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International Center for Agricultural Research in the Dry Areas

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## RESEARCH REPORT

No. 34

DEVELOPMENT PLAN  
FOR THE  
ARID ZONE RESEARCH INSTITUTE

by

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

April 1989

# 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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FOR  
THE ARID ZONE RESEARCH INSTITUTE

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Arid and semi-arid, non-irrigated land represents more than half of the total land area of Pakistan. It can be subdivided into two major categories on ecological grounds: A) The uplands (>1000m) which have a temperate climate in which both aridity and cold are major factors limiting plant growth and B) The hot deserts which have a subtropical climate in which aridity and high evapotranspiration rates are the major factors limiting plant growth.

The majority of the semi-arid uplands (>150mm but <300mm rain per annum), approximately 15 million hectares, is found in Baluchistan. A second, smaller but contiguous, area of land is found in the elevated regions of the southern and western sectors of North West Frontier Province (NWFP). These two areas form a single ecological zone which has a continental Mediterranean climate, unique in Pakistan, and is the most important production zone for small ruminants in the country. Additionally, there are the semi-arid Northern Areas of Pakistan which have a dry alpine type of climate as found in Gilgit, Skardu and Hunza. These latter areas have some potential for development of their dryland agriculture, but not as much as in upland Baluchistan, as the potential agricultural area is much smaller with largely unproductive mountainous slopes being a major feature of the landscape.

The hot deserts of Pakistan are both arid (<150 mm rain per annum) and semi-arid and are found in southern and western Baluchistan, Tharparkar, Cholistan and the Thal area. Their productivity per unit area is low, but their combined land area is considerable, with grazing of both large and small ruminants being the principle agricultural activity. The potential for improvement of dryland agricultural activities in these areas is poor owing to the low and unreliable annual rainfall and to the very high evapotranspiration rates which seriously reduce the chances of successful range rehabilitation measures.

Increased livestock production from these arid zones is one of the principal recommendations from the National Commission on Agriculture's Report (1988). The Pakistan Agricultural Research Council's (PARC) Arid Zone Research Institute (AZRI) is the principal research establishment charged by the Government of Pakistan to assist in the realization of such increases in production. However, in the recent strategic plan for the Arid Zone Research Institute (Nov. 1988, MART/AZR Res. Rep. 23), it is proposed that research emphasis in the medium term be placed initially on the development of livestock offtake from small ruminants in temperate upland environments, rather than hot deserts, because of the greater and more easily realized potential productivity of the temperate uplands.

## INSTITUTIONAL SCOPE OF WORK

### 1. General Responsibilities:

In order to effectively address the research problems inherent in attempting to increase productivity from dryland agriculture, the Institute will work in six general areas of research which are emphasized in AZRI's strategic research plan:

- a. Improvement of livestock management,
- b. Improvement of rangeland management and rehabilitation,
- c. Evaluation of introduced germplasm of annual forages, perennial grasses and legumes, as well as range forage shrubs and trees,
- d. Improvement of forage and dual purpose crop agronomic strategies assisted by water harvesting techniques,
- e. Research into the development of appropriate extension methodologies for livestock and crops in disadvantaged rural areas,
- f. Evaluation of the socio-economic aspects of small ruminant production and associated forage and dual purpose crop production.

This research program will involve a mixture of on-station, on-farm/range and laboratory studies, surveys, and economic and social studies. Research work will be carried out using an integrated multidisciplinary approach in fulfillment of the goals of the Institute's strategic plan. All aspects of the research effort will be complemented by appropriate modes of training for AZRI staff and collaborating provincial officers.

### 2. Specific responsibilities:

#### **i. Livestock Management Research**

Livestock management scientists will be involved in the following areas of research:

- a. Studying the effect of improved quantities and quality of animal feed on sheep and goats throughout the annual production cycle. The relationships between different and variable sources of feed and key animal production and offtake quality parameters will be determined.

b. Examination of the use of alternative management feeding strategies which could include: use of introduced forage reserves for flushing and for supplemental feeding pastures, use of mineral/protein/energy blocks on rangelands, allocation of dam's milk to offspring, and alternative breeding schedules.

c. Investigation of the relationships between livestock diseases and parasites to fertility, mortality, productivity and quality of offtake from grazing animals.

d. Linkages with the appropriate provincial extension agencies will be fostered to ensure their commitment to extend AZRI generated technologies.

#### ii. Rangeland Management and Rehabilitation Research

Rangeland management scientists will be involved in the following areas of research:

a. The utility of range forage shrub reserve plantations will be examined on marginal crop land and sites with preferential subsoil moisture availability and the potential for water harvesting. This will include the possibility of dual purpose forage and fuel wood species.

b. To examine options for the rehabilitation of rangeland vegetation. This will include testing introductions of perennial grasses, forage legumes and forage shrubs into range plant communities. In conjunction with these introductions, land treatment practices designed to improve precipitation capture and moisture retention in the root zone, such as ripping, contouring, micro-catchment formation and other types of runoff capture technology, will be tested in order to improve plant establishment and productivity.

c. To study the effects of alternative grazing strategies on the longterm sustainability of range and livestock productivity. These studies will act as baseline data for estimates of current and future range carrying capacity and potential range forage production.

d. Linkages with the appropriate provincial extension agencies will be fostered to ensure their commitment to extend AZRI generated technologies.

### iii. Research into Germplasm Introduction and Evaluation

Germplasm evaluation scientists will be involved in the following areas of research:

a. To introduce germplasm lines of perennial fodder/fuelwood species suitable for AZRI research environments on marginal crop land or rangeland. In particular, this will include forage shrubs, perennial grasses and forage legumes, and dual purpose forage/fuelwood trees and shrubs. The principal screening pressures to be considered will be: persistency under severe environmental conditions of drought, cold and heat; regeneration capacity; responses to grazing pressure by small ruminants; palatability and digestibility of forage material; forage yields, energy and protein content; and productivity and suitability of fuelwood.

b. To introduce germplasm lines of annual crop species suitable for AZRI research environments. In particular this will include forage and dual purpose food/forage crops such as *Vicia* spp., barley, lentils, chickpeas and breadwheat. Principal screening pressures to be considered will be: adaption to the physical environment including suitable maturity date, cold, heat and drought tolerance; disease and insect resistance; forage, straw and grain quality, and potential acceptability into current farming systems.

### iv. Water Harvesting Agronomy Research

Water harvesting agronomists will be involved in the following areas of research:

a. Examination of improved water capture and distribution strategies for growth of annual crops. This will include examination of contour bund design, desert terraces, spillways in bunds, field leveling with locally available technology and surface sealing techniques.

b. To investigate whether, in the presence of improved methods of water harvesting, alternative agronomic strategies will be economically profitable and can assist in ensuring a better, and more stable, return to investment by farmers than the current uncertain, subsistence system. Emphasis would be placed on producing more abundant, and alternative, sources of animal feed for sale or for direct consumption in mixed livestock/crop enterprises. In addition, in conjunction with agricultural economists, the social acceptability of alternative water harvesting strategies will be assessed.

c. To assist the rangeland improvement scientist in examining ways in which small scale runoff catchment technology can help achieve better and more sustained productivity of range vegetation.

d. Linkages with the appropriate provincial extension agencies will be fostered to ensure their commitment to extend AZRI generated technologies.

#### **v. Research into Agricultural Extension Methodology**

The extension scientists will be involved in the following areas of research:

a. To provide supporting research to provincial research agencies by which the problems associated with managing, performing and monitoring agricultural extension in disadvantaged, low density rural populations can be overcome.

b. To address the problems associated with extension in the area of livestock management for transhumant and migratory flocks and flock owners.

c. To investigate appropriate extension methods and communication techniques by which agricultural extension messages can best reach a poorly educated and largely illiterate multilingual population.

d. To determine what are the most effective means by which AZRI generated technologies can be presented to the extension agencies of provincial governments to ensure rapid and widespread extension efforts with a high probability of farmer/herder acceptance, as well as the development of steps for engendering self-reliance for the further spread of innovations in the agricultural community.

e. To consider how dryland agricultural research performed at the Arid Zone Research Institute can involve provincial extension agencies most effectively in order to enhance AZRI's research activities and to ensure a commitment to extend AZRI generated technologies.

#### **vi. Socio-economic Agricultural Research**

Socio-economic agricultural scientists will be involved in the following areas of research:

a. The examination of the profitability and compatibility of AZRI generated technologies with current agricultural systems. This will require assessment of both individual technologies and enterprise option studies in order to

maximize farm/flock production efficiency and minimise the longterm risk experienced by communities supported largely by agriculture.

b. Investigation of the socio-economic constraints to livestock production in the semi-arid areas of Pakistan, such as marketing, credit and collateral relationships; influences of potential GOP price support; feed subsidies; and other policies generally affecting upland livestock producers.

c. Identification and delimitation of research domains within the AZRI mandate area in order to facilitate the generalization of location specific research.

d. Investigative surveys in semi-arid areas to assess additional constraints to production not being addressed or not given due emphasis by AZRI's research program.

e. To assess farmer adoption rate and adaption of AZRI generated technologies and to evaluate the ongoing and future impact of AZRI's research in progress.

f. Linkages with the appropriate provincial socio-economic agencies will be fostered to ensure maximum efficiency in data collection, interpretation and use.

#### **INSTITUTIONAL ESTABLISHMENT - PRESENT STATUS & FUTURE NEEDS**

As of January 1st 1989 the current establishment of the Institute includes 32 scientific staff in the following grades: 1 (19), 4 (18), 18 (17) and 7 (16). Discipline specialities, highest degree levels, dates of attainment and staff distribution by research group are given in Table 1. Five additional staff members have been sent for long term higher degree overseas or local university training and three more have been nominated and cleared for further training with departure in late summer 1989 being projected. Their original disciplines and current areas of speciality are shown in Table 2.

It is evident from the data presented in Table 1 that in general the Institute is presently severely lacking in senior personnel capable of acting as research group leaders having both up to date research skills (recent doctorate) and the experience in scientific management (five years post-doctoral experience) to enable the research groups to function at their full potential. This situation is likely to prevail in the period 1990-92, but will start to improve after that period with the continued return of AZRI trainees

with higher degrees (Table 2). However, variability exists across the research groups which is considered in detail below:

#### i. Livestock Management Research

The offtake products from small ruminants are the high value "core commodities" for which research at the Institute is supposed to engender sizable increases in productivity to fulfill the recommendations in the Report by the National Commission on Agriculture. A very large proportion of all the sheep and goats in Pakistan (probably more than 75%) are raised in non-irrigated arid areas which fall under AZRI's research mandate. Yet at AZRI the group leader of the research group responsible for improved livestock management, nutrition and health is a grade 17 officer (expected to be promoted to grade 18) who has returned from Ph.D training in the USA only in the last three months. In addition, there is one nutritional specialist (both grade 17). Three officers are currently overseas or at local universities on training and are projected to return in late 1989 (management specialist) and late 1991 (veterinary pathologist and veterinary scientist).

Clearly, with the present manpower, this section can achieve only very limited objectives. Specialists are needed in the following discipline areas: sheep and goat management, prophylactic health care, and nutrition/health interactions.

#### ii. Range Management and Rehabilitation Research

Small ruminants are currently almost exclusively dependent on range feed resources. There is a concern that widespread overgrazing is occurring and that the productivity of the current ecological system is not being sustained. Inadequate nutrition has been identified by the NCA report as the major constraint to increased offtake of livestock products from small ruminants. Therefore the current and potential future vegetational productivity of rangelands is of primary importance.

At the Institute the current staff of the range improvement group is only four officers, two at grade 17 and two at grade 16, whose level of training and active research experience is somewhat limited. With the need for the inclusion of range rehabilitation measures for improved feed and fuelwood supplies, this becomes a very broad area of research encompassing germplasm evaluation, hydrology, forestry, grazing management, and the analysis of the quality and quantity of range vegetation. This diversity requires an enhanced level of research management. AZRI is currently lacking senior experienced staff, trained in range management, to fulfill this managerial function. Also,

urgently required are specialists in the establishment, measurement and maintenance of range grasses and legumes, shrubs and trees under controlled and uncontrolled grazing conditions.

### iii. Germplasm evaluation

This area of research acts as one major link between increases in range feed productivity and additional animal feed from forage crops and crop residues. Both the current pattern of dryland cropping and the natural range vegetation are extremely limited in the number of plant species being grown. Though some of the local range species are quite productive - *Artemisia intermedia*, *Haloxylon griffithii*, *Chrysopogon* spp., *Olea* spp., as is the local breadwheat landrace, there is considerable scope for the introduction or re-introduction of species that are likely to be adapted to the environment and to be more productive on a sustained basis. The current successful introductions by AZRI of *Atriplex canescens*, *Eragrostis curvula*, *Vicia villosa* ssp. *dasycarpa*, and more disease resistant cereals and food legumes indicate that a potential exists for new crop and range species that has not yet been fully exploited. Furthermore, conservation of current wild species and crop landraces is another important area in which germplasm scientists need to be much more involved than at present.

The current staff of germplasm evaluation scientists at AZRI is three, all of whom are grade 17 officers, with one additional officer on long term higher degree training who is scheduled to return in early 1991. This group is augmented by some of the current responsibilities for perennial species being absorbed by one of the range rehabilitation scientists. In addition, one grade 17 officer, who is posted at D.I. Khan substation, is largely involved in germplasm evaluation studies. Until late 1987 Dr. B. Roidar Khan acted as the senior research manager in germplasm evaluation until being appointed as Director of the Institute. He continues to provide senior managerial guidance to the research group. Some expansion of staff is called for particularly in the areas of perennial legumes, shrubs and fuel wood species, germplasm conservation and annual forage crops.

### iv. Research into Improved Water Harvesting & Agronomy

The experiences of AZRI's conventional agronomic research program in the period 1985-89 in upland Baluchistan has demonstrated just how marginal some of these semi-arid environments are for improved crop productivity. Large and profitable increases in either food crops (wheat and lentils) or forage crops (barley and vetches) will not be forthcoming by standard packages of "improved technology" unless more water can be made more reliably available to

crops. Initial indications of new techniques for improved water harvesting have suggested a much better scope for improvement. This is of vital importance because it appears that in the medium term most of the additional animal feed material required by the livestock industry will have to come from lands currently used for cropping.

The Institute is reasonably well supplied with "conventional agronomists" (mostly soil chemists) but there is no one with up-to-date skills in water harvesting techniques or with a strong background in soil physics or agrometeorology. At present there are five agronomists (of mixed disciplinary backgrounds - chemists, botanists etc.) at headquarters (1 grade 18, 4 at grade 17 and 1 at grade 16) with three grade 18 staff (all soil chemists) acting as Deputy Directors in the three AZRI substations, and with one grade 17 officer and two grade 16 officers supporting substation activities. It is evident that an increase in numbers of agronomists is probably not required but a re-allocation of personnel, substituting new staff with particular skills in arid land agronomy, water harvesting and agricultural engineering for the current conventionally trained staff, would be useful. In addition, a recently returned trainee with up-to-date skills in agronomy would be a useful addition as research team leader.

#### v. Research into Agricultural Extension Methodology

It is an unfortunate fact that the agricultural extension services of the provincial governments for small ruminant husbandry and dryland cropping in semi-arid areas are either ineffective or non-existent. This is of major concern to AZRI as the improved technologies that will soon be forthcoming from its research programme will require effective widespread extension to have the desired impact. This will not be forthcoming unless the Institute takes steps to assist the provincial agencies responsible for extension in several ways: involving them in the research process, acquiring better understanding of how extension is best performed in a thinly dispersed and migratory population, and helping them with the challenges of extending technologies to a largely illiterate, multilingual population.

AZRI currently has three scientists who act in an extension research capacity, two grade 17 agronomists and one grade 17 communications scientist. Training levels in modern extension techniques are deficient in the staff and there is no senior (grade 18) research coordinator. This area urgently requires a stronger establishment with staff specifically trained in extension education, particularly those relevant to small ruminant production and crop husbandry, communication techniques, and multi-media technology.

## vi. Agricultural Socio Economics

There is a clear need for AZRI to have a strong socio-economic studies group. Research will be needed to determine the profitability and risk factors associated with AZRI-generated technologies, to consider potentially important anthropological or sociological issues and to evaluate the impact of the Institute's research Program.

At present AZRI is extremely deficient in this area. There are five staff, two grade 17 and three grade 16 officers. Their level of training is poor and their current effectiveness is low. A senior research coordinator is most urgently required in this area and, in addition, at least two better qualified grade 17 staff need to be re-allocated to, or trained in, this research field.

## Staff Establishment & Qualifications

	Discipline	Degree	Date	University
Dr. Roidar - Director	Agron.	Ph.D	1982	Kansas State
Research Group/Grade				
<b>Livestock Management</b>				
Shahid Ahmad (17)	Nutrition	Ph.D	1988	New Mexico State
Atiq-ur-Rehman (17)	Nutrition	MSc.	1985	Faisalabad
<b>Range Rehabilitation</b>				
M.I. Sultani (17)	Range	MSc.	1983	Faisalabad
Rana Asghar (17)	Range	MSc.	1975	Faisalabad
Javed Afzal (16)	Forestry	MSc.	1987	Peshawar (PFI)
Ahmed Gul (16)	Botany	MSc.	1986	Baluchistan
<b>Germplasm Evaluation</b>				
Asghar Ali (17)	Botany	MSc.	1981	Sind (Jamshero)
Sarfraaz Ahmad (17)	PBG	MSc.	1987	Peshawar Ag. Uni.
Irshad Begum (17)	Botany	MSc.	1981	Punjab Uni.
<b>Agronomy</b>				
Hassan Raza (18)	Soil sci.	MSc.	1969	Sind (Tandojam)
		MSc.	1983	(U.S.A.)
Sher Mehmood (17)	Soil Sci.	MSc.	1982	Peshawar Ag. Uni.
M. Islam (17)	Chemistry	MSc.	1978	Baluchistan
A. Samiullah (17)	Chemistry	MSc.	1982	Baluchistan
Zahid Ali (17)	Ag. Eng.	BSc.	1984	Faisalabad
F. Rehman (16)	Botany	MSc.	1984	Baluchistan
<b>Extension</b>				
Bilal Chowdry (17)	Ext Edu.	MSc.	1976	Faisalabad
M. Aslam (17)	Agronomy	MSc.	1983	Faisalabad
Arshad Ali (17)	Agronomy	MSc.	1984	Faisalabad
<b>Ag. Economics</b>				
F. Sabir (17)	Econ.	MSc.	1984	Punjab
K. Mahmood (17)	Ag. Econ.	MSc.	1985	Faisalabad
M. Afzal (16)	Econ.	MA.	1984	Baluchistan
Asif Masood (16)	Stats.	MA.	1985	Islamia Univ.
Ehtasham-ul-haq (16)	Econ.	MA.	1988	Baluchistan
<b>Substations</b>				
Bahawalpur				
Mustaq Ahmed (18)	Soil Sei.	MSc.	1974	Faisalabad
Tahir Bux (17)	Soil Sei.	MSc.	1983	Faisalabad
Umerkot				
Y.A. Memon (18)	Soil sci.	MSc.	1984	Queensland Aus.
M. Ismail (16)	Soil sci.	BSc.	1981	Sind (Tandojam)
Dl Khan				
Ruhul Amin (18)	Soil sci.	MSc.	1975	AU Beirut
Abdur Rashid (17)	Agronomy	MSc.	1982	Peshawar Ag. Uni.

### Staff Long Term Training Projections

Name	Current Discipline	Training Field	Dept. Date	Arrive Date	Univ.
<b>A)</b>					
<u>In Progress</u>					
A. Wahid	Livestock Manage	Livestock Manage	1986	1989	Oregon St.
Anwar Khan	Botany	Barley Genoplasm	1987	1990	Montana St
Babar Kazi	Agronomy	Range Manage	1988	1991	New Mexico
Nasir Khan	Vet. Sci.	Vet. Pathology	1988	1991	Ohio State
M. Munir	Vet. Sci.	Vet. Sci.	1989	1991	Tandojam U
<u>Nominated and Approved</u>					
Arshad Ali	Agronomy	Water Harvesting	1989	1992	
Zahid Ali	Ag. Eng.	Ag. Hydrology	1989	1991	
Khalid Mahmood	Ag. Econ.	Ag. Econ.	1989	1992	
<b>B.</b>					
<u>Proposed Ph.D training areas</u>					
<u>Discipline</u>		<u>Dept. Date</u>			
1. Breeding Methodology for dryland forage legumes		1990			
2. Ag. Economics of dryland production of sheep & goats		1990			
3. Techniques for Ag. extension in dryland Agriculture		1990			
4. Improved methodology of H <sub>2</sub> O capture and utilization		1990			
5. Techniques of rangeland vegetation rehabilitation		1991			
6. Drought tolerance selection strategies for dual purpose food/forage crops (lentil/wheat)		1991			
7. Physical environmental constraints to crop productivity on marginal lands		1991			
8. Agricultural economics of raising and marketing small ruminants in sparsely populated areas		1992			
9. Evaluation of dual purpose forage/fuelwood trees and shrubs for rangeland rehabilitation		1992			
10. Techniques for agricultural extension of technologies designed for migratory small ruminant flock owners		1992			