the form of short courses overseas or locally in other parts of Pakistan. Its principal value is in providing concentrated skill techniques usually associated with the necessary scientific technical background. Such courses are principally of value in giving untrained new recruits a "flying start" to their area of field research and as a mind broadening experience (this concept is currently at variance with PARC policy). They may also be of value in rejuvenating the knowledge of more mature staff members in modern research techniques. Numbers of trainees per year required to support AZRI's expanded research program are much harder to estimate than for long term training but this is likely to average approximately four scientists a year. This number would be greater with expansion into new environments which would require new skills.

Local Workshops

This training mode has been one of the most important and successful in the first research phase 1985-90. An average of at least five workshops a year have been organized for AZRI staff and a wide range of collaborating provincial government research organizations. These workshops have been designed to be highly practical and skill oriented without being too time demanding. They have engendered considerable local goodwill amongst collaborating scientists and it would be a priority that funding for this type of training continue at a similar level for the next decade.

English Language Training

Poor English language spoken and written skills are possibly the major areas of weakness in the scientific community in Pakistan, particularly those scientists coming from rural, arid zone backgrounds which is our principal target group for recruitment. AZRI's English language program has developed "ad hoc" in the 1985-90 period but is now recognised as a major asset. Funds to continue such training for the next decade will be required, particularly if expanded recruitment or greater provincial collaborative training programs are contemplated.