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# HIGH-ELEVATION RESEARCH IN PAKISTAN: THE MART/AZR PROJECT

Annual Report for 1988

# High Elevation Research in Pakistan
# The MART/AZR Project

## Small Ruminant Production and its Sustained Improvement in Upland Baluchistan

Annual Report for 1988

Arid Zone Research Institute, Quetta, Pakistan
and
International Center for Agricultural Research in the Dry Areas
(ICARDA)

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# LIST OF COMMON ABBREVIATIONS

| | |
|---|---|
| ARI | Agricultural Research Institute, Sariab (Government of Baluchistan) |
| AZRI | Arid Zone Research Institute (PARC) |
| CSU | Colorado State University |
| FAO | Food and Agricultural Organization of the United Nations |
| GOP | Government of Pakistan |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| MART | Management of Agricultural Research and Technology Project |
| MART/AZR | MART Project (Arid Zone Research Component) |
| PARC | Pakistan Agricultural Research Council |
| USAID | United States Agency for International Development |
| DM | Dry Matter |
| SY | Seed Yield |
| TDM | Total Dry Matter |

## SUMMARY

This report covering the 1987-88 production year highlights research designed **to improve the sustained production of small ruminants in upland Baluchistan.** Production of sheep and goats is the principal dryland agricultural activity in the continental Mediterranean climatic zone in Pakistan and is of major economic importance in Baluchistan.

## INTRODUCTION TO THE LIVESTOCK PRODUCTION SYSTEMS OF UPLAND BALUCHISTAN

Ninety-three percent of Baluchistan is rangeland, of which 21 million ha, or 60%, are used for grazing. All of Baluchistan would be classified as arid or semiarid. Rangelands are the major feed source for 90 to 95% of the sheep and goats. There is severe overgrazing in many areas and cutting of range shrubs for fuelwood is common. This combination of range resource abuses will have lasting effects on livestock production in Baluchistan. During the past 30 years sheep and goat numbers have increased at the rate of seven percent per year, to more than 18 million head. Still, the estimated annual demand for mutton in Pakistan to the year 2000 exceeds the current offtake rate (FAO, 1987).

## PRODUCTION CONSTRAINTS AND RESEARCH OPPORTUNITIES

1. Feed shortages and nutritional deficits:

Poor rangeland productivity, especially in the winter months, is causing severe nutritional deficits.

2. Livestock management problems:

Mortality and morbidity losses from disease and parasites are high because standard health cover is not widely available or sufficiently utilized by farmers. Animals are more susceptible to disease and parasite effects because of poor nutrition and flock management. The latter issue includes improper care of the newborn, poor shearing practices, and improper housing conditions.

3. Range management problems:

Rangeland management is not practiced on most grazing lands. Range improvement practices such as controlled grazing schemes or plant introductions are not yet significant factors in livestock production. Reasons for this include problems of rangeland tenure status, lack of practical range management interventions, and undeveloped capacity to extend available technology to potential users.

## RESEARCH DESIGNED TO IMPROVE RANGE FORAGE RESOURCES BY RANGE REHABILITATION OR GRAZING MANAGEMENT

### A. Range Plant Introductions

Eight species of exotic range grasses were tested for their suitability in upland Baluchistan. Extremely low rainfall and dry soil conditions at all study sites in 1988 provided a severe test of these entries for use on arid rangelands. The most promising survivors among the cool-season grasses were Elymus junceus and Oryzopsis hymenoides, which were also among the best entries in the 1986-87 trials. Other grasses showed some drought tolerance in the 1987-88 trials. Among them is a warm-season species, Eragrostis curvala, or weeping lovegrass which has provided the most impressive performance of any grass tested to date. A vigorous, if scattered, stand had become established following summer rains. In mid-November 1988 the weeping lovegrass was still green and a few plants were flowering. In contrast, the dominant indigenous grasses, Chrysopogon aucheri and Cymbopogon jawarancusa, were almost completely dried and dormant by November, and had provided only poor quality grazing after September.

Results of introduction experiments with Atriplex canescens, or fourwing saltbush, conducted at Zarchi and Tomagh showed that only one at-planting irrigation was needed to achieve essentially 100% survival of transplants on harsh upland sites. A fourwing saltbush forage reserve planting trial at Tomagh has demonstrated the productive potential of this species when it is grown under favorable soil moisture conditions. Six months after planting of seedlings most of the shrubs were at least 1.5m tall and the stand was producing an estimated 6,000 kg(DM)/ha of useable forage.

B. Grazing Studies

Observations from grazing studies and range exclosures established for two years tend to support the expectation that vegetation changes induced by grazing management alone will be very slow in the Artemisia-Haloxylon and Cymbopogon-Chrysopogon range types in Baluchistan.

## RESEARCH DESIGNED TO INCREASE RUMINANT PRODUCTIVITY BY IMPROVED LIVESTOCK MANAGEMENT

A. Nutritional Management Studies

A study conducted at Tomagh measured the effects of supplemental feeding on fertility and productivity of Harnai ewes. Lambing percentage rates in local flocks are reported to be from 60 to 70%. The Tomagh study flock had a 94% fertility rate and a 99% weaning rate, demonstrating that improved nutritional and health management can have a substantial influence on the productivity of range sheep in upland Baluchistan.

B. Feeding Trials and Forage Value Studies

One study conducted at AZRI compared fourwing saltbush forage with conventional feeds. By the ninth day, the palatability index had become almost stable at 99%, 98%, and 69% for lucerne hay, fourwing saltbush and wheatstraw + barley grain, respectively. There was a slight increase in body weights of sheep fed fourwing saltbush, supporting the belief that fourwing saltbush could be a useful forage reserve species for the maintenance of sheep.

## C. Livestock Health Surveys and Studies

A survey in Kovak Valley showed that 100% of the 900 animals sampled were infested with internal parasites. The incidence rate for tick infestation was 35% and for sheep scab, 23%. In a more extensive survey, which included parts of four major sheep-producing districts, almost 80% of the 340 sheep sampled were infested with internal parasites. Some of animals carried six different species of parasites.

A study was conducted at Zarchi to compare the efficacy of two anthelmintics, oxfendazole and levamisole, for the control of internal parasites in Baluchi sheep. The oxfendazole-treated ewes contained no eggs or larvae, whereas in levamisole-treated ewes the control of eggs and larvae was only 91% and 71%, respectively. Based on these surveys, and the known relationships between parasite burdens and livestock productivity, recommendations have been made for further study of this problem, for expanded diagnostic laboratory services, and for increased emphasis on livestock health extension.

## RESEARCH DESIGNED TO INCREASE ANIMAL FEED RESOURCES FROM IMPROVEMENTS TO CROPPING SYSTEMS ON MARGINAL LANDS

Little rain fell before February, and totals during the cropping season were extremely low. It is estimated that less than 10% of the arable land in the experimental areas was planted to dryland field crops. In most cases crop failure occurred. This does not mean that the experiments were a failure, however. Though years as dry as 1987/88 can be expected not more than one year in ten, if valid conclusions are to be drawn, agronomy trials must be conducted over the full range of likely environmental conditions.

### Water Harvesting

The water harvesting trials consist of preparing catchment areas at the top of gently sloping fields (0.5 - 1% slope) to encourage incident rainfall to run off onto the bunded, cropped area. Soil water content to 1 m depth, sampled gravimetrically was measured at three different positions within each plot of the Dasht water harvesting field 1 on 21 March 1988, after 78 mm rain in five showers had fallen. In each position soil water content was increased significantly ($P<0.1\%$) by the water harvesting treatments. On a cropped area basis yields were increased at all sites by water harvesting. There is not a shortage of "kushkaba" land in upland Baluchistan and so it would be practical to prepare catchment areas on currently under-utilized land.

### Wheat production

A. Agronomy Trials

Crop failure occurred at all sites except Khuzdar (pre-planting irrigation) and no response to N, phosphate or K fertilizers was observed. Results of a trial in which three varieties were compared showed that "Zamindar" produced slightly more hay,

straw and grain over all, but this was statistically significant at only one site of the five. The variety "PAK81" did not produce higher yields than the local.

B. Germplasm Evaluation Trials

The absence of cereal diseases in 1987-88, particularly yellow rust, was noted in germplasm evaluation trials on bread and durum wheats. Disease resistance to this rust is a principal objective of current AZRI selection strategies, as the local landrace is acutely sensitive.

The local landrace check was highly productive under the prevailing conditions, and in the absence of disease pressure, none of the introduced lines could be considered to be clearly higher-yielding, though several lines could be adequate replacements for the local landrace.

**Barley Production**

A. Agronomy Trials

Barley variety trials, in which five exotic varieties from Syria are compared with either Dasht or Khuzdar local varieties, have now been conducted over a wide range of arid environments in the last three years. "Arabic abiad" was the only variety to produce significantly more grain than the local when averaged over all trials, and was the only variety to produce equal (in fact, slightly greater) amounts of straw. "Arabic abiad" can be expected to give higher gross benefits than the local and, as the environment improves, the differences between the two varieties will increase.

B. Germplasm Evaluation Trials

Several of the introduced lines were as good as the local control, with some seemingly better, including Alger/Union and some of the arabic landraces. Positive progress has been made in providing adapted replacement cultivars from two

distinct genetic backgrounds which could replace the local control whose susceptibility to disease is questionable. These replacement cultivars may now be available for wider testing.

**Forage and Dual Purpose Legume Production**

A. Agronomy Trials

As seen in the previous year, Vicia villosa ssp. dasycarpa produced much higher hay yields than the lentil control, but in contrast to last year, V. sativa and V. narbonensis also gave higher hay yields.

B. Germplasm Evaluation Trials

In the forage legume trials at ARI Sariab, last year's outstanding line, Vicia villosa ssp. dasycarpa #683, was again one of the best lines in terms of dry matter production, as was V. sativa #384. However, all lines, with one important exception, effectively failed to make grain. The exception, V. ervilia #2542, which was noted in previous years to show a measure of drought tolerance, again displayed this capacity, under the harshest of conditions.

In the lentil trials the results were encouraging, as two lines from previous AZRI selections produced substantially more dry matter than the well adapted local control. ILL 5720 and ILL 5865 produced a creditable 1.5 t/ha of forage material.

## IDENTIFICATION OF SOCIAL ORGANIZATION AND COMMUNICATION PATTERNS IN RURAL COMMUNITIES FOR EFFECTIVE AGRICULTURAL EXTENSION

### A. Identification of Social Organization and Communication Patterns Within Villages

Because it is known that there is a strong tribal base in Baluchistan, the specific patterns of local social organization and settlement patterns were studied. This included a study of the communications networks and their significance for the transfer of information. Information was also obtained on the nature of economic, religious, and social contacts which these villages have with the wider system.

### B. Mass Media

Because of the physical isolation of some of these village communities, their access to mass media is somewhat limited and is essentially restricted to radio (43% of all individuals sampled in the five locations have radios). Radio listening habits are based principally on language. The survey results indicate that 20% of the respondents have cassette tape recorders in operating condition. This might help extension communicators to develop effective cassette tape listening schemes as a medium for disseminating information about production innovations. The low level of literacy in this population (17%) currently precludes the use of printed media as a general extension vehicle. However, because villagers often listen to others read aloud (73%), further evaluation of the possible uses of some written materials may be worthwhile, particularly if designed to be read aloud.

## C. Access to Extension Services

The data also indicate that the current level of access to agricultural extension services is extremely limited and restricted primarily to irrigated crop farming. Agricultural fairs apparently represent the only significant exception. Almost 45% farmer attendance at fairs offers a good opportunity for extension services to exploit. Information from the provincial livestock department on the subject of animal health was available to 43% of the livestock producers in all five locations, but access varied from 86% in the Zarchi area to 7% in Kovak Valley.

## D. Implications for Effective Agricultural Extension

The analysis of the data obtained from the Community Profiles and the Agricultural Extension Survey will provide an excellent base to help design effective programs in agricultural extension. Failure to take into account the local communication patterns described, when developing broad scale extension programs for AZRI-generated technologies, risks undermining the entire value of the Institute's research efforts.

# CONCLUSION

In conclusion, the research results obtained in the 1987-88 production year indicate that the potential for sustained improvement of small ruminant production in upland Baluchistan is substantial. However, further research and extension efforts are still required to ensure that this potential is achieved rapidly and effectively in the future.

**SMALL RUMINANT PRODUCTION AND ITS SUSTAINED IMPROVEMENT IN UPLAND BALUCHISTAN:** Annual Report of the Arid Zone Research Institute and MART/AZR Project for 1987-88.

## INTRODUCTION

The Arid Zone Research Institute and the MART/AZR Project have a fully integrated research program which is implemented by five research groups: Farming Systems/Agricultural Economics, Range and Livestock Management, Agronomy, Germplasm Evaluation and Agricultural Extension/Communication. The scientific staff of AZRI and MART/AZR have all contributed to this report and are thus jointly responsible for the scientific findings described. A full listing of the individuals concerned is presented in Appendix A.

This report covering the 1987-88 production year highlights research designed **to improve sustained production of small ruminants in upland Baluchistan.** Production of sheep and goats is the principal dryland agricultural activity in the continental Mediterranean climatic zone in Pakistan and is of major economic importance in Baluchistan. Research sites are shown in Figure 1. The research incorporates:

1. A description of currently operating systems of livestock production in upland Baluchistan;

2. An examination of the biological and economic constraints to production within these systems and the likelihood of effective returns to research in attempting to overcome these constraints;

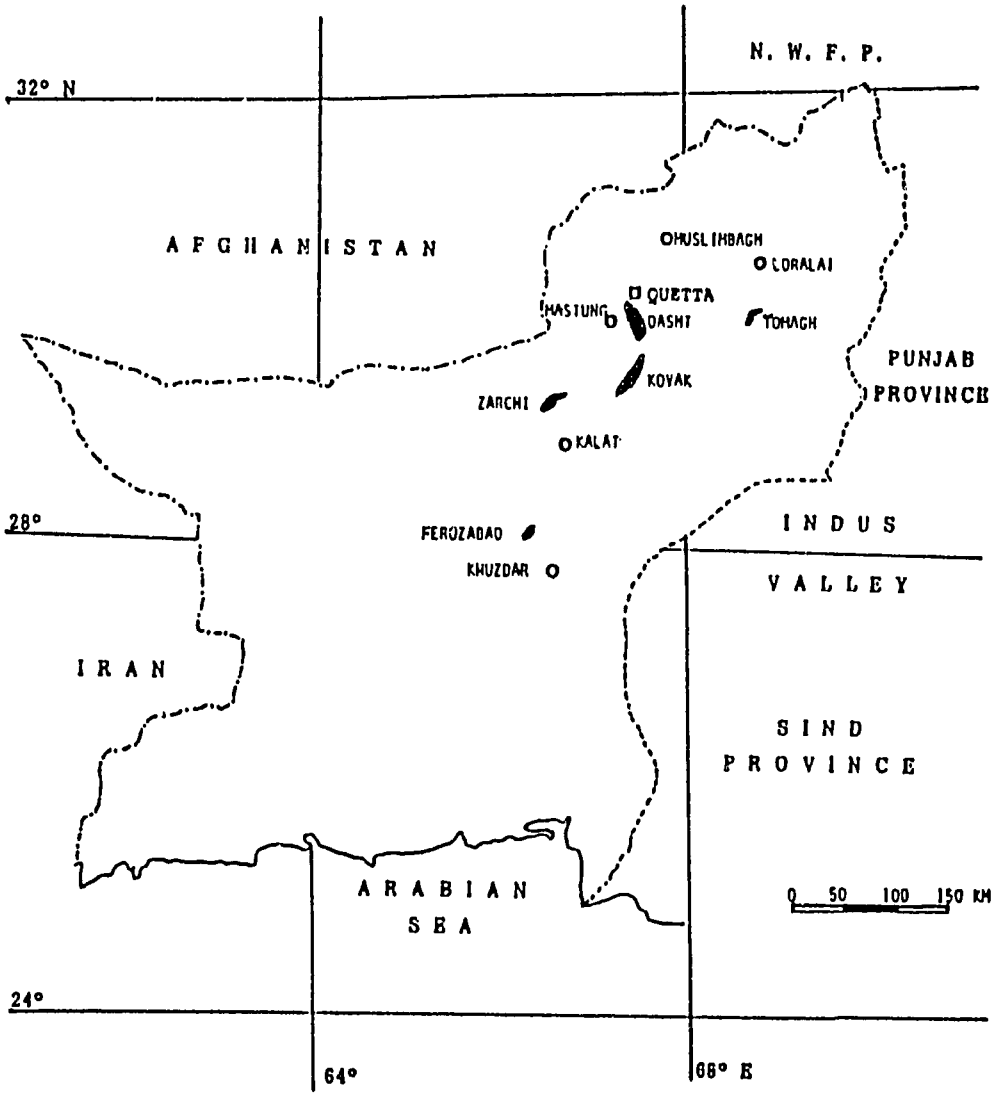
3. An investigation of the biological feasibility of selected interventions to improve range forage production;

4. An evaluation of the likely impact of supplemental feeding of small ruminants at critical periods in their production cycle and of prophylactic health care on potential productivity;

5. A study of the ways in which improvements to current cropping systems on marginal land can lead to an enhanced supply of animal feed, through the introduction or wider dissemination of forage crops (barley, *Vicia* spp. etc.) or better production of current dual purpose crops (wheat and lentils); and

6. An analysis of the constraints to communication, within and between agricultural communities, which affect transfer of AZRI-generated technology to farmers and small ruminant producers.

Figure 1. MART/AZR Project experimental sites in Baluchistan Province, Pakistan



## INTRODUCTION TO THE LIVESTOCK PRODUCTION SYSTEMS OF UPLAND BALUCHISTAN

The higher altitude areas of northern Baluchistan (1,000 m to over 3,000 m) are classified as having a continental semi-arid Mediterranean climate, and the lower regions as hot sub-tropical desert. Rainfall is low and uncertain (50-350 mm) and occurs in both winter and summer, with the former predominant in the north-west which is less affected by summer monsoons. Winters are cold at the higher altitudes with temperatures frequently below freezing from mid-November to the end of February.

While the land area of Baluchistan is very large (34.7 million ha), only a very small area (4%) is cultivable (1.47 million ha), of which 0.68 million ha are irrigated and produce such crops as vegetables, orchard fruits, wheat, barley, rapeseed, chickpeas and lucerne. In the rainfed areas, wheat, barley, rapeseed and cumin are the major winter crops with some sorghum grown as a summer crop. There are few linkages between the irrigated and dryland farming systems. Farmers' perceptions, supported by meteorological data, suggest that sufficient rainfall for crop growth occurs only six years in ten. Wheat and barley yields in even the best rainfall years are only 400 to 900 kg/ha.

Ninety-three percent of Baluchistan is rangeland, of which 21 million ha, or 60%, are used for grazing. All of Baluchistan would be classified as arid or semiarid. About 11.7 of the 20.9 million ha of rangeland are classified as poor grazing providing only 30-50 Kg/ha of dry matter (DM) while there are only 2.9 million ha of better quality rangeland providing 250-280 kg/DM/ha (FAO, 1983). The vegetation of the northern area is a grassland type on the lower range and mixed shrub-grassland on the higher rangeland with Chrysopogon and Cymbapogon being the major grass genera. In the south, the vegetation can be classified as an Artemisia and Haloxylon shrub steppe (Hasnain, 1985). Rangelands are the major feed source for 90 to 95% of the sheep and goats. Overall there is a deficit of 7% total

digestible nutrients (TDN), 13% digestible protein (DP) and 11% DM (FAO, 1983). Some forage crops, such as alfalfa, are produced under irrigated conditions but are used almost exclusively as fodder for draft animals. There is severe overgrazing in many areas and cutting of range shrubs for fuelwood is common. This combination of range resource abuses will have lasting effects on livestock production in Baluchistan.

The livestock sector of Baluchistan contributes an estimated 25% (1982-83) of the Gross Agricultural Product of Baluchistan (FAO, 1983). About 80% of the population depends on livestock in part or in whole for their livelihood (FAO, 1983). Sheep and goats are the major types of livestock in Baluchistan and represent 56 and 37%, respectively, of all livestock numbers (excluding poultry). The growth in numbers of both sheep and goats since 1955 has increased substantially at the rate of 7% a year (Table 1). Still, an estimate of mutton demand for Pakistan to the year 2000 exceeds the current offtake rate (FAO, 1987). Baluchistan exports mutton to other provinces, with most going to the Karachi market (reliable figures unavailable). At present there are about 0.6 sheep and goats per person in Pakistan and 4.3 sheep and goats per person in Baluchistan.

Sheep and goat production systems can be classified as either transhumant (65% and 52% of all sheep and goats), or nomadic (30% of all sheep and goats), or household (5% and 18% of all sheep and goats) (FAO, 1983). Transhumant flocks are mainly owned by farmers who cultivate dryland crops and whose flocks are grazed around the cropped areas and on the open range. Most of the rangelands are tribally owned but are grazed in common by farmers of the same tribe. In winter, both the farm family and the livestock move out of the upland areas down to the warmer Indus Valley plain. There, animal feed is more abundant and many farmers find employment and live in homes on established tribal lands. There are

Table 1. Sheep and goat numbers, census years, Pakistan and Baluchistan Province

| Year | Sheep | | | Goats | | | Ratio Sheep/Goats | |
|---|---|---|---|---|---|---|---|---|
| | Pakistan | Baluch. | % Baluch. of Pakistan | Pakistan | Baluch. | % Baluch. of Pakistan | Pakistan | Baluch. |
| | Millions | | | | | | | |
| 1955 | 8.1 | 1.2 | 14.8 | 7.6 | 0.7 | 9.2 | 1.07 | 1.71 |
| 1960 | 12.4 | 2.6 | 21.0 | 10.0 | 1.6 | 16.0 | 1.24 | 1.63 |
| 1972 | 13.7 | 3.9 | 28.5 | 15.6 | 3.2 | 20.5 | 0.88 | 1.22 |
| 1976 | 18.9 | 5.1 | 27.0 | 21.7 | 4.4 | 20.3 | 0.87 | 1.16 |
| 1986P | 23.3 | 11.1 | 47.6 | 29.9 | 7.3 | 24.4 | 0.78 | 1.52 |
| % Growth Rate 1955 - 1986[a] | | | | | | | | |
| | 3.4 | 7.2 | | 4.4 | 7.6 | | | |

Source: Government of Pakistan, Agricultural Statistics of Pakistan, Ministry of Food, Agriculture and Co-operatives, Islamabad, Pakistan, and

P Preliminary Report, Pakistan Census of Livestock 1986, Agricultural Census Organization, Statistics Division, Govt. of Pakistan, Lahore.

[a] Geometric growth rate.

also household (sedentary) flocks that over-winter in upland Baluchistan. Nomadic flocks (Powindas from both Pakistan and Afghanistan) also move throughout Baluchistan on established routes. They winter in the Indus Valley areas and use pastures at higher altitudes in the summer. A 1982 estimate of Afghan Powinda sheep and goat numbers was 415,000 and 493,000 respectively and Afghanistan refugee flocks were estimated to be 267,000 sheep and 254,000 goats (FAO, 1983).

Sheep are mainly of the fat-tailed type and a number of breeds exist. The Bibrik and Harnai sheep breeds are found predominant in the northern Districts of Baluchistan while the Baluchi and Rakhshani breeds are found in the southern Districts. Northern goat breeds include the Kajli (Pahari) in Loralai District, and the Khurassani in Loralai, Zhob and Chagai Districts. The Lehri goat is found on the plains in Sibi and Kachhi Districts (see Hasnain, 1985 for breed characteristics). Breeding animals are selected more on a survival basis rather than on a productivity basis, especially for those flocks that migrate (Buzdar and Jameson, 1984). A high incidence of disease and parasitism exists and many lambs die of enterotoxaemia, bacterial and viral diseases. Anthrax and contagious pleuropneumonia have been and remain serious livestock health problems. (Hasnain, 1985).

Past research efforts on range livestock production have been minimal considering the prominence of the Baluchistan sheep and goat livestock industry. Very few researchers work on range-livestock problems. The Baluchistan Livestock Department is involved with veterinary service programs but coverage is small, as is the coverage of the livestock extension program. Livestock Department research on lamb and kid fattening has been on-going since 1980. Breed improvement and cross-breeding programs have been established at the Maslakh range using the Karakul breed. Cross-breeding programs have also just begun with Angora goats. Baluchistan as yet has not developed a definitive breeding policy and few reports and results are available from the

current research and breeding program (Coop, 1987). AZRI has started a range-livestock research program that includes some of the basic range management areas: grazing systems, range livestock diets, forage plant values, and range rehabilitation. AZRI livestock research stresses the influences of supplementary feeding, prophylactic health care, and other management interventions on small ruminant production in the context of a rangeland economy.

## PRODUCTION CONSTRAINTS AND RESEARCH OPPORTUNITIES

The overall constraint to increasing sheep and goat production in Baluchistan is the harsh climatic environment with low and erratic intra- and inter-year rainfall and cold winter and hot summer air temperatures. These climatic conditions define the major constraints to production faced by sheep and goat owners in Baluchistan. Some of the major constraints and hypotheses for research and extension opportunities are listed below:

1. Feed shortages and nutritional deficits

Poor rangeland productivity, especially in the winter months, absence of early cool-season range grasses and lack of readily available and cost effective supplementary feeds are causing severe nutritional deficits. The nutritional deficit in winter months seems to be correlated with animal deaths in this period. The low conception, lambing and weaning percentages reflect the low nutritional status of the animals.

Research on improving rangeland productivity includes studies of (1) suitability of introduced perennial grasses and legumes for reseeding ranges, (2) feasibility of introducing forage shrubs into grasslands, and (3) productivity and compatibility of forage shrub reserves in range-livestock production systems. Preliminary results indicate that fourwing saltbush (Atriplex canescens) is well adapted to the

arid areas of upland Baluchistan, and that it can provide a maintenance diet for small ruminants (Atiq-ur-Rehman et al, 1988).

Rangeland productivity is also studied in terms of (1) grazing systems, (2) kinds of livestock grazed, and (3) stocking rates. Results from study of these variables are needed to develop recommendations for sustainable grazing use of rangelands.

Opportunities exist for increasing fodder production in dryland agriculture. Further researcher-managed and farmer-managed trials are required to ascertain the forage potential of combining new forage species such as the promising V. villosa ssp. dasycarpa or barley with water harvesting and fertilizer application (ICARDA, 1987). The possibility of summer crops such as sorghum for fodder could also be examined.

Increasing the nutritive value of crop residues, the use of range cubes, molasses blocks, mineral supplements and other non-conventional feeds are also alternatives that require further research.

Research trials are also required to ascertain which periods, i.e., pre-flushing, flushing, gestation, or lactation, and which feed sources will give the best economic returns from supplemental feeding.

2. Animal disease and health problems

Mortality and morbidity losses from diseases and parasites are high because standard health cover is not widely available or sufficiently utilized by livestock. Technology exists to alleviate most animal disease and health problems in Baluchistan. Costs are well within the livestock owners' means, but extension programs and more veterinary field services will be needed to achieve widespread use of adequate animal health practices.

3. Flock management problems

Common flock management practices in Baluchistan include: keeping the young away from their mothers during the day, leaving wool on the head and belly at shearing, sealing and drying the umbilical cord of newborn animals with manure or dirt, improper handling of animals, insufficient ventilation in winter housing, and incorrect administration of vaccines and dipping solutions. These practices can increase mortality and morbidity rates, and decrease productivity. Many of these practices can be eliminated or corrected at little or no cost. Livestock management studies which include a farmer-managed flock as a control to compare with improved management practices would yield useful results for both research and extension purposes.

4. Infrastructure deficiencies

Infrastructure common to a healthy livestock industry such as credit availability, transportation facilities and roads, marketing, abattoir and meat inspection facilities, and veterinary health coverage are lacking. Economic studies are needed on the problems and solutions of credit availability for livestock farmers (e.g., use of livestock as collateral), alternative marketing strategies, and the rate of return to veterinary and health coverage.

5. Range management problems

Rangeland management is not practiced on most grazing lands in Baluchistan. Range improvement practices such as controlled grazing schemes or plant introductions are not yet significant factors in livestock production. Reasons for this include problems of rangeland tenure status, lack of practical range management interventions, and undeveloped capacity to disseminate available technology to potential users. Unfortunately, solutions to such issues will not be available soon enough to avoid continued degradation of the rangelands which are the foundation of the livestock economy of Baluchistan. Research leading to a

better understanding of proper stocking rates, seasons of use, flock management and composition, and forage plant introductions should provide the basis for practical demonstrations of sound range management. Research is also needed to determine the roles and potential impact of cooperative grazing associations and other strategies which can be used in harmony with existing tribal systems.

6. Low genetic potential of livestock

Breeding animals are selected first for their ability to survive the harsh environment and second for criteria such as growth rate, wool yield and quality, and lambing percentage. Animals that survive the low rainfall years might not necessarily be the ones to take full advantage of high rainfall years. Research is needed to determine to what extent the existing genetic pool and selection from it are affecting small ruminant production. If there are constraints to production from these factors, they would be most likely to occur when nutrition, health and flock management are improved. Therefore, to maximise the benefits of research efforts in livestock and range management there should be a concomitant program to improve the genetic potential of sheep and goats raised in this region.

## EXPLORATORY ECONOMIC TECHNOLOGY SCREENING FOR SHEEP PRODUCTION IMPROVEMENT IN BALUCHISTAN, PAKISTAN

As an exercise to determine which of the principal constraints to livestock production would most appropriately receive investment of research effort, an exploratory technology screening was performed for sheep production in Baluchistan. This exercise is not intended to be definitive but rather is refined and re-refined as additional research findings become available. It is used to indicate which research areas should receive priority. In the initial run of the model, summarized in this report, an attempt has been made to examine likely management interventions at levels of potential production. In subsequent analyses a sub-optimal solution would probably be a more pragmatic approach for the longterm.

Methodology:

A sheep flock model* was used to evaluate the impact on overall flock productivity and economic performance of changes in production parameters resulting from interventions in sheep-based farming systems. The model compares the costs and benefits and calculates benefit-cost ratios of traditional farming practices and interventions which are to be screened.

Given specific data, the model calculates the input requirements and the output of a unit of 100 breeding females under existing and improved conditions. The model is currently able to evaluate interventions resulting from supplementary feeding of fodder and concentrates, vaccination and parasite control, improved management and improved breeding practices. It is sufficiently flexible to handle seasonal and year-round lambing patterns and feeding

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* Unpublished. Originally developed by E.R. Mallorie, Consultant in Livestock Economics, 29, Westbourne Terrace, London W2 3UN. See MART/AZR Research Report 23 by Nagy, Stubbs and Mallorie, forthcoming.

programs. It is also able to account for changes in flock structure which result in increased pressure on grazing and can adjust results so that similar numbers of "ewe equivalent units" are used in both traditional and intervention situations.

Eight health and nutritional management interventions were screened by using the flock model. Two scenarios were followed: (1) analysis of the interventions with technical coefficients and prices representing a good agricultural rainfall year (> 250 mm rainfall), and (2) an analysis of the interventions with technical coefficients and prices representing a poor agricultural rainfall year (< 175 mm rainfall). The main criterion for screening the interventions is economic profitability using benefit-cost ratios, dominance analysis and marginal rates of return. Interventions are then subjectively screened for their technological feasibility within the farming system, risk, and product market availability.

The flock model was run under traditional farmer practices and under eight intervention packages which included health, feeding, management and breeding practices. The eight intervention scenarios for both good and poor agricultural years used in the model were as follows:

1. Vaccination of ewes, rams and unweaned lambs against enterotoxaemia (V).

2. "V" as given above, plus de-worming (in March and July) and dipping (end of May) (D).

3. "V" plus "D", as given above, plus Improved Management (M). Improved management factors consist of: (1) keeping lactating mothers and their lambs together at all times, (2) proper shearing of animals, (3) improved treatment of lambs at birth by treating the umbilical cord with an iodine solution, (4) greater care in handling of very young

lambs, (5) timely flock inspection and culling procedures, and (6) the use of a higher ram/ewes breeding ratio.

4. "V" plus "D", as given above, plus flushing ewes and supplementary feeding of ewes during lactation at the levels presented in Table 2 under heading F1.

5. "V" plus "D" plus "M", as given above, plus flushing ewes and supplementary feeding of ewes during lactation at the levels presented in Table 2 under heading F2.

6. "V" plus "D" plus "M", as given above, plus flushing ewes and supplementary feeding of ewes during lactation plus feeding pre-weaned and post-weaned lambs at the levels presented in Table 2 under heading F3.

7. "V" plus "D" plus "M", as given above, plus flushing ewes and supplementary feeding of ewes during lactation plus feeding pre-weaned and post-weaned lambs and feeding ewe and ram replacements in poor years at the levels presented in Table 2 under heading F4.

8. "V" plus "D" plus "M" plus flushing ewes and supplementary feeding of ewes during lactation plus feeding pre-weaned and post-weaned lambs, and feeding ewe and ram replacements in both good and poor years at the levels presented in Table 2 under heading F5 plus improved ram breeding stock.

The feeding regimes as presented in Table 2 for good agricultural years represent about 40% to 45% of the adult sheep requirements for high production. The remainder of their feed is obtained from the range. In poor agricultural years, the feeding regimes presented in Table 2 represent about 90% of adult sheep requirements to achieve potential levels of productivity.

Table 2. Supplementary feeding regimes for ewes, lambs and replacement stock during good and poor agricultural years

| | Supplementary Feed Interventions for Good and Poor Rainfall Years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (4) | | (5) | | (6) | | (7) | | (8) | |
| | Good | Poor | Good | Poor | Good | Poor | Good | Poor | Good | Poor |
| | F1 | | F2 | | F3 | | F4 | | F5 | |
| | Kg/DM/Head/Day | | | | | | | | | |
| Dry Ewe (Flushing) | | | | | | | | | | |
| Lucerne | 0.2 | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 |
| Wheat straw | 0.0 | 0.6 | 0.0 | 0.6 | 0.0 | 0.6 | 0.0 | 0.6 | 0.0 | 0.6 |
| Concentrates[1] | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Days on feed | 30 | 60 | 30 | 60 | 30 | 60 | 30 | 60 | 30 | 60 |
| Lactating Ewe | | | | | | | | | | |
| Lucerne | 0.3 | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 |
| Wheat straw | 0.0 | 0.6 | 0.0 | 0.6 | 0.0 | 0.6 | 0.0 | 0.6 | 0.0 | 0.6 |
| Concentrates | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Days on feed | 90 | 60 | 90 | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| Lambs: Pre-Weaning | | | | | | | | | | |
| Lucerne | | | | | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 |
| Wheat straw | | | | | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 |
| Concentrates | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Days on feed | | | | | 60 | 90 | 60 | 90 | 60 | 90 |
| Lambs: Post-Weaning | | | | | | | | | | |
| Lucerne | | | | | 0.1 | 0.3 | 0.1 | 0.3 | 0.1 | 0.3 |
| Wheat straw | | | | | 0.0 | 0.2 | 0.0 | 0.2 | 0.0 | 0.2 |
| Concentrates | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Days on feed | | | | | 60 | 60 | 60 | 60 | 60 | 60 |
| Ewe & Ram Replacements | | | | | | | | | | |
| Lucerne | | | | | | | | 0.3 | 0.1 | 0.3 |
| Wheat Straw | | | | | | | | 0.2 | 0.0 | 0.2 |
| Concentrates | | | | | | | | 0.0 | 0.0 | 0.0 |
| Days on feed | | | | | | | | 60 | 30 | 60 |

[1]Concentrates milled at local mill in Quetta containing 40% peas, 25% molasses, 15% wheat bran, 12% rice polishings, 5% barley, and 2% limestone: 87% DM, 14.6% DP and 68% TDN.

Summary of Results and Conclusions:

The economic results from the model for both good and poor agricultural year scenarios for traditional practices and for the eight interventions are presented in Table 3. The benefit-cost ratios for the good agricultural year scenario are all greater than 1.0 indicating that it would be economically rational to choose all the interventions over the traditional practice (T). The benefit cost ratios of the poor agricultural year scenario (Table 3) are not all greater than 1.0. The benefit cost ratios of interventions 4, 5, and 6 are lower than 1.0 indicating that the traditional practice has a higher net revenue and therefore would be chosen over these three interventions.

Of the eight interventions, the three involving vaccination, de-worming, dipping and management were economically profitable under both good and poor agricultural years especially when in combination (intervention 3). Comprehensive livestock health services are not yet available throughout Baluchistan. Most farmers are not sufficiently informed to administer their own vaccinations and do their own de-worming and dipping. Improved flock management offers a high payoff to farmers, but the lack of technical facilities and intervention services currently precludes widespread impact from these measures. None of the three interventions are particularly costly and thus should be within the current economic means of the farmers.

Interventions that involved feeding (4 through 8) did not prove to be economically profitable in poor agricultural years. Intervention 8, which included improved ram breeding stock as well as feed, could be profitable with a 20% decrease in feed costs. Interventions 7 and 8 were profitable in good agricultural years even with an increase in the feed cost of 20%.

**Table 3. Costs, revenues and benefit cost ratios of eight health, feed and breeding interventions for the sheep industry, upland Baluchistan, Pakistan.**

| | | Health, Feed & Breeding Interventions[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Traditional (T) | V (1) | V,D (2) | V,D,M (3) | V,D F1 (4) | V,D M,F2 (5) | V,D M,F3 (6) | V,D M,F4 (7) | V,D, M,F5,R (8) |
| GOOD RAINFALL YEAR | Rupees per 100 ewe flock | | | | | | | | |
| Costs | | | | | | | | | |
| Feed Costs | 0 | 0 | 0 | 0 | 10454 | 10904 | 12704 | 14539 | 14989 |
| Vet. Costs | 0 | 108 | 1338 | 1595 | 1629 | 1710 | 1604 | 1712 | 1712 |
| Ram Costs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 724 |
| Total Costs | 0 | 108 | 1338 | 1595 | 12083 | 12614 | 14308 | 16251 | 17425 |
| Revenue | 25626 | 32817 | 34976 | 41570 | 46002 | 55001 | 48007 | 62144 | 65168 |
| Net Revenue | 25626 | 32709 | 33638 | 39975 | 33919 | 42387 | 33699 | 45893 | 47743 |
| Benefit Cost Ratio | - | 66.4 | 7.0 | 10.0 | 1.7 | 2.3 | 1.6 | 2.3 | 2.4 |
| POOR RAINFALL YEAR | | | | | | | | | |
| Costs | | | | | | | | | |
| Feed Costs | 0 | 0 | 0 | 0 | 27581 | 37997 | 44147 | 50769 | 50769 |
| Vet. Costs | 0 | 102 | 1289 | 1470 | 1482 | 1569 | 1558 | 1656 | 1687 |
| Ram Costs | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1246 |
| Total Costs | 0 | 102 | 1289 | 1470 | 29063 | 39566 | 45705 | 52425 | 53702 |
| Revenue | 26910 | 34476 | 36896 | 42560 | 48971 | 64153 | 65349 | 82447 | 95056 |
| Net Revenue | 26910 | 34374 | 35597 | 41090 | 19908 | 24587 | 19644 | 33022 | 41354 |
| Benefit Cost Ratio | - | 74.1 | 7.7 | 10.7 | 0.8 | 0.9 | 0.8 | 1.1 | 1.3 |

V = Vaccination of rams, ewes and unweaned lambs against entrotoxemia;
D = De-worming and dipping; M = Improved management as described in text;
F1 to F5 represent alternate feeding regimes as described in Table 2;
R = Improved ram breeding stock; US$1 approx. = 18.5 Pak Rupees.

The information from the model suggests that feeding animals in good agricultural years is profitable but that it is not profitable in poor years to feed sheep at such high rates. To follow a scenario of feeding in good years only may be practical for the farmer but it still leaves the nutritional problem in poor years unsolved. Interventions 4 through 8 have a high feeding level with the best available feeds which are priced at the market level. For feeding to become a viable intervention in poor years, feed costs must decrease by at least 20% or sheep prices must rise.

Further technical and economic exploratory study is required into the prospect of farmers using their labour and land resources to grow and store their own feed relative to buying feed from the market. The gain in value added through the use of the farmers' labour and land resources may make feeding more profitable in both good and poor agricultural years. There is also a need to research alternative feed types. Fodders such as V. villosa ssp. dasycarpa may be alternatives that farmers can grow (ICARDA, 1987). The potential for increased barley production in rainfed Baluchistan exists given that the present market becomes larger and more stable. Fourwing saltbush plantations could also satisfy the need for economical forage.

It may be more appropriate to think of feeding sheep at lower levels (maintenance levels and above) rather than at full productivity levels in poor years as was done in the model. Research is required on feeding regimes which are at, or above, maintenance levels to assess the technical and economic feasibility of different nutritional inputs in both good and poor years.

Feed costs are high in poor years because ranges do not provide sufficient feed and the animals must be given about 90% of their feed intake to achieve high levels of production. Feed availability could be increased by the use of forage reserves. Preliminary research on fourwing saltbush, Atriplex canescens, a nutritious, palatable, drought tolerant

forage shrub, indicates that it could, at the very least, be used as maintenance feed in poor years (Atiq-ur-Rehman et al., 1988). Fourwing saltbush might, however, provide more than a maintenance ration and further research is underway to assess its role in combination with other supplemental feeds in both good and poor agricultural years, and in different periods in the annual production cycle of animals.

The use of the exploratory model in this analysis has only begun to be used and has much more potential. The information from the model has pointed out broad directions that research might follow to ensure that interventions are economically viable and therefore have a better chance of being adopted by farmers. After more basic data have been gathered on simple interventions, an additional step is to examine specific interventions such as farmers growing their own fodder crops and creating forage reserves using fourwing saltbush.

The information from the model also clearly indicates that feeding interventions must reflect differences in requirements for both good and poor years. Sheep production is dynamic and responds to weather conditions. As such it may be more appropriate in the future to build a model to follow flock dynamics over a period of years to fully assess the profitability of interventions.

## RESEARCH DESIGNED TO IMPROVE RANGE FORAGE RESOURCES BY RANGE REHABILITATION OR GRAZING MANAGEMENT

### A. Range Plant Introductions

Eight species of exotic range grasses were tested for their suitability in replicated trials at eight locations in upland Baluchistan, as follows: AZRI farm, Quetta; AZRI farm, Mastung; Forest Department station, Mastung; Zarchi Range-Livestock Research Station, near Kalat; a farmer's field near Zarchi station; Dasht valley; and a farmer's field near Tomagh Range-Livestock Research Station. Early trials were established in December at three of the above sites (AZRI farms at Quetta and Mastung, and at Tomagh). Planting of identical trials took place at all locations in the first week of February. The following perennial species and varieties were included in the trials:

| Scientific Name | Common Name | Variety |
|---|---|---|
| Agropyron desertorum | Crested wheatgrass | Hycrest |
| Agropyron desertorum | Crested wheatgrass | Ephraim |
| Agropyron desertorum | Crested wheatgrass | Nordan |
| Agropyron trichophorum | Pubescent wheatgrass | VNS |
| Agropyron intermedium | Intermediate w'grass | VNS |
| Agropyron elongatum | Tall wheatgrass | Alkar |
| Agropyron elongatum | Tall wheatgrass | Jose |
| Agropyron dasystachyum | Thickspike w'grass | Critana |
| Elymus junceus | Steppe ryegrass | |
| Oryzopsis hymenoides | Desert ricegrass | Paloma |
| Eragrostis curvula | Weeping lovegrass | |

The grasses were planted in four-row plots, with four replications at each site and planting date. Suitability trials of range grasses do not, as a normal practice, use pre- or post-planting irrigation to compensate for precipitation deficits. All but two of the AZRI 1987-88 trials were conducted under natural environmental conditions. The February

planting at the AZRI farms at Mastung and Quetta each received a pre-planting irrigation equivalent to a 20mm rainfall, but neither trial showed any significant response to this treatment.

The pre-soaking of range grass suitability trials is not generally recommended and should not be used in the testing of grass germplasm for drought tolerance, because it can be assumed that in actual practice range grasses would be used under non-irrigated conditions. Presoaking creates artificial soil water conditions which can preclude or obscure extrapolation of plant responses to actual rangeland moisture stresses, even when the intent is only to simulate favorable germination and survival conditions.

Extremely low rainfall and dry soil conditions at all study localities in 1988 provided a severe test of the suitability of the grass entries for use on arid rangelands. Precipitation amounts for the 15-month period starting in mid-August, 1987, based on measurements taken near the five study localities, was as follows: Quetta and Tomagh, 170mm; Dasht valley, 125mm; Mastung, 100mm; and Zarchi, 50mm. These amounts range from 20% to 70% of the minimum precipitation generally considered necessary for successful range seedings.

It is therefore not surprising that the range grass trials for the 1987-88 planting season were almost a complete failure in terms of seedling survival into the summer-fall period. There was significant germination and early seedling growth at some of the sites, but by November 1988 only a few entries remained alive.

The most promising survivors were Elymus junceus and Oryzopsis hymenoides. These two cool-season species were also among the best entries in the 1986-87 trials. The other grasses showing some tolerance to the severe drought in the 1987-88 trials were: Pubescent wheatgrass, intermediate wheatgrass, tall wheatgrass, thickspike wheatgrass and weeping

lovegrass. The latter species has provided the most impressive performance of any grass tested to date.

Weeping lovegrass was included in a seeding mixture with five wheatgrasses in a furrow-planted block seeding at Tomagh in mid-March. There was sufficient soil moisture at the time of planting and from rains in late March to germinate some of the wheatgrass; but most of these seedlings were gone by August. However, a vigorous, scattered stand of weeping lovegrass became established following summer rains. By late August some of these plants were 40cm high and setting seed. In the second week of November the weeping lovegrass stand was still green, and a few plants were in flowering stage. Performance of weeping lovegrass at this site would be worth noting even if this had been a favorable rainfall year, which for Tomagh would mean a total of more than 350mm. However, for the current year, in which less than half that amount was received at Tomagh, results of the weeping lovegrass seeding are particularly impressive.

There is now reason to believe that weeping lovegrass, or a similar warm-season grass, can be found which can make efficient use of summer rainfall and provide much needed green forage well into the fall breeding season. In contrast to the lush growth of weeping lovegrass, extending into November 1988, the dominant indigenous grasses, Chrysopogon aucheri and Cymbopogon jawarancusa were almost completely dried and dormant by November, and had provided only poor quality grazing after September. Further study should lead to selection of suitable warm-season and cool-season grasses to be used for improved pastures in this region.

Stands of perennial grasses that can provide nutritious grazing until late fall and then start growth in the early spring could serve as important supplemental forage resources during two of the most critical phases in the annual production cycle of sheep and goats, i.e., the breeding season and the late gestation/early lactation periods. Grass suitability trials to date have not convincingly

identified proven performers in either the cool-season or warm-season types, but weeping lovegrass now shows promise of satisfying the latter demand.

Fourwing saltbush introduction and forage reserve trials produced encouraging results during the past year. Experiments conducted at Zarchi and Tomagh comparing one, two, and three irrigations of newly planted seedlings showed that only one at-planting irrigation was needed to achieve essentially 100% survival of transplants on harsh upland sites exposed to continual wind. Other studies will help to define site limitations and develop planting techniques for successful introduction of fourwing saltbush into degraded rangelands.

One such study at Tomagh has indicated that fourwing saltbush seedlings can be transplanted into existing natural range vegetation with a reasonable chance of survival, if certain conditions are met. These include the availability of vigorous seedlings, sufficient open space in the plant community, and at least one irrigation. Further studies are planned which will test micro-catchment soil moisture enhancement techniques to support establishment of newly transplanted seedlings. Development of this approach could make fourwing saltbush introduction into rangelands an economically feasible practice.

A fourwing saltbush forage reserve planting trial at Tomagh has demonstrated the productive potential of this species when it is grown under favorable soil moisture conditions. The test site is in a valley bottom where surface irrigation was available to establish the stand, and where sub-surface water flow could sustain optimum growth of the plants. Seedlings averaging 30 to 40cm in height were planted in March and irrigated as needed to maintain vigorous growth. Six months later most of the shrubs were at least 1.5m tall and the stand was producing an estimated 6,000 kg(DM)/ha of useable forage.

Fourwing saltbush nurseries were expanded at three locations to increase production of seedlings. Forage reserve plantations and establishment trials at Quetta, Zarchi and Tomagh absorbed 90% of the seedling production for the year. Results from experiments conducted during 1987 and 1988 have generated considerable interest in the concept of fourwing saltbush forage reserve plantings both within AZRI's research program and with outside cooperators.

The Baluchistan Forest Department has proposed a range development project in Ziarat District which would rely heavily on fourwing saltbush as the alternative forage source to relieve grazing pressure on public rangelands. Their decision was prompted largely by the success of fourwing saltbush plantings at Tomagh. A goat production scheme for women in Sind Province is planning to use fourwing saltbush as a forage source and as a possible cash crop, based on discussions and examination of work at AZRI headquarters in Quetta.

The AZRI Extension Section will expand its fourwing saltbush cooperative seedling production and forage reserve programs with cooperating farmers in Baluchistan. AZRI livestock nutritionists will be using greater quantities of fourwing saltbush in feeding and grazing experiments. New studies planned by the range management team at AZRI to test fourwing saltbush introduction techniques on rangelands could require thousands of additional seedlings.

All of these applications taken together could exceed AZRI's seedling production capacity. Therefore, plans are being made to contract with farmers to produce enough fourwing saltbush seedlings to meet the varied and increasing demands for this forage shrub. Meantime, AZRI will continue its nursery program to maintain a supply of seedlings and to refine germination and establishment techniques.

B. Grazing Studies

The deferred rotation vs. continuous grazing comparison study at Zarchi was expanded in 1988 to include a "passive" mode synchronized with the "active" mode. "Passive" grazing treatment blocks, replicated four times, were established near the deferred rotation and continuous grazing pastures on which sheep are herded by AZRI with controlled stocking rates and seasons of use (the "active" grazing mode area). Under the "passive" grazing treatment method, developed on this project, treatment plots are opened or closed to grazing on a regular schedule, but the researchers do not actively herd or directly control the animals. Stocking densities and herding practices used by local stockmen determine the grazing pressures on the plots opened to the livestock using the area. The "passive" treatment blocks are therefore subject to what can be termed ambient grazing conditions.

The present deferred rotation study employs an 18-month cycle in which any given plot or pasture is deferred for two years for each of the six-month "seasons", March-August and September-February. This scheme achieves, for example, a two-year spring-summer grazing deferment for a given treatment area. Because the deferred rotation and the continuous grazing areas each cover the same amount of rangeland, and the deferred rotation pastures are each one-third of that total and are grazed by all animals for six-month periods, the effective stocking density on the deferred rotation is 50% greater than on the continuously grazed area. The latter carries a density of 67 ewes/1000 ha, while the deferred rotation range is stocked at 100 ewes/1000 ha, on an annual basis.

The deferred rotation-continuous grazing study is designed to examine whether deferment of grazing during certain six-month "seasons" can affect significant vegetation changes, and what kind of changes might be induced. If improvement in the range vegetation could be achieved under a deferred rotation grazing system which permitted higher

stocking densities than continuous grazing, an economically and ecologically acceptable technique would be available to land users. The answers to such questions might be difficult to obtain and will require persistence, given the ecological conditions at Zarchi. Nonetheless, the study is basic to an understanding of these vegetation-grazing interactions.

Observations from grazing studies and range exclosures established for two years tend to support the expectation that vegetation changes induced by grazing management alone will be very slow in the Artemisia-Haloxylon and Cymbopogon-Chrysopogon range types in Baluchistan. In exclosures at Tomagh there has been some indication that Chrysopogon aucheri, the more palatable of these two dominant grasses, produces seed more quickly under protection than does Cymbopogon jawarancusa, but there are no signs of any significant vegetation changes at these sites. Vegetation sampling has been done on all grazing study areas and exclosures, and should be continued on a regular basis for at least the next few years.

## RESEARCH DESIGNED TO INCREASE RUMINANT PRODUCTIVITY BY IMPROVED LIVESTOCK MANAGEMENT

### A. Nutritional Management Studies

A study conducted at Tomagh during the last production cycle, from mid-September 1987 through weaning in the summer of 1988, measured the effects of supplemental feeding on fertility and productivity of Harnai ewes. Results indicated that supplementation with cottonseed cake during the last month of gestation had a significant effect on the birth weights of lambs, whereas supplementation with barley grain had no significant effect on this parameter. Flushing with either cottonseed cake or barley grain had no significant effect on lamb birth weights. Flushing did have a significant effect on maintenance of body weights of ewes during the first 120 days of pregnancy, but there was no significant difference between cottonseed cake and barley grain in this respect. Late gestation supplementary feeding with barley grain had a significant effect on maintenance of body weights of ewes, but cottonseed cake did not.

Harnai ewes in this study had a 94% fertility rate and a 99% weaning rate, demonstrating that with good nutritional and general health management it is possible to achieve high levels of productivity with range sheep under arid conditions in upland Baluchistan. A second cycle of studies designed to investigate these same basic questions was started in October, 1988 at both Tomagh and Zarchi, and scheduled for completion in the summer of 1989. Some of the results from the 1987-88 study are summarized in Table 4.

**Table 4. Reproductive performance of Harnai ewes in a supplemental feeding study at Tomagh.**

| | |
|---|---|
| 1. Date of breeding | 30 Sept 1987 |
| 2. Number of ewes at breeding | 81 |
| 3. Number of ewes at lambing | 81 |
| 4. Number of ewes lambed | 76 |
| 5. Number of lambs aborted | 0 |
| 6. Number of lambs born | 76 |
| 7. Number of lambs dead (0-90 days) | 1 |
| 8. Number of lambs weaned | 75 |
| 9. Fertility rate (#4 + #5 / #3) | 94% |
| 10. Prolificacy rate (#6 / #4) | 100% |
| 11. Weaning rate (#8 / #6) | 99% |
| 12. Lambs weaned per ewe bred | 0.93 |
| 13. Ewes conceived in each oestrus: First, 75; second, 6; later, 0 | |
| 14. Services per conception | 1.14 |
| 15. Average gestation period (days) | 155 |
| 16. Lamb sex ratio (male:female) | 1:1.2 |

## B. Feeding Trials and Forage Value Studies

The potential importance of fourwing saltbush as a forage reserve and range improvement species prompted a series of experiments to evaluate its feeding value for small ruminants under Baluchistan conditions. The first study (Atiq-ur-Rehman et al., 1988), conducted at AZRI during February and March 1988, compared fourwing saltbush forage with conventional feeds. Twenty-four Harnai yearling sheep were used to assess the palatability and nutritive value of the following rations: Fourwing saltbush, lucerne hay, and wheat straw + barley grain.

A palatability index derived from the data showed that there was a continuous rise in uptake of all rations after the second day of feeding. By the ninth day, the palatability index had become almost stable at 99%, 98%, and 69% for lucerne hay, fourwing saltbush and wheatstraw + barley grain, respectively. Weight gain data suggested that after the rumen microflora had adjusted to the fourwing saltbush, the sheep maintained their body weight on this forage. During the last week there was a slight increase in body weights of sheep fed fourwing saltbush, supporting the belief that fourwing saltbush could be a useful forage reserve species for the maintenance of sheep.

Laboratory analyses of fourwing saltbush samples collected in late October gave crude protein values of about 7.5%, which is equivalent to barley grain, but only about one-half the protein level of cottonseed cake. The crude protein values obtained for these fall samples of fourwing saltbush are substantially lower than ones reported elsewhere for this species, and it is expected that higher values will be obtained from samples collected at other seasons. Further analyses will be done on samples collected monthly from several locations.

## C. Livestock Health Surveys and Studies

Two surveys were conducted between October 1987 and March 1988 to determine the incidence of internal and external parasites in sheep in upland Baluchistan. The first survey (Khan et al., 1988a) involved seven flocks totalling 900 animals in Kovak Valley, Kalat District. The second survey (Khan et al., 1988b) covered 68 flocks of sheep in Kalat, Pishin, Loralai, and Zhob districts.

In the Kovak Valley survey 100% of the animals sampled were found to be infested with internal parasites, represented by the genera Nematodirus, Haemonchus, Strongyloides, Trichostrongylus, Marshallagia and Fasciola. The incidence rate for tick infestation by Ixodes ricinus was 35% and for sheep scab (Psoroptes ovis), 23%. The more extensive survey included parts of four major sheep-producing districts and two of the most common breeds in Baluchistan, Baluchi and Harnai. Almost 80% of the 340 sheep sampled in this survey were infested with internal parasites. Some of the animals carried six different species of parasites.

In addition to the genera found in the Kovak Valley flocks, the broader survey also found six other nematodes, two other trematodes, and four cestodes present in the sampled sheep. Incidence of internal parasites by districts was: Kalat, 94%; Zhob, 80%; Loralai, 71%; and Pishin, 70%.

A number of anthelmintics are available on the market which have proven to be effective in small ruminants. However, continual use of the same de-wormer in a given area can result in the development of resistance in some parasites. This could lead to a serious breakdown in parasite control and result in reduced livestock production.

A study was conducted at Zarchi to compare the efficacy of two anthelmintics, oxfendazole and levamisole, for the control of internal parasites in Baluchi sheep. A sample of 23 ewes was selected from the station experimental flock, which had been

purchased recently from local farmers. The ewes had not received anthelmintics prior to the study and were found to be infested with a variety of parasites, including Nematodirus spp., Moniezia spp., Dictyocaulus filaria, Marshallagia marshalli, Fasciola hepatica, Paramphistomum cervi, Strongyloides papillosus, Chabertia ovina, and Avitellina centripunctata.

In phase one of the study all 23 ewes were treated with the recommended dosage of levamisole in September, 1987. The same treatment was repeated for the whole group in November and January. In late January the ewes showed severe respiratory symptoms and were also found to be heavily infested with lung worm (Dictyocaulus filaria). The animals were treated again with levamisole in February and March. During this period the parasite infestations in the ewes diminished to a moderate level. In April, their respiratory symptoms again became severe, and fecal samples revealed heavy infestations of Dictyocaulus filaria, Nematodirus spp., and Trichostrongyloides spp.

The comparison phase of the study then started, with two groups of 10 ewes each. One group received oxfendazole at the recommended dosage of 0.2 ml/kg(liveweight) and the other group received levamizole at the recommended dosage of 0.5 ml/kg(liveweight). Three ewes were reserved as an untreated control group. Fecal samples were collected from all animals before treatment and seven days after treatment. Egg and larval counts were made from the samples, using standard laboratory techniques.

The oxfendazole-treated ewes contained no eggs or larvae, whereas in levamisole-treated ewes the control of eggs and larvae was only 91% and 71%, respectively. Eggs of Marshallagia marshalli, Fasciola hepatica, and Bunostomum spp., and larvae of Dictyocaulus filaria were still present in the levamisole-treated animals.

The efficacy of oxfendazole against gastrointestinal parasites observed in this study, and the performance of levamisole in some animals agrees with reports of other workers regarding these compounds. These findings also tend to support the previously mentioned concern about the build up of resistance in parasites resulting from continual, long-term use of certain anthelmintics. Levamisole has been one of the most widely used anthelmintics for more than 20 years in this region; whereas, oxfendazole has been in wide use for only a few years. Further study of internal parasite control in sheep and goats, involving flocks in different areas, would be needed to determine conclusively which anthelmintics should be used and to devise the most effective treatment schedules.

Based on these surveys, and the known relationships between parasite burdens and livestock productivity, it was recommended that: (1) Extensive studies on seasonal and spatial distribution of parasite infestations and diseases in Baluchistan be conducted and that appropriate control measures be developed for each area, (2) a network of well-equipped and well-staffed disease- and parasite-diagnostic laboratories be established in Baluchistan, and (3) livestock extension services be encouraged and assisted in their role of introducing parasite and disease control practices to the livestock owners in all areas of the province.

## RESEARCH DESIGNED TO INCREASE ANIMAL FEED RESOURCES FROM IMPROVEMENTS TO CROPPING SYSTEMS ON MARGINAL LANDS

Nineteen eighty seven/eighty eight was the third year of a set of agronomic and germplasm evaluation trials instituted by AZRI and ICARDA. There are two types of dryland cropping in Baluchistan: "kushkaba" or purely rainfed; and "sailaba" or land that receives additional run-on water, usually from ephemeral streams. Trials were conducted at several sites in upland Baluchistan; Dasht, Kovak, Kalat, Mastung, ARI Sariab and Kan Mehtarzai, with an annual rainfall average of about 220 mm, most of which falls in the spring (January to April); and Khuzdar, in Khuzdar district, with an annual rainfall average of about 220 mm, 30-40% of which falls in the summer (July/August). The Khuzdar site is at 1270 m altitude and experiences little frost, while the other sites range from 1700 to 2200 m and experience numerous frosts during winter. All trials except at ARI Sariab were planted on farmers' fields, but were managed by the scientists.

The rainfall and air temperature records for 1987/88 are presented in Figure 2 and Table 5. It can be seen that little rain fell before February, and that totals during the cropping season were extremely low. In response to this, and to requests from the farmers, pre-planting irrigation was carried out at most of the sites, either in early October (germplasm trials only) or early February. Orchard water requirements at this time were low, enabling some farmers to provide pre-planting irrigation for their field crops. Despite this, most farmers did not risk planting dryland field crops, and it is estimated that less than 10% of the arable land in these areas was planted to dryland field crops. Absolute minimum air temperatures were a few degrees less extreme in winter than experienced in the 1986/87 season (ICARDA, 1987).

**Figure 2. Seasonal rainfall records for agronomy sites, 1987-88**

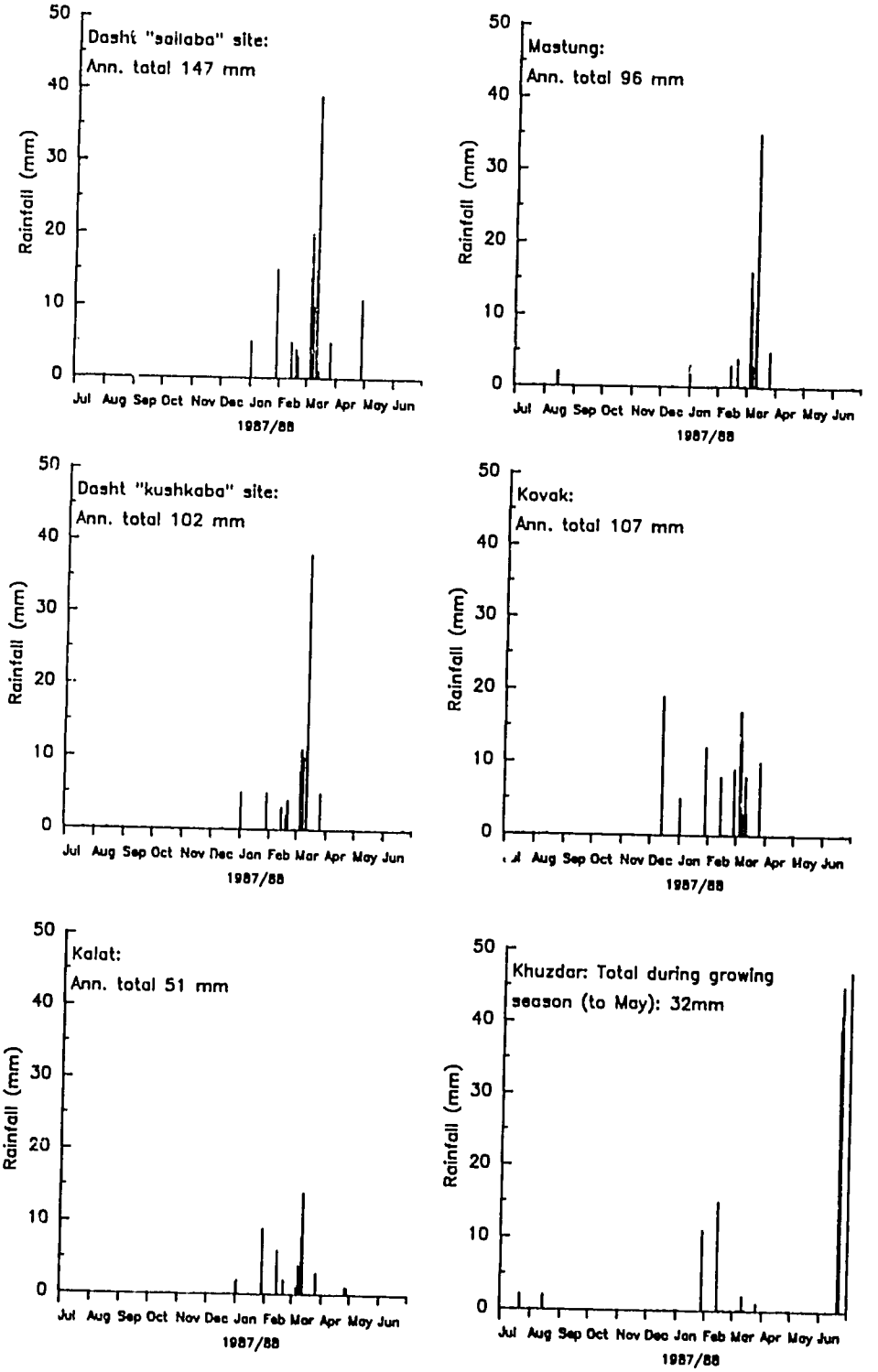


**Table 5. Rainfall and air temperature records at germplasm evaluation trial sites in upland Baluchistan**

| MONTH | ARI SARIAB 30 14'N 67 02'E | | | KHUZDAR 27 44'N 66 23'E | | |
|---|---|---|---|---|---|---|
| | Total Rainfall (mm) | Mean Max. temp.* (Degrees C) | Mean Min. temp. (Degrees C) | Total Rainfall (mm) | Mean Max temp.* (Degrees C) | Mean Min. temp. (Degrees C) |
| Sept. | 0 | 32.1 | 12.6 | 0 | 37.1 | 17.4 |
| Oct. | 0 | 25.3 | 6.3 | 0 | 33.7 | 11.4 |
| Nov. | 0 | 18.0 | -3.4 | 0 | 27.3 | 9.0 |
| Dec. | 0 | 17.0 | -2.3 | 0 | 22.1 | 1.8 |
| Jan. | 9.1 | 13.4 | -1.1 | 10.6 | 20.3 | 1.5 |
| Feb. | 17.8 | 15.6 | 1.3 | 14.5 | 20.4 | 5.2 |
| Mar. | 117.0 | 19.0 | 4.3 | 2.0 | 24.3 | 8.4 |
| Apr. | 3.6 | 26.9 | 13.1 | 0 | 33.2 | 14.1 |
| May | 0 | 32.4 | 18.0 | 0 | 35.1 | 17.4 |
| Jun. | 3.8 | 35.8 | 20.2 | 14.8 | 39.6 | 20.7 |
| Seasonal total of frost days | | | 76 | | | 12 |
| Seasonal absolute min. air temp. | | | -7 | | | -5 |

| MONTH | KAH MEHTARZAI 67 45'N 31 00'E | | |
|---|---|---|---|
| | Tot Rai (mm) | Mean Max temp. (Degrees | Mean Min. temp. (Degrees C) |
| Sept. | 0 | 29.1 | 12.0 |
| Oct. | 0 | 27.2 | 6.4 |
| Nov. | 0 | 16.0 | -7.3 |
| Dec. | 0 | 7.5 | -9.0 |
| Jan. | 34. | 2.4 | -9.7 |
| Feb. | 31. | 11.5 | -2.3 |
| Mar. | 0 | 7.4 | -2.4 |
| Apr. | 0 | 17.7 | 0.5 |
| May | 0 | 22.4 | 7.2 |
| Jun. | 0 | 30.0 | 13.0 |
| Seasonal total of frost days | | | 111 |
| Seasonal absolute min. air temp. | | | -12 |

* Screened air temperature at 1.5 m.

The AZRI agronomy trials were planted at five sites in February 1988, following irrigation, or immediately after the small rains in the middle of February. The growing season was accordingly short (90 days in Khuzdar, 110 days elsewhere). Crops emerged in early March and so were not exposed to any freezing temperatures. Flowering occurred in early (Khuzdar) to late April, and crops were mature by mid-May (Khuzdar) or early June (rest of the sites). In most cases crop failure occurred, ie. seed yields were less than the amount of seed planted initially. This does not mean that the experiments were a failure, however. Though years as dry as 1987/88 can be expected not more than one year in ten, if valid conclusions are to be drawn, agronomy trials must be conducted over the full range of likely environmental conditions. AZRI trials have now been conducted in a "normal" rainfall year (1985/86), a "good" rainfall year (1986/87), and a "poor" rainfall year (1987/88), and thus the various technologies have been tested in the minimum range of environmental conditions required for valid conclusions to be drawn.

Table 6 summarizes the chemical properties of the farmers' fields where the agronomy trials were conducted. These are similar to the data presented for the previous year's trials (ICARDA, 1987): high in pH and $CaCO_3$, low in organic matter and nitrogen, but with reasonable availability of phosphate. Bulk densities were sampled to 160 cm in Dasht, Kovak and Khuzdar, and were found to average 1.4 $g/cm^3$, lower than the 1.6 $g/cm^3$ reported previously (ICARDA 1987). The data support the general use of a figure of 1.4 g/cm3, if bulk density cannot be measured directly.

The soil water content to 1 m depth is presented in Table 7. Note particularly the higher water content of the two water harvesting fields in Dasht compared to the "kushkaba" fields, evidence of run-on from the catchment areas to the cropped areas in these trials.

**Table 6. Summary of soil chemical characteristics of the farmers' fields used in the 1988 trials.**

| Site Location | pH (1:1) | Lime (%) | O.M. (%) | Kjeld-N ppm | P-Olsen ppm |
|---|---|---|---|---|---|
| 1 Khuzdar | 8.6 | 23.6 | 0.40 | 307 | 4.4 |
| 2 Kalat | 8.4 | 21.6 | 0.54 | 427 | 9.0 |
| 3 Kovak | 8.5 | 22.0 | 0.54 | 426 | 8.2 |
| 4 Dasht S.* | 8.3 | 22.5 | 0.59 | 474 | 8.6 |
| 5 Dasht K.* | 8.4 | 26.1 | 0.53 | 434 | 6.3 |

* Dasht S. - Dasht "sailaba" site;
Dasht K. - Dasht "kushkaba" site.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Khuzdar | $27^0$ 47'N | $66^0$ 23'E | | Kovak | $29^0$ 28'N | $66^0$ 47'E | |
| Kalat | $29^0$ 06'N | $66^0$ 33'E | | Dasht | $29^0$ 58'N | $66^0$ 52'E | |

**Table 7. Soil water content (mm to 1 m depth) at planting, 1988 trials.**

| Site Location | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| Khuzdar* | 95 | 206 | 112 | | | 137 |
| Kalat* | 64 | 85 | 111 | 87 | | 87 |
| Kovak | 45 | 35 | 40 | 54 | 31 | 41 |
| Dasht S.# | 42 | 49 | 41 | 48 | | 45 |
| Dasht K.# | 28 | 18 | 26 | 33 | | 26 |
| Dasht K.WH# | 60 | 44 | | | | 52 |

* Khuzdar, Kalat sites received pre-planting irrigation.

\# Dasht S. - Dasht "sailaba" sites (ie. stream + rainfed land)

\# Dasht K. - Dasht "kushkaba" sites (ie. rainfed land)

\# Dasht K.WH - Dasht "kushkaba" water harvesting sites.

**Water Harvesting**

The full area of "kushkaba" land is rarely, if ever, completely planted in upland Baluchistan. Even in 1986/87, a good year, only about 50-70% was planted (almost exclusively to wheat). Accordingly a practice that concentrates the water from one part of a field to another, to permit better crop growth should be acceptable in the local farming system in many areas. The water harvesting trials consist of preparing catchment areas at the top of gently sloping fields (0.5 - 1% slope) to encourage incident rainfall to run off onto the bunded, cropped area. Catchment preparation consists simply of tractor-plowing to remove weeds and then pulverizing the soil with a heavy wooden plank dragged behind the tractor, so that it should form a solid "capped"

layer following wetting by rain. These catchments will last indefinitely if undisturbed, and should in fact become more solid and impervious with time and repeated wetting. Occasional weeding is required.

Three treatments were imposed: control, where all the plot is planted; 1:1 catchment:crop area where half the plot forms a catchment and half the plot is cropped; and 2:1 catchment:crop area where 2/3 of the plot forms a catchment and only 1/3 is cropped. Note that seed and labor requirements at planting are accordingly reduced. All trials were planted to wheat, the major dryland crop grown by farmers. Wheat is used for dual purposes, (1) providing green grazing in early winter and straw at harvest for supplemental feeding of livestock and (2) the grain for human consumption.

Table 8 shows soil water content to 1 m depth, sampled gravimetrically at three different positions within each plot (near to the bund, in the center of the cropped area, and at the end of the cropped area) of Dasht water harvesting field 1 on 21 March 1988, after 78 mm rain in five showers had fallen. In each position soil water content was increased significantly ($P<0.1\%$) by the water harvesting treatments. The data indicate that overall the 1:1 treatment resulted in an additional 41 mm being stored in the cropped area, and an additional 67 mm in the 2:1 treatment.

**Table 8. Soil water content (mm to 1m depth) at different positions within the water harvesting trial at Dasht on 21 March 1988, after 78mm in five showers. (Each of the four replicates of each treatment was sampled three times at each position.)**

| Treatment | C | 1:1 | 2:1 | Mean | S.E. | Probability |
|---|---|---|---|---|---|---|
| Position: | | | | | | |
| Next to bund | 189 | 225 | 221 | 212 | 0.32 | P<0.1% |
| Centre of cropped area | 113 | 174 | 217 | 168 | 0.34 | P<0.1% |
| End of cropped area | 110 | 131 | 172 | 138 | 0.26 | P<0.1% |
| Mean | 136 | 177 | 203 | 172 | 0.02 | P<0.1% |

This is in agreement with visual observations: standing water covered the complete cropped area in the 2:1 treatments for several days, most of the 1:1 cropped area, and only the first 10 m or so of the control treatments. Two problems were apparent: a. infiltration rates were low, resulting in considerable loss of the additional water to evaporation; and b. the standing water was sufficient to be harmful to the wheat. The farmer's reluctance to allow the bunds to be broken to remove the standing water resulted in greater water storage, but at the expense of poor subsequent crop growth, and even crop death in some areas. To get the maximum benefit from this technology farmers will have to be persuaded to put spillways in the bunds at about 10 cm height, and/or switch to barley which is better able to withstand waterlogging. Another alternative would be to use the land for growing

sorghum on residual stored moisture, which could be planted when the probability of runoff generating rains is much lower (mid-late March).

In the water harvesting plots, yields were much higher in the cropped area. Table 9 summarizes the final yield data from the three water harvesting trials. Yields were low in all cases. On a cropped area basis yields were increased at all sites by water harvesting. On Dasht field 1 seed yields were increased from 25 kg/ha to 96 and 90 kg/ha, representing the difference between crop failure and success. Only on Dasht field 1 were hay and grain yields increased on a total area basis as well. The catchment areas for this field were prepared in July 1986 and appear to have been more efficient at generating runoff. These results are extremely promising, suggesting that even in very dry years yields can be increased on a total area basis, and certainly on a cropped area basis. There is not a shortage of "kushkaba" land in upland Baluchistan and so it would be practical to prepare catchment areas on currently underutilized land.

**Table 9. Final wheat yields (kg/ha) of water harvesting trials, 1988.**

A. Yield per CROPPED area.

| | Dasht field 1 | | | Dasht field 2 | | | Mastung | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hay | Straw | Grain | Hay | Straw | Grain | Hay | Straw | Grain |
| Control | 83 | 105 | 25 | 34 | 75 | 12 | 83 | 108 | 8 |
| 1:1 | 400 | 281 | 96 | 61 | 146 | 22 | 96 | 139 | 9 |
| 2:1 | 317 | 352 | 90 | 74 | 271 | 44 | 187 | 260 | 23 |
| Mean | 267 | 246 | 70 | 56 | 164 | 26 | 122 | 169 | 13 |
| S.E. | 56.1 | 44.0 | 13.6 | 16.0 | 25.1 | 4.5 | 13.1 | 16.7 | 2.2 |
| Prob. | P<2% | P<2% | P<2% | NS | P<1% | P<1% | P<1% | P<1% | P<1% |

B. Yield per TOTAL (crop+catchment) area.

| | Dasht field 1 | | | Dasht field 2 | | | Mastung | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hay | Straw | Grain | Hay | Straw | Grain | Hay | Straw | Grain |
| Control | 83 | 105 | 25 | 34 | 75 | 12 | 83 | 108 | 8 |
| 1:1 | 200 | 141 | 48 | 30 | 73 | 11 | 48 | 70 | 5 |
| 2:1 | 106 | 117 | 30 | 25 | 90 | 15 | 62 | 87 | 8 |
| Mean | 130 | 121 | 34 | 30 | 79 | 13 | 64 | 88 | 7 |
| S.E. | 23.6 | 15.4 | 6.6 | | 9.6 | 2.0 | | | |
| Prob. | P<3% | NS | P<8% | | | | | | |

**Wheat production**

A. Agronomy Trials

Table 10 summarizes the results of a $2^5$ factorial trial with one replicate repeated at each location, where the factors were: local/ improved wheat variety; +/- nitrogen fertilizer (40 kg/ha N applied as $NH_4NO_3$, 10 kg/ha in the seedbed and 30 kg/ha topdressed at flowering); +/- phosphate fertilizer (60 kg/ha phosphate applied as triple superphosphate in the seedbed); +/- potassium fertilizer (60 kg/ha $K_2SO_4$ applied in the seedbed); and +/- weeding. As these trials were planted in the spring the "improved" variety was changed from "Zarghoon", used in previo s years, to "Zamindar", a short-season Spring wheat.

The results shown in Table 10 indicate crop failure at all sites except Khuzdar (pre-planting irrigation) and no response to N, phosphate or K fertilizers. "Zamindar" gave higher grain yields at two sites and less straw yields at all sites but one. Weeding also had little effect in this dry season when the limiting factor was obviously water. Overall hay production was 56% higher than final dry weights, indicating that it would probably be better to cut the crop for fodder rather than allow it to go on to maturity in such years.

## Table 10. Wheat/N/P/K/Weeding Trials, 1988

| Site[a] | Hay dw (kg/ha) 1 | 2 | 3 | 4 | 5 | Mean | Total dw (kg/ha) 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local cv. | 300 | 1025 | 186 | 721 | 208 | 488 | 474 | 502 | 181 | 276 | 133 | 313 |
| Improved cv. | 447 | 976 | 225 | 471 | 210 | 466 | 480 | 391 | 151 | 174 | 297 | 299 |
| | | | | * | | | | * | | * | * | |
| N0 | 336 | 1057 | 185 | 651 | 198 | 485 | 444 | 449 | 174 | 210 | 217 | 299 |
| N1 | 411 | 944 | 227 | 541 | 220 | 469 | 510 | 444 | 158 | 241 | 213 | 313 |
| P0 | 396 | 1027 | 205 | 559 | 204 | 478 | 516 | 435 | 174 | 210 | 221 | 311 |
| P1 | 352 | 974 | 207 | 633 | 213 | 476 | 438 | 459 | 158 | 241 | 209 | 301 |
| K0 | 412 | 1026 | 164 | 707 | 218 | 505 | 510 | 466 | 172 | 238 | 198 | 317 |
| K1 | 335 | 975 | 247 | 484 | 200 | 448 | 444 | 428 | 160 | 212 | 232 | 295 |
| W0 | 375 | 1049 | 213 | 624 | 222 | 497 | 417 | 474 | 154 | 249 | 206 | 300 |
| W1 | 372 | 952 | 198 | 567 | 196 | 457 | 537 | 419 | 179 | 202 | 223 | 312 |
| Main effects S.E. | 75 | 94 | 35 | 66 | 26 | 28 | 65 | 37 | 15 | 19 | 21 | 15 |
| Site mean | 374 | 1001 | 206 | 596 | 209 | 477 | 477 | 446 | 166 | 225 | 215 | 306 |
| Across sites S.E. | | | | 44 | | | | | | | 24 | |
| | | | | *** | | | | | | | *** | |

[a] Site names are given in Table 6.

* Treatment means significantly different at $P<0.05$

*** Site means significantly different at $P<0.001$.

**Table 10. (contd.) Wheat/N/P/K/Weeding Trials, 1988**

| Site[a] | Straw dw (kg/ha) 1 | 2 | 3 | 4 | 5 | Mean | Grain dw (kg/ha) 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local cv. | 385 | 489 | 105 | 265 | 106 | 270 | 89 | 13 | 76 | 11 | 26 | 43 |
| Improved cv | 306 | 363 | 99 | 165 | 235 | 234 | 170 | 10 | 54 | 10 | 63 | 52 |
| | | * | | * | * | * | * | | | | * | * |
| N0 | 309 | 430 | 109 | 201 | 170 | 244 | 132 | 12 | 66 | 9 | 47 | 53 |
| N1 | 383 | 421 | 96 | 229 | 171 | 260 | 128 | 10 | 65 | 12 | 42 | 51 |
| P0 | 372 | 418 | 106 | 200 | 179 | 255 | 142 | 10 | 68 | 10 | 42 | 54 |
| P1 | 320 | 434 | 99 | 230 | 162 | 249 | 118 | 12 | 62 | 11 | 47 | 50 |
| K0 | 382 | 449 | 104 | 229 | 156 | 264 | 128 | 11 | 69 | 10 | 42 | 52 |
| K1 | 309 | 403 | 101 | 201 | 185 | 240 | 132 | 11 | 61 | 11 | 46 | 52 |
| W0 | 297 | 463 | 81 | 239 | 165 | 249 | 120 | 11 | 73 | 10 | 41 | 51 |
| W1 | 395 | 389 | 123 | 191 | 176 | 255 | 140 | 11 | 58 | 11 | 48 | 54 |
| | | | | * | | | | | | | | |
| Main effects | | | | | | | | | | | | |
| S.E. | 51 | 38 | 19 | 18 | 18 | 13 | 18 | 2.2 | 7.5 | 1.7 | 4.2 | 7.2 |
| Site mean | 346 | 426 | 102 | 215 | 170 | 252 | 130 | 11 | 65 | 10 | 46 | 52 |
| Across sites S.E. | | | | 27 | | | | | | 11 | | |
| | | | | *** | | | | | | *** | | |
| Kjeld-N | | | | | | | 257 | 427 | 447 | 576 | 603 | |
| P-Olsen | | | | | | | 2.9 | 9.0 | 8.1 | 9.9 | 8.2 | |

[a] Site names are given in Table 1.

* Treatment means significantly different at $P<0.05$.
*** Site means significantly different at $P<0.001$.

Table 11 shows the results of a second fertilizer trial with four levels of N (0, 20, 40 and 80 kg/ha applied in the form of $NH_4NO_3$) factorially combined with four levels of phosphate (0, 30, 60 and 120 kg/ha applied in the form of triple superphosphate); three replicates per trial. Responses to applied N were small and inconsistent. However, at one site, and averaged over all sites, there were significant differences between the various phosphate treatments. In most cases the response to phosphate was curvilinear, with addition of phosphate above 60 kg/ha apparently causing a decrease in yield. This is examined in Table 11 which shows the results of a set of orthogonal tests comparing the effects of the different phosphate levels. The significant differences between total dry weights for site 5 (Dasht "kushkaba") can be attributed entirely to the lower values of the P0 treatment compared to the rest. Although the differences in grain production were not large enough to be significant at four out of the five sites, averaged over all sites they were. Orthogonal contrasts show that the differences can be attributed to the lower value of the P0 treatment in comparison with the rest. (It is permissible to conduct such tests on data averaged over all sites in this case because site P, and site NP interactions were not significant.) The data thus suggest a small increase in grain yield with application of phosphate, and that the differences between 30, 60 and 120 kg/ha phosphate were not significant, ie. responses can be obtained with only 30 kg/ha phosphate. The responses were of course not large enough to pay for even this reduced amount of fertilizer.

## Table 11. Nitrogen/Phosphate Fertilizer Trials, 1988

| | Hay dw (kg/ha) | | | | | | Total dw (kg/ha) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | 1 | 3 | 4 | 5 | Mean | | 1 | 3 | 4 | 5 | Mean |
| N0 | 454 | 449 | 621 | 216 | 435 | N0 | 772 | 393 | 367 | 72 | 401 |
| N20 | 713 | 563 | 530 | 246 | 513 | N20 | 769 | 413 | 327 | 61 | 398 |
| N40 | 713 | 456 | 623 | 217 | 502 | N40 | 758 | 346 | 315 | 85 | 378 |
| N80 | 608 | 376 | 931 | 237 | 536 | N80 | 619 | 348 | 571 | 77 | 404 |
| P0 | 702 | 370 | 636 | 197 | 478 | P0 | 646 | 318 | 325 | 64 | 338 |
| P30 | 579 | 603 | 662 | 220 | 516 | P30 | 646 | 451 | 400 | 85 | 396 |
| P60 | 521 | 512 | 449 | 244 | 432 | P60 | 702 | 378 | 238 | 83 | 350 |
| P120 | 683 | 358 | 958 | 256 | 564 | P120 | 924 | 353 | 617 | 83 | 494 |
| | | | * | | | | | | | * | |
| Mean | 621 | 461 | 678 | 229 | 497 | Mean | 729 | 375 | 395 | 79 | 395 |
| S.E. | 103 | 105 | 148 | 23 | 53 | SE. | 98 | 53 | 132 | 5.8 | 47 |

Orthogonal comparisons of different levels of P:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 702 | 370 | 636 | 197 | 476 | | 646 | 318 | 325 | 64 | 338 |
| (30,60,120) | 594 | 491 | 690 | 240 | 504 | | 757 | 394 | 418 | 84 | 413 |
| Prob. | NS | NS | NS | NS | NS | | NS | NS | NS | P<1% | NS |
| 30 | 579 | 603 | 662 | 220 | 516 | | 646 | 451 | 400 | 85 | 396 |
| (60,120) | 602 | 435 | 704 | 250 | 498 | | 813 | 366 | 428 | 83 | 422 |
| Prob. | NS | NS | NS | NS | NS | | NS | NS | NS | NS | NS |
| 60 | 521 | 512 | 449 | 244 | 432 | | 702 | 378 | 238 | 83 | 350 |
| 120 | 683 | 358 | 958 | 256 | 564 | | 924 | 353 | 617 | 83 | 494 |
| Prob. | NS | NS | P<2% | NS | NS | | NS | NS | P<6% | NS | NS |

Table 11. (contd.) Nitrogen/Phosphate Fertilizer Trials, 1988

| Site | Straw dw (kg/ha) 1 | 3 | 4 | 5 | Mean | | Grain dw (kg/ha) 1 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N0 | 614 | 288 | 349 | 33 | 321 | N0 | 158 | 106 | 18 | 39 | 80 |
| N20 | 615 | 302 | 313 | 35 | 316 | N20 | 153 | 112 | 16 | 46 | 82 |
| N40 | 605 | 236 | 298 | 44 | 296 | N40 | 155 | 109 | 17 | 41 | 80 |
| N80 | 510 | 229 | 544 | 38 | 330 | N80 | 109 | 119 | 27 | 39 | 74 |
| P0 | 542 | 226 | 309 | 30 | 277 | P0 | 105 | 92 | 16 | 34 | 62 |
| P30 | 508 | 306 | 382 | 36 | 308 | P30 | 138 | 145 | 18 | 49 | 88 |
| P60 | 557 | 265 | 219 | 41 | 271 | P60 | 145 | 113 | 19 | 43 | 80 |
| P120 | 737 | 258 | 594 | 43 | 408 | P120 | 187 | 96 | 23 | 39 | 86 |
| | | | * | | | | | | | * | * |
| Mean | 586 | 264 | 376 | 38 | 316 | Mean | 143 | 112 | 19 | 41 | 79 |
| Std. error | 78 | 66 | 130 | 4.4 | 41 | SE. | 21 | 28 | 3.2 | 3.3 | 8.8 |

Orthogonal comparisons of different levels of P:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 542 | 226 | 309 | 30 | 277 | | 105 | 92 | 16 | 34 | 62 |
| (30, 60, 120) | 601 | 276 | 398 | 40 | 329 | | 157 | 118 | 20 | 44 | 85 |
| Probability | NS | NS | NS | NS | NS | | NS | NS | NS | P<2% | P<3% |
| 30 | 508 | 306 | 382 | 36 | 308 | | 138 | 145 | 18 | 49 | 88 |
| (60,120) | 647 | 262 | 407 | 42 | 339 | | 166 | 105 | 21 | 41 | 83 |
| Probability | NS | NS | NS | NS | NS | | NS | NS | NS | NS | NS |
| 60 | 557 | 265 | 219 | 41 | 271 | | 145 | 113 | 19 | 43 | 80 |
| 120 | 737 | 258 | 594 | 43 | 408 | | 187 | 96 | 23 | 39 | 86 |
| Probability | NS | NS | P<5% | NS | P<3% | | NS | NS | NS | NS | NS |
| Kjeld-N | | | | | | | 326 | 426 | 472 | 376 | |
| P-Olsen | | | | | | | 5.5 | 8.2 | 10. | 6.6 | |

Table 12 presents the results of a third wheat trial in which three varieties were compared with and without fertilizer (60 kg/ha phosphate applied as triple superphosphate in the seedbed, and 40 kg/ha N applied as $NH_4NO_3$, 10 kg/ha in the seedbed, and 30 kg/ha topdressed at tillering), and with and without seed dressing against fungal disease (vitavax); three replicates at each site. "Zamindar" produced slightly more hay, straw and grain dry weight over all, but this was statistically significant at only one site of the five. The variety "PAK81" also did not produce higher yields than the local. Averaged over all sites fertilizer significantly increased hay, straw and total dry weight at maturity. The effects of fertilizer were greatest at site 1 (Khuzdar), where pre-planting irrigation was given, and also N and phosphate status of the soil were lowest. No diseases were observed in this season and there was no response to seed-dressing.

## Table 12. Wheat Variety/Fertilizer/Vitavax Trials, 1988

Hay dw (kg/ha)

| Site | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| Loc | 459 | 746 | 206 | 373 | 77 | 372 |
| Zam | 762 | 743 | 196 | 247 | 116 | 412 |
| P81 | 358 | 855 | 319 | 277 | 123 | 386 |
| S.E. | 94 | 76 | 21 | 57 | 12 | 29 |
| | * | | | | * | |
| -F | 461 | 718 | 236 | 250 | 111 | 355 |
| +F | 591 | 845 | 245 | 347 | 100 | 425 |
| S.E. | 77 | 62 | 42 | 47 | 10 | 24 |
| | | | | | | * |
| -V | 548 | 791 | 215 | 308 | 116 | 395 |
| +V | 505 | 772 | 266 | 289 | 94 | 385 |
| S.E. | 77 | 62 | 42 | 47 | 10 | 24 |
| Mean | 526 | 781 | 241 | 299 | 105 | 390 |

Sites S.E. 49.9 ***

Total dw (kg/ha)

| | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| Loc | 849 | 321 | 94 | 218 | 103 | 317 |
| Zam | 1065 | 345 | 129 | 171 | 175 | 377 |
| P81 | 846 | 350 | 121 | 149 | 130 | 319 |
| S.E. | 129 | 20 | 14 | 47 | 10 | 28 |
| | | | | | * | |
| -F | 748 | 338 | 122 | 144 | 138 | 298 |
| +F | 1092 | 340 | 107 | 215 | 134 | 377 |
| S.E. | 105 | 18 | 12 | 39 | 8 | 23 |
| | * | | | | | * |
| -V | 920 | 349 | 112 | 197 | 133 | 342 |
| +V | 921 | 329 | 117 | 162 | 140 | 333 |
| S.E. | 105 | 16 | 12 | 39 | 8 | 23 |
| Mean | 920 | 339 | 115 | 180 | 136 | 338 |

Sites S.E. 46.5 ***

Straw dw (kg/ha)

| Site | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| Loc | 658 | 267 | 83 | 214 | 94 | 263 |
| Zam | 781 | 285 | 114 | 167 | 151 | 299 |
| P81 | 615 | 282 | 110 | 145 | 121 | 254 |
| S.E. | 97 | 17 | 13 | 47 | 9 | 22 |
| | | | | | * | |
| -F | 551 | 276 | 108 | 141 | 123 | 239 |
| +F | 817 | 279 | 98 | 210 | 116 | 304 |
| S.E. | 79 | 14 | 10 | 38 | 7 | 18 |
| | * | | | | | * |
| -V | 691 | 289 | 102 | 193 | 118 | 278 |
| +V | 677 | 267 | 104 | 158 | 122 | 265 |
| S.E. | 79 | 14 | 10 | 38 | 7 | 18 |
| Mean | 684 | 278 | 103 | 175 | 120 | 272 |

Sites S.E. 52.2 ***

Grain dw (kg/ha)

| | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| Loc | 191 | 55 | 11 | 5 | 9 | 54 |
| Zam | 284 | 60 | 15 | 4 | 25 | 78 |
| P81 | 232 | 69 | 11 | 4 | 15 | 66 |
| S.E. | 44 | 6 | 2 | 1 | 2 | 9 |
| | | | | | * | |
| -F | 197 | 62 | 15 | 4 | 15 | 59 |
| +F | 275 | 60 | 10 | 5 | 18 | 74 |
| S.E. | 36 | 5 | 2 | 1 | 1 | 7 |
| | | | * | | | |
| -V | 228 | 60 | 11 | 5 | 15 | 64 |
| +V | 244 | 62 | 14 | 4 | 18 | 68 |
| S.E. | 36 | 5 | 2 | 1 | 1 | 7 |
| Mean | 236 | 61 | 12 | 4 | 16 | 66 |

Sites S.E. 10.3 ***

| | | | | | |
|---|---|---|---|---|---|
| Kjeld-N | 257 | 427 | 447 | 472 | 486 |
| P-Olsen | 2.9 | 9.0 | 8.1 | 10. | 6.9 |

## B. Germplasm Evaluation Trials

The absence of cereal diseases in 1987-88, particularly yellow rust (*Puccinia striiformis*), was also noted in germplasm evaluation trials on bread and durum wheats at Khuzdar, ARI Sariab and Kan Mehtarzai. Disease resistance to this rust is a principal objective of current AZRI selection strategies, as the local landrace is acutely sensitive. Twice in the last decade wheat crops have been destroyed throughout upland Baluchistan by this disease.

With this major exception the local landrace of breadwheat is extremely well adapted to the variable local conditions and "improved" varieties are sought that initially can match its yield potential. Evaluation nurseries of bread and durum wheats were planted in early autumn (to assess tolerance to cold), with the aid of supplemental irrigation, and owing to very low levels of incident precipitation in spring, received further supplemental irrigation at Khuzdar and Kan Mehtarzai in order to ensure preservation of germplasm seed sources.

The data presented in Table 13 indicates that the local landrace check was highly productive under the prevailing conditions, and in the absence of disease pressure none of the introduced lines could be considered to be clearly higher-yielding, though several lines could appear to be adequate replacements for the local landrace. All introduced lines have been selected through artificially inoculated disease screening nurseries at ICARDA in Aleppo, Syria and are therefore presumed to have an enhanced level of disease resistance.

Table 13. Autumn Planted Bread Wheat Yield Trials (H.A.) 1987-88 at ARI Sariab

| S.NO. | PEDIGREE | TDM kg/ha | SY kg/ha |
|---|---|---|---|
| 1 | Sham 4 (Spring type check) | 2766 | 391 |
| 2 | ICW-HA81-1473-2AP-1AP-2AP-1AP-0AP | 2966 | 282 |
| 3 | ICW-HA81-1369-1AP-3AP-2AP-0AP | 3333 | 216 |
| 4 | ICW-HA81-1470-1AP-1AP-1AP-0AP | 2533 | 194 |
| 5 | ICW-HA81-1470-1AP-1AP-2AP-0AP | 2366 | 145 |
| 6 | ICW-HA81-1500-1AP-2AP-1AP-0AP | 2066 | 124 |
| 7 | ICW-HA81-2213-3AP-1AP-2AP-0AP | 2766 | 269 |
| 8 | ICW-HA81-1409-1AP-3AP-3AP-0AP | 2733 | 173 |
| 9 | ICW-HA81-1337-3AP-4AP-3AP-0AP | 2300 | 109 |
| 10 | ICW-HA82-0595-1AP-1AP-0AP | 2733 | 230 |
| 11 | ICW-HA82-0595-1AO-2AP-0AP | 1733 | 104 |
| 12 | Bezostaya | 1666 | 97 |
| 13 | ICW-HA81-1587-4AP-1AP-0AP | 2633 | 203 |
| 14 | ICW-HA81-1610-1AP-2AP-0AP | 2933 | 191 |
| 15 | ICW-HA81-1610-1AP-3AP-0AP | 3200 | 309 |
| 16 | ICW-HA82-0626-2AP-2AP-0AP | 3166 | 291 |
| 17 | ICW-HA81-1863-2AP-1AP-3AP-1AP | 2533 | 211 |
| 18 | ICW-HA81-1587-1AP-3AP-3AP-1AP | 1966 | 58 |
| 19 | ICW-HA81-1337-4AP-1AP-1AP | 3133 | 187 |
| 20 | ICW-HA81-1369-1AP-1AP-1AP | 2433 | 158 |
| 21 | ICW-HA81-1532-2AP-6AP-2AP | 2300 | 220 |
| 22 | ICW-HA81-1667-1AP-1AP-1AP | 1933 | 143 |
| 23 | ICW-HA82-0785-7AP-1AP | 2000 | 105 |
| 24 | Local white (check) | 3666 | 370 |
| | C.V. (%) | 32 | 64 |
| | S.E. | 169 | 26 |

Nurseries of material promoted from observation nurseries in 1986-87 to yield trials by AZRI suggest some promise of lines higher yielding than the local landrace. Line number ICW-HA81-1610-1AP-3AP-0AP performed particularly well at Kan Mehtarzai, the highest testing location (2230m). Similarly, seven lines were notable in observation nurseries, particularly ICW81-1471 and SWM-11507-4AP-1AP-2AP-0AP.

Nurseries sown in spring were much less productive than those planted in autumn. Even with some supplemental irrigation many lines effectively failed to make grain. The local landrace is not productive under these environmental conditions as its maturity period is too long, whereas some lines of AZRI selections from observation nurseries in 1986-87 were promising (Table 14).

It is evident that though AZRI is now in possession of many breadwheat lines potentially adapted to the environment there is still a long way to go before a confident recommendation for wide scale agronomic testing can be made.

Table 14. Spring planted breadwheat observation nurseries in 1988 at ARI Sariab, Kalat and Khuzdar

| S.NO. | ENTRY | ARI SARIAB | | KALAT | | KHUZDAR | |
|---|---|---|---|---|---|---|---|
| | | TDM kg/ha | SY kg/ha | TDM kg/ha | SY kg/ha | TDM kg/ha | SY kg/ha |
| 1 | SWM11625-2AP-3AP-4AP-0AP | 866 | 33 | 2000 | 498 | 1466 | 216 |
| 2 | SWM11623-2Y-0Y-1AP-0AP | 1266 | 56 | 14600 | 349 | 1066 | 205 |
| 3 | CM59456-3AP-1AP-3AP-1AP-0AP | 1200 | 60 | 1933 | 424 | 1533 | 264 |
| 4 | CM4985-2AP-2AP-1AP-2AP-1AP-0AP | 1466 | 273 | 1733 | 437 | 933 | 146 |
| 5 | CM56718-5Y-2Y-3M-3Y-1M-0Y | 1333 | 230 | 000 | 154 | 1000 | 136 |
| 6 | CM70307-9M-3Y-1M-2Y-0M | 1000 | 78 | 1133 | 272 | 1133 | 224 |
| 7 | ICW80-0157-1AP-1AP-2AP-0AP | 1733 | 244 | 1266 | 205 | 1066 | 165 |
| 8 | CM69599-2AP-1AP-2AP-0AP | 1600 | 202 | 1266 | 248 | 1466 | 178 |
| 9 | CM69599-2AP-2AP-2AP-0AP | 1333 | 90 | 1933 | 440 | 1200 | 210 |
| 10 | SWM11027-2AP-3AP-3AP-4AP-0AP | 666 | 37 | 1333 | 344 | 1333 | 314 |
| 11 | SWM11027-2AP-3AP-3AP-4AP-0AP | 933 | 64 | 1933 | 506 | 1133 | 178 |
| 12 | Local White (check) | 666 | 38 | 1400 | 122 | 400 | 56 |
| | C.V. (%)* | 58 | 138 | 30 | 36 | 38 | 53 |
| | S.E. | 80 | 15 | 62 | 15 | 57 | 11 |

* C.V. and S.E. are of total tested entries (55).

**Barley Production**

A. Agronomy Trials

Table 15 summarizes the results of the barley variety trials, in which five exotic varieties from Syria were compared with either Dasht or Khuzdar local varieties, as appropriate, all with and without fertilizer (60 kg/ha phosphate applied as triple superphosphate in the seedbed, and 40 kg/ha N applied as $NH_4NO_3$, 10 kg/ha in the seedbed, and 30 kg/ha topdressed at tillering), three replicates per site. In these dry conditions differences between varieties in hay, straw and grain production were not statistically significant. Of the five Syrian varieties "Arabic abiad" generally performed best. Fertilizer increased hay, straw, grain and total dry weight at maturity at all sites, and analyzed over all sites the increases were statistically highly significant.

These barley varieties have now been tested over a wide range of arid environments in the last three years. The 1988 trials represent very poor yields from very harsh environments, the 1986 trials represent quite good yields in reasonably favorable environments (probably as good as can be expected in Baluchistan) and the 1985 trials represent moderate yields in "normal" (for Baluchistan) environments. Figure 3 shows how this data can be used for "stability analyses" by plotting the value for the variety of interest against the appropriate trial mean, and comparing the resultant line with that of the local variety. Examples are shown for "Arabic abiad" and for "Arabic aswad".

Gross benefits (calculated as grain*1.75R + straw*0.5R) are compared in Figure 3. The line for "Arabic abiad" is significantly different from the local, while that for "Arabic aswad" is not. Examination of Figure 3 reveals that in all environments, even the harshest, "Arabic abiad" can be expected to give higher gross benefits than the local, and that as the environment improves, the differences between the two varieties will increase.

# Table 15. Barley Variety Trials, 1988

A. Hay dry weight (kg/ha)

| Site | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LB7 | 462 | 1113 | 282 | 327 | 160 | 469 |
| LB50 | 605 | 1025 | 281 | 237 | 179 | 465 |
| LB90 | 444 | 1086 | 257 | 256 | 160 | 441 |
| A.abiad | 465 | 1098 | 305 | 287 | 191 | 469 |
| A.aswad | 372 | 1234 | 223 | 272 | 168 | 454 |
| Local D# | 545 | 1235 | 231 | 354 | 137 | 500 |
| Local K# | 449 | 1044 | 286 | 319 | 167 | 453 |
| S.E. | 90.0 | 137 | 60.3 | 55.3 | 22.0 | 36.9 |
| -F | 359 | 1013 | 251 | 270 | 154 | 409 |
| +F | 596 | 1225 | 282 | 316 | 177 | 519 |
| S.E. | 48.1 | 73.0 | 32.3 | 29.6 | 11.8 | 19.7 |
| | *** | * | | | | *** |
| Mean | 477 | 1119 | 266 | 293 | 166 | 464 |

B. Total dw at maturity (kg/ha)

| | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LB7 | 778 | 452 | 169 | 125 | 148 | 334 |
| LB50 | 926 | 347 | 138 | 111 | 126 | 330 |
| LB90 | 880 | 452 | 130 | 82 | 159 | 341 |
| A.abiad | 956 | 489 | 130 | 157 | 158 | 378 |
| A.aswad | 896 | 431 | 116 | 122 | 153 | 344 |
| Local D# | 980 | 477 | 154 | 125 | 140 | 375 |
| Local K# | 1046 | 402 | 185 | 157 | 147 | 387 |
| S.E. | 104 | 72.5 | 18.8 | 21.6 | 14.3 | 26.4 |
| -F | 823 | 366 | 137 | 100 | 148 | 315 |
| +F | 1023 | 506 | 156 | 151 | 146 | 396 |
| S.E. | 55.5 | 38.8 | 10.1 | 11.5 | 7.7 | 14.1 |
| | * | * | | *** | | *** |
| Mean | 923 | 436 | 146 | 125 | 147 | 355 |

C. Straw dry weight (kg/ha)

| Site | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LB7 | 626 | 421 | 135 | 105 | 132 | 284 |
| LB50 | 608 | 299 | 99 | 75 | 112 | 239 |
| LB90 | 613 | 407 | 83 | 56 | 145 | 261 |
| A.abiad | 694 | 435 | 87 | 110 | 133 | 292 |
| A.aswad | 692 | 388 | 84 | 93 | 137 | 279 |
| Local D# | 751 | 439 | 132 | 103 | 122 | 309 |
| Local K# | 725 | 387 | 145 | 138 | 129 | 305 |
| S.E. | 69.1 | 66.5 | 14.0 | 19.8 | 13.8 | 20.2 |
| | | | ** | | | |
| -F | 615 | 334 | 103 | 79 | 131 | 252 |
| +F | 731 | 460 | 115 | 114 | 129 | 310 |
| S.E. | 36.9 | 35.5 | 7.5 | 10.6 | 7.4 | 10.8 |
| | * | * | | * | | *** |
| Mean | 673 | 397 | 109 | 97 | 130 | 281 |

D. Grain dry weight (kg/ha)

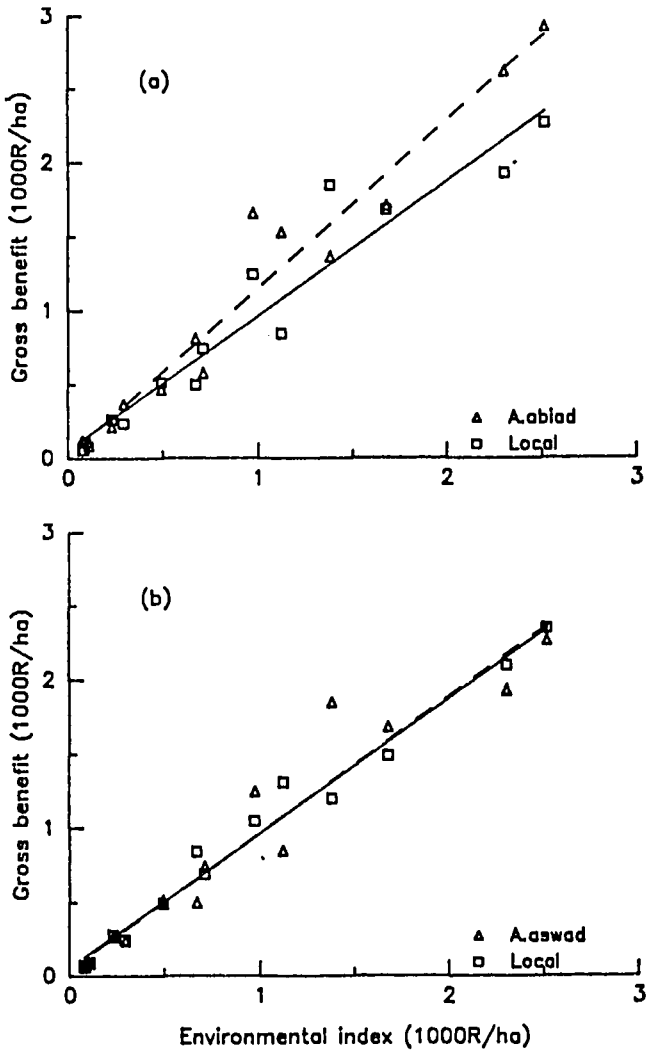
| | 1 | 2 | 3 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LB7 | 142 | 31 | 34 | 20 | 16 | 49 |
| LB50 | 321 | 48 | 39 | 35 | 14 | 91 |
| LB90 | 267 | 45 | 47 | 25 | 15 | 80 |
| A.abiad | 258 | 54 | 43 | 47 | 24 | 85 |
| A.aswad | 196 | 42 | 33 | 29 | 16 | 63 |
| Local D# | 219 | 38 | 22 | 22 | 19 | 64 |
| Local K# | 321 | 15 | 40 | 19 | 18 | 83 |
| S.E. | 43.5 | 9.4 | 6.5 | 6.5 | 2.6 | 9.1 |
| | | | | * | * | * |
| -F | 203 | 32 | 34 | 20 | 17 | 61 |
| +F | 289 | 46 | 40 | 36 | 17 | 86 |
| S.E. | 23.2 | 5.0 | 3.5 | 3.5 | 1.4 | 4.9 |
| | * | * | | ** | | *** |
| Mean | 246 | 39 | 37 | 28 | 17 | 73 |

| | | | | | |
|---|---|---|---|---|---|
| Kjeld-N (ppm) | 257 | 427 | 426 | 423 | 376 |
| P-Olsen (ppm) | 2.9 | 9.0 | 8.2 | 7.9 | 6.6 |

# - Local D: Local Dasht variety; Local K: Local Khuzdar variety

* - statistically significant at $P < 5\%$
** - statistically significant at $P < 1\%$
*** - statistically significant at $P < 0.1\%$

Figure 3. Gross benefits of production of barley varieties across a range of harsh environments



Tables 16 and 17 summarize these analyses for all five exotic varieties tested. In Table 16a (without fertilizer) it can be seen that all of the exotic varieties had a higher harvest index than the local, and produced more grain. However, "Arabic abiad" was the only variety to produce significantly more grain than the local when averaged over all trials, and was the only variety to produce equal (in fact slightly greater) amounts of straw. Accordingly "Arabic abiad" gave the highest gross benefits of the minus fertilizer treatments. Similarly "Arabic abiad" was the only variety to produce more hay than the local. Similar patterns are seen in the data with fertilizer, but here the differences are smaller. In no trial did the increased yields due to fertilizer pay for the cost of the fertilizer, even in 1986/87, therefore these data can be ignored in the variety comparisons. However, if other technologies such as water harvesting raise yields to the level where fertilizer response is economic, these data will be useful.

Table 17 summarizes the "stability analyses" for each variety. Regression coefficients for gross benefits, total dry weight at maturity and hay dry weight are presented and compared with the values for the local variety. As shown in Figure 3, only "Arabic abiad" gave values that resulted in regression lines that exceeded the local control.

The data indicate that all the exotic varieties were capable of producing more grain than the local, but "Arabic abiad" was the most consistent. "Arabic abiad" was the only variety that was able to match the local, on average, in straw production. Accordingly "Arabic abiad" was able to produce higher gross benefits than the local in almost all trials. "Arabic abiad" also produced more hay than the local, on average. However, the other varieties may prove useful in irrigated conditions, or if other technologies can raise yield levels. For current farming practice "Arabic abiad" is the only variety that warrants further large-scale testing.

**Table 16. Average barley crop production over all sites and years**

A. Without fertilizer.

| Variety | Hay dry weight (kg/ha) | Straw dry weight (kg/ha) | Grain dry weight (kg/ha) | Total dry weight (kg/ha) | Harvest index (%) | Gross benefits (R/ha) |
|---|---|---|---|---|---|---|
| LB7 | 1108 b | 629 a | 324 ab | 953 ab | 27 ab | 882 ab |
| Wadi Hassa | 1215 ab | 563 a | 324 ab | 887 b | 32 a | 848 b |
| Tadmor | 1121 b | 585 a | 348 ab | 933 ab | 31 a | 902 ab |
| Arabic aswad | 1237 ab | 577 a | 334 ab | 911 ab | 30 ab | 873 ab |
| Arabic abiad | 1594 a | 754 a | 378 a | 1132 a | 29 ab | 1039 a |
| Local | 1369 ab | 738 a | 289 b | 1025 ab | 24 ab | 874 ab |
| Mean | 1274 | 641 | 333 | 974 | 29 | 903 |
| SE. | 123.8 | 63.2 | 24.8 | 71.0 | 2.0 | 57.1 |

B. With fertilizer.

| Variety | Hay dry weight (kg/ha) | Straw dry weight (kg/ha) | Grain dry weight (kg/ha) | Total dry weight (kg/ha) | Harvest index (%) | Gross benefits (R/ha) |
|---|---|---|---|---|---|---|
| LB7 | 1360 a | 712 c | 417 a | 1129 ab | 27 a | 1086 a |
| Wadi Hassa | 1198 a | 633 c | 381 ab | 1014 b | 31 a | 983 a |
| Tadmor | 1488 a | 741 bc | 406 ab | 1147 ab | 30 a | 1082 a |
| Arabic aswad | 1364 a | 696 c | 382 ab | 1078 ab | 29 a | 1016 a |
| Arabic abiad | 1606 a | 878 ab | 363 ab | 1241 a | 27 a | 1074 a |
| Local | 1327 a | 922 a | 311 b | 1233 ab | 21 b | 1005 a |
| Mean | 1390 | 764 | 377 | 1140 | 27 | 1041 |
| SE. | 152.1 | 55.8 | 32.8 | 70.6 | 1.8 | 69.1 |

Hay dry weight - above ground biomass at "milk grain" stage.
Total dry weight - above ground weight at crop maturity.

a,b,c - means with different letters differ significantly at $P<0.05$ (Duncan's multiple range test).

**Table 17. Barley Variety Trials: "Stability analyses" after Eberhart and Russell (1966) - linear regressions of individual variety parameters against overall site means of treatments without fertilizer**

A. Gross benefits (R/ha)

| Variety | N | - Fertilizer r | b | a | + Fertilizer r | b | a |
|---|---|---|---|---|---|---|---|
| LB7 | 14 | 0.97 | 1.01 | -20 | 0.96 | 1.44 * | -210 |
| Wadi Hassa | 14 | 0.99 | 0.94 | -4 | 0.94 | 1.08 | 11 |
| Tadmor | 14 | 0.97 | 1.09 | -79 * | 0.98 | 1.28 * | -76 |
| Arabic aswad | 14 | 0.96 | 0.92 | 41 | 0.98 | 1.11 | 18 |
| Arabic abiad | 14 | 0.98 | 1.13 * | 16 * | 0.99 | 1.23 | 33 |
| Local | 14 | 0.99 | 0.91 | 52 | 0.97 | 1.06 | 50 |

B. Above-ground dry weight at crop maturity (kg/ha)

| Variety | N | - Fertilizer r | b | a | + Fertilizer r | b | a |
|---|---|---|---|---|---|---|---|
| LB7 | 14 | 0.94 | 0.99 | -7 | 0.95 | 1.33 | -164 |
| Wadi Hassa | 14 | 0.97 | 0.90 | 6 | 0.93 | 1.03 | 16 |
| Tadmor | 14 | 0.96 | 1.05 | 87 | 0.98 | 1.28 | -01 |
| Arabic aswad | 14 | 0.93 | 0.84 | 95 * | 0.97 | 1.04 | 66 * |
| Arabic abiad | 14 | 0.96 | 1.17 | -4 | 0.99 | 1.29 | -19 |
| Local | 14 | 0.99 | 1.06 | -4 | 0.98 | 1.26 | 7 |

C. Hay (biomass at "milk grain" stage) dry weight (kg/ha)

| Variety | N | - Fertilizer r | b | a | + Fertilizer r | b | a |
|---|---|---|---|---|---|---|---|
| LB7 | 14 | 0.94 | 0.85 | 21 | 0.96 | 1.01 | 80 |
| Wadi Hassa | 14 | 0.96 | 1.01 | -69 | 0.91 | 0.75 | 248 |
| Tadmor | 14 | 0.96 | 0.94 | -76 | 0.93 | 1.44 | -344 |
| Arabic aswad | 14 | 0.96 | 0.90 | 93 | 0.97 | 0.91 | 204 |
| Arabic abiad | 14 | 0.97 | 1.40 * | -292 | 0.95 | 1.34 * | -100 |
| Local | 14 | 0.85 | 0.02 | 327 | 0.73 | 0.70 | 436 |

* - Linear regressions for each variety were compared with those for the local variety without fertilizer (control). Slopes (b) and intercepts (a) marked with * differ significantly from the control values at P< 5%.

Table 18 presents the first year results of the trial examining the residual effects of phosphate trial, using barley as a test crop. Hay, straw, grain and total (straw+grain) dry weights generally showed small, curvilinear increases with increasing phosphate application, but again the increases were not sufficient to pay for the cost of the fertilizer in these dry conditions. This trial will be continued to examine any residual effects of the phosphate applied.

B. Germplasm Evaluation Trials

It is evident from the barley yield trial of material selected by AZRI, that very severe water stress was experienced by all lines at the grainfilling stage. Furthermore, there was considerable variability within and between replications due to local moisture variability in the test field resulting in very high coefficients of variation in the experiment. Conclusions from these data must be considered as tentative. However, with winter planting, the results shown in Table 19 indicate that several of the introduced lines are as good as the local control, with some seemingly better, including Alger/Union and some of the arabic landraces and selections (Abiad, Aswad, LB7 and LB50).

**Table 18. Barley response to phosphate (Residual Effects of Phosphate Trial, Year 1 Data)**

Hay dw (kg/ha)

| | 1 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|
| P0 | 650 | 153 | 359 | 203 | 341 |
| P60 | 677 | 169 | 555 | 137 | 305 |
| P120 | 858 | 228 | 559 | 204 | 462 |
| P240 | 629 | 165 | 380 | 198 | 343 |
| | | | | | * |
| Mean | 704 | 178 | 463 | 186 | 383 |
| SE. | 161 | 24 | 98 | 16 | 49 |

S.E. sites 48.5 ***

Total dw (kg/ha)

| | 1 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|
| P0 | 1304 | 134 | 250 | 75 | 441 |
| P60 | 1489 | 150 | 276 | 82 | 499 |
| P120 | 1586 | 170 | 257 | 102 | 529 |
| P240 | 1077 | 163 | 360 | 82 | 421 |
| Mean | 1364 | 154 | 286 | 85 | 472 |
| SE. | 247 | 39 | 41 | 7 | 52 |

S.E. sites 52.1 ***

Straw dw (kg/ha)

| | 1 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|
| P0 | 952 | 111 | 199 | 68 | 333 |
| P60 | 1030 | 125 | 214 | 76 | 361 |
| P120 | 1225 | 137 | 205 | 94 | 415 |
| P240 | 763 | 146 | 269 | 72 | 313 |
| Mean | 992 | 128 | 222 | 76 | 355 |
| SE. | 198 | 29 | 28 | 8 | 40 |

S.E. sites 40.0 ***

Grain dw (kg/ha)

| | 1 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|
| P0 | 353 | 22 | 51 | 7 | 108 |
| P60 | 459 | 25 | 62 | 6 | 138 |
| P120 | 361 | 33 | 52 | 8 | 114 |
| P240 | 314 | 18 | 91 | 9 | 108 |
| Mean | 372 | 24 | 64 | 7 | 117 |
| SE. | 63 | 11 | 4.3 | 0.9 | 15 |

S.E. sites 15.2 ***

| | | | | |
|---|---|---|---|---|
| Kjeld-N | 326 | 450 | 374 | 369 |
| P-Olsen | 5.5 | 8.1 | 5.5 | 5.7 |

**Table 19. Barley Yield Trial (AZRI selections from BYT HA 1986-87) winter planting 1987-88 at ARI Sariab**

| NAME OR CROSS/PEDIGREE | TOTAL DRY MATTER (kg/ha) | GRAIN YIELD (kg/ha) |
|---|---|---|
| OP/SY//Alger/Union,385-2-2 ICB-78-0976-9AP-0AP | 2900 | 447 |
| LIGNEE-131 | 4050 | 155 |
| GERBEL (C) | 2450 | 16 |
| ROHO//Alger/Ceres, 362-1-1 ICB-77-0181-1AP-2AP-2AP-0AP | 3950 | 83 |
| Alger/Union | 5350 | 888 |
| LB 50 | 3150 | 571 |
| LB 90 | 3700 | 291 |
| Arabi Aswad | 4050 | 564 |
| Arabi Abiad | 3200 | 579 |
| LB-(7) | 5000 | 592 |
| Local Barley | 3900 | 284 |
| Coefficient of Variation | 39% | 111% |
| Standard Error | 443 | 136 |

Positive progress has been made in providing adapted replacement cultivars from two distinct genetic backgrounds which could replace the local control whose susceptibility to disease is questionable. These replacement cultivars may now be available for wider testing.

In the spring planted trials, with a separate set of selections from 1986-87, grain yields were all below 125 kg/ha and therefore all the lines effectively failed due to drought. The top yielding line in dry matter terms was the improved check Faiz. However, it is not appropriate to draw definitive conclusions from this trial.

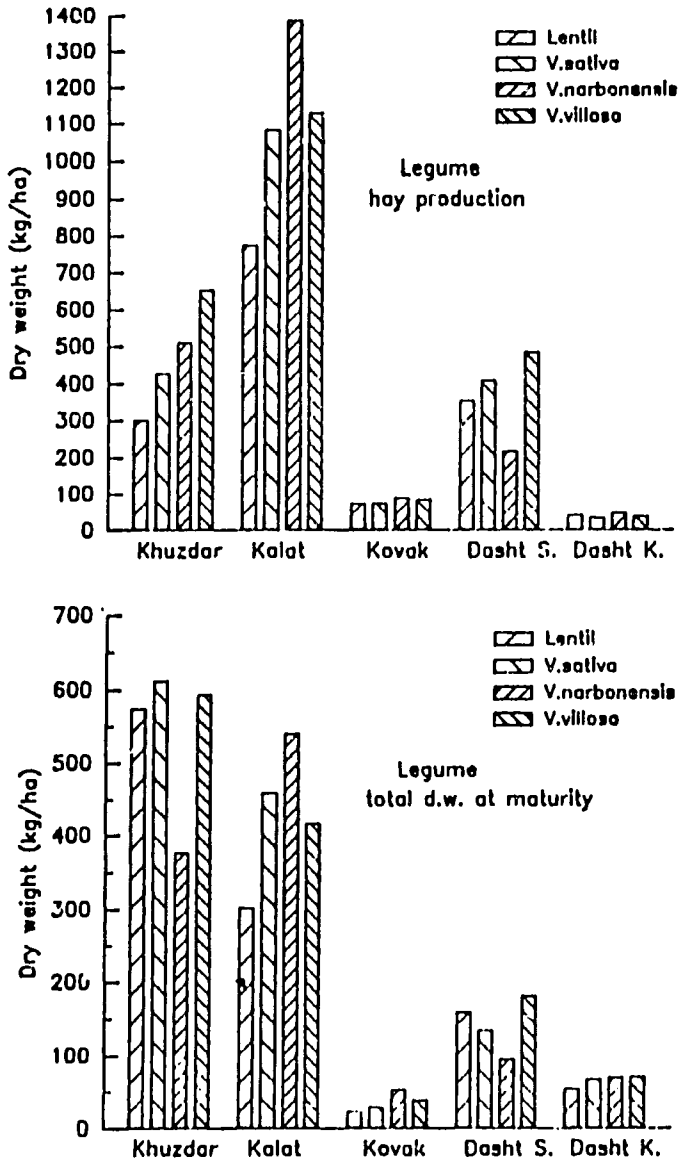
## Forage and Dual Purpose Legume Production

### A. Agronomy Trials

Figure 4 and Table 20 summarize the results of the lentil/forage legume trial where three forage legumes were compared with the local lentil as a control, with and without inoculation of N-fixing *Rhizobia* bacteria, with and without phosphate (60 kg/ha phosphate applied as triple superphosphate in the seedbed), three replicates per trial. As seen in the previous year *Vicia villosa* ssp. *dasycarpa* produced much higher hay yields than the lentil control, but in contrast to last year, *V. sativa* and *V. narbonensis* also gave higher hay yields. This year the crops were not subject to cold-screening. Neither inoculation nor phosphate had any effect on the crops. The three forage legumes produced slightly more straw and seed than the lentil control, overall, but differences were not statistically significant. In two of the trials no seed was produced. This highlights the greater water requirements of the legume crops as compared to barley, (Tables 15 and 20). The results still support *V. villosa* as a useful crop to introduce into the local farming system as it is capable of withstanding cold (last year's results), can produce very high hay yields in good conditions (last year's results) and also produce acceptable hay yields in

poor conditions. The lack of response to inoculation is probably due to conditions being too dry to allow N-fixation or possibly even bacterial survival.

**Figure 4. Productivity of forage legumes in agronomy trials at five locations in Baluchistan**



# Table 20. Forage Legume Trials, 1988

Hay dw (kg/ha)

| | 1 | 3 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LL | 299 | 772 | 71 | 351 | 40 | 306 |
| Vs | 425 | 1080 | 72 | 406 | 33 | 403 |
| Vn | 508 | 1384 | 87 | 215 | 46 | 448 |
| Vd | 651 | 1120 | 82 | 481 | -37 | 475 |
| S.E. | 100 | 103 | 10 | 94 | 5 | 34 |
| | | * | | | | *** |
| -P | 352 | 1132 | 76 | 347 | 34 | 308 |
| +P | 589 | 1049 | 80 | 379 | 39 | 427 |
| S.E. | 71 | 73 | 7 | 66 | 4 | 24 |
| | * | | | | | |
| -I | 485 | 1032 | 75 | 357 | 37 | 397 |
| +I | 456 | 1148 | 82 | 369 | 36 | 418 |
| S.E. | 71 | 73 | 7 | 68 | 4 | 24 |
| Mean | 470 | 1090 | 78 | 363 | 37 | 407 |

Sites S.E. 53.9 ***

Straw dw (kg/ha)

| | 1 | 3 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LL | 494 | 161 | 22 | 152 | 53 | 176 |
| Vs | 504 | 226 | 28 | 94 | 66 | 183 |
| Vn | 303 | 228 | 52 | 50 | 68 | 140 |
| Vd | 503 | 293 | 37 | 134 | 69 | 207 |
| S.E. | 81 | 34 | 6 | 20 | 5 | 17 |
| | | | * | * | | * |
| -P | 424 | 253 | 30 | 93 | 62 | 172 |
| +P | 479 | 201 | 39 | 121 | 64 | 180 |
| S.E. | 58 | 24 | 4 | 14 | 4 | 12 |
| -I | 407 | 243 | 30 | 111 | 65 | 171 |
| +I | 496 | 211 | 39 | 104 | 62 | 182 |
| S.E. | 58 | 24 | 4 | 14 | 4 | 12 |
| Mean | 451 | 227 | 35 | 107 | 64 | 176 |

Sites S.E 17.0 ***

Total dw (kg/ha)

| | 1 | 3 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LL | 573 | 301 | 22 | 158 | 53 | 221 |
| Vs | 611 | 458 | 28 | 133 | 66 | 259 |
| Vn | 376 | 539 | 52 | 94 | 68 | 225 |
| Vd | 593 | 415 | 37 | 180 | 69 | 258 |
| S.E. | 96 | 42 | 6 | 25 | 5 | 20 |
| | | * | | | | |
| -P | 514 | 455 | 30 | 122 | 62 | 236 |
| +P | 562 | 400 | 39 | 161 | 64 | 245 |
| S.E. | 68 | 30 | 4 | 17 | 4 | 14 |
| -I | 484 | 443 | 30 | 145 | 65 | 233 |
| +I | 592 | 413 | 39 | 137 | 62 | 248 |
| S.E. | 68 | 30 | 4 | 17 | 4 | 14 |
| Mean | 538 | 428 | 35 | 141 | 64 | 241 |

Sites S.E. 20.0 ***

Grain dw (kg/ha)

| | 1 | 3 | 2 | 4 | 5 | Mean |
|---|---|---|---|---|---|---|
| LL | 78 | 87 | 0 | 4 | 0 | 34 |
| Vs | 106 | 146 | 0 | 26 | 0 | 56 |
| Vn | 73 | 197 | 0 | 30 | 0 | 60 |
| Vd | 90 | 78 | 0 | 31 | 0 | 39 |
| S.E. | 17 | 12 | | 6 | | 4 |
| | | * | | * | | *** |
| -P | 89 | 127 | 0 | 19 | 0 | 47 |
| +P | 84 | 126 | 0 | 27 | 0 | 47 |
| S.E. | 12 | 8 | | 4 | | 3 |
| -I | 77 | 125 | 0 | 23 | 0 | 45 |
| +I | 96 | 124 | 0 | 22 | 0 | 48 |
| S.E. | 12 | 8 | | 4 | | 3 |
| Mean | 87 | 126 | 0 | 23 | 0 | 47 |

Sites S.E. 5.4 ***

| | | | | | |
|---|---|---|---|---|---|
| Kjeld-N (ppm) | 257 | 427 | 426 | 374 | 376 |
| P-Olsen (ppm) | 2.9 | 9.0 | 8.2 | 5.5 | 6.8 |

B. Germplasm Evaluation Trials

In the forage legume trials, the severely dry conditions compromised the value of the results as supplemental irrigation had to be applied twice at both Khuzdar and Kan Mehtarzai in order to preserve seed reserves for the following season. ARI Sariab was selected to examine the response of the introduced cultivars to severe moisture stress. As is evident from the data given in Table 21 last year's outstanding line *Vicia villosa ssp. dasycarpa* #683 was again one of the best lines in terms of dry matter production as was *V. sativa* #384 and, in the absence of very severe cold conditions, *Lathyrus sativus* #3. Yields were low with both autumn and spring planting but the advantage of autumn planting remained clear. All lines with one important exception effectively failed to make grain. *V. ervilia* #2542, which was noted in previous years to show a measure of drought tolerance, again displayed this capacity, under the harshest of conditions. The frost sensitivity of this line normally precludes it from winter seeding at elevations as high as Quetta, but this year it was able to survive largely undamaged and yielded impressively.

The *Vicia pannonica* line L-1464 which was tried in these trials for the first time was a disappointing failure and will be discarded unless it can survive in the 1988-89 trials.

In the lentil trials, which are being used to assess this crop species for its dual purpose productivity, the dry conditions almost completely prevented seed production at ARI Sariab in both the autumn and spring sowings. Nevertheless, the results were encouraging as shown in Table 22, as two lines from previous AZRI selections produced substantially more dry matter than the well adapted local control. ILL 5720 and ILL 5865 produced a creditable 1.5 t/ha of forage material. As these are selections from the 1986-87 yield trial, it is evident that they are well enough adapted to both very cold and wet winter conditions and to mild dry

of environmental response. This is a necessity in the highly variable climatic conditions of the Baluchistan uplands.

Table 21. Productivity (kg/ha) of annual sown forage legumes during 1987-88 at ARI Sariab

| ENT. | NAME | ACC.NO. | AUTUMN PLANTING TDM | AUTUMN PLANTING SY | SPRING PLANTING TDM | SPRING PLANTING SY |
|---|---|---|---|---|---|---|
| 1 | V.SATIVA | 384 | 1331 | 48 | 279 | 3 |
| 2 | " | 709 | 672 | 37 | 305 | 89 |
| 3 | " | 597 | 643 | 9 | 269 | 20 |
| 4 | " | 1652 | 352 | 10 | 213 | 3 |
| 5 | " | 1486 | 399 | 4 | 346 | 2 |
| 6 | " | 2541 | 669 | 58 | 548 | 187 |
| 7 | V.ERVILLIA | 2542 | 969 | 225 | 294 | 118 |
| 8 | V.DASYCARPA | 683 | 1245 | 9 | 131 | 13 |
| 9 | L.SATIVUS | 347 | 681 | 47 | 308 | 128 |
| 10 | " | 3 | 1195 | 42 | 434 | 156 |
| 11 | V. SATIVA | 709 | 700 | 20 | 222 | 14 |
| 12 | " | 1361 | 207 | 7 | 81 | 2 |
| 13 | " | 490 | 927 | 28 | 232 | 24 |
| 14 | V.VILLOSA* | L-1437 | 796 | 9 | 49 | 0 |
| 15 | V.DASYCARPA* | L-2527 | 689 | 11 | 59 | 3 |
| 16 | V.PANNONICA* | L-1464 | 0 | 0 | 0 | 0 |
| 17 | LOCAL LENTIL | CHECK | 831 | 10 | 104 | 0 |
| 18 | " | CHECK | 701 | 12 | 101 | 0 |
| GRAND MEAN | | | 723 | 33 | 221 | 42 |
| COEFF. OF VAR. | | | 49 | 87 | 34 | 64 |
| STANDARD ERROR | | | 206 | 16 | 43 | 16 |
| PROBABILITY | | | <0.05 | <0.05 | <0.05 | <0.05 |

Genotypes in first year of testing.

**Table 22. Production (kg/ha) of lentil lines (1986/87 selections) during 1987-88 at ARI Sariab**

| ENT. NO. | ILL NO. | ORIGIN | AUTUMN PLANTING TDM | AUTUMN PLANTING SY | SPRING PLANTING TDM | SPRING PLANTING SY |
|---|---|---|---|---|---|---|
| 1 | 975 | CHILE | 1111 | 14 | 325 | 64 |
| 2 | 1939 | MOROCCO | 1327 | 10 | 472 | 85 |
| 3 | 5677 | ICARDA | 1102 | 25 | 496 | 92 |
| 4 | 5687 | ICARDA | 285 | 12 | 334 | 88 |
| 5 | 5690 | ICARDA | 350 | 7 | 249 | 50 |
| 6 | 5714 | ICARDA | 876 | 8 | 357 | 30 |
| 7 | 5720 | ICARDA | 1591 | 22 | 542 | 79 |
| 8 | 5730 | ICARDA | 1114 | 20 | 215 | 14 |
| 9 | 5731 | ICARDA | 659 | 8 | 212 | 12 |
| 10 | 5838 | ICARDA | 508 | 12 | 183 | 10 |
| 11 | 5855 | ICARDA | 445 | 11 | 163 | 2 |
| 12 | 5865 | ICARDA | 1572 | 29 | 302 | 44 |
| 13 | 707 | CYPRUS | 1152 | 18 | 197 | 9 |
| 14 | 842 | LEBANON | 841 | 10 | 85 | 0 |
| 15 | 5747 | ICARDA | 873 | 9 | 160 | 2 |
| 16 | 5750 | ICARDA | 905 | 13 | 125 | 0 |
| 17 | PRECOZ | ----- | 691 | 12 | 143 | 4 |
| 18 | CHECK | LOCAL | 1105 | 22 | 93 | 0 |
| GRAND MEAN | | | 917 | 15 | 258 | 32 |
| COEFF. OF VAR. | | | 26 | 64 | 77 | 175 |
| STANDARD ERROR | | | 139 | 5 | 115 | 33 |
| PROBABILITY | | | <0.05 | >0.05 | >0.05 | >0.05 |

# IDENTIFICATION OF SOCIAL ORGANIZATION AND COMMUNICATION PATTERNS IN RURAL COMMUNITIES FOR EFFECTIVE AGRICULTURAL EXTENSION

## Agricultural Extension Survey and Community Profiles Study

A Community Profiles Study and an Agricultural Extension Survey were conducted by AZRI in the five regions where on-farm agronomy and livestock research are being conducted. The objectives of both studies were to obtain significant baseline information about the nature of community social organization and structures, indigenous communication patterns, flow of agricultural information, and current access to institutional extension messages. This information is required to aid in the identification of appropriate strategies for technology transfer and in support of agricultural extension programs. The Community Profiles were compiled from a series of informal group interviews with a variety of community members in each of the five regions. In each of the interviews several aspects were discussed including: the community and how it was established; the social and ethnic composition of each community; the nature of and changes in, the resource base; leadership patterns and decision-making structures; and the relations and activities between members of a community. In contrast, the Agricultural Extension Survey was designed to obtain information from three major areas of the communities' structure and culture:

a. A profile outlining the farmers' characteristics of education, literacy, language abilities, as well as perceptions of their relationship to, and place within their villages and as part of a larger system;

b. Information about the nature of communication patterns and factors influencing the type of communication in and beyond these communities; and

c. Current access to extension services and perceptions about which services are most needed and why.

The survey took, as its sample population, one half of the original respondents of the Household Agricultural Production Systems Survey (conducted in Summer of 1987) which were randomly selected.

A. The Nature of Community Structures

The combined findings of the community profile study and the agricultural extension survey show that the cornerstone of community organization continues to be a tribally defined structure. This structure utilizes kinship relations as its fundamental building block, and it is within this structure that social, economic as well as political relationships are organized. This organizational characteristic also influences the distribution of people in each region, and thus one finds villages which are occupied not only by members of a single tribe, but primarily by other members of the same tribal section and its lineage subdivisions.**

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** (1) Tribe: a group, often congruent with an ethnic group, associated with a particular territory and which uses real or eponymous genealogical ties to define group membership.
(2) Tribal Section: a sub-tribal unit whose members are joined by kinship lines which most often cannot be traced to a definite ancestor. In Baluchistan, tribal sections are called "shalwar", in Brahui, and "zai" in Pashto.
(3) Lineage: units of social organization within a tribal section whose members can actually trace genealogical ties to a definite ancestor. The members of a lineage usually also form a residential group and, after the nuclear or extended family, the minimal community reference point. In Baluchistan lineages are called "aziz" in Brahui, and "zai" in Pashto (same as the term for the tribal section, but can be differentiated verbally).

Resources, notably land and water rights, are also allocated and used along tribal and lineage lines. Land and water rights are in many cases held in forms of traditional communal ownership, while livestock and some land, notably those lands under cultivation of irrigated cash crops and dryland cereals, are under private ownership. The tribal organizational basis of these communities creates particular patterns of communication and social obligations.

B. Communications Within Villages

Because of the social organization prevalent in these communities, which is strongly structured along kinship lines it is not surprising to find that the transfer of news and information, as well as other forms of communication, such as marriages and other ritual processes, are also structured similarly. Thus, information is open and fairly unstructured within small villages; this is corroborated by both interviews on information exchanges and visiting habits (Table 23). These data also illustrate that communication between villages is generally unrestricted. Information gathered on the nature and frequency of individual visits within villages illustrates this point.

**Table 23. Visiting patterns within villages in all five locations**

| | |
|---|---|
| Neighbours who are also relatives | 100% |
| Neighbours who are not relatives | 70% |
| Members of the same lineage (aziz or zai) | 43% |
| Tribal section (shalwar or zai) | 60% |

It is important to note, however, that strong networks based on friendship alone are generated between people in communities which share contiguous space, or are not separated by long distances, even though they may not be related by kinship. These networks are activated by people, particularly at those periods of the year when there is a need for intensive labor, notably during harvest and planting. This generates a system of reciprocal labor exchange which acts as a bond between members of these communities. Data from the Household Survey (Nagy and Farid Sabir, 1987) on family participation and labor exchanges in agricultural production show that there is a predominance of friendship and distant relatives (in contrast to immediate family and affinal kin) in these networks (Table 24).

**Table 24. Ranking of personnel participating in labor exchanges in five locations**

| | |
|---|---|
| Distant relatives | 35% |
| Friends | 30% |
| Brother's family | 20% |
| Wife's family | 13% |
| Outside of village | 2% |

C. Interpersonal Contacts with the Wider System

The boundaries of each community, when defined by ethnic or tribal ties, also mark the boundaries of communication networks and flow of information. There is relatively little information which is transferred between communities which have no common ties. This limited information transfer between small communities and wider society is due to two factors: (1) the relative isolation of the communities and (2) the fact that information is not generally perceived as a valued commodity by people in rural areas. Nevertheless, regardless of their isolation, most individuals in these villages maintain some form of contact with larger population centers. The data shown in Table 25 indicate that

the most frequent places visited by these farmers in isolated rural areas visit are markets close to their own communities. They visit on average once a week to purchase domestic supplies and in some cases for the sale of livestock or other farm products. Visiting relatives at these centers is the secondary motivation for travel, implying a strong social obligation to participate in family events, marriages, funerals, etc.

**Table 25. Reasons for visits to outlying population centers by villagers in five locations**

| | |
|---|---|
| Buying food/household items | 99% |
| Visiting relatives | 50% |
| Religious purposes | 32% |
| Business | 27% |
| Buying agricultural inputs | 26% |
| Selling agricultural products | 21% |
| Selling things made in household | 2% |

Seasonal employment at these centers outside the village also constitutes an important contact between villagers and the wider world. Through seasonal employment villagers not only receive information and goods from outside but also gain important sources of revenue. It is unclear, however, to what degree seasonally employed villagers contribute to innovation in the villages or to improving the general level of awareness and information dissemination. All of the villages sampled are sufficiently isolated so that they do not have contact with itinerant merchants very often. Thus, individuals in the villages retain control of the kinds and frequency of contact which they wish to have with the outside world.

## D. Mass Media

Another form of contact between these communities and wider society is through their access to information from the mass media. Because of the location of these communities, their access to mass media is somewhat limited and is essentially

restricted to radio (43% of all individuals sampled in the five locations have radios). Because electricity is not available in most of these areas, families have to rely on battery operation of radios, which is expensive. Radio listening habits are based principally on language. Each of the communities sampled differed in their preference for stations according to the predominant language of the community (Table 26).

**Table 26. Predominant languages in the five locations**

| Language | % Who Speak and Understand |
|---|---|
| Brahui | 100% |
| Baluch | 27% |
| Urdu | 30% |
| Pashto | 26% |

According to the data shown in Table 26 any extension messages will only be generally well received if they are in the language dominant in each region.

Contrary to researchers' expectations, the survey results indicate that 20% of the respondents have cassette tape recorders in operating condition. This may allow extension communicators to consider using cassette tape listening schemes as a medium for disseminating new ideas and innovations.

The low level of literacy in this population (17%) currently precludes the use of printed media as a general extension vehicle since it would automatically discriminate against a large percentage of the population. However, because villagers accord considerable importance to written materials, and people often listen to others read (73%), further evaluation of the possible uses of some written materials may be worthwhile, particularly if designed to be read aloud.

## E. Access to Extension Services

An assessment of the farmers' preparedness to receive agricultural extension information was made from the data obtained on information availability concerning agricultural production and practices within villages. Information was also gathered on villagers' perceptions about what information would be most valuable to them in improving their crop and livestock production. This information will be used to define areas of high priority for extension programs.

The data also indicate that the current level of access to agricultural extension services is almost non-existent, because the provincial government agricultural extension services have very limited resources. They have also generally focused their efforts on areas where responses are expected to be quicker and have more impact on the Gross Agricultural Product of the province, e.g. irrigated horticulture. Agricultural fairs represent the only exception which provides contact with extension services judged on attendance numbers (46%). Evaluation studies are needed to understand and improve the effectiveness of such fairs for knowledge and information transfer.

Access to livestock extension services is much greater than crop extension agencies in dryland areas. Information about livestock health was available from the provincial livestock department in all five locations to a minority of livestock producers (43% for all five locations), but with wide variability between areas from 86% in Zarchi to 7% in Kovak). This information was only on issues of animal health. Access to veterinary services is similarly limited in these five locations and 55% of the livestock producers have had their livestock vaccinated in the past 12 months, though only 50% have had vaccinations administered through the livestock service.

F. Implications for Effective Agricultural Extension

The analysis of the data obtained from the Community Profiles and the Agricultural Extension Survey will provide an excellent base to help design effective programs in agricultural extension. Failure to take into account the local communication patterns described, when developing broad scale extension programs for AZRI generated technologies, risks undermining the entire value of the Institute's research effort.

## CONCLUSION

In conclusion, the research results obtained in the 1987-88 production year indicate that the potential for sustained improvement of small ruminant production in upland Baluchistan is substantial. However, further research and extension efforts are still required to ensure that this potential is effectively achieved in the future.

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**APPENDIX A**

**SCIENTIFIC STAFF LIST AZRI and MART/AZR PROJECT**

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