THE MART/AZR PROJECT

HIGH ELEVATION RESEARCH IN PAKISTAN

Pakistan Agricultural Research Council

ARID ZONE RESEARCH INSTITUTE

Brewery Road, Quetta, Pakistan.

No. 77

AZRI RESEARCH PLANS FOR 1992/93
(prepared by AZRI/PARC and ICARDA/AZRI staff)

by

B. Roidar Khan, E.F. Thomson
and A.L. Rodríguez

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MART/AZR PROJECT RESEARCH REPORTS

This research report series is issued by the Management of Agricultural Research and Technology Project/Arid Zone Research Component (MART/AZR). The project is sponsored financially by the Mission to Pakistan of the United States Agency for International Development (USAID).

The project contract is implemented by the International Center for Agricultural Research in the Dry Areas (ICARDA) 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).

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 North Africa.

Libraries, individuals and institutions may obtain single copies of this research report series free of charge and may request that their names be placed on a mailing list for periodic notifications of published papers by writing to the ICARDA Office, P.O. Box 362, Quetta, Pakistan.

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INTRODUCTION

The Arid Zone Research Institute of the Pakistan Agricultural Research Council (PARC) was established to take responsibility for three major areas of PARC's national research mandate, namely:

a) to identify and address the problems associated with the agricultural development of the arid areas of Pakistan, where the potential for irrigation is either non-existent or undeveloped, by creating an effective research capability;

b) to investigate and quantify the present technical constraints to agricultural productivity in these dry areas, in order to develop and test appropriate innovations designed to overcome these constraints;

c) to consider the economic and social acceptability of possible technological improvements, and to develop suitable methods for rapid and effective dissemination of new agricultural information.

The attainment of these objectives is being pursued within the context of maintaining the sustainability of range- and crop-based production systems, and should not increase the risks of further degradation of fragile ecosystems.

The MART/AZR project was established by PARC at AZRI in late 1985 with funding from USAID and during the first four years was implemented by ICARDA and Colorado State University. The objectives of the project are to assist in the development and strengthening of the research capacity of AZRI, and to help in the initiation and execution of a research program in dryland agriculture. The project was extended in December 1989 and is expected to continue until August 1994. During the final phase it is being implemented by ICARDA.

The format of this report continues the one introduced last year. It is hoped that it gives a clear picture of the proposed research. Both on-going and new research is presented as separate protocols. The report for the 1992/93 season is the product of the efforts of AZRI and ICARDA scientists, and is the seventh annual workplan since the start of MART/AZR's assistance to AZRI. Technical results of the previous six seasons work in highland Baluchistan have been published in Research Reports Nos 1-76. A full list can be obtained from the AZRI/ICARDA office, PO Box 362, Quetta, from where individual reports can also be requested.

A comprehensive review of the research at AZRI has taken place since the beginning of 1992 and the printing of this report has been delayed until January 1993 so that any last minute changes could be included. The review process involved the annual planning meeting held in Quetta on May 11 and a AZRI/NARC (National Agricultural Research Center, Islamabad) joint meeting held at NARC headquarters on May 31, 1992. As well as reviewing the research proposed for the 1992/93 season, special efforts were made to identify and initiate joint research between AZRI and scientists at ICARDA headquarters and between AZRI and NARC scientists. One of the main outputs of the planning process was to reduce the numbers of proposed new protocols so that AZRI scientists would have more time

to analyse the previous years' results and write reports. This also allowed AZRI to focus more closely its research on a small number of promising technologies.

A second output of the planning process was a reduction in the number of experimental sites that will be used in 1992/93, particularly in Loralai District. This reduction is necessary due to the difficulties of conducting research so far from Quetta. It may lead to criticism that AZRI is not covering the main agroclimatic zones of Balochistan but it should increase the precision of the research due to more frequent visits to sites. The sites are shown on page 4.

The start of the two BOSTID grants in April 1992 has supplemented the MART/AZR operational funds which have been decreasing during 1992 and will fall even further in 1993. Indeed, the BOSTID grants are providing most of the operating funds for the water-harvesting and livestock research.

AZRI continues to be organised into five disciplinary sections although the Extension Section is administratively under the Agronomy Section (Table 1). Considerable changes to the staff composition have occurred during the last 12 months which indicates the serious intent of PARC to strengthen AZRI. Indeed, six new staff have been added, three have moved to PARC headquarters and one on a temporary contract left in December. It is hoped that more staff will be transferred to the Range Section, arguably one of the most important at AZRI, and that the two new staff on contract will get regular appointments very soon. The Agronomy Section was strengthened by the return of one long-term trainee in January 1992.

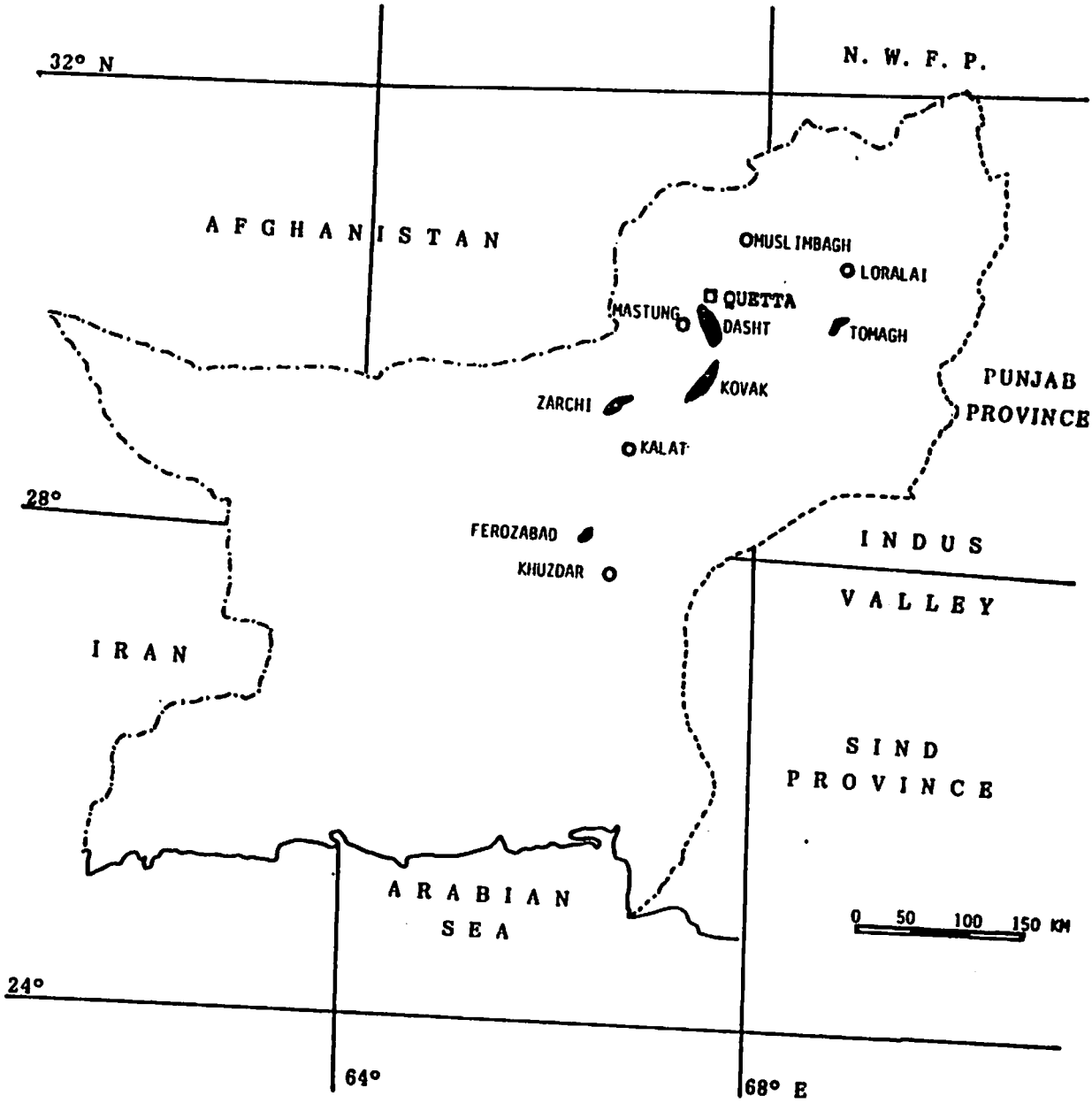
Table 1. AZRI Headquarters Scientific Staff on December 31, 1992.
(Staff with names preceded by an "*" joined during 1992)
(Staff with names preceded by a "+" left during 1992)

Director AZRI	Bakht Roidar Khan (PSO[1], PhD)
Agronomy/water-harvesting Section	K.N. Babar (PSO, Deputy Director) *Nisar A. Malik (SSO[2]), left in December Muhammad Islam (SO[3]) M. Arshad Ali (SO, LTT[4]) +Mohammad Aslam (SO), left in May Zahid Ali Qureshi (SO, LTT) Ahmad Samiullah (SO)
Germplasm Section	M. Anwar Khan (SO) Safraz Ahmed (SO) Irshad Begum (SO) Asghar Ali (SO, LTT) S.A. Jaleel (ASO[5])
Range Section	*Sarwat N. Mirza (SO, PhD), joined in May +Abdul Wahid Jasra (SSO, PhD), left in May Javed Afzal (SO, ad-hoc appointee) [illegible]id Hussan (SO, ad-hoc appointee)
Livestock Section	Shahid Rafique (SSO, PhD) +Muhammad Munir (SO), left in May *Inam ul-Haque (SO), joined in March *Ejaz Rasool (SO, on contract), joined in May Atiq-ur-Rehman (SO, LTT) K. Nasir Mahmood (SO, LTT) *Riaz Hussain (SO, BOSTID funded) joined Nov
Economics Section	Usman Mustafa (SO, PhD) Khalid Mahmood (SO, LTT) Muhammed Afzal (ASO) Mohammad Jamil (SO, ad-hoc appointee) Imran Ali (SO, on contract) Nisar Ali Shah (ASO, BOSTID funded)
Extension Section	M. Bilal Ahmad Chowdry (SO)
Agricultural Engineering	*M. Adel Akbar (AAE), joined in December

[1]PSO = Principal scientific officer [2]Senior scientific officer,
[3]Scientific officer, [4]Long-term trainee (PhD/MS). [5]Assistant S.O.

ICARDA Advisor: Euan F. Thomson (Quetta Office Team Leader/Livestock Scientist)

AZRI EXPERIMENTAL SITES IN HIGHLAND BALOCHISTAN



AGRICULTURAL ECONOMICS SECTION

The five research protocols presented below are the detailed version of the future activities of the Agricultural Economics Section outlined in the 1990 and 1991 Annual Reports (AZRI and ICARDA, 1991 and 1992). They emphasize the need to develop linkages with the emerging private sector of Balochistan. This will enable the identification of bottlenecks in production and marketing of AZRI commodities, and suggest alternatives to these bottlenecks. The report "Skin Marketing in Highland Balochistan" (Rodriguez *et al.*, 1992) is a good example of the steps in this direction.

The first research protocol, "Pricing of Small Ruminants by Producers, Wholesalers and Commission Agents in Highland Balochistan", is still a top priority project and is a continuation of research guidelines generated in previous studies on livestock economics. The second protocol, "Seasonal Price Indices of Agricultural and Livestock Commodities of the Quetta Market", was scaled down, excluding the Karachi market, due to human resource constraints.

With the participation of AZRI in ICARDA's Dryland Resource Management Project (DRMP), the protocol entitled "Risk Analysis of Cereal Crops Grown Under Water-Harvesting Techniques in Highland Balochistan" was expanded to cover the social and economic aspects of water-harvesting. This expansion was large enough to merit another protocol: "Farmers' Perceptions of Water-harvesting Technology in *kushkaba* Agricultural Systems in Highland Balochistan". The latter project is also a top priority for the Agricultural Economics Section while the former is still a second priority. The adoption potential of water-harvesting techniques for cereal production is possibly one of the most exciting topics of sustainable low-input rainfed agriculture in highland Balochistan. These two protocols strengthen the collaboration between the Agronomy and Agricultural Economics Sections. A new project is proposed to support the activities conducted by the Agronomy Section on an alternative camel planter which could increase the efficiency of soil moisture utilization and planting under dryland farming conditions ("Diagnostic Survey for Camel Planter in Highland Balochistan").

The research being conducted in the Livestock Section will be complemented by a study on the impact of lamb fattening practices, and improved fertility and body condition on the income of livestock producers in highland Balochistan. The project proposed in the Livestock Section - Fertility of Balochi and Harnai ewes as influenced by differences in their body condition scores (Protocol L01) - shows how the Agricultural Economics Section supports other Sections in AZRI. The economics of lamb fattening will be studied once the trial has been conducted by the Livestock Section in 1993.

AZRI Research Protocol
(Agricultural Economics Section)

Protocol code: E01 (continued) **Priority:** 1

Title of project: pricing of small ruminants by producers, wholesalers and commission agents in highland Balochistan

Collaborating institutions: ICARDA

Principal AZRI investigator: Mr Imran Ali

Collaborating AZRI scientific staff: Dr Usman Mustafa
Mr Mohammad Afzal
Mr N. Ali Shah

Collaborating non-AZRI scientific staff: Dr Abelardo Rodríguez (ICARDA, FRMP)

Date of commencement: January, 1991

Date of completion: March, 1992

Site of project: Quetta

1. Introduction

The objective of this study is to quantify the factors that determine the pricing of small ruminants by producers, wholesalers and commission agents. The underlying hypothesis is that the pricing mechanism of different market agents can provide valuable information to agricultural policy makers and producers. This study was started in January 1991 and will continue for a period of two years in the Quetta livestock market. Quantification of the seasonal changes in livestock prices will allow the estimation of the strength of the relationship between weather variables and forage production with price dynamics. The lags between shortages of forage availability and livestock prices can be used to develop livestock production and marketing strategies.

2. Objectives

- to quantify pricing mechanisms of producers, wholesalers and traders on the basis of body condition, sex, breed, age, live weight and time of the year.

- to test the homogeneity of the pricing models and the interaction of variables as a mechanism to assess the impact of extension services.

- to quantify the relationship between the changes in prices and the changes in forage availability.

3. Experimental Methods and Procedures

Each month since January 1991, 200 expected[1] prices have been recorded in the Quetta livestock market from producers and market intermediaries (either butchers, *beoparis* or commission agents). Half of these expected prices are for sheep and the other half are for goats. For each animal species (sheep or goats), 50 expected prices are from producers and 50 expected prices are from intermediaries. In the absence of any records of livestock transactions in the market, the producers and the intermediaries give the expected price per animal to the AZRI enumerators. The expected price given by producers and intermediaries is not for the same animal. Thus, it can be considered as the expected price at the beginning of the bargaining process. In addition to the expected price per animal, the following information is recorded: liveweight measured with a portable scale, liveweight estimated by the market agent, species, sex, breed, body condition (fatness), calendar month, and whether or not the data were collected on a meatless day. Econometric models will be developed using linear, log linear and double-log price models for the different market agents, animal species, sex and season. The homogeneity of models and interaction of variables will be tested using analysis of covariance (Johnston, 1972). Precipitation will be used as a proxy for forage availability and will be entered as another variable to determine its relation with price seasonality.

4. Experimental design

Regression analysis, analysis of covariance.

5. *Publications*

A MART/AZR Research Report will be prepared based on the preliminary analysis of the first year's data (February 1992). A manuscript will be sent for consideration by an international refereed journal (Agricultural Economics) later in 1993.

6. References

Johnston, J. 1972. Econometric Methods. McGraw Hill, New York.

[1]This is the price that the seller expects to receive.

AZRI Research Protocol
(Agricultural Economics Section)

Protocol code: E03 (continued) **Priority:** 1

Title of project: seasonal price indices of agricultural and livestock commodities of the Quetta market

Collaborating institutions: Agricultural and Livestock Products Marketing and Grading Department, Government of Pakistan (ALPMGD) and ICARDA

Principal AZRI investigator: Mr Mohammad Afzal

Collaborating AZRI scientific staff: Dr Usman Mustafa
Mr N. Ali Shah
Mr Jamil Ahmad

Collaborating non-AZRI scientific staff: Mr Malik Muhammad Yousaf, Marketing and Grading Inspector (ALPMGD) and Abelardo Rodríguez (ICARDA, FRMP)

Date of commencement: July, 1990

Date of completion: September, 1992

Site of project: Quetta

1. Introduction

Seasonal price indices of agricultural and livestock commodities are useful for planning production and marketing strategies. If AZRI is to develop technological packages to improve food and fiber production for farmers and pastoralists of highland Balochistan, it is important to determine the opportunity costs of consuming or selling these commodities. Because Balochistan is not isolated from other provinces it is important to know how integrated are the markets of the major cities of Pakistan. For this purpose Quetta and Karachi are taken as examples. (Note: Karachi has been dropped because of a limitation of human resources in the Section). The seasonal price indices of the major consumption center in Balochistan can be used as a base-line for whole farm modeling and regional planning.

2. Objectives

- to develop seasonal price indices for agricultural and livestock commodities in Quetta.

3. Experimental Methods and Procedures

The following data set is being assembled/updated:

- Quetta market monthly prices data from July 1985 to April 1991 has been collected for 24 agricultural commodities from the Agricultural and Livestock Products Marketing and Grading Department.

Wholesale and retail prices of the following categories have been collected:

I. Cereals and starchy foods (wheat flour, maida, suji, rice Basmati, rice Irri, maize, sugar, gur (brown sugar) and potato).

II. Lentils-gram, mung, mash and sasoor.

III. Vegetables and spices (chillies, turmeric, garlic, ginger and onion).

IV. Milk (buffalo) and hen eggs.

V. Meat: beef (with bone) and mutton (with bone).

VI. Edible oil-rape and mustard oil.

This data set will be used for developing seasonal price indices following the guidelines of Trapp (1990, 1992).

4. Experimental design

None.

5. Publications

A MART/AZR Research Report will be prepared and a paper will be submitted to a domestic refereed journal (e.g., **Pakistan Journal of Agricultural Social Sciences**).

6. References

Trapp, J.N. 1990. Seasonal price index update for Oklahoma. Current Farm Economics 63(3):40-69.

Trapp, J.N. 1992. Forecasting Oklahoma slaughter cattle prices using seasonal indices: an evaluation. Current Farm Economics 65(1):14-24.

AZRI Research Protocol
(Agricultural Economics Section)

Protocol code: E04 (continued, part of BOSTID) **Priority:** 1

Title of project: risk analysis of cereal crops grown under water harvesting techniques in Highland Balochistan

Collaborating institutions: ICARDA

Principal AZRI investigator: Dr Usman Mustafa

Collaborating AZRI scientific staff: Mr Zahid Ali Qureshi (BOSTID)

Collaborating non-AZRI scientific staff: Drs Thieb Oweis and Abelardo Rodríguez (ICARDA, FRMP)

Date of commencement: May, 1992

Date of completion: February, 1993

Site of project: Quetta

1. Introduction

Because of the low and erratic rainfall conditions of highland Balochistan, water harvesting techniques have potential to increase yields and reduce long-term variability of crop production. Four years of data for wheat and two years for barley have been analyzed to determine the net benefits of two treatments (1:1 and 2:1 proportions of catchment to crop area) compared to the control (no catchment area, traditionally managed). "Results from wheat trials showed that the 1:1 treatment had 35% higher net benefits (520 Rs/ha) than the control (386 Rs/ha) with a 30% reduction in the coefficient of variation. The 2:1 treatment had 18% lower net benefits (317 Rs/ha) than the control and reduced the variation in net benefits by 27%. Likewise, barley trials showed that the 1:1 treatment yielded 7% higher net benefits (999 Rs/ha) than the control (937 Rs/ha) and reduced by 15% the variation in net benefits. Treatment 2:1 had 39% lower net benefits (575 Rs/ha) than the control and 14% less variation. Either too little water in dry seasons or too much water in wet seasons collected in the cropped areas resulted in low performance of water-harvesting treatments across locations and seasons for both wheat and barley. However, there were some trials that showed the benefits of water-harvesting techniques in dry seasons" (Rodríguez *et al.*, 1992).

The net benefits of four years of data for wheat and two for barley are scattered points in the probability distributions of net benefits. In situations where weather variability is extremely influential on crop performance, it is necessary to incorporate the probabilities of different rainfall intensities in the economic analysis. Thus, simulation techniques will be used to find distributions of net benefits of these cereal crops. Stochastic dominance analysis will be used to find farmer's preferences for different water-harvesting

techniques. Once the adoption potential of water-harvesting techniques is known, the optimal land allocation for different crops and other managerial aspects, can be further assessed. As a by-product of this research, the basic structure of the crop module of the AZRI model (AZRI and ICARDA/AZR, 1991) will be developed.

2. Objectives

- to asses the adoption potential of water-harvesting techniques for cereal crops grown in highland Balochistan.
- to find out if water harvesting practices (1:1 or 2:1 catchment to crop area treatments) are preferred by farmers over the traditional management practice.
- to compare farmers' preferences between alternative water-harvesting practices.
- to provide guidelines for on-farm optimal land, labor and capital allocation.

3. Experimental Methods and Procedures

Historical rainfall data will be read with BELINDA (Kidd et al. 1987). Simulations of water run-off of different treatments of water-harvesting will be made with CARE (model developed by Dr. E. Perrier) following the guidelines provided by Rees (1990). Water-use-efficiency coefficients estimated by the Agronomy Section will be incorporated into a simulation model that will include enterprise budgets for one growing season. The net returns from 50-85 growing seasons will be calculated with partial budgets specifically developed for different rainfall conditions in highland Balochistan (Khuzdar or Kalat, Quetta and Loralai areas). The probability distributions of crop yields and net returns under different treatments will be analyzed with a generalized stochastic dominance analysis package (Cochran and Raskin, 1988) to assess the farmers' preferences for different water harvesting-techniques. Based on the results of the stochastic analysis of cereals grown under water-harvesting techniques, some guidelines will be provided to assess on-farm optimal land, labor and capital allocation.

4. Experimental design

Simulation models and stochastic dominance analysis.

5. Publications

A MART/AZR Research Report will be prepared and a paper will be submitted to an international refereed journal (Agricultural Systems).

6. References

Arid Zone Research Institute (AZRI) and International Institute for Agricultural Research in the Dry Areas (ICARDA). 1991. 1990 Annual Report. MART/AZR Project Research Report No. 65, ICARDA, Quetta.

Cochran, M.J. and Raskin, R. 1988. A user's guide to generalized stochastic dominance program for IBM PC version GSD 2.1. Department of Agricultural Economics, University of Arkansas, Fayetteville, Arkansas, Staff Paper SP0688, April, 1988.

Kidd, C.H.R., Rees, D.J., Keatinge, J.D.H., Rehman, F., Samiullah, A. and Raza, S.H. 1987. Meteorological data analysis of Balochistan. MART/AZR Project Research Report, No. 19, ICARDA Quetta.

Rees, D. 1990. Consultancy Report to the MART/AZR Project, November 7 to December 12, 1990. Unpublished document, Quetta.

Rodríguez, A., I. Ali, M. Afzal and N.A. Shah. Skin Marketing in Highland Balochistan. MART/AZR Project Research Report No. 76. ICARDA, Quetta. 1992.

AZRI Research Protocol
(Agricultural Economics Section)

Protocol code: E05 (new, part of DRMP and BOSTID) **Priority:** 1

Title of project: farmers' perceptions of water-harvesting technology in *kushkaba* agricultural systems in highland Balochistan

Collaborating institutions: ICARDA (as part of the DRMP project)

Principal AZRI investigators: Dr Usman Mustafa and Mr K. N. Babar (BOSTID)

Collaborating AZRI scientific staff: Mr Mohammad Islam
Mr Ahmad Samiullah
Mr Imran Ali
Mr Mohammad Afzal
Mr Nisar Ali Shah

Collaborating non-AZRI scientific staff: Drs E. Bailey, Thieb Oweis and Abelardo Rodríguez (ICARDA, FRMP)

Date of commencement: February 1992

Date of completion: December 1993

Site of project: Khuzdar, Kalat, Mastung, Dasht, Sanjavi, Loralai and Zhob

1. Introduction

The most limiting factor for crop production in rainfed agriculture is the skewed distribution of rainfall in both time and space (Kidd *et al.*, 1988). In an attempt to improve the utilization of rain water, AZRI has been growing cereals, lentils and forage legumes using catchment-basin water-harvesting techniques (CBWH) in highland Balochistan since 1986. Farmers have long practiced water-harvesting by constructing bunds (Khan *et al.*, 1990) but it is necessary to obtain more precise information about land use in *kushkaba* agricultural systems as well as the farmers' expectations for improvement in yields and net benefits before they adopt CBWH. Even though AZRI has not released the CBWH as a technological package, which could allow monitoring of adoption rates, it is possible to evaluate the potential impact of these techniques in marginal lands with 125-250 mm annual rainfall.

This project is an essential element of the BOSTID project on water-harvesting. The results will be used as a case study for Balochistan, which is part of the DRMP (Dry Land Resource Management Project) project coordinated by ICARDA's FRMP.

2. Objectives

- to evaluate farmers perceptions about water-harvesting technology in *kushkaba* farming systems in highland Balochistan.

- to assess the adoption potential of water-harvesting techniques to grow cereals, lentils and forage legumes.

3. Experimental Methods and Procedures

A formal survey will be conducted at Khuzdar, Kalat, Mastung, Dasht, Sanjavi, Loralai and Zhob to get information about farmers' perceptions of water-harvesting technology. A three stage stratified random sampling technique will be used to get information from farmers (Mustafa, 1991). Cross-tabulation, ANOVA procedures and regression analysis will be used to describe and analyze the data.

4. Experimental design

The project uses statistical procedures applicable to surveys.

5. Publication

MART/AZR Research Report and paper in a refereed journal.

6. References

Kidd, C.H.R., Rees, D.J., Keatinge, J.D.H., Rehman, F., Samiullah, A. and Raza, S.H. 1987. Meteorological data analysis of Balochistan. MART/AZR Project Research Report, No. 19, ICARDA Quetta.

Khan, R. B., E.F. Thomson, A.Y. Allan and A. Rodríguez. 1991. AZRI research plans for 1990/91. MART/AZR Research Report No. 70, ICARDA, Quetta.

Mustafa, U. 1991. Economic impact of land degradation (salt affected and water logged soils) on rice production in Pakistan's Punjab. PhD dissertation, University of the Philippines at Los Baños, Philippines.

AZRI Research Protocol
(Agricultural Economics Section)

Protocol code: E06 (new) **Priority:** 2

Title of project: diagnostic survey for camel-drawn seed-drill in highland Balochistan

Collaborating institutions: ICARDA

Principal AZRI investigator: Dr Usman Mustafa

Collaborating AZRI scientific staff: Mr Mohammad Islam
Mr Mohammad Afzal
Mr Imran Ali

Collaborating non-AZRI scientific staff: Dr Abelardo Rodríguez (ICARDA, FRMP)

Date of commencement: April 1993

Date of completion: August 1994

Site of project: Highlands of Balochistan (exact locations to be decided)

1. Introduction

In the arid highlands of Balochistan Arabian camels (*Camelus dromedarius*) are traditional sources of draft power and transport which are still important today. Dryland farming communities in these areas are severely disadvantaged in comparison to farmers with access to irrigation water, and are generally resource poor (Keatinge *et al.* 1992). It is unlikely that tractors will displace camels for agricultural use in highland Balochistan (AZRI/ICARDA, 1991). The Agronomy Section has been working for the last four seasons on a camel-drawn seed-drill to increase the efficiency of soil moisture utilization and planting of dryland crops. A number of on-farm evaluations have shown labor savings and improved yields of cereal crops from use of the camel-drawn seed-drill (AZRI/ICARDA, 1992, pp. 44-45). However, no study has been conducted to assess the potential demand for this camel-drawn seed-drill. This information is crucial to the development of a marketable and efficient camel-drawn seed-drill.

2. Objectives

- to determine the importance of mechanical and animal draft power amongst the farmers of highland Balochistan.

- to find out farmers' views about, and demand for, the camel-drawn seed-drill.

- to evaluate the social and economic costs of the camel-drawn seed-drill on farm and its effects on the environment.

3. Experimental Methods and Procedures

A formal survey will be conducted with farmers to obtain relevant information using a three stage stratified random sampling technique (Mustafa, 1991). Financial and economic analyses will also be made for calculating the social and economic costs.

4. Experimental design

A conventional survey design.

5. Publication

MART/AZR Research Report and paper in a refereed journal.

6. References

Keatinge, J.D.H, A. Rodríguez, G. Farid Sabir, A. Afzal and N.A. Shah, 1992. Camel in the Farming Systems of the Arid Highlands of Western Pakistan: Is Management Research a Worthwhile Investment? Journal of Arid Environments. In press.

AZRI/ICARDA (Arid Zone Research Institute/International Center for Agricultural Research in the Dry Areas). 1991. High Elevation Research in Pakistan, the MART/AZR Project Annual Report 1990. MART/AZR Research Report No. 65, ICARDA, Quetta.

AZRI/ICARDA (Arid Zone Research Institute/International Center for Agricultural Research in the Dry Areas). 1992. High Elevation Research in Pakistan, the MART/AZR Project Annual Report 1991. MART/AZR Project special publication, ICARDA, Quetta, 63 pp.

Mustafa, U. 1991. Economic impact of land degradation (salt affected and water logged soils) on rice production in Pakistan's Punjab. PhD dissertation, University of the Philippines at Los Baños, Philippines.

AZRI Research Protocol
(Agricultural Economics Section)

Protocol code: E07 (new) **Priority:** 2

Title of project: economics of improved fertility of ewes in highland Balochistan

Collaborating institutions: ICARDA

Principal AZRI investigator/s: Dr Usman Mustafa and Dr Shahid Rafique (AZRI Livestock Section)

Collaborating AZRI scientific staff: Mr Syed Imran Ali
Mr Inam ul-Haq (AZRI Livestock Section)

Collaborating non-AZRI scientific staff: Dr Abelardo Rodríguez (FRMP, ICARDA)

Date of commencement: November, 1992

Date of completion: July, 1994

Site of project: Zarchi and Tomagh

1. Introduction

The destruction of the vegetation cover by overgrazing and the cutting of shrubs and bushes for fuelwood is leading to the destruction of the ranges of Balochistan. The shallow soils become exposed to erosion by wind and water until finally the landscape is totally denuded and unable to support plants. The ownership of animals which are unproductive due to the acute shortage of native forage, only adds to the grazing pressure on the rangelands (Mohammad, 1989). Since 1955 the population of both sheep and goats has increased at an annual rate of seven percent (FAO, 1987) and their numbers in nearly all locations are too high in relation to the quantity and quality of the food supplies (Gordon, 1984). Animals grazing native ranges usually lose weight during winter, resulting in poor conception rates, low lambing percentages, low birth weights and high lamb mortality (Atiq-ur-Rehman *et al.*, 1990). A minimum of 10-12 percent crude protein in the diet is essential to promote the growth of lambs (Ali, 1988) but such levels are seldom found in the range-based diet on offer.

The Livestock Section of AZRI has an ongoing study at Tomagh and Zarchi on the performance of lambs from ewes with different body condition scores. The ewes are given different levels of supplementary feeding in late pregnancy and early lactation, and graze two contrasting rangeland types. It is important to conduct an economic analysis on the results of this study so that levels of supplementary feeding can be defined according to the prevailing prices of inputs and outputs.

2. Objectives

- to assess the impact of improved fertility and body condition on the economics of sheep production in highland Balochistan, and

- to recommend policies for planning demand-oriented production methods.

3. Experimental Methods and Procedures

Data will be collected from the past and current experiments at Tomagh and Zarchi and used to develop biological production functions. Partial budget analysis will be used to calculate the economic benefits of different supplementation practices.

4. Experimental Design

None.

5. Publication

MART/AZR Research Report and paper in national referred journal. An interim report will be produced by July 1993.

References

Ali, A. 1988. Nutritional status of livestock in Pakistan with special reference to feeding on rangelands. Proceedings of Range-livestock Seminar, MART/AZR Project, December 21-23, 1988, AZRI, Quetta.

Atiq ur-Rehman, S. Rafique, Amanat Ali and M. Munir. 1990. Nutritive evaluation of fourwing saltbush in growth and digestibility trials with Harnai lambs in upland Balochistan. AJAS 3(4): 299-303.

FAO (Food and Agriculture Organization) 1987. Pakistan livestock research: Agricultural Research II Project Report, Annex 3. FAO, Islamabad, pp. 33.

Gordon C. H, 1984. A program for improving livestock productivity of meat and wool. *In:* Pakistan's Edible Oilseeds Industry. International Cooperation and Development, United States Department of Agriculture and USAID, Washington, D.C.

Mohammad, N. 1989. Rangelands management in Pakistan. International Center for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

LIVESTOCK SECTION

If one accepts the somewhat outdated statistics, one sees that the population of small ruminants in Balochistan was growing at an alarming rate until the mid-1980s. It is likely that this population growth rate has continued and if one extrapolates to the end of the century, there could be 25-30 million small ruminants in Balochistan by the year 2000. Even if one is sceptical about this number, it has to be taken seriously as it will put even greater pressure on the already heavily degraded rangelands. The principle strategy to remove some of this grazing pressure is to grow forage crops on cultivated land and forage shrubs on land marginal for crop production. The Germplasm Evaluation Section at AZRI is looking at the former, and the Range Section at the latter aspect of this strategy.

Another aspect of the strategy to increase animal production from the range-based systems of Balochistan is to ensure that the animals have the genetic potential to make efficient use of scarce feed resources. The main research activities of the Livestock Section are to define the body condition that enables a ewe to lamb once a year and to assess the genetic potential for fattening of lambs from two of the Province's main sheep breeds, the Balochi and the Harnai. This research is described in Protocols L01, L02 and L04 and makes up a large part of the BOSTID project. The research will generate essential biological data which the Economics Section needs for the economic analysis of animal production systems.

A third essential component of research in the Livestock Section is the *assessment* of the nutritive value of existing and new feedstuffs. Large quantities of wheat straw are transported from the Indus Valley into Balochistan as can be seen from the number of trucks loaded with straw, and the large dumps of straw in large and small towns. This is a clear indication that the demands far outstrips the supply of wheat straw produced in the Province. However, it is not known how much is imported into the Province. Even though the contribution of locally produced wheat straw may be small compared to imports, it is important that the feeding value of straw from promising selections of wheat and barley be at least equal to that of the local landraces. This will ensure that farmers do not reject the new selections on the grounds that the straw is unpalatable for their animals. Protocol L03 addresses this question.

The nutritive value of fourwing saltbush has also not been studied in detail, particularly when it is used as a supplement to wheat straw, rather than as the sole component of the diet. Indeed, it is likely that animals benefiting from a forage reserve will also receive other feeds such as cereal straw. A study on the use of saltbush as a supplement with wheat straw is described in Protocol L05.

Accurate data on the performance of sheep and goats in farm flocks is still missing and the study proposed in Protocol L06 attempts to fill the gap. The activity is part of the BOSTID project. Such data is essential for assessing the potential of flocks to increase productivity. The next step after collecting this base-line data is to see whether improved management leads to economic increases in output.

AZRI Research Protocol
(Livestock Section)

Protocol code: L01 (continued, BOSTID) **Priority:** 1

Title of project: fertility of Balochi and Harnai ewes as influenced by differences in their body condition scores

Collaborating institutions: None

Principal AZRI investigator: Dr Shahid Rafique (SSO)

Collaborating AZRI scientific staff: Mr Inam-ul-Haq (SO)

Collaborating non-AZRI scientific staff: None

Date of commencement: July, 1992

Date of completion: March, 1994

Site of project: Zarchi (Kalat) and Tomagh (Loralai)

1. Introduction

Studies at AZRI Range-Livestock Research Stations, Zarchi and Tomagh during the last three years have revealed how additional feeding of ewes prior to breeding enhances lambing rate. Now there is a need to better understand the factors which determine ewe fertility, rather than just recommending to farmers that they feed (flush) all ewes before breeding. This understanding will allow development of more precise management recommendations that ensure, with a high probability, that ewes will be fertile. Body condition score (BCS) is known to be an important determinant of ewe fertility and the proposed trial will study it's value as a predictor of ewe fertility. For body condition scoring the ewes are manually palpated on their back at the lumbar region to assess the presence of a fat layer over the transverse processes. Then a score, ranging from 0.5 (very thin, weak and emaciated animal) to 4.0 (over fat animal), is given to the ewe depending upon the thickness of the fat layer. The study will use 70-80 ewes grazing degraded ranges at both Tomagh and Zarchi. Starting one month before breeding takes place, ewes will be fed one of three levels of supplement that maintains them at a constant BCS until two months after conception. Three BCS categories will be used, ranging from very thin to fat. The study will last for one year. The study is a part of the BOSTID project on the productivity of indigenous sheep breeds.

2. Objectives

- to determine the relationship between fertility, liveweight and body condition score of Balochi and Harnai ewes grazing two types of degraded native rangelands of highland Balochistan.

3. Experimental Methods and Procedures

Seventy-to-eighty ewes of both the Balochi (at Zarchi in Kalat District) and Harnai (at Tomagh in Loralai District) breeds and 2-5 years of age, will be used in a completely randomized design. The ewes will be divided into groups according to three body condition score categories: 1.0-1.5 (thin), 2.0-2.5 (medium) and 72.5 (fat) and balanced for age and weight. Three supplemental feeding levels will be applied to these three groups: the tentative feeding levels will be 250, 500, and 800 g/h/d of barley grain and cotton seed cake (ratio 3:1). However, the levels will be adjusted in an effort to maintain the differences in the body condition scores of the three groups. Feeding will start from August 1, 1992, two months prior to breeding, and continue for at least one month after conception has occurred. Breeding will start from October 1 and last for two months. Feeding will be terminated on January 31. Group feeding will be applied to sub-groups of 4-5 ewes so that each sub-group will be considered as one experimental unit. The ewes will graze the native range and will be fed the supplemental ration in the afternoon when they return from grazing. If possible, vasectomized rams will be introduced to ewes on July 1 so the start of the breeding season can be defined from the initiation of cycling activity in ewes. Three intact rams will be introduced into flocks on October 1 and stay with the ewes for two months (random mating with multiple sires). Records of the exact mating dates and individual ram activity on specific ewes will be maintained by using colour markers on rams. Colours of crayons will be changed at 17 day intervals. All the animals will be drenched with levamisol for internal parasite control before the experiment starts and vaccinated against the prevalent bacterial and viral diseases. Complete health records will be kept. Ewes will be weighed and body condition scored once every 15 days. A complete record of all the inputs of supplementation will be maintained and cost-benefit ratios would be determined (see Economics Section, Protocol E07, page 17).

4. Experimental design

Completely randomized design.

5. Publication

MART/AZR Research Report will be published after completion of the experiment and later on, after gathering two to three years data, the research findings will be published in a national or international refereed journal.

6. References

None.

AZRI Research Protocol
(Livestock Section)

Protocol code: L02 (carried over from 1991/92, BOSTID) **Priority:** 1

Title of project: assessing the fattening potential of Balochi lambs under intensive feedlot conditions

Collaborating institutions: None

Principal AZRI investigator: Dr Shahid Rafique (SSO)

Collaborating AZRI scientific staff: Mr Inam-ul-Haq (SO)

Collaborating non-AZRI scientific staff: None

Date of commencement: May, 1993

Date of completion: July, 1993

Site of project: AZRI, Quetta

1. Introduction

One way to reduce the grazing pressure on the heavily degraded rangelands of highland Balochistan is to wean lambs when they reach 3-4 months of age and fatten them intensively. The weaned lambs could be either fattened by the farmers themselves, or sent to commercial feedlots at other locations. Inevitably, many questions concerning feedlot fattening arise, such as the source of feeds, the genetically determined growth and fattening potential of local breeds, and the optimal feed formulation for the prevailing prices of inputs and outputs. The latter two of these questions will be addressed in a pilot study using Balochi male lambs. Diets with different formulations will be used to derive a response curve between diet energy concentration and growth rate of the lambs. This pilot study will provide experience concerning the problems associated with such trials, for example diet palatability and intake levels. The trial is a part of the BOSTID project on the productivity of indigenous sheep breeds.

2. Objective

- to assess the fattening potential of male Balochi lambs under intensive feedlot conditions.

3. Experimental Methods and Procedures

Thirty-to-forty, three-to-four month old Balochi male lambs will be used in a randomized complete block design with two replicates. The study will last three-four months. The lambs will be randomly divided into groups and allotted one of the three treatments at random. The treatments will be four diets formulated to give different energy concentrations but equal in protein content. Diets will

be offered *ad-libitum*, and composed from locally available ingredients such as barley grain, cottonseed cake, wheat bran, urea, and wheat straw. Lambs will be fed in subgroups of 4-5 lambs per pen and these subgroups will serve as replicates. A mineral-vitamin mix and water will be available in pens. Lambs will be weighed on two consecutive days at the start and finish of the trial after an overnight fast, and every 15 days during the intervening period. Feed intakes of subgroups will be measured each day. The dijestibility of the diets, and the nitrogen balance of the lambs on the diets, will be measured.

4. Experimental design

Randomized complete block.

5. Publication

MART/AZR Research Report and a paper in a refereed national journal.

6. References

None.

AZRI Research Protocol
(Livestock Section)

Protocol code: L03 (carried over from 90/91) **Priority:** 2

Title of project: nutritive value of straw from local and improved lines of wheat and barley

Collaborating institutions: None

Principal AZRI investigator: Mr Inam-ul-Haq (SO)

Collaborating AZRI scientific staff: Dr Shahid Rafique (SSO)
Mr Ejaz Rasool (SO)

Collaborating non-AZRI scientific staff: None

Date of commencement: June, 1993

Date of completion: September, 1993

Site of project: AZRI, Quetta

1. Introduction

The rangelands of highland Balochistan are showing severe symptoms of overgrazing because of the excessive population of small ruminants. One potential solution to this problem is to use a part of the cultivated land to grow forage crops which can be conserved and used during periods of shortage. Research at AZRI over the last few years has identified some good forage species. Woollypod vetch (*Vicia villosa* subsp. *dasycarpa*), an annual legume, is one with high yield potential, even when annual rainfall is below 300 mm. The Syrian barley landrace *Arabi Abiad* has shown good yield potential under local conditions and two wheat varieties, Gerek and ICW1471 selected by the Germplasm Section, have shown considerable promise. The trial described here aims to determine the nutritive value of the straws from these cereals as compared with the local landraces.

2. Objectives

- to study the palatability, intake and digestibility of wheat and barley straws from landraces and improved lines grown under rainfed conditions in highland Balochistan

3. Experimental Methods and Procedures

Straw from Arabi Abiad, Gerek, ICW1471 and the local landraces of wheat and barley will collected after the 1993 harvest, threshed to pass through a 2.5 cm screen and stored at ambient temperature.

Twenty mature Balochi male castrates will be used in a completely randomized design and divided randomly into five groups of four animals each. The five

treatments will be allotted to the five groups of sheep at random. The straw will be individually fed *ad libitum* to the sheep penned in metabolism crates at the Animal Nutrition Research Unit (ANRU), AZRI, Quetta. Records of daily feed offered and refusals will be keep and daily samples taken. Water will be available free choice. Ten-to-fifteen days will be given as the adaptation period and five-to-seven days will be the collection period. Faeces voided daily by each lamb will be collected and weighed. Ten percent of the daily output of faeces will be dried at 60°C for 48 hours in a force-draught oven. The samples of feed, orts and dry faeces for each sheep will be pooled across days and stored at room temperature for later analysis. Sub-samples will be milled and dry matter and nitrogen contents will be determined by standard methods (AOAC, 1984), and ADF and NDF analyzed using the procedures of Goering and Van Soest (1970). Digestibility of the dry and organic matter will be calculated.

4. Experimental design

Completely randomized design.

5. Publication

MART/AZR Research Report and paper in national refereed journal.

6. References

AOAC (Association of Official Analytical Chemists) 1984. Official Methods of Analysis. Washington, D.C. 14th edition.

Goering, H.K. and Van Soest, P.J. (1970). Forage fibre analyses (apparatus, reagents, procedures and some applications). Agricultural Handbook, U.S. Department of Agriculture, No. 379.

AZRI Research Protocol
(Livestock Section)

Protocol code: L04 (carried over from 91/92, BOSTID) **Priority:** 1

Title of project: performance of lambs from ewes with different body condition scores, given two levels of supplementary feed in late pregnancy and early lactation, and grazing two rangeland types in highland Balochistan

Collaborating institutions: None

Principal AZRI investigator: Dr Shahid Rafique (SSO)

Collaborating AZRI scientific staff: Mr Inam-ul-Haq (SO)

Collaborating non-AZRI scientific staff: None

Date of commencement: March, 1993

Date of completion: June, 1994

Site of project: Zarchi and Tomagh

1. Introduction

Previous studies at AZRI confirm other studies that supplementary feeding of ewes in late pregnancy and early lactation improves lamb growth rate and reduces ewe and lamb mortality. However, even though supplementation appears to be an attractive option, few farmers use supplements other than wheat straw. Indeed, it may be undesirable to encourage farmers to feed supplements since they might try to own more animals which would put even more pressure on the already heavily degraded rangeland. Supplementation should therefore be kept to a minimum. This study will attempt to establish that minimum, but at the same time investigate higher levels of supplementation so that biological response curves can be determined. Different market prices of inputs and outputs can then be applied so that a feeding level can be determined that maximizes returns to the farmer facing a changing price environment. Possible interactions between body condition scores of ewes and level of supplementation will also be studied. This project is part of the BOSTID study on the performance of indigenous sheep breeds.

2. Objectives

- to monitor the performance of lambs from ewes of the Balochi and Harnai breeds with different body condition scores, fed three levels of supplementary feed during late pregnancy and early lactation, and grazing two rangeland types in highland Balochistan.

3. Experimental Methods and Procedures

Seventy-to-eighty pregnant ewes of the Balochi (at Zarchi in Kalat District) and Harnai (at Tomagh in Loralai District) breeds from the fertility trial L01 will be used in a completely randomized design with a factorial arrangement of treatments (three supplement levels x three body condition scores). The three body condition score groups will be 1.0-1.5 (thin), 2.0-2.5 (medium) and over 2.5 (fat) and each group will be further divided into three sub-groups. Different supplemental feeding levels will be applied to the sub-groups: no supplement (control), and a modest and a high level of supplementation covering 50 and 100 percent of metabolizable energy requirements, respectively. The supplement will contain a ratio of barley grain, cottonseed cake and wheat bran to give 12 percent crude protein. During pregnancy levels of feeding will be adjusted once every 15 days according to the expected date of lambing, then again at lambing and at 15 day intervals thereafter. Feeding will start on March 1, 1993 and continue for approximately 90 days after lambing has taken place. Lambing is expected to start on April 1 and should be over in 60 days. Group feeding (4-5 ewes per group) will be practised and each group will serve as an experimental unit. The ewes will graze the native range and will be fed the supplements in the afternoon after returning from grazing. Wheat straw will be fed as maintenance ration to the control ewes if they cannot be supported by range grazing alone. Records of the exact lambing dates, sex of lamb, lamb birth and weaning weights and mortality will be maintained. All the animals will be drenched with levamisol for internal parasitic control and treated for external parasites. Ewes will be vaccinated against the prevalent bacterial and viral diseases. Ewes and lambs will be weighed and ewes body condition scored fortnightly. Economics of providing these supplements in terms of inputs and outputs would also be assessed (see Economics Section, Protocol E07, page 17).

4. Experimental design

Completely randomized design with factorial arrangement of treatments.

5. Publication

MART/AZR Research Report and paper in a national or international refereed journal.

6. References

None.

AZRI Research Protocol
(Livestock Section)

Protocol code: L05 (carried over from 90/91) **Priority:** 2

Title of project: digestibility and intake of wheat straw as influenced by different levels of fourwing saltbush offered to sheep

Collaborating institutions: Balochistan Livestock Department (GOB), Animal Science Institute (NARC).

Principal AZRI investigator: Ejaz Rasool (SO)

Collaborating AZRI scientific staff: Dr Shahid Rafique (SSO)
Mr Inam-ul-Haq (SO)

Collaborating non-AZRI scientific staff: Dr M. Alam Mengal, V.O. Government Dairy Livestock Deptt., Quetta
Feed Evaluation Unit (ASI) NARC

Date of commencement: July, 1992

Date of completion: September, 1992

Site of project: AZRI, Quetta

1. Introduction

The rangelands of highland Balochistan are showing severe symptoms of overgrazing because of the excessive population of small ruminants. One potential solution to this problem is to identify promising grasses, shrubs and trees for use as forage reserves during periods of shortage, and thus reduce the grazing pressure on the heavily degraded rangelands. Research at AZRI over the last few years has identified a good shrub species, *Atriplex canescens*, commonly known as fourwing saltbush. It is a perennial, cold and drought tolerant plant with moderate protein content (8-10 percent) in the leaves. The research studies at AZRI on the nutritive value of this shrub have proven its usefulness as a maintenance forage. Its intake and protein digestibility by sheep is comparable with conventional forages such as lucerne (Atiq-ur-Rehman et al., 1990). However, it is known that minerals such as sodium, potassium, phosphorus and calcium are present in quite high concentrations and prolonged feeding of fourwing saltbush might have a negative impact on animal health. The trial described here aims to study the use of fourwing saltbush, offered to sheep at different levels as a supplement to wheat straw.

2. Objective

- to study the effect of different levels of fourwing saltbush as a supplement to wheat straw on the intake and digestibility of the diets and the blood levels of sodium, potassium, calcium and phosphorus in sheep.

3. Experimental Methods and Procedures

In November-December, 1991 fourwing saltbush leaves and twigs were collected at AZRI Farm and Tomagh Range-Livestock Research Station, air dried and stored at room temperature.

Sixteen Harnai males of approximately two years of age, will be used in a completely randomized design. They will be divided randomly into four groups of four animals each. The four groups will be offered either 150, 300, 450 or 600 g/head/day of dried fourwing saltbush leaves (most of the twigs will be removed). In addition, chopped wheat straw will be provided *ad libitum* to each sheep. However, the amount of wheat straw offered will be adjusted to ensure that sheep refuse less than 10 percent of the prescribed amount of saltbush offered. This will help ensure that the mean intakes of the four saltbush levels remain approximately equally spaced. The rations will be fed individually, starting with saltbush followed by straw. Each animal will be penned in metabolism crates at the Animal Nutrition Research Unit of AZRI. Before the start of the main experiment the animals will be put in the crates and given wheat straw and 200 g cottonseed cake for one week and then given another week to adapt to the saltbush/wheat straw regime. Then a 14 day preliminary period will start followed by a 7-10 day period when faeces and urine will be collected to measure digestibility and nitrogen balance. At the end of the collection period the animals will be returned to a wheat straw and cotton seed cake diet for one week. Animals will be weighed every week in the morning before feeding.

Records of daily feed offered and refused will be made and representative samples saved. Water will be offered twice a day at 9:00 and 14:00 h and water intake will be recorded. Faeces voided daily by each animal will be collected and weighed. Ten percent of the total faeces will be dried every day in an oven at 60°C for 48 hours. The feed and faecal samples will be analyzed for dry matter, ash and crude protein (Kjeldahl) using standard methods (AOAC, 1984), and fibre content (NDF, ADF). Blood samples of each animal will be collected weekly from the jugular vein and the serum analysed at the Feed Evaluation Unit (ASI, NARC) for its content of sodium, potassium, calcium and phosphorus.

4. Experimental design

Completely randomized design with four animals per treatment.

5. Publication

MART/AZR Research Report and paper in national refereed journal.

6. References

AOAC (Association of Official Analytical Chemists) 1984. Official Methods of Analysis. Washington, D.C. 14th edition.

Atiq-ur-Rehman, S. Rafique, Amanat Ali and M. Munir: 1990. Nutritive evaluation of fourwing saltbush in growth and digestibility trials with Harnai lambs in upland Balochistan. AJAS (Asian-Australasian Journal of Animal Science). 3:229-303.

AZRI Research Protocol

(Livestock Section)

Protocol code: L06 (new, BOSTID) **Priority:** 2

Title of project: on-farm performance of Balochi and Harnai sheep breeds under traditional management in highland Balochistan

Collaborating institutions: Balochistan Livestock Department

Principal AZRI investigator: Dr Shahid Rafique (SSO)

Collaborating AZRI scientific staff: Mr Inam-ul-Haq (SO)

Collaborating non-AZRI scientific staff: not yet decided

Date of commencement: December, 1992

Date of completion: June, 1994

Site of project: Zarchi and Tomagh areas

1. Introduction

Studies during the last 3-4 years at AZRI and its two Range-Livestock Research Stations at Zarchi and Tomagh have shown that improved nutritional management of ewes during their breeding cycle improves ewe fertility, lamb growth rate and reduces ewe and lamb mortality. However, even though the results obtained so far appear promising as compared to the performance of ewes raised under traditional management practices, the comparisons made so far have been based on information collected through surveys in these areas or from controlled experiments that are not truly representative of local flocks. This study aims to involve the sheep of farmers and to monitor the year round management of sheep by them. The study will establish a basis for comparing performance of sheep raised under traditional and improved nutritional management in highland Balochistan. It will also document the information collected so far through surveys on sheep/goat production practices and potentials in the region. The study is a part of the BOSTID project on the performance of indigenous sheep breeds.

2. Objectives

- to monitor the performance of ewes of the Balochi and Harnai breeds raised under traditional production/management systems in highland Balochistan.

3. Experimental Methods and Procedures

One to two flocks near Zarchi (in Kalat) and near Tomagh (in Loralai) will be involved in this survey. All the sheep in the flocks will be ear tagged, aged, and weighed and body condition scored once every 14 days. Records of all kind of management being provided by the farmers throughout the year will be

maintained. All inputs and output will be closely monitored. Exact breeding and lambing dates, sex of lamb, lamb birth and weaning weights and mortality will be recorded. Lambs will also be weighed fortnightly. The economics of raising sheep using the prevailing production systems will also be assessed.

4. Experimental design

Completely randomized design, with farms as replicates.

5. Publication

MART/AZR Research Report and paper in a national or international refereed journal.

6. References

None.

RANGE SECTION

The last year has seen a further narrowing of the focus of the Range Section, partly because the Section only has three scientific officers and partly because fourwing saltbush appears to be the most promising technology emerging from the Section. The research on exotic grasses has completely stopped since they showed only a limited adaptation to the conditions of highland Balochistan, with the exception of weeping lovegrass (*Eragrostis curvula*) which has shown good persistence at Tomagh due to the summer rainfall at that site (AZRI/ICARDA, 1991). Furthermore, it seems most unlikely that farmers in Balochistan will reseed rangeland because of the cost, the need to import seed, the lack of control over marauding flocks and the management requirements needed to ensure good persistence of exotic grasses.

It is also emerging that fourwing saltbush is best suited for growing on land marginal for cultivation where there is some soil but low plant cover. The former is important for the storage of water, which helps the seedlings survive through the first summer, whereas the latter is necessary since competition from native shrubs has been seen to severely reduce growth of saltbush. This information is being taken into account when selecting sites for demonstrating forage reserves.

It should not need mentioning that the on-farm testing of saltbush with full participation of farmers is an essential part of the research process and such activities need to be accelerated at AZRI. A forage reserve was established near Miamgundi in March 1992 and two further sites will be added in 1993. This aspect of the research is described in more detail in Protocol Ex03 (page 87) of the Extension Section.

The fuelwood production of saltbush will also be investigated in 1993 although at the time of writing details had not been finalized. This adds an important dimension to saltbush which is now considered to be a dual-purpose plant. Its regrowth after pruning of different intensities, and the yield of wood, will be measured.

Focusing on just one species to provide feed from rangeland and land marginal for cultivation has obvious weaknesses. For this reason another perennial forage shrub, *Salsola vermiculata*, is being multiplied in the AZRI nursery. Seed was received from the Pasture, Forage and Livestock Program of ICARDA in the spring 1992. This shrub's main advantage is that it can be propagated direct from seed. Research is likely to begin in 1993 when enough seed is available.

References

AZRI/ICARDA (Arid Zone Research Institute/International Center for Agricultural Research in the Dry Areas) 1991. 1990 Annual Report. MART/AZR Project Research Report No. 65, ICARDA, Quetta.

AZRI Research Protocol
(Range Section)

Protocol Code: R02 (on-going) **Priority:** 1

Title of project: plant spacing, fertilization and water catchment effects on survival and productivity of fourwing saltbush (*Atriplex canescens*)

Collaborating institutions: none

Principal AZRI investigator: Mr Abid Hussain (SO)

Collaborating AZRI scientific staff: Dr Sarwat N. Mirza (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: June, 1990

Date of completion: June, 1993

Site of project: AZRI, Tomagh and Zarchi

1. Introduction

No quantitative information exists on the basic agronomic management of fourwing saltbush (FWSB) in Balochistan. Plant density and possible benefits of responses to fertilizer, particularly manure, requires investigation if production of forage reserves of this shrub is to be as high as possible.

2. Objectives

- to determine the effects of fertilization, plant spacing and method of water-catchment on the growth of fourwing saltbush (*Atriplex canescens*)

3. Experimental Methods and Procedures

The trial is being conducted at Tomagh, Zarchi and AZRI HQ. One year-old seedlings of uniform size were transplanted into plots in June 1990.

3.1. Treatments: three factors are being investigated:

- fertilizer: manure, N plus P, and no fertilizer
- plant spacings: 2.5 and 2 m
- water-catchment system: saucer-shaped, V-shaped

These three factors combine to give 12 treatments, each applied on 100 m^2 plots.

3.2. Procedures: the plants in the fertilizer treatments received a single dose of 31 g and 20 g Nitrophos (23-23-0) for the 2 and 2.5 m spacing treatments, respectively. This is equivalent to 50 kg/ha. In the case of sheep manure, amounts applied were based on a 1 t/ha dressing: 400 g/plant and 630 g/plant for the 2 and 2.5 m spacing treatments, respectively. A single irrigation of 15 l/plant was applied at the time of planting.

3.3. Observations: measurements of plant survival, height and crown diameter will be made every two months during the growing season for three years. At the end of the study the biomass of plants will be determined.

4. Experimental design

RCB with factorial arrangement of treatments (3 x 2 x 2), and two replications at each site.

5. Publication

MART/AZR Project Report, and national/international refereed journal.

6. References

None.

AZRI Research Protocol
(Range Section)

Protocol Code: R03 (on-going) **Priority:** 1

Title of project: establishment of fourwing saltbush (*Atriplex canescens*) on rangelands with land treatments to improve moisture storage

Collaborating institutions: none

Principal AZRI investigator: Mr Abid Hussain (SO)

Collaborating AZRI scientific staff: Dr Sarwat N. Mirza (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: May, 1990

Date of completion: May, 1993

Site of project: Zarchi and Tomagh (Mastung trial abandoned because plots grazed by sheep and high plant mortality)

1. Introduction

Fourwing saltbush (*Atriplex canescens*) is a new introduction to Balochistan but it's success is largely dependent on establishing a good stand of bushes. The question therefore arises: can small scale water-harvesting land treatments help in the establishment and persistency of fourwing saltbush? This study investigated four different methods of capturing run-off water: saucer-shaped, V-shaped basins, furrows and ripped lines.

2. Objectives

- to study the effects of four micro-basin water-harvesting methods on the establishment and survival of fourwing saltbush (*Atriplex canescens*).

3. Methods

The trials are being conducted at Zarchi and Tomagh. The four different micro-basin water harvesting techniques are designed to collect the run-off from rangeland and thereby enhance the water supply to the salt bushes.

3.1. **Treatments:** the four micro-basin water-catchment treatments are:

a. saucer catchments; each saucer has a 2 m diameter
b. V-shaped catchments: the Vs have 2 m arms at 90° to each other
c. contour furrows: at 2 m spacing
d. ripping: at 2 m spacing.

Treatments a. and b. were applied by hand and c. and d. by a tractor-drawn plough.

3.2. Procedures: six-month old seedlings were transplanted in 1990 and a single irrigation of 15 l water was given to each plant.

4. Experimental design

RCB with four replications.

5. Publication

MART/AZR Project Report and paper in national/international refereed journal.

6. References

None.

AZRI Research Protocol
(Range Section)

Protocol code: R04 (on-going) **Priority:** 1

Title of project: plant spacing and survival, production, and utilization of fourwing saltbush (*Atriplex canescens*) in highland Balochistan

Collaborating institutions: none

Principal AZRI investigator: Mr Javed Afzal (SO)

Collaborating AZRI scientific staff: Dr Sarwat N. Mirza (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: February, 1991

Date of completion: February, 1994

Site of project: AZRI and Karkhasa National Forest

1. Introduction

Atriplex canescens, commonly known as fourwing saltbush (FWSB), is a promising plant species for revegetating the depleted range areas of upland Balochistan. It could also be used to establish forage reserves on farm land close to villages. Our experience with FWSB forage reserves established by AZRI has shown that if stands become too dense, they are poorly used by sheep and goats. The purpose of this study is to find the optimum plant density that maximizes off-take of FWSB in Balochistan. It is anticipated that the higher plant spacing will make better use of the scarce rainfall because more will be used by the plants rather than lost by evaporation. However, the life-span of closely spaced plant may be shorter because of competition effects. This will be less serious provided the plants remain small as a result of grazing.

2. Objectives

- to study the effect of plant spacing on productivity and survival rate of fourwing saltbush (*Atriplex canescens*) established on marginal lands of highland Balochistan, and
- to determine the optimum plant spacing for efficient utilization and grazing management of fourwing saltbush stands.

3. Experimental Methods and Procedures

This study will be conducted at two locations; AZRI station, Quetta, and Karkhasa National Park near Quetta (Forest Department, Govt. of Balochistan). At each location, two blocks (replicates) of 3000 m^2 each and differing in their soil

types, will be planted with fourwing saltbush (*Atriplex canescens*). The three plant spacing treatments will be applied within each block.

3.1. Treatments: the three treatments are:

T1 = 1 x 1 m spacing (10,000 plants/ha)
T2 = 2 x 2 m spacing (2,500 plants/ha)
T3 = 3 x 3 m spacing (1,111 plants/ha)

Six-month old seedlings about 20-25 cm high and grown at the AZRI nursery, were transplanted into plots during the first week of February, 1991.

3.2. Data Collection: data is being collected as follows:

Years I and II: a) establishment (survival rate),
b) plant height and crown diameter of 15 randomly selected plants/treatment.

Year III: a) forage production in the beginning of May 1993 will be estimated. The weight estimate method (Pieper, 1978) will be used to assess forage production. It involves sampling 15 randomly selected plants/treatment,
b) plant height and crown diameter of 15 randomly selected plants/treatment every two months,
c) After determining the forage production, the stand will be grazed by sheep. Stocking rates will be adjusted according to forage production in each treatment. Plant utilization by sheep will be estimated by using the before and after method (Pieper 1978).

4. Experimental design

A RCB design is being used, with two locations and two replicates at each location.

5. Publication

MART/AZR Research Report and national/international refereed journal.

6. References

Pieper, R.D. 1978. Measurement techniques for herbaceous and shrubby vegetation. Dept. of Animal and Range Sciences, New Mexico State University, Las Cruces, New Mexico, U.S.A.

AZRI Research Protocol
(Range Section)

Protocol code: R05 (on-going) **Priority:** 1

Title of project: establishment of fourwing saltbush (*Atriplex canescens*) transplanted in three different winter and spring months on a rangeland in Balochistan

Collaborating institutions: none

Principal AZRI investigator: Mr Javed Afzal (SO)

Collaborating AZRI scientific staff: Dr Sarwat N. Mirza (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: February, 1992

Date of completion: February, 1995

Site of project: Tomagh

1. Introduction

The most critical stage in the planting of fourwing saltbush (*Atriplex canescens*) is the initial seedling establishment. The general procedure for planting at AZRI is to grow the seedlings in a nursery for 4-6 months and to transplant them in late winter/early spring (Feb-March) when they are roughly 20-25 cm high. Low seedling survival has resulted in the past when no additional water is applied at transplanting. We suspect this is because the seedling is weakened by the lack of soil moisture. In this study FWSB will be transplanted in three winter/spring months so that the most appropriate period can be found when maximum seedling establishment is achieved with minimal or no additional watering.

2. Objectives

- to determine the survival rate, crown diameter, plant height and productivity of fourwing saltbush (*Atriplex canescens*) transplanted in December, February and April.

3. Experimental Methods and Procedures

3.1.Treatments: the three transplanting treatments are:

a) December, 1991 (early winter transplanting)
b) February, 1992 (mid-winter transplanting)
c) April, 1992 (spring transplanting)

An area with fairly uniform soil type was levelled and fenced at Tomagh. The area was divided into four blocks (replicates) and each block subdivided into

three plots. In each sub-plot fourwing saltbush seedlings 15-20 cm high were planted at 2x2 m distance.

3.2. Observations: the following observations are being recorded once every two months over a three year period:

a) survival rate,
b) crown diameter and plant height of 20 randomly selected plants per treatment (or within 10% of population mean).
c) forage production, estimated from crown diameter, and growth rate, will be determined at the end of the study.

The soil will be analyzed at the start of the experiment.

4. Experimental design

RCB design with four replications.

5. Publication

MART/AZR Project Report and national/international refereed journal.

6. References

none.

AZRI Research Protocol
(Range Section)

Protocol code: R08 (on-going) **Priority:** 1

Title of project: grazing potential of fourwing saltbush (*Atriplex canescens*) by sheep in upland Balochistan

Collaborating institutions: none

Principal AZRI investigator: Dr Sarwat N. Mirza (SO)

Collaborating AZRI scientific staff: Mr Abid Hussain (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: June, 1991

Date of completion: October, 1994

Site of project: AZRI

1. Introduction

Atriplex canescens, commonly known as fourwing saltbush, is a drought resistant forage shrub and grows well under arid and semi-arid environments with annual rainfall of 200-250 mm. It furnishes good forage for livestock in all seasons. The growing season of fourwing saltbush is from March till September but it retains some leaves during winter and is considered as a valuable winter browse for livestock. The response of fourwing saltbush to grazing has not been widely investigated, although there is evidence that fourwing saltbush can withstand moderate to heavy grazing pressure (Rumbaugh *et al.*, 1982). However, unless suitable management techniques are applied, sustained productivity is not maintained (Jefferies and Pitman, 1986). Fourwing saltbush has successfully been established in arid regions of upland Balochistan. Its utilization by animals is generally recommended after 18 to 24 months of growth (Ueckert, 1985). There is a need to establish effective methods of utilization and managing established *Atriplex* stands particularly for grazing (Kernick, 1986). The current study will look at various management strategies like continuous and deferred grazing and its impact on sustained productivity of fourwing saltbush.

2. Objectives

- to study the effect of continuous and deferred rotational grazing by sheep on regrowth and productivity of fourwing saltbush, and
- to determine the effect of continuous and deferred rotational grazing of fourwing saltbush on sheep performance.

3. Methods

This experiment will be conducted on fourwing saltbush blocks established during 1990 at AZRI field, Quetta. Yearling rams of Harnai and Balochi breeds will be used for this grazing study. Sheep will be allowed to browse two fourwing saltbush blocks of size 35x163 m each planted at 1.5x1.5 and 2x2 m spacing. Each block will be further subdivided into three subplots. In one of the subplots of each block, five rams will be allowed to graze four hours each day for four consecutive months, that is from July through October (continuous grazing), while the rest of the two subplots of each block will be used for deferred rotational grazing by rams. Ten rams will be allowed to graze one of the two subplots for about two months followed by grazing in the other subplot for two months. Thus the grazing pressure in the two treatments will be similar. The same grazing trial will be repeated for the next two years.

3.1. Data Collection: new leafy growth on seven randomly selected plants in each subplot will be estimated before the start of grazing to estimate biomass availability. Plant height and circumference of 50 % of the population will also be estimated in each subplot before the trial begins. Eight fenced cages of size 1.5 x 1.5 m each will be placed in one of the three subplots of each block to be used for continuous grazing treatment to monitor changes in vegetation height, circumference and forage consumed by the animals after the end of the trial. These parameters will also be measured in the other two subplots of each block to be used for deferred rotational grazing, just before the animals enter the subplot. Plant heights, circumference, and forage production estimates will be compared for the two systems at the end of the grazing trials. Regrowth characteristics of fourwing saltbush will be estimated for the two grazing treatments before the start of the trials in the spring 1993.

4. Experimental design

Randomised block design.

5. Publication

MART/AZR Project Report and paper in refereed national/international journal.

6. References

Jefferies, R.L. and M.G. Pitman. 1986. Perspectives of the biology of halophytes in natural habitats in relation to forage production. In: Forage and fuel production from salt affected wasteland. Barret-Leonard, E.G., C.V. Malcolm, W.R. Stern and S.M. Wilkins. Research for Development Seminar, Western Australian Department of Agriculture, Jarrah Road, South Perth 6151, Western Australia.

Kernick, M.D. 1986. Forage plants for salt affected areas in developing countries. In: Forage and fuel production from salt affected wasteland. Barret-Leonard, E.G., C.V. Malcolm, W.R. Stern and S.M. Wilkins. Research

for Development Seminar, Western Australian Department of Agriculture, Jarrah Road, South Perth 6151, Western Australia.

Rumbaugh, M.D., Johnson, D.A., Van Epps, G.A. 1982. Forage yield and quality in a great basin shrub and legume experiment . J. Range Manage. 35(5): 604-609.

Ueckert, D.N. 1985. Use of shrubs for Rangeland Revegetation. In: L.D. White, D.E. Guyn, and T.R. Troxel (eds). Proceedings of the International Ranchers Roundup. Laredo, Texas. Texas Agricultural Extension Service, pages 190-196.

AZRI Research Protocol
(Range Section)

Protocol code: R09 (on-going) **Priority:** 1

Title of project: establishing artificial plant communities and measuring ecological potential of local endangered plant species in Balochistan

Collaborating institutions: none

Principal AZRI investigator: Dr Sarwat N. Mirza (SO)

Collaborating AZRI scientific staff: Mr Abid Hussain (SO)
Mr Javed Afzal (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: January, 1992

Date of completion: January, 1997

Site of project: AZRI and Tomagh

1. Introduction

The rangelands of Balochistan have been severely over grazed for generations. Many of the original plant communities have been lost and palatable climax species (*Chrysopogon aucherii, Tetrapogon spp.*, etc.) are now found only in scattered locations. These locations are generally remote and inaccessible. Since grazing pressure and the destruction of Balochi plant associations is continuing at an ever increasing rate, it may soon be impossible to reconstruct complex assemblages or communities of native plants.

Plant communities growing on the major soil types of Balochistan were never adequately studied before they were lost. Relic stands are used as a standard against which management actions can be judged. Assessments of ecosystem progression or regression are possible where relic communities exist. In the absence of relic stands (as is the case in Balochistan) artificially constructed communities can fulfil a similar function.

2. Objectives

- to establish seed banks of local endangered plant species of Balochistan for use in future research challenges,
- to study the response of individual plant communities (production of forage as measured by quality, quantity, etc.),

- to develop a realistic, concrete concept of ecological potential for various plant communities in arid ecosystems of Balochistan, and

- to use the established artificial communities for economic and managerial analysis for future development of Balochi rangelands.

3. Experimental Methods and Procedures

Artificial plant communities of local endangered plant species (grasses, forbs and shrubs) will be created in various phases. Wahid (1990) identified valuable and endangered plant species on two typical rangelands, a grassland (Tomagh) and a shrubland (Zarchi) of Balochistan. Seeds of the important plant species will be gathered from various scattered locations during May-July 1992, or clones will be transplanted from remnant populations into AZRI range shrub nurseries. We will expand this plant material in live herbariums, then establish structured communities at sites that typify the major range types in Balochistan. In the case of bunch grasses, tufts will be collected and directly transplanted into selected sites during the appropriate season. Initially, two blocks (approximately one ha each) of soil will be prepared and fenced at Tomagh. Tufts of *Chrysopogon aucherii*, a very palatable grass species (Wahid, 1990), will be uprooted from various protected pockets in the Tomagh area and will be planted in these two blocks in the last week of January/first week of February 1992 depending upon the onset and distribution of winter precipitation. A gradual creation of artificial communities of other local species will continue, keeping in view the source and nature of their propagation.

3.1. Observations: a 15 to 30 m permanent transect will be laid down in each block. The following parameters will be recorded:

Years I and II: seedling establishment (i. density - no. of plants/ha (during growing season), ii. cover percentage - at the end of each growth period on a permanent transect, iii. frequency percentage - once in two years, iv. height (cm) - after every two months on permanent transect). Appropriate procedures as described by Pieper (1978) will be used to estimate the above mentioned parameters. All blocks will be completely protected from grazing by fencing. Complete weather records will be collected using automatic weather stations to determine the ecological potential of plant species under the prevailing climatic conditions.

Years III, IV and V: during each year standing crop biomass will be measured every two months, using appropriate non-destructive methods described by Pieper (1978). Finally, forage production potential of all local plant species will be estimated.

Plant samples will be collected at various stages of growth and will be analyzed in the laboratory for dry matter and crude protein, to estimate nutrient status of individual plants. Any ecological changes, such as invasion and establishment of other plant species, will be closely monitored. Interspecific competition between the invading species and artificially established species will be examined. This study will be conducted at the AZRI station in Quetta and Tomagh range research station.

4. Experimental design

Completely randomized design.

5. Publication

MART/AZR Project Report and national/international refereed journal.

6. References

Pieper, R.D. 1978. Measurement techniques for herbaceous and shrubby vegetation. Department of Animal and Range Sciences, New Mexico State University, Las Cruces, New Mexico, U.S.A.

Wahid, A. 1990. Dietary composition and nutritional status of sheep and goats grazing two rangeland types in Balochistan, Pakistan. Ph.D. Dissert., Oregon State Univ. Corvallis, U.S.A.

AZRI Research Protocol
(Range Section)

Protocol Code: R10 (new - supported by Productivity Enhancement Project (PEP) of PARC) **Priority:** 1

Title of project: seedling multiplication of *Atriplex canescens* for establishing forage reserves

Collaborating institutions: none

Principal AZRI investigator: Dr Sarwat N. Mirza (SO)

Collaborating AZRI scientific staff: Mr Abid Hussain (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: October, 1992

Date of completion: July, 1994

Site of project: AZRI and Tomagh

1. Introduction

Atriplex canescens (fourwing saltbush) is a perennial forage shrub and has successfully been established in nurseries and under field conditions in the arid ranges of highland Balochistan. Seeds of fourwing saltbush do not germinate under field conditions and can only be raised as seedlings in nurseries. Because of its adaptability, persistency and drought tolerance under arid conditions, this shrub can be successfully used to rehabilitate degraded rangelands as well as establishing forage reserves on marginal land. In order to promote this plant among the farming community, there is a need to demonstrate the establishment of fourwing saltbush blocks as forage reserves on private land. The Range and Extension Sections of AZRI are already engaged in activities such as contacting progressive farmers and asking them to establish forage reserve blocks of fourwing saltbush on their marginal land. In the beginning these plants will be provided to farmers and agricultural departments free of cost but later the necessary training will be provided to develop *Atriplex* nurseries in villages and at the Forest and Livestock Departments. For this purpose, large numbers of *Atriplex* seedlings need to be raised at AZRI nurseries for further distribution to farmers and government agencies involved in range rehabilitation.

A massive expansion of the size of the AZRI saltbush nursery was started in December 1992. It is planned to have at least 150,000 seedlings in plastic pots by March 1993 and these should be ready for planting by December 1993. Further expansion is planned to eventually give a nursery producing 300,000 to 500,000 seedlings. With the establishment of nurseries by the Forest Department and in villages, a target annual production of 1-3 million seedlings should be achieved by mid-1995.

2. Objectives

- to raise *Atriplex canescens* seedlings for range rehabilitation and establishing forage reserves.

3. Experimental Methods and Procedures

Seeds of fourwing saltbush will be collected at the end of September, 1992 from forage blocks at AZRI, Quetta. Seeds will be dewinged manually and using the new dewinger developed at NARC, and sown during early spring 1993 in plastic bags at AZRI and Tomagh nurseries. About 25,000 seedling will be ready for planting during the period December 1992 to late February 1993. They will be supplied free of cost to progressive farmers and the provincial departments engaged in range improvement work.

4. Experimental Design

None.

5. Publications

None.

6. References

None.

GERMPLASM SECTION

The germplasm research of AZRI was closely scrutinized during 1992, the aim being to accelerate the identification and release of improved genotypes to replace the current landraces in highland Balochistan. In addition, the methods used and the number and location of the testing sites, were reviewed.

The identification of improved genotypes concerns in particular bread wheat lines with resistance to yellow rust (YR) (*Puccinia striiformis*). This fungal disease reached epidemic levels during the last three growing seasons which were wetter than average. In each of these years two lines, Gerek and ICW1471, showed good resistance to YR. Gerek is a Turkish bread wheat that has been used in that country for over 20 years and it was first tested by AZRI in the 1989/90 season. ICW1471 was amoung the F2 material sent by ICARDA in September 1982. Efforts to identify more bread wheat lines with resistance to YR are continuing so that other resistant lines have reached an advanced stage of testing should the resistance of Gerek and ICW1471 to YR weaken.

Another part of the effort to increase the number of lines of bread wheat with resistance to YR is the crossing experiment described in Protocol G06. This experiment examines the observation that the local bread wheat landrace of Balochistan is a poor combiner. It will be crossed with 10 lines carrying YR resistance and the haploidy technique will be used to accelerate the selection process. It is most encouraging that the Crop Diseases Research Institute (CDRI) of PARC is fully involved in this effort. It could, however, be 10 years before the success or otherwise of the experiment is known.

Particular attention is now being given to field verification and seed multiplication. Field verification is an essential step in the process leading to the eventual release of a new variety which is sanctioned by the Varietal Evaluation Committee of Pakistan. The Agronomy Section of AZRI tested some of the new promising lines in 1991/92 and in 1992/93 will repeat the evaluations at four sites (see Protocol A05, page 76). Several hundred kilograms of Gerek, ICW1471, *Arabi Abiad* and the barley landrace 39-58 will be increased in 1992/93 so that by the end of the season it is hoped that well over one tonne of each of these lines will be available to give to the provincial Department of Agriculture for large-scale field testing. Two lines of lentils with large seeds are also being multiplied although the quantity of seed from each line is still less than 100 kg. The seed multiplication activity is described by Protocol G05.

The method used to test germplasm continues to use a pre-soaking irrigation and early planting to ensure that the plants have sufficient leaf area by early winter to allow testing for cold tolerance. Later irrigations are applied in spring if loss of the material is in jeopardy due to drought. Irrigation also ensures that the seed yield of promising lines is maximized. However, this approach means that material is tested under more favourable management conditions than it will encounter under farmer conditions. The Agronomy Section conducts verification trials under such conditions (see Protocol A02, page 71). It would be desirable for the Germplasm Section to test all new material under true rainfed conditions, as well as under favourable conditions.

Some changes in the number and location of the test sites have been made this year. The site at Kili Bokhara east of Loralai will be only be used for

seed multiplication since it is so far away. The high elevation site at Khan Mehtarzai, which has been used for many years, will be dropped since each year it has been difficult to find suitable sites on farmer's land. Two new sites on a Department of Agriculture farm has been chosen, one at an even higher location at Sur Tal (Pishin District) where seed potato multiplication takes place and the other at Giddah, near Khuzdar. Another site near Sibi on a Department of Agriculture farm will be used for multiplying spring barleys. These two new sites have good supplies of water so that the maximum seed yields can be guaranteed. The other sites at AZRI station (for all crops) and Kalat (for lentils) are being maintained for seed multiplication.

AZRI Research Protocol
(Germplasm Section)

Protocol code: G01 (continued) **Priority:** 1

Title of project: evaluation and selection of exotic winter and spring barley germplasm for the arid highlands of Balochistan

Collaborating institutions: ARI, Quetta (GOB)
NARC, Islamabad
CDRI, Murree, Karachi, Islamabad

Principal AZRI investigators: Mohammad Anwar Khan (SO)

Collaborating AZRI scientific staff: S.A. Jalil (ASO)
Sarfraz Ahmad (SO)
Irshad Begum (SO)

Collaborating non-AZRI scientific staff: Salim Mughal (WB-ARI)
Sher Muhammad (WB-ARI)

Date of commencement: 1985 (each year new germplasm is included)

Date of completion: 1995 with annual reviews of progress

Site of project: ARI Sariab (Quetta) and Kalat

Experimental Details

1. Introduction

Barley (*Hordeum vulgare* L.) is the world's fourth most important cereal crop after bread wheat, rice and maize. Much of it is produced in regions with climates unfavourable for production of other major cereals. It has a wider ecological adaptation than wheat. It is a dependable crop under extreme environmental conditions and is considered to be a poor soil and a poor man's crop. In fact, the majority of barley is produced under moisture stress conditions because in these areas barley is the only option left to farmers. It is mostly grown for animal feed either as winter grazing, or as grain and straw, or both (Khan, 1991). Drought stress commonly affects plant growth and development because it controls the physiological processes and conditions that determine the quantity and quality of plant growth. Water stress just before, during, and after fertilization is especially detrimental to yield (Alvarado, 1974; Wells and Dubetz, 1970).

Screening for yield ability (grain plus straw) under biotic and abiotic stress is an obvious procedure when breeding barley for target traits. Recent studies on barley in highland Balochistan have shown more encouraging results than from any other crop (Ahmad *et al.*, 1991) and efforts to select exotic lines adapted to the prevailing environmental conditions and sowing time in the highlands of Balochistan will continue.

2. Objectives

- to select cold, drought and heat-tolerant and disease-free genotypes of barley for winter and spring planting with high straw and grain yield.

3. Experimental Methods and Procedures

3.a. Yield Trials (new and selected material)

Description	Winter Sowing	Spring Sowing
Test entries	500 (approximately)	150 (approximately)
Design	RCB	RCB
No. of replications	3	3
Plot area	7.5 m^2	7.5 m^2
Fertilizer rate	20:20:0	20:20:0
Seed treatment	Vitavax	Vitavax
Irrigation	Pre-planting$^+$	Pre-planting$^+$

$^+$ in case of no rain at planting time irrigation will be given at all experimental sites to facilitate crop establishment, evaluation for cold resistance and good seed increase. Subsequent irrigations will also be given at ARI Sariab (Quetta) if warranted.

Variables to be measured:

1. Days to emergence
2. Growth habit
3. Cold resistance (1-5 scale)
4. Drought/heat tolerance (1-5 scale)
5. Days to heading
6. Plant height (cm)
7. Spike type (two/six-rowed)
8. Disease resistance
9. Total dry matter yield (kg/ha)
10. Grain yield (kg/ha)
11. Yield components:
    - i. No. of tillers/unit area
    - ii. No. of spikelets/spike
    - iii. 1000 kernel weight (gm)
12. Harvest index
13. Lodging (%)
14. Chemical analysis (for selected lines)

3.b. Observation nurseries (new material)

Observation nurseries will be non-replicated in single rows. Other procedures will be the same as in yield trials.

4. Publication

MART/AZR Research Report and refereed national or international publication.

5. References

Ahmad, S., I. Begum, S.A. Jaleel, M.A. Khan, B.R. khan and A.Y. Allan. 1991. Germplasm Evaluation in Arid Highlands of Balochistan, Annual Report 1991. MART/AZR Research Report No. 73, ICARDA (Quetta) Pakistan.

Avalardo, J.N. 1974. Effect of soil water stress on growth of barley. Ph.D. thesis, Colorado State University, Fort Collins -USA (Diss. Abstr. Int. 35/08- B:3715).

Khan, M.A. 1991. Evaluation of cytoplasmic male sterile hybrid barley in hill plots. Master's thesis, Montana State University, Bozeman, USA.

Wells, S.A., and S. Dubetz. 1970. Reaction of two barley cultivars to a period of soil water stress during heading. Canadian Journal of Plant Science 50:704-710.

AZRI Research Protocol
(Germplasm Section)

Protocol code: G02 (continued) **Priority:** 1

Title of project: evaluation and selection of bread wheat genotypes for winter and spring sowing in the arid highlands of Balochistan

Collaborating institutions: ARI, Quetta (GOB)
NARC, Islamabad
CDRI, Murree, Karachi, Islamabad

Principal AZRI investigators: Irshad Begum (SO)
Sarfraz Ahmad (SO)

Collaborating AZRI scientific staff: Mohammad Anwar Khan (SO)
S. A. Jalil (ASO)

Collaborating non-AZRI scientific staff: Salim Mughal (WB-ARI)
Sher Muhammad (WB-ARI)

Date of commencement: 1985 (each year new germplasm is included)

Date of completion: 1995 with annual reviews of progress

Site of project: ARI Sariab (Quetta) and Kalat

Experimental Details

1. Introduction

Bread wheat (*Triticum aestivum* L.) is the most important staple food crop grown under rainfed conditions in highland Balochistan (Ahmad *et al.*, 1990; Khan and Saleem, 1985). Wheat and barley account for approximately 70% of the cultivated area that falls under the mandate of ICARDA. 65% of this rainfed area, where moisture is one of the most important limiting factors, is planted with wheat (Jenkins and Srivastava, 1985). The scientists of the Germplasm Evaluation Section of AZRI are working to evaluate and select exotic cultivars that can replace local cultivars of wheat which are cold and drought tolerant but are extremely sensitive to yellow rust (*Puccinia striiformis*). It is not so easy to include disease resistant traits into the local cultivar by traditional methods of breeding because it is not a good combiner (Tahir, personal communication). For this reason we need to use more advanced and novel breeding techniques (Agrios, 1988) that do not exist at present at AZRI. For example, genetic engineering, tissue culture, haploidy, etc. Only one option is left for AZRI, namely, the evaluation and selection of exotic cultivars from germplasm sent by ICARDA, which must have enhanced disease, drought and cold resistance and tolerance with grain and straw production at least equal to local landraces.

For spring sowing we need a cultivar which has a short life cycle to escape terminal drought. The local bread wheat landrace (Local White) is a winter type and requires 6-7 months to complete its life cycle. Thus, it is not suitable for spring planting. For spring planting, heat and drought tolerant genotypes with

shorter life cycle are required. The Germplasm Evaluation Section, in close collaboration of ICARDA, has been trying for several years to introduce exotic germplasm for spring planting at different ecological zones of highland Balochistan. So far ten potentially promising lines of spring wheat have been selected for further testing (Ali *et al.*, 1989). It is hoped that success in this direction will help the farmers in the area.

2. Objectives

- to select cold, drought and heat-tolerant and disease free genotypes of bread wheat with high straw and grain yield for winter and spring planting.

3. Experimental Methods and Procedures

3.a. Yield trials (new and selected material)

Description	Winter Sowing	Spring Sowing
Test entries	650 (approximately)	150 (approximately)
Design	RCB	RCB
No. of replications	3	3
Plot area	7.5 m^2	7.5 m^2
Fertilizer rate	20:20:0	20:20:0
Seed treatment	Vitavax	Vitavax
Irrigation	Pre- planting[+]	Pre-planting[+]

[+] in case of no rain at planting time irrigation will be given at all experimental sites to facilitate crop establishment, evaluation for cold resistance and good seed increase. Subsequent irrigations will also be given at ARI Sariab (Quetta) if warranted.

Variables to be measured:

1. Days to emergence
2. Growth habit
3. Cold tolerance (1-5 scale)
4. Drought/heat tolerance (1-5 scale)
5. Days to heading
6. Plant height (cm)
7. Disease resistance (1-10 scale)
8. Total dry matter yield (kg/ha)
9. Grain yield (kg/ha)
10. Yield components:
    i. No. of tillers/unit area
    ii. No. of spikelets/spike
    iii. 1000 kernel weight (gms)
11. Harvest index
12. Lodging (%)
13. Chemical analysis (for selected lines)

3.b. Observation nurseries (new material)

Observation nurseries will be non-replicated in single rows. Other procedures will be the same as in yield trials.

4. Publication

MART/AZR Research Report and refereed national or international publication.

5. References

Ahmad, S., I. Begum, S.A. Jaleel, M.A. Khan, B.R. Khan and A.Y. Allan. 1991. Germplasm Evaluation in Arid Highlands of Balochistan, Annual Report 1991. MART/AZR Research Report No. 73, ICARDA (Quetta) Pakistan.

Ahmad, S., J.D.H. Keatinge, B.R. Khan and A. Ali. 1990. Evaluation of winter wheat germplasm for the arid highlands of Balochistan. Sarhad Journal of Agriculture 6(5):459-465.

Agrios, G.N. 1988. Plant Pathology. Third edition, Academic Press Inc., San Diego, California, USA.

Ali, A., S. Ahmad and B.R. Khan. 1989. Germplasm evaluation for the arid uplands of Balochistan, Pakistan. Highlights. AZRI publication, Quetta, Pakistan.

Khan, A., and M. Saleem. 1985. Wheat grain yield as affected by Date and Rate of Seeding. RACHIS. 4(2):35-37.

Jenkins, G., and J.P. Srivastava. 1985. Information network for wheat and barley research in the Middle East and North Africa. RACHIS 4(2):41-45.

AZRI Research Protocol
(Germplasm Section)

Protocol code: G03 (continued) **Priority:** 1

Title of project: evaluation and selection of exotic large-seeded winter and spring type lentil germplasm for highland Balochistan

Collaborating institutions: ARI, Quetta (GOB), NARC Islamabad

Principal AZRI investigator/s: Sarfraz Ahmad (SO)

Collaborating AZRI scientific staff: Mohammad Anwar Khan (SO)
S.A. Jaleel (ASO)

Collaborating non-AZRI scientific staff: M. Ikram
(Legume Scientist) ARI Sariab

Date of commencement: 1985 (each year new germplasm is included)

Date of completion: 1995 with annual reviews of progress

Site of project: ARI Sariab (Quetta) and Kalat

Experimental Details

1. Introduction

Lentil is an important source of protein and being a leguminous crop it also increases soil fertility. In highland Balochistan the area under lentil cultivation is less than 100 ha (Government of Pakistan, 1988). The local lentil landrace is small-seeded which makes it less desirable to consumers than large seeded types (Keatinge *et al.*, 1990). Therefore, the introduction of large seeded, cold and drought tolerant genotypes in this area will be a positive step to boost lentil production. Previous exotic germplasm evaluation studies of lentil have identified some material with good potential for highland Balochistan (Moneim *et al.*, 1991). Therefore, efforts are continuing to introduce additional exotic germplasm for testing.

The local lentil landrace is a winter type and requires 6-7 months to reach maturity. Thus, it is not suitable for spring planting, but in some areas of highland Balochistan the chances of success with spring planting are higher due to more rain falling in the period from December to March. For spring planting, early maturing, heat and drought tolerant genotypes with good seed setting characteristics are required for the area. Efforts are being made, with the collaboration of ICARDA food legume scientists, to introduce exotic germplasm for spring planting at multiple sites in highland Balochistan. It is hoped that the new introductions will provide a broader genetic base for selecting desirable genotypes.

2. Objectives

- to select large seeded, cold, drought and heat-tolerant and disease free lentil genotypes with high seed and straw production.

3. Experimental Methods and Procedures

3.a. Yield trials (new and selected material)

Description	Winter Sowing	Spring Sowing
Test entries	60 (approximately)	50 (approximately)
Design	RCB	RCB
No. of replicates	3	3
Plot area	7.5 m^2	7.5 m^2
Fertilizer rate	20:20:0	20:20:0
Seed treatment	Benlate	Benlate
Inoculation	*Rhizobium spp.*	*Rhizobium spp.*
Irrigation	Pre- planting+	Pre-planting+

+ in case of no rain at planting time irrigation will be given at all experimental sites to facilitate crop establishment, evaluation for cold resistance and good seed increase. Subsequent irrigations will also be given at ARI Sariab (Quetta) if warranted.

Variables to be measured:

1. Days to emergence
2. Plant stand per m^2
3. Seedling pigmentation
4. Low/high temperature damage*
5. Days to flowering
6. Days to maturity
7. Plant height (cm)
8. Number of pods per peduncle
9. Number of pods per plant
10. Number of seeds per pod
11. Total dry matter yield (kg/ha)
12. Grain yield (kg/ha)
13. Harvest index (%)
14. Straw yield (kg/ha)
15. 1000 seed weight (gms)
16. Stress susceptibility*
17. Pest and disease susceptibility*
18. Pod shedding
19. Protein content (for selected lines)

* (1-5 scale)

3.b. Observation nurseries (new material)

Single row observation nurseries with two replications. Other practices will be the same as in yield trials.

4. Publication

MART/AZR Research Report and refereed national or international publication.

5. References

Moneim, A.A., J.D.H. Keatinge, B.R. Khan, and S. Ahmad. 1991. Germplasm evaluation of dual-season lentil (*Lens culinaris*) lines for the arid highlands of west Asia. Journal of Agricultural Science (Cambridge) 117(3):347-354.

Government of Pakistan. 1988. Agricultural statistics of Pakistan 1987/88. GOP, Islamabad.

Keatinge, J.D.H., N. Buzda, G.F. Sabir, M. Afzal, N.A. Shah, and A. Ali. 1990. Lentil production in highland Balochistan, Pakistan: Current status. Lens 17(1): 13-15.

AZRI Research Protocol
(Germplasm Section)

Protocol code: G04 **Priority:** 2

Title of project: introduction, evaluation and selection of forage legumes for winter and spring planting in the highlands of Balochistan

Collaborating institutions: ARI, Quetta

Principal AZRI investigators: Sarfraz Ahmad (SO)

Collaborating AZRI scientific staff: Mohammad Anwar Khan (SO)
S.A. Jaleel (ASO)

Collaborating non-AZRI scientific staff: ARI Sariab (Forage Legume Scientist)

Date of commencement: 1985 (each year new germplasm is included)

Date of completion: 1995 with annual reviews of progress

Site of project: ARI Sariab (Quetta) and Kalat

Experimental Details

1. Introduction

The feed deficit affecting small ruminants, particularly in winter months, is a major constraint to productivity in highland Balochistan. To reduce grazing pressure on degraded rangelands, efforts are being made to introduce forage legume species suitable for cultivation in the rainfed areas of highland Balochistan. Annual forage legumes of *Vicia* and *Lathyrus* species have shown promise in other Mediterranean and highland environments (Moneim *et al.*, 1990). In highland Balochistan, *Vicia villosa ssp. dasycarpa, V. sativa, V. ervillia, V. narbonensis, V. pannonica, Lathyrus sativus and L. ochrus* have been tested, and some *Vicia* lines have shown good potential in the area (Keatinge *et al.*, 1991). Due to the better performance of *Vicia* spp. in previous years, efforts will continue in future to introduce additional exotic germplasm for selecting desirable drought tolerant, cold resistant genotypes with high forage and seed yields.

Evaluation studies of forage legumes conducted in highland Balochistan with spring planting have shown that *Vicia ervillia* exhibited some potential for spring planting (Keatinge *et al.*, 1991). In 1991/92 a large number of *Lathyrus sativus* lines supplied by NARC were also included in the spring evaluation program. Efforts will continue in future to introduce new exotic forage legume species in highland Balochistan for selecting drought and heat-tolerant genotypes with high forage and seed production.

2. Objectives

- to introduce palatable, cold and drought-tolerant forage legumes suitable for winter and spring planting.

3. Experimental Methods and Procedures

3.a. Yield trials (new and selected material)

Description	Winter Sowing	Spring Sowing
Test entries	70 (approximately)	40 (approximately)
Design	RCB	RCB
No. of replications	3	3
Plot area	7.5 m^2	7.5 m^2
Fertilizer rate	20:20:0	20:20:0
Seed treatment	Benlate	Benlate
Inoculation	*Rhizobium spp.*	*Rhizobium spp.*
Irrigation	Pre-planting+	Pre-planting+

+ in case of no rain at planting time irrigation will be given at all experimental sites to facilitate crop establishment, evaluation for cold resistance and good seed increase. Subsequent irrigations will also be given at ARI Sariab (Quetta) if warranted.

Variables to be measured:

1. Days to emergence
2. Growth habit
3. Low temperature damage*
4. Days to flowering
5. Days to maturity
6. Plant height (cm)
7. Total dry matter yield (kg/ha)
8. Grain yield (kg/ha)
9. Stress susceptibility*
10. Pest and disease susceptibility*
11. Pod shedding
12. Protein content

* (1-5 Scale)

3.b. Observation Nurseries (new material)

Single row observation nurseries. Other practices will be the same as 3.a.

4. Publication

MART/AZR Research Report and national or international publication.

5. References

Keatinge, J.D.H. A. Ali, B.R. Khan, A.M. Abdel Ali Moneim, and S. Ahmad. 1991. Germplasm evaluation of annual sown forage legumes under environmental conditions marginal for crop growth in the highlands of west Asia. Journal of Agronomy 166:48-57.

Moneim, A.A., P.S. Cocks and Y. Swedan. 1990. Yield stability of selected forage vetches (*Vicia spp.*) under rainfed conditions in west Asia. Journal of Agriculture Science (Cambridge) 111:295-301.

AZRI Research Protocol
(Germplasm Evaluation Section)

Protocol code: G05 (continued) **Priority:** 1

Title of project: seed multiplication of selected lines of cereals and food and forage legumes

Collaborating institutions: ARI, Quetta (GOB), progressive farmers

Principal AZRI investigator/s: Mohammad Anwar Khan (SO)

Collaborating AZRI scientific staff: S.A. Jalil (ASO)
Sarfraz Ahmad (SO)
Irshad Begum (SO)

Collaborating non-AZRI scientific staff: Salim Mughal (WB-ARI)
Sher Muhammad (WB-ARI)

Date of commencement: October, 1991

Date of completion: 1992 (repeated every year)

Site of project: AZRI, Sibi, Pishin (Sur Tal), ARI Sariab (Quetta), Kili Bokhara and Kalat

Experimental Details

1. Introduction

Before the start of the MART/AZR ICARDA had a collaborative program with ARI Sariab to improve the germplasm of bread wheat, barley, lentils and forage legumes. Since the 1985/86 cropping season the AZRI Germplasm Section has largely taken over the work on crops for rainfed conditions, leaving ARI Sariab to concentrate on the improvement of crops for irrigated conditions.

This protocol describes the considerable efforts at AZRI to increase the seed of promising germplasm selected over the last seven years.

2. Objectives

- to multiply seed of promising selected exotic cultivars of both cereals and food and forage legumes for further testing by the Agronomy Section of AZRI, and eventual release.

3. Experimental Methods and Procedures

3.a. Seed multiplication plots (selected lines)

Test Entries: 17 cereals
6 food/forage legumes

		Approximate area (hectares)
Bread Wheat:		
	1. Gerek (winter)	3.00
	2. ICW 1471 (winter)	2.00
	3. WAT 1007 (spring)	0.10
	4. WAT 923 (spring)	0.09
	5. WAT 620 (spring)	0.09
	6. WAT 614 (spring)	0.07
	7. WAT 310 (spring)	0.05
	8. WAT 613 (spring)	0.03
	9. WAT 1003 (spring)	0.06
	10. WPT 1216 (spring)	0.03
	11. HAW-16 (winter)	0.03
	12. WOL89-73 (winter)	0.03
Barley:	1. Landrace 39-58 (winter)	5.00
	2. *Arabi Abiad* (facultative)	0.50
	3. *Wadi Hassa* (facultative)	0.75
	4. W12291/W12269 (spring)	1.00
Lentil:	1. ILL 5865 (winter)	0.10
	2. ILL 5677 (winter)	0.20
Forage Legumes:	1. *Vicia dasycarpa* Acc. 683 (winter)	1.50
	2. *Vicia ervillia* Acc. 2542 (spring)	0.30

Note: Planting area depends upon the availability of land and the quantity of seed from the 1991/92 season.

No. of Replication: non-replicated.

Fertilizer rate: 60:60:0

Seed treatment: Vitavax and Benlate in case of cereals and food/forage legumes, respectively.

Irrigation: required for maximizing the yield.

Sowing Time: fall and spring.

AZRI Research Protocol
(Germplasm Evaluation Section)

Protocol code: G06 (new) **Priority:** 1

Title of project: improving the local bread wheat landrace through innovative breeding techniques

Collaborating institutions: NARC, Islamabad

Principal AZRI investigator: Mohammad Anwar Khan (SO)
Sarfraz Ahmad (SO)

Collaborating AZRI scientific staff: Irshad Begum (SO)
Syed Abdul Jaleel (ASO)

Collaborating non-AZRI scientific staff: Dr Nafees S. Kisana (SSO)
(Wheat Program, NARC)
Dr M. Aslam (Director, CRDI, NARC)

Date of commencement: October, 1992

Date of completion: July, 2002

Site of project: AZRI and NARC, Islamabad

Experimental Details

1. Introduction

Bread wheat is the most important crop in rainfed areas of highland Balochistan. Local landraces, either white or red-seeded, are grown widely in the Province as they are highly adapted as well as resistant to abiotic stresses. Moreover, they possess good grazing potential, high straw production and good bread/chapati making qualities which makes them acceptable to the local farming communities. However, these landraces are highly susceptible to yellow rust (*Puccinia striiformis*) (Ahmad *et al.*, 1991a). Like other fungal diseases, yellow rust is moisture and humidity loving and therefore a good rainfall year favours the occurrence of the fungal diseases. When epidemics occur they cause heavy economic losses to the farm community in highland Balochistan (Ahmad *et al.*, 1991b).

Crop improvement is a challenging task due to the harsh environmental conditions experienced in highland Balochistan. Moreover, the probability that exotic genotypes with all the desirable traits will adapt to the local conditions is very low. It is not very common to get all the desirable gene combinations in one genotype. For the last three consecutive years (1990-92) Balochistan's wheat crop has suffered yellow rust attacks caused by a very primitive race (E0-16) and the economic losses in the Province have been devastating. The local landrace of wheat has no resistant genes against yellow rust (Aslam, 1992) and the breeding history of these landraces is not known. Some researchers claim that these local landraces have very poor combining ability which is hard to believe until proven and no published reports are known that support this claim.

It is thus possible that AZRI's scientists will conduct pioneering research when they try to improve the local landrace of wheat of Balochistan by introducing disease resistance. A combination of traditional and advanced breeding techniques (double haploid technique) will be applied to achieve this goal. This breeding approach will enable us to develop new promising varieties in a shorter period of time than using traditional methods alone. Double haploid plants are homozygous at all loci and thus by this method one saves considerable time by avoiding the need to grow segregating populations. The crossing program will attempt to incorporate genes that carry resistance to yellow rust while at the same time retaining the other desirable traits of the local landrace of bread wheat.

2. Objectives

- to incorporate genes for yellow rust resistance into the local landrace of bread wheat in Balochistan.

3. Experimental Methods and Procedures

Ten exotic yellow rust resistant parents will be utilized in a crossing program with the local landrace of wheat (Table 1). Exotic genotypes will be used as male donor (non-recurrent) parents while the local landrace will used as the adapted parent (recurrent parent). The proposed crossing procedure is outlined below:

First Year: crossing of local white (rust susceptible variety) with exotic rust resistant genotypes at AZRI farm Quetta. Approximately 200 crosses will be made with each parent.

Second Year: growing F1 seed at AZRI farm and backcrossing it with each of the rust resistant parents, thus obtaining backcross one (Bc1).

Third Year: growing Bc1 at AZRI farm and again crossing it with the rust resistant parents to obtain Bc2.

Fourth Year: Bc2 seed will be sent to NARC, Islamabad for the double haploid procedure and artificial disease inoculation testing.

Fifth Year: testing of disease resistant double haploid genotypes in Balochistan against various environmental stresses.

Sixth-to-Tenth Year: seed increase and varietal approval procedure.

5. Publication

MART/AZR Research Report and refereed publication.

6. References

Ahmad, S., J.D.H. Keatinge, B.R. Khan and A. Ali. 1991a. Evaluation of winter

wheat germplasm for the arid highlands of Balochistan. Sarhad Journal of Agriculture 6(5): 459-465.

Ahmad, S., A. Rodriguez, G.F. Sabir, B.R. Khan and M. Panah. 1991b. Economic losses of wheat crop infested with yellow rust in highland Balochistan: survey results. MART/AZR Research report No. 67, ICARDA, Quetta, Pakistan.

Aslam M., Director (CDRI) Islamabad. 1992. Personal communication.

Table 1. Adaptive (recurrent) and donor (non-recurrent) parents

Parent	Source/ent#	Pedigree
1.	-	Local landrace
2.	BC91-92/13	Hunza-4 ICW-H81-1341-1AP-3AP-0AP
3.	BC91-92/26	Tx62A4793-7/CB809/Veery'S' ICW-H81-1863-2AP-1AP-5AP-2AP-1AP-0AP
4.	BC91-92/29	Bez/Tob/8156/4/On/3/6.Lee/Kf/5/Bgs/Sort/kal/Bb ICW-H81-1470-1AP-1AP-1AP-0AP
5.	BWYT-SLR91-92/3	Shi#4414/Crow'S'SWM11508-4AP-4AP-3AP-4AP-0AP
6.	WYRGP91-92/2	71St2959/Crow'S' SWM 11623-2Y-0Y--1AP
7.	WYRGP91-92/3	71St2959/Crow'S' SWM11623-9AP-3AP-7AP-5AP-4AP-0AP
8.	WYRGP91-92/19	Clement/Ald'S' SWM9813-5Y-2Y-0Y-3AP-1AP-0AP
9.	WYRGP91-92/25	HD2169/Bow'S' ICW81-0705-05AP-300AP-7AP-0AP
10.	WYRGP91-92/41	Ns732/Her SWM11179-2AP-3AP-1AP-2AP-2AP-0AP
11.	F2 (HA)92-93	Bez//Tob/8156/4/On/3/6*Th/KF // 6*Lee/KF/5/Myna'S' ICW1471

AGRONOMY SECTION

During the last two years the research of the Agronomy Section has undergone a substantial change in focus. In general it has been simplified with the ending of all conventional agronomic studies so that the main focus is now research on different methods of water-harvesting to enhance crop growth and make better use of scarce rainfall. This research is largely funded by a BOSTID project.

The water-harvesting research was singled out for review in 1992. As a result the number of catchment-basin water-harvesting (CBWH) trials has been reduced from five to three and the number of strip cropping trials increased from one to three. In addition, one row spacing trial has been added. There are several reasons for giving CBWH less emphasis. First, it has been studied for six cropping seasons and the agronomic results need to be carefully reviewed. Second, the set-up costs to make the catchment area are considered to be sufficiently high to make the technology less attractive to farmers. Third, the size of the plots is so large that during heavy rain an amount of moisture too great to be absorbed flows onto the cropped area and water-logging occurs. Conversely, if only light rains occurs, the run-off is so small that it does not reach the crop furthest from the catchment area. Fourth, the overall economics of CBWH does not seem to be very attractive. However, the method of calculating these net benefits, which is based on using crop production divided by the sum of the cropped and the catchment areas, is not accepted by those who feel cultivable land is not limiting in Balochistan. The question of land availability has yet to be investigated. The recent survey of farmers' perceptions of water-harvesting indicates that farmers are opportunistic. When rain is poor they only crop a small area but if good rains occur as the season advances, they plant further and further up the slope of the field.

Contour strip cropping seems to hold promise and in 1992/93 replicated trials will be laid-out at three sites (Protocol A01, page 68). The technology is used in many countries with semi-arid climates and requires sloping land. The ratios 1:1 and 1.5:1 catchment to cropped land, will be investigated in the experiments. However, were natural slopes are so small that the slope of the catchment strips has to be increased mechanically, the question immediately arises whether farmers will be prepared to make this investment. This is the same weakness as CBWH.

New to AZRI at least is the practice of wide row spacing to reduce competition for moisture in the rooting zone. It has the attraction of not having any set-up or maintenance costs. During the coming season AZRI will conduct one pilot study at Mastung on this technology (see Protocol A , page).

AZRI Research Protocol
(Agronomy Section)

Protocol code: A01 (on-going, supported by BOSTID) **Priority:** 1

Title of project: catchment-basin water-harvesting to increase crop yields and reduce inter-year variability of crop yields

Collaborating institutions: ICARDA

Principal AZRI investigator: Mr Mohammad Islam (SO)

Collaborating AZRI scientific staff: Mr Zahid Ali (SO)
Mr K.N. Babar (PSO)
Mr Nisar Ali Shah (ASO) (Economics Section)

Collaborating non-AZRI scientific staff: Dr T. Oweis (FRMP, ICARDA)

Date of commencement: December, 1985

Date of completion: continuing with annual review

Site of project: Mastung, Kolpur, Spezand (the Dasht and the second Mastung trial will be dropped starting this season)

Experimental Details

1. Introduction

Catchment-basin water-harvesting (CBWH) is being studied at AZRI to improve crop yields on valley bottom soils which have very poor and slow permeability. Low earth banks (bunds) are constructed around plots measuring 60 x 20 m. The soil on the upper portion of the plots is sealed to allow the water to run off onto the lower remaining infiltration area where crops are grown. In the past the crops being tried were wheat, barley, lentils, an annual forage legume called woollypod vetch, and also fourwing saltbush (*Atriplex canescens*), a forage shrub. However, starting this year only wheat and barley will be used as the yield of the legumes tested for several years have been poor. Aspects to be studied include: the effects of the water-harvesting treatments on crop yields; techniques for preparing the run-off areas and prolonging their life-spans; use of spill-over water for *Atriplex* forage production; and the income stabilizing and risk reduction associated with the use of water-harvesting.

2. Objectives

- in general, to enhance the supply of food and feed crops in highland Balochistan using sustainable water-harvesting techniques which increase the frequency of economic crop yields and reduce the risk of crop failures,

- to quantify the improvement in yields and water-use-efficiencies obtained from better water-harvesting treatments,

- using promising water-catchment designs, to establish saltbush fodder reserves using spill-over water from infiltration areas,

- to estimate the reduction in the risks of crop failures achieved by the use of water-harvesting practices, and

- to involve farmers in the use of water-harvesting as a technology for increasing crop yields.

3. Experimental Methods and Procedures

Until the 1992/93 season five CBWH trials were being conducted at four sites close to Quetta: at Mastung (two trials), Dasht, Kolpur and Spezand. As from October 1992 there are only three trials, since one trail at Mastung and the Dasht site have been dropped. Each trial consists of three replicates and four main treatments which are: control with no water-harvesting applied, and 1:1 (which indicates that half of the plot is used for water-catchment and half is used for growing the crops), 2:1 and 3:1. The buffer zones are planted with Atriplex for forage production.

A double split is applied to each main treatment: the first split is the two crops - locally available or AZRI improved varieties of wheat and barley. The second split is with or without NP fertilizer. A seed rate of 90 kg/ha, and fertilizer rates of 130 kg N/ha and 130 kg P_2O_5/ha (Nitrophos, 23:23:0) are used.

Soil samples are taken for gravimetric moisture determination at all sites, while neutron probe access tubes are installed only at the Mastung site. Crop observations are made at the different phenological stages, and when mature, crop samples are taken for measuring straw and grain yield. Water-use-efficiencies of crops are calculated.

The AZRI Agricultural Economics Section is making economic analyses to estimate benefit:cost ratios and variability in profit margins over time. This variability will allow calculation of the risk involved in applying this technology (see protocol E04, page 10).

The experiments are conducted on farmers fields except at Mastung which is land belonging to the Department of Agriculture. At the completion of the trials and after getting the required samples, the rest of the crop is given to farmers.

4. Experimental Design

Each trial has three or four replicates and three or four main treatments (control, 1:1, 2:1 and 3:1) and each main treatment is split into 2 treatments i.e., two crops (barley and wheat) and then split again for fertilizer application (with and without). Thus, a double split-plot design is being used.

5. Publication

MART/AZR Research Report and refereed journal.

6. References

None.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A02 (on-going) **Priority:** 2

Title of project: seed multiplication of improved lines and varieties

Collaborating institutions: none

Principal AZRI investigator: Mr Mohammad Islam (SO)

Collaborating AZRI scientific staff: Mr Zahid Ali (SO)
Mr K.N. Babar (PSO)

Collaborating non-AZRI scientific staff: none

Date of commencement: July, 1991

Date of completion: on-going

Site of project: Mastung, Kolpur, Dasht, AZRI (Quetta)

Experimental Details

1. Introduction

Seed multiplication of promising lines of winter and spring wheat and barley is being carried out to meet the requirements for future research trials and for progressive farmers. Of the forage legumes, woollypod vetch (*Vicia villosa* spp. *dasycarpa*) and three lines of lentil, are being multiplied.

2. Objectives

- multiply the seed of improved crop varieties on farmers' fields for on-farm trials and for experiments, and
- involve farmers in the increase of the promising seed.

3. Experimental Methods and Procedures

Planting is made in blocks without any statistical design.

4. Experimental design

None.

5. Publication

AZRI Annual Report.

6. References

None.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A03 (on-going) **Priority:** 2

Title of project: agro-meteorological monitoring in different ecological zones

Collaborating institutions: none

Principal AZRI investigator: Mr Mohammad Islam (SO)

Collaborating AZRI scientific staff: Mr Zahid Ali (SO)
Mr K.N. Babar (PSO)
Dr S. Rafique (SSO, Livestock Section)

Collaborating non-AZRI scientific staff: none

Date of commencement: 1985

Date of completion: on-going

Site of project: Mastung, Kolpur, AZRI, ARI (Sariab) and Tomagh

Experimental Details

1. Introduction

Most of Balochistan is on the fringes of the monsoon area and does not receive large or reliable amounts of summer rainfall. Variability in seasonal precipitation is a major reason for the very poor yield expectations in the Province. The agro-meteorology of highland Balochistan has already been described, particularly the rainfed aspects and the analyses of rainfall data from 1878 to 1986. The results show that of the 107 years of data available, 38 years received less than 200 mm, 83 years less than 275 mm, and 94 years less than 350 mm rainfall. In addition to rainfall, other parameters such as air and soil temperature, humidity, sunshine hours and evapo-transpiration also play a major role in determining the yield of field crops, especially in rainfed farming systems. For the study of these parameters in highland Balochistan, automatic weather stations are placed at five locations with different altitudes. The data is collected and stored on computer for future research needs.

2. Objectives

- to collect agro-meteorological data from different ecological zones of highland Balochistan.

3. Experimental Methods and Procedures

Automatic weather stations (AWS), recording seventeen different weather parameters, are installed at AZRI (Quetta), ARI (Sariab), Kolpur, Mastung, and Tomagh. Data are collected every fortnight from each site, and processed in a computer package.

4. Experimental Design

None.

5. Publication

AZRI Annual Report.

6. References

None.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A04 (on going) **Priority:** 1

Title of project: routine analysis of soil, plant and animal samples

Collaborating institutions: none

Principal AZRI investigator: Mr Mohammad Islam (SO)

Collaborating AZRI scientific staff: staff of all AZRI Sections

Collaborating non-AZRI scientific staff: none

Date of commencement: 1985

Date of completion: on-going

Site of project: AZRI (Quetta)

Experimental details

1. Introduction

A laboratory for the analyses of soil, plant and animal samples is operational at AZPI for the different projects. Samples are collected by researchers according to their particular requirements. Analytical work is being carried out using standard methods.

2. Objectives

- to measure the chemical composition of various soil, plant and animal samples.

3. Experimental Methods and Procedures

Samples of the required materials are collected by the researchers and processed according to standard methods.

4. Experimental design

None.

5. Publication

AZRI Annual Report.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A05 (on going) **Priority:** 1

Title of project: varietal trials of promising cereals and legumes selected by the Germplasm Section

Collaborating institutions: none

Principal AZRI investigator: Mr K.N. Babar (PSO)

Collaborating AZRI scientific staff: Mr Mohammad Islam (SO)
Mr Zahid Ali (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: October, 1991

Date of completion: on-going

Site of project: Mastung, Kolpur and Dasht

Experimental Details

1. Introduction

Seed of different genotypes which have performed well during germplasm testing needs to be tested in on-farm agronomy trials at different locations in highland Balochistan.

2. Objectives

- to verify under farmer conditions promising lines of cereals and food and forage legumes.

3. Experimental Methods and Procedures

Seed of promising cereals, lentils and forages are planted under *sailaba* and *khushkaba* conditions in highland Balochistan using farmer practices. The trials are very simple; the plot size is 2x12 m with three replications, the seed rate is 100 kg/ha and no fertilizer is used. Each trial has 3-4 varieties. Crop observations are made at different phenological stages; number of plants after emergence, biomass at flowering, crop yield and total dry matter yield at harvesting.

4. Experimental Design

Each trial has 3-replications with a RCB design:

- Trial A has 4 entries of wheat (local white, Gerek, ICW1471, Punjab 85)
- Trial B has 3 entries of lentils (local, ILL5865, ILL5677)
- Trial C has 3 entries of barley (local white, 39-58, *Arabi Abiad*)

5. Publication

AZRI Annual Report.

6. References

None.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A06 (new) **Priority:** 1

Title of project: contour strip-cropping for increasing crop yields

Collaborating institutions: ICARDA

Principal AZRI investigator: Mr Mohammad Islam (SO)

Collaborating AZRI scientific staff: Mr Zahid Ali (SO)
Mr K.N. Babar (PSO)

Collaborating non-AZRI scientific staff: Dr. T. Oweis (FRMP, ICARDA)

Date of commencement: January, 1992

Date of completion: 3-years with annual review

Site of project: Mastung, Kolpur and Dasht

Experimental Details

1. Introduction

In the on-going catchment-basin water-harvesting trials in highland Baluchistan it was observed that after frequent good rains water collects near the bunds. This causes water-logging which can delay planting and also kill established crops. Dr. Owes, during his visits to AZRI in 1991 and 1992 proposed the concept of strip-cropping where the plots are along the contours with 2 and 3 m wide water-catchment strips and 2 m wide strips of crops.

2. Objectives

- to evaluate contour strip-cropping as a practice for increasing crop yields in highland Balochistan.

3. Experimental Methods and Procedures

Land will be prepared using a single pass of a spring-tinned cultivator or mouldboard plough to form strips of cropped land with 1:1 amd 1:1.5 ratios of cultivated to uncultivated land. A control treatment will also be used. The normal plot width will be 2 m of crop with the catchment area above the crop. The catchment widths will be 2 m in the 1:1 treatment and 3 m in the 1:1.5 treatment. The plots will be at least 30 m in length, along the contour. The seed rate will be 100 kg/ha and locally available or AZRI improved varieties of wheat or barley will be used. If needed, the slope of the catchment strips will be increased using a blade to 2%.

4. Experimental Design

A RCB will be used with three replications of the three treatments on each site.

5. Publication

AZRI Annual Report and paper in national refereed journal.

6. References

None.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A07 (new, supported by BOSTID) **Priority:** 1

Title of project: measurement of run-off from the compacted soil catchment areas of water-harvesting trials

Collaborating institutions: ICARDA

Principal AZRI investigator: Mr Zahid Ali (SO)

Collaborating AZRI scientific staff: Mr Mohammad Islam (SO)
Mr K.N Babar (PSO)

Collaborating non-AZRI scientific staff: Dr T. Oweis (FRMP, ICARDA)

Date of commencement: October, 1992

Date of completion: for three years

Site of project: Mastung

Experimental Details

1. Introduction

Water-harvesting is a centuries old agricultural system designed specially to increase the productivity of arid and semi-arid lands. Balochistan has an arid and semi-arid climate with a mean annual rainfall varying from 50 to 350 mm. Less than 10% of the median rainfall occurs in summer (Rees et al., 1989) but the intensity of rainfall is low as compared with winter rainfall. The Agronomy Section of AZRI has carried out water-harvesting trials in highland Balochistan at various locations since 1986 and obtained encouraging results showing increasing crop yields in farmers fields. Knowing the exact quantity of run-off water to be expected from a catchment area is very important since it determines the efficiency of the system in terms of rainfall use, and ultimately crop yields.

2. Objectives

- to measure the quantity of water which runs off from the compacted soil of the catchment area onto the cropped area, so that predictions can be made of run-off according to rainfall intensity and catchment-to-cropped area.

3. Experimental Methods and Procedures

A factorial design with three factors will be laid-out. The three factors are:

- size of catchment area (five sizes): 4 x 2 m, 4 x 4 m, 4 x 8 m, 4 x 16 m, and 4 x 32 m.
- slope (three): natural slope (about 0.5 %), 1 % and 2 %.
- soil surface treatment (two): natural (no treatment) and compacted.

Run-off water from the catchment surfaces will be collected in metal water tanks or barrels and the depth of water in these containers measured using a graduated dip stick after every rain fall event. From the depth of the water measured the total volume of water collected in the tank will be determined. The size of the containers will be varied according to each treatment to ensure that they have sufficient capacity based on a 50 percent expected run-off probability. The 50 percent expected run-off probability from specially managed soil surfaces is determined using the Catchment Area Run-off Evaluation (CARE) model prepared by Dr E.R. Perrier.

4. Experimental Design

This pilot study is unreplicated.

5. Publication

MART/AZRI Research Report.

6. References

Rees, D.J. Samiullah, A., Rehman, F., Kidd, C.H.R., Keatinge, J.D.H. and Raza, S.H. 1990. Precipitation and temperature regimes in upland Balochistan: their influence on rain-fed crop production. Agricultural Meteorology 52: 381-396.

AZRI RESEARCH PROTOCOL
(Agronomy Section)

Protocol code: A08 (new) **Priority:** 1

Title of project: effects of row spacing on cereal crop yields

Collaborating institutions: ICARDA

Principal AZRI investigator: Mr K.N. Babar (PSO)

Collaborating AZRI scientific staff: Mr Mohammad Islam (SO)
Mr Zahid Ali (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: January, 1993

Date of completion: 3-years with annual review

Site of project: Mastung

Experimental Details

1. Introduction

AZRI is already conducting experiments on catchment-basin water-harvesting (CBWH) (see Protocol A01) and strip cropping (see Protocol A06) as practices to enhance crop production under *khushkaba* conditions in Balochistan. However, both these practices require a slope to be prepared and this involves costs which farmers are unlikely to want to pay. This constraint may limit the adoption of the practice. For this reason an experiment is proposed to define the row spacing which maximizes crop yields. This will then be recommended to farmers for growing wheat and barley crops under *khushkaba* conditions. It is hoped that the practice might be more attractive than CBWH and strip-cropping since there are not initial set-up costs incurred when preparing an artificial slope. After preparing the seed bed that farmers are already doing, it would then only be necessary to make one more operation to plant the seed.

2. Objectives

- to investigate different row spacings in cereal crops as a way to enhance crop yields.

3. Experimental Methods and Procedures

A seedbed will be prepared using a single pass of a spring tinned cultivator and them barley and wheat sown in 4 m wide plots with the following row spacings: , , , and cm row spacing. Short-duration varieties of wheat and

barley will be sown in February using a seed rate of 100 kg/ha.

Crops will be sampled at maturity and grain and straw yields determined.

4. Experimental Design

A RCB will be used with three replications of the eight treatments (two cereal species and four row spacings).

5. Publication

AZRI Annual Report and paper in national refereed journal.

6. References

None.

EXTENSION AND COMMUNICATION SECTION

The work of the Extension Section is arguably the most important at AZRI. This is because research that fails to be translated into sustainable technologies that farmers adopt is largely academic and a luxury that most developing countries today are even less able to afford. This does not imply that there should be no basic research. It means that there should be the correct balance between basic and applied research, the latter also being known as adaptive research.

During the first seven years of the MART/AZR project most of the research has been of a basic nature. Now it is essential to give much more attention to adaptive research. However, it is proving very difficult to change this balance. There are three immediately obvious reasons for this. First, the Extension Section at AZRI continues to be the weakest in terms of human resources. For the last two years it has had one scientific officer. Paradoxically, there was an Extension Advisor during the first four year phase of MART/AZR when there were no technologies to extend. However, during the current and second phase there was no Extension Advisor written into the project document.

The second obstacle to changing the balance between basic and adaptive research is the all pervading attitude among discipline oriented scientists that adaptive research is for extension experts who should work closely with the provincial Extension Service. Thus, one sees a reluctance of staff outside the Extension Section to get involved in true adaptive research that involves farmer participation. The staff would prefer to write papers, irrespective of quality, since their promotion depends on the number of publications they have.

A third obstacle is that most of the AZRI staff come from other provinces and thus few of them speak the local languages of Balochistan, Balochi, Brahoui and Pushto. Only some of them have farming backgrounds and therefore have difficulty, indeed little interest, in working closely with farmers.

The protocols elsewhere in this document and in the Extension Section indicate that increased emphasis is being given to adaptive research involving farmers. The Economics Section, with input from the Agronomy Section, conducted a survey on farmers' perceptions of water-harvesting. This occurred because of the influence of the Dryland Resource Management Project (DRMP) at ICARDA (see Protocol E05, page 13). However, the survey is more diagnostic than adaptive research. The Livestock Section has also started to work closely with farmers since this was written into the BOSTID project proposal. The Range and Extension Sections are testing the saltbush technology with participation of farmers (Protocols Ex01 and Ex05, pages 83 and 88) and the Extension Section and the Agronomy Section have a project to involve farmers in the testing of the water-harvesting technology (Protocol Ex04). However, it should generally be taken for granted that farmers are involved in research if it is being conducted on-farm, thus obviating the need for projects such as protocol Ex04.

A further strengthening of the Extension Section is anticipated in 1993.

AZRI RESEARCH PROTOCOL
(Extension and Communication Section)

Protocol code: ExO1 (continuing) **Priority:** 1

Title of Project: farmer participation in the establishment and management of reserves of fourwing saltbush

Collaborating institutions: none

Principle AZRI investigator: M. Bilal Ahmad Chaudhary (SO)

Collaborating AZRI scientific Staff: K.N. Babar (PSO)
Nisar A. Malik (SSO)
Mohammad Islam (SO)
Sarwat Naz (SO) (Range Section)

Collaborating non-AZRI scientific staff: none

Date of commencement: April, 1992

Date of completion: on-going with annual review

Site of project: Dasht (Miangundi) and two new sites on farmers' fields

Experimental Details

1. Introduction

The species of the genus *Atriplex*, commonly known as saltbush, have a high productivity and an ability to establish under arid conditions (Kleinkopf *et al.*, 1975). This makes them strong candidates for introduction into degraded rangelands in arid or semi-arid regions of the world. The rangelands of Pakistan have an inherently low productivity due to environmental constraints and chronic overgrazing which has depleted the natural vegetation (Khan *et al.*, 1988).

2. Objectives

- to involve farmers in the establishment and management of forage reserves of fourwing saltbush.

3. Experimental Methods and Procedures

In Marach/April 1992 about 8,000 fourwing saltbush (FWSB) seedlings were planted with 4 m row and 1 m plant spacing on marginal land near Miamgundi village. About half of the FWSB were planted on sloping land that had been previously cultivated and is therefore fairly clear of *Artemisia* (sagebrush). The remaining seedlings were planted among a fairly dense stand of sagebrush and are therefore exposed to competition effects. About 2,000 young mulberry trees were also planted as an incentive to the farmers to grow FWSB. Data on plant survival, crown diameter and plant height is being recorded. In 1993, if not before, it

is expected that the farmers' animals will start grazing the FWSB. Two other sites will be selected and planting started as soon as there is sufficient moisture.

4. Experimental design

None.

5. Publication

MART/AZR research report.

6. References

Khan, K.N.M., A. Rehman and M.B.A. Chaudhary. 1988. Incidence of internal and external parasites in sheep in Kovak valley (Kalat District) of upland Balochistan. MART/AZR Project Research Report No. 13, ICARDA, Quetta.

Kleinkopf, G.E., A. Wallace and J.W. Cha. 1975. Sodium relations in desert plants. 4. Some physiological responses of *Atriplex confertifolia* to different levels of sodium chloride. Soil Science 120: 45-48.

AZRI RESEARCH PROTOCOL
(Extension and Communication Section)

Protocol code: Ex02 (continuing) **Priority:** 1

Title of Project: comparative performance of a camel-drawn seed-drill with the traditional wooden plough/planter for rainfed areas

Collaborating institutions: none

Principle AZRI investigator: Mr M. Bilal Ahmad Chaudhary (SO)

Collaborating AZRI scientific Staff: Mr Mohammad Islam (SO)
Mr Nisar A. Malik (SSO)
Mr K.N. Babar (PSO)

Collaborating non-AZRI scientific staff: none

Date of commencement: October, 1990

Date of completion: July, 1994

Site of project: Kolpur and Spezand

Experimental Details

1. Introduction

After several years of research the scientists of AZRI are ready to transfer some technologies to the provincial Agricultural Extension Department for onward dissemination to farmers. The camel-drawn seed-drill is a piece of improved equipment designed by AZRI scientists specially for the farmers of highland Balochistan. The effectiveness and performance of this drill has to be tested under farmers' conditions prior to handing it over to the provincial Extension Department.

2. Objectives

- to test a camel-drawn seed-drill under farmer conditions, and to compare it with the traditional wooden plough/planter.

3. Experimental Methods and Procedures

Two sites are being used with two 30x30 m plots at each site. The first plot is planted by the farmer using his traditional wooden plough while the second is planted with the camel-drawn seed-drill. The time and labour inputs at planting and at harvesting and the grain and straw yield is monitored.

4. Experimental Design

None.

5. Publication: MART/AZR research report.

AZRI RESEARCH PROTOCOL
(Extension and Communication Section)

Protocol code: Ex03 (continuing) **Priority:** 1

Title of Project: preparation of promotional video documentary about AZRI

Collaborating institutions: none

Principle AZRI investigator: Mr M. Bilal Ahmad Chaudhary (SO)

Collaborating AZRI scientific Staff: Mr Mirza Shahid Mahmood (SPA)

Collaborating non-AZRI scientific staff: none

Date of commencement: October, 1992

Date of completion: October, 1993

Site of project: various locations in highland Balochistan

Experimental Details

1. Introduction

For many years now AZRI has been involved in research to improve the living standard of the farmers of highland Balochistan. The research includes studies on better varieties of cereals and food and forage legumes, improved cropping practices which increase yields, and better livestock and range management practices. But so far little attention has been given to disseminate the research findings and achievements of AZRI to the general public, provincial officials and the farming community.

2. Objectives

- to disseminate the findings and achievements of AZRI to provincial officials and farmers.

3. Experimental Methods and Procedures

The shooting of the video will be made by the AZRI senior photographer and the script will be written by a professional writer, either from PBC or PTV. The video will be produced in the local languages and English.

AZRI RESEARCH PROTOCOL
(Extension and Communication Section)

Protocol code: Ex04 (new) **Priority:** 2

Title of Project: involving farmers in water-harvesting studies

Collaborating institutions: none

Principal AZRI investigator: Mr M. Bilal Ahmad Chaudhary (SO)

Collaborating AZRI scientific staff: Mr Mohammad Islam (SO)
Mr Zahid Ali (SO)

Collaborating non-AZRI scientific staff: none

Date of commencement: October, 1992

Date of completion: October, 1994

Site of Project: Dasht

Experimental Details

1. Introduction

In Balochistan, the largest province of Pakistan, agricultural output is low and unpredictable due to the low and erratic rainfall. AZRI scientists are trying to introduce technologies which will enable farmers to increase their crop yields. The technology known as "water harvesting" is one in which the upper-half of sloping fields is used to catch the rain water which runs onto the other half where a crop is planted. This results in higher crop yields since the crops receive additional moisture. The technology has shown promise under experimental conditions but the research has been conducted without the involvement of farmers. There is thus no indication whether the farmers will adopt it or not.

2. Objectives

- to involve farmers in testing and verification of the water-harvesting technology.

3. Experimental Methods and Procedures

The study will be conducted on two locations in Dasht valley. At each location two plots of 60x20 m will be prepared. One plot will be used for water-harvesting (1:1 ratio of catchment to cropped area) and the other as a control. Three planting methods will be compared: (i) drill-planting by tractor, (ii) the camel-drawn seed-drill and (iii) the traditional wooden plough/planter. Wheat will be planted.

4. Experimental Design: none.

5. Publications: MART/AZR research report.

AZRI RESEARCH PROTOCOL
(Extension and Communication Section)

Protocol code: Ex05 (new - supported by Productivity Enhancement Project (PEP) of PARC) **Priority:** 2

Title of Project: using saltbush to revegetate a hill behind AZRI

Collaborating institutions: none

Principal AZRI investigator: Dr Sarwat N. Mirza (SO, Range Section)

Collaborating AZRI scientific staff: Mr M. Bilal Ahmad Chaudhary (SO)
Mr Abdul Razzaq (SO)
Mr Mohammad Islam (SO, Agronomy Section)
Dr Usman Mustafa (SO, Economic Section)

Collaborating non-AZRI scientific staff: Forest Department GOB

Date of commencement: December, 1992

Date of completion: on-going with annual review

Site of Project: hill behind AZRI

Experimental Details

1. Introduction

AZRI has been conducting research on saltbush for several years but has still to test it on a large scale under farm conditions. Seedling production is being increased so that the technology can be tested on a large number of farms starting in December 1993 (see Protocol R10, page 47). Prior to starting the large scale on-farm testing operation, a pilot study will be initiated to revegetate with saltbush 2-3 ha of a hill behind AZRI. Most of the native shrubs on this hill, like most of the hills behind AZRI, have been uprooted by local people for fuelwood. This will reduce competition for water between the native shrubs and saltbush which seems to be sensitive in this respect. However, it is unclear how well saltbush will flourish on steeply sloping land where the soil drains freely. This could place even saltbush under severe moisture stress in late summer and autumn and reduce its chances of survival.

Although final plans have not been made, it is anticipated that two saltbush seedlings will be planted at each end of 2 m long trenches. These serve to harvest water and promote infiltration, the ultimate aim being to reduce run-off and promote recharge of aquifers. Some trenches are already present on the hill from a previous project but additional trenches will be prepared. A number of mulberry trees will also be planted. No fencing will be used since this gives the impression to farmers that the technology requires it.

The farmers in the village next to the hill have already agreed to participate project. The incentives that they have requested have yet to be finalized.

It is hoped that this pilot project will generate valuable information about the acceptability of the technology by farmers.

2. Objectives

- to demonstrate to farmers and provincial officials the potential of saltbush in combination with water-harvesting for revegetating a hill-side from which most of the native shrubs have been removed for fuelwood,
- to transfer the saltbush technology to a groups of farmers,
- collect bio-economic data about the technology in order to forecast its potential at other sites, and
- assess the acceptability of the technology by the farmers.

3. Experimental Methods and Procedures

These have yet to be finalized.

4. Experimental Design:

None.

5. Publications

MART/AZR research report.

6. References

None.