

AZRC Research Highlights 1984 - 2004

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ARID ZONE RESEARCH CENTRE, QUETTA

1. ANIMAL SCIENCES RESEARCH PROGRAM

Introduction

Twenty million heads of sheep and goats in Balochistan constitute more than one-third of small ruminant population of Pakistan. These animals are the major livestock wealth of the Province that covers 34.7 million hectares, almost 44% of country's land area. More than 80% people of the Province derive their livelihood directly or indirectly from small ruminant production. But these animals are underfed because of low forage availability in quantity and quality on the ranges and their overall productivity is very low. The major constraints in increasing small ruminants productivity are the harsh climate with low and erratic rainfall, cold winters and hot summers. Other constraints include poor flock management, animal diseases and health problems, lack of sufficient infrastructure, land tenure system and the rangeland management and control problems. The research work at AZRC for improving output of small ruminants' production operations is being conducted in the light of this scenario.

OBJECTIVES

- Studies on raising sheep and goats under grazing conditions with minimal supplemental feeding and monitoring changes in their performance under different ecological zones of the province
- Estimate cost-benefit ratio for raising range-based sheep and goats with minimal supplemental feeding and determine the type and requirements of supplemental feeds
- Assessment of different arid zone feeds and forages through *in vivo* and *in vitro* techniques
- Studies on the impact of different diseases on the productivity of range-based sheep and goats

SALIENT FINDINGS

- Productivity of moderately thin ewes improved to above 90% with flushing during breeding at AZRC Research Stations.
- Strategic supplemental feeding at private farmers' flock level increased sheep productivity from 60-65% to more than 90% in poor rainfall years.
- Field surveys and lab work indicated 60-80% sheep/goats infected with internal parasites that lead to high mortality and morbidity rates.
- Health cover package (vaccination, drenching and dipping) reduced sheep mortality to almost one third (from 12 to 4%)
- Lamb fattening trials resulted in daily gain upto 250 grams by lambs of native breeds and FCC 1:4 to 1:6 were achieved.

ON-GOING RESEARCH ENDEAVORS

- Seasonal incidence of internal parasites in sheep and goats in and around the Quetta.
- Assessing the warble fly infestation in Balochistan
- Assessment of skin damage due to different parasitic infestation in sheep and goats in Quetta.
- Breed evaluation of Harnai range-sheep under optimum nutritional and health management provision in Tomagh, Balochistan

FUTURE RESEARCH VISION

- Performance of Harnai range-ewes under optimal feeding and health management conditions in Asghara (Ziarat dist) valley of Balochistan.
- Incidence of internal, external and blood parasites; and hydatid cyst problems in sheep and goats slaughtered at the Quetta, Kuchlak and Mastung slaughter houses. (Funded by Pakistan Science Foundation)
- Development of health, nutrition and breeding management package for increased output from range-sheep/goats production operation in Balochistan. (submitted to ALP for funding)

ACCOMPLISHMENTS

Effect of winter supplementation on the performance of Balochi ewes grazing native rangeland in highland Balochistan (1988).

A study was conducted on winter supplemental feeding of Balochi ewes and their performance in Kalat area of Balochistan. Eighty-two ewes were randomly divided into two groups of 40 and 42 animals. Two treatments (T1 and T2) studied were: 250 gm/animal/day of a 50:50 mixture of cottonseed cake and barley grain fed from Oct. to Dec. 18, 1988 plus grazing and 500 gm/animal/day of the same feed mixture fed in addition to grazing. Lucerne hay and wheat straw in a 50:50 ratio were provided to all the ewes for a period of one month @ 320 gm/animal/day to sustain them in severe winter. Same feeding levels to the same ewe groups were again fed from March 1 to May 27, 1989. Three breeding rams stayed with the flock from Nov. 1 to Dec. 13, 1988. Lambing took place from April 2 to May 12, 1989. Conception, lambing and mortality percentage was found different ($P < .05$) between T1 and T2 (22.5 vs 52.4%, 22.5 vs 52.4% and 12.5 vs 4.8%, respectively). Lamb birth weight (3.4 vs 3.2 kg) were similar for T1 and T2 but lamb weaning weights were found different between T1 and T2 (12.6 vs 14.8 kg). The ewes on T2 maintained higher body weights through out winter supplementation (flushing) and decrease in ewe mortality. Late-gestation and early-lactation supplemental feeding of ewes results in increases in weaning weights of their lambs.

Fertility of range based Balochi ewes as influenced by improved nutrition in Zarchi area of highland Balochistan (1989-92).

Three experiments were conducted during range grazing scarcity period of winter, spring and part of summer, to study the effect of improved nutrition on Balochi ewes in highland Zarchi range area of Balochistan province. Experiment involved 48 ewes, of varying ages, split into three equal groups each allocated to a different treatment of range grazing only (T1), medium level of supplementation with range grazing (T2), and a high level of supplementation without range grazing (T3). There was no difference in conception and lambing and mortality rates among the three treatment groups. Lambs from T3 ewes had significantly higher birth and weaning weights than those from T1 and T2 ewes, whereas the lamb from the two latter groups did not differ in these parameters. Average body weight of T3 ewes was significantly higher than both T1 and T2 ewes from the 3rd fortnight onward, whereas that of T1 and T2 ewes differed only from the 5th to 13th fortnight of the experiment.

Fourwing saltbush as winter maintenance forage for sheep in upland Balochistan (1990).

Sixteen Harnai lambs were used in a completely randomized design to study the nutritive value of fourwing saltbush as a winter maintenance browse in comparison to native grazing with or without protein and energy supplementation at Tomagh Range Livestock Research Station, in Loralai district, Balochistan. The animals were divided into four groups of four lambs each. These four groups were assigned four treatments at random; fourwing saltbush grazing alone, range plus Lucerne hay (100 g/head/day), range grazing plus barley grain (100 g/head/day) and range grazing alone for ten weeks. The results indicated that the two range grazing plus supplementation treatments produced weight gains, which were not significantly different from each other ($p < 0.05$). Both of these treatments yielded significantly higher weight gains ($p < 0.05$) than did range grazing alone except for the last week of study. Fourwing grazing provided cumulative weight gains at 3, 4, 6, 7 and 8 weeks which were not significantly different from the range grazing plus Lucerne hay treatment and gained an average 6 percent in body weight over the 10 weeks period of study. Results of this study suggest that under fourwing saltbush grazing alone, lambs do not only maintain their body weight but can also gain weight in winter.

Impact of fourwing saltbush on feed and water intake and on blood serum profile in sheep (1991).

Sixteen rams were used to evaluate the influence of varying levels of fourwing saltbush hay on feed and water intakes as well as the blood serum mineral status in a completely randomized design. The animals were grouped randomly in four groups with four animals each. The four groups were randomly allotted low, medium and high and very high levels of saltbush hay supplementation in addition to wheat straw. The animals were given fresh water *ad libitum*. Weekly body weight was recorded for each individual animal. Blood serum was collected for mineral contents. The experiment lasted for eight weeks. The inclusion of saltbush leaves in the diet showed a non-significant effect on the total dry matter intake at low, medium and high levels of saltbush, whereas at very high level the total dry matter intake declined. There had been also a significant increase in water intake for very high level of saltbush ration. Lower levels showed no effect on water intake. The animals maintained their body weight from one to week eight. No treatment by week's interaction on potassium and sodium levels was detected. However, higher levels of saltbush significantly increased the potassium and sodium

contents in serum. Calcium contents were significantly lowered ($P < 0.01$) with the inclusion of saltbush leaves in the diet. Phosphorus contents increased ($P < 0.05$) with higher levels of saltbush. No clinical or sub-clinical toxicological symptoms were observed in the sheep with higher mineral contents.

Nutritive evaluation of fourwing saltbush in growth and digestibility trials with Harnai lambs in upland Balochistan (1990).

Twenty-four Harnai lambs 6 to 7 month old, weighing 16 ± 2 kg were used in completely randomized design in growth and digestibility trials to study fourwing saltbush ration supplemented with cottonseed cake. The animals were divided at random into three groups of 8 animals each. Three isonitrogenous (10.5% CP) experimental rations containing: 1. wheat straw + lucerne hay (24:76), 2. fourwing saltbush (*Atriplex canescens*) + cotton seed cake (71:29), and 3. wheat straw + cotton seed cake (41:59) were allotted to each group randomly. All the animals were taken out for grazing in a dormant native range for about 3 hours in the afternoon during the growth trial. At the end of 8 weeks lambs on ration 3 gained significantly ($p < 0.10$) more weight compared to those on rations 1 and 2, which maintained their body weight. The crude protein digestibility of the fourwing saltbush based ration was comparable with the other two treatments (71 vs 70 and 71%). However, the digestibility of dry matter (41%), acid detergent fiber (13%) and neutral detergent fiber (22%) of this ration was significantly lower ($p < 0.10$) than the other two diets. The results suggest that lambs can be maintained on fourwing saltbush during winter without significant loss in body weight with 30% extra protein concentrates supplementation.

Productivity of range-based Harnai ewes as influenced by improved nutrition in Tomagh, Balochistan (1989-92)

Under this study, three experiments were carried out during 1989 - 1992 to explore the production potential of indigenous sheep with improvement in their nutrition and management under the local harsh environmental conditions and define the animals' supplemental feed requirements for optimum production. A 100% conception rate was observed in this experiment in all the three treatments. The lambing percentage in T2 and T3 was 100% and 93.75% lambing was observed in T1. These lambing rates are higher than 60-70% reported in surveys of this area. A significant difference ($P < 0.05$) in ewe live-weight at lambing was observed. The mortality rate of ewes in treatment T1 was 6% against zero % mortality in the other two treatments ($P > 0.05$). Differences in birth weights of lambs from ewes under treatments T2 and T3 was non-significant ($P > 0.050$) but these two treatments were different from treatment T1 in birth weight of lambs. The difference in fortnightly body weight of sheep indicates that the better nutritional management helped the animals to maintain their body weight although the difference in initial weight of animals under the three treatments was non-significant. Future studies would address the question of early and late breeding in the season with and without supplemental feeding.

Rainfed farming system and socio-economic aspects in Kalat division of Highland Balochistan (1991).

The objective of this study was to understand crop-livestock interactions and related socio-economic aspect in the area, to identify constraints in high productivity and to study farmers' priorities and agricultural research opportunities. Ninety farmers were interviewed randomly from twenty-five villages at Kalat and Khuzdar districts during the month of September, 1988. The majority of the farmers in the region are smallholders and hinder the adoption of new technologies. Livestock husbandry is closely integrated

with crop production and plays an important role in the farmers' decision making process. Cropping intensity is much lower and yield of major crops is well below its potential level.

Lamb fattening under intensive feedlot conditions in Balochistan (1993).

Sixteen Balochi lambs 8 to 10 month of age weighing 18.4 to 33.2 kg were used for this trial conducted during 1993 at Animal Nutrition Research Unit (ANRU) of AZRC, Quetta. The lambs were randomly divided into eight groups in such a way that two lambs having almost similar live weights were put in one group. Each pair was then randomly assigned to one of eight fattening pens. Two experimental rations having similar metabolizing energy (ME; 2600 kcal/kg) but differing in CP levels was prepared. Four randomly selected groups served as control and received the basal ration A that contained 12 percent CP. Urea was included in ration B to increase the CP level of the basal ration to 17 percent. No difference ($P>0.05$) in the average daily gain and feed efficiency of lambs fed the two rations were observed. However, daily feed intake was higher for the lambs fed ration B with 17 percent CP.

Performance of Balochi lambs grazing *Vicia villosa* and barley pastures in winter (1993).

Intake and weight gain by sheep and forage production of five different forage species i. e., two vetch lines *Vicia villosa*, *subsp. dasycarpa* (Acc 683 and Acc Gilgit) and three varieties of barley (*Arabic abiad*, Frontier 87 and a local landrace) were studied at AZRC Farm, Quetta. The two vetches produced higher ($P<0.05$) forage yields during pre-flowering, flowering and maturity stages followed by two barley varieties whereas the local barley was lowest in forage production. During flowering stage, intake was higher for barley *Arabic abiad* followed by other species and local barley. At maturity stage, intake was higher for barley varieties as compared to vetch species. Weight gain by sheep grazing on barley *Arabic abiad* was highest and these gain did not differ from barley Frontier 87 and vetch Acc Gilgit followed by vetch Acc 683 and local barley produced the lowest gains.

Evaluation of different exotic grass species in upland Balochistan (1994).

Eight cool-season and three warm-season exotic grass species were raised and evaluated for above ground dry matter biomass in Mastung and Tomagh areas in upland Balochistan. Tall wheatgrass and pubescent wheatgrass exhibited high dry matter biomass in southern upland region (Mastung) both in fall, 1989 and spring 1990. In north-eastern region (Tomagh), weeping lovegrass outperformed in dry matter biomass production, however, some other species such as tall wheatgrass, pubescent wheatgrass, thickspike wheatgrass, orchardgrass and steppe wildrye also exhibited encouraging results. Mixture of cool-season and warm-season grasses proved highly successful and showed promise to extend forage availability year round in upland Balochistan where winter forage deficit is a serious problem for livestock.

Nutritional and health management of small ruminants in the Dasht valley near Quetta, Balochistan (1995).

A diagnostic survey of Dasht valley was carried out in August, 1995 to take stock of existing situation and describe crop and animal production practices in the area so that a demonstration of AZRI (Arid Zone Research Institute) generated technologies at the sheep/goats farmers' level could be undertaken for enhancing output of sheep and goats production operations. Small ruminant raising is the second most priority in the Dasht

valley after crop cultivation and raised mainly to meet domestic milk, wool and meat needs, as an insurance against crop failure, unforeseen hazards, expected droughts and other emergencies and to serve as cash reserves. Animals depend on native range grazing, crop residues and contribution of each feed component to meet the nutritional requirements is almost 50%. Animals are allowed to go for range grazing for 4-5 hours daily in the morning and crop residues mostly wheat, maize, sorghum and onion straws are fed in the afternoon. Breeding starts in July August after harvesting wheat and barley crop and first lambing takes place in November-December. Next breeding starts in April May and second lamb crop is born in August September. Fertility varies from 70-80% in the area and twinning is very uncommon in sheep (<1%) while it is frequent in goats particularly in breeds from Sindh and even triplets are common under intensive management. Prolificacy (no. of lamb born/no. of ewes lambing) is almost 100% in sheep and up to 120 to 130% in goats. Lambs/kids are weaned when 3-4 month old and usually weight 8-10 kg. Enterotoxaemia, pleuro-pneumonia, anthrax, mange and liverfluke and other internal parasites are prevalent. Mortality of adult stock varies from 10-12%. A few cases of FMD (foot and mouth disease) and piroplasmiasis are also reported. Lamb mortality is high overall in Balochistan (30-40%); and ranges from 15-20% in the valley. This is a big loss to the farmers and needs special attention for improving overall sheep/goats productivity. Another important finding recorded during the survey was castration of male lambs/kids through open surgery conducted locally. Four to five percent cases get infected after this surgery. Veterinary services are insufficient in the area to carry out full vaccination and drenching program. Farmers usually approach Civil Veterinary Hospital, Quetta for urgent needs and medicines prescribed are purchased from city markets.

Value of barley grain and cottonseed cake as supplements to fourwing salt bush; and live weight gains and water consumption of sheep fed the salt bush diets (1996).

Fifteen sheep were used in a trial which compared the feeding value of whole barely grain and cottonseed cake a supplements to a basal diet of leaves of fourwing saltbush (*Atiplex canesens*). Diet SB (salt bush) contained 700 g (air dry matter) of salt bush alone, diet SB+BG (barley grain) contained 700 g SB with 400 g whole barley grain and diet SB+CS (cottonseed cake) contained 700 g SB with 400 g cottonseed cake. The digestibility of the dry matter of the diets SB (69%) and SB+CS (70%) were lower than diet SB+BG (76%). Sheep offered SB alone daily lost 80 g weight whereas those feed the other two diets gained 11 g (SB+CS) or 17 g (SB+BG) per day. Daily water consumption of the sheep offered the 3 diets was similar ($P>0.05$) but their water consumption was higher ($P<0.001$) than an other separate group of sheep offered daily 700 g wheat straw and 700 g barley grain. The results indicate that at the levels of SB feeding used, barley grain and cottonseed cake had similar value as supplements to fourwing salt bush harvested in summer. The addition of supplement to SB enabled sheep to gain some live weight. However, the presence of saltbush leaves in the diets resulted in higher water intakes by the sheep.

Parasitic infection of sheep and goats in Quetta and Kalat areas of Balochistan (1997-99).

Limited information gathered in the past is available regarding epidemiology of parasitic diseases in the Quetta and Kalat areas and this study was, therefore, conducted to document the available data and see any change in parasitic infection of small ruminants in the area over the last few years. Per-rectal samples from sheep and goats were collected from Quetta and Kalat (Kovak and Zarchi valley) areas of Balochistan to

assess the endoparasitism. The quantitative examination showed *Trichuris globulosa*, *Marshallagia marshalli* and *Strongyloides papillosa* infestation. Average number of egg per gram of faeces (EPG) ranged from 291-546. The infected animals were dull, depressed, and weak; and poor conditioned.

Prevalence of livestock diseases in Balochistan (2001).

To document the present status of livestock (sheep, goats, cattle, buffaloes, camels, horses, and asses/mules) mostly sheep and goats diseases in Balochistan, four years livestock disease occurrence/prevalence record/data (July, 1997 to June, 2001) were obtained from the Directorate of Animal Health, Livestock and Dairy Development Department, Government of Balochistan, Quetta. These data/record were analyzed month-wise and year-wise using Microsoft Excel Computer package to evaluate distribution of livestock diseases throughout the study period. These data indicated seven types of livestock maladies prevalent in Balochistan. The highest number of animals/cases treated/recorded at the Civil Veterinary Hospitals of the Province were due to endo-parasites i.e., lungworms 2,507,683 (31.74%), wireworms 1,393,604 (17.64%) and liver-fluke 1,277,822 (16.17%) followed by ecto-parasites i.e., mange 702,132 (8.88%) and ticks 534,114 (6.76%), contagious diseases 214,065 (2.70%), non contagious diseases 396,270 (5.01%), systematic diseases 114,234 (1.44%), metabolic diseases 100,867 (1.27%) and other miscellaneous diseases 659,131 (8.34%) during the study period. Prevalence of almost all these diseases was higher in summer than winter and higher during the last year (2000-2001) than the previous years of the study (1997-2000). It seems that rise of temperature in summer, severe drought conditions prevailing in the province over the last 4-5 years, inadequate availability of feed in quality and quantity from the rangelands and poor health management lead to higher incidence of livestock diseases in Balochistan. Therefore, great devotion is required to treat these diseases under the present scenario as well as viewing the future prospects of livestock production in Balochistan.

Incidence of internal parasites in sheep and goats of Asghara valley in Ziarat district of Balochistan (2002)

A study was carried out at Arid Zone Research Centre, Quetta during July, 2001 to January, 2002 to monitor internal parasitic infestation in sheep and goats of Asghara Valley in Ziarat district. A total of 105 fecal samples were collected randomly from 10-15% animals in a sheep/goats flock directly from the rectum and analyzed for presence/absence and identification of parasitic ova. The centrifugal floatation method was used for the detection of parasite eggs in the feces. Results indicate that parasitic infestation was 57% in sheep and 43% in goats in the AZRC flock; and 80% and 60% in sheep and goats, respectively in private farmers' flocks. The peak infestation (73% in sheep & 60% in goats) was recorded during August in the AZRC flock and during September (93% in sheep and 80% in goats) in private farmers' flocks of the valley. Seven different types of internal parasites i.e., nematodes species: *Strongyloides*, *Trichostrongylus*, *Haemonchus* and *Nematodirus* trematode species: *Fasciola hepatica*, the cestode species: *Moniezia* and protozoa species: *Eimeria* were observed in the two flocks. It seems evident that there is need to disinfect the private farmers' sheep/goats flocks in the valley more frequently against internal parasites to ensure minimum infestation level in these animals for enhancing their productivity.

Assessing the fattening potential of Balochi and Harnai male-lambs fed different protein and energy rations under confinement in Quetta (2002)

AZRC

Two feeding trials were conducted to study the fattening potential of Balochi and Harnai male-lambs. Trial-I used 16 Balochi male-lambs, 8-10 months old weighing 18.4 to 33.2 kg divided into 8 groups with body-weights similar within a group. Four groups (8 lambs) were assigned at random to one of the two iso-caloric (2600 Kcal metabolizable energy (ME)/kg of feed) rations with 12% (A) or 17% CP (B). Lambs were fed the rations *ad libitum* for 5 week. Daily feed offered and refused was weighed and weight of the lambs was taken weekly. Weight gain by the lambs fed on ration A (189 ± 29 g/h/d) or B (245 ± 29 g/h/d) did not differ. More ($P < 0.05$) feed was consumed by the lambs fed on ration B (1739 ± 80 g/h/d) as compared to those fed on ration A (1446 ± 80 g/h/d). Feed efficiency of the lambs fed ration A (7.9 ± 1.4) or B (7.2 ± 1.4) did not differ. It is concluded that male Balochi lambs, 8-10 month old fed on rations having 12 or 17% CP and 2600 Kcal ME/kg of feed make similar gains. Trial-II involved 16 Balochi and 16 Harnai male-lambs, 4-5 month old, randomly divided into 8 groups with 4 lambs of the same breed in a group. Two iso-nitrogenous (14% CP) rations A and B with 2300 or 2700 Kcal of ME/kg of feed, respectively were assigned to the 8 groups randomly such that there were two groups (8 lambs) of each breed on each ration. Rations were fed *ad libitum* for 12 weeks and feed offered/refused was weighed daily and lambs were weighed weekly. Lambs fed on ration A gained weight (131 ± 12 g/h/d) similar to that by lambs fed on ration B (150 ± 12 g/h/d). Feed intake also did not differ by the lambs fed on ration A (1038 ± 18 g/h/d) or B (1060 ± 18 g/h/d). Balochi lambs gained more ($P < 0.05$) weight (172 ± 12 g/h/d) than Harnai lambs (127 ± 12 g/h/d). Feed intake was also higher ($P < 0.05$) by Balochi lambs (1215 ± 18 g/h/d) than by the Harnai lambs (1016 ± 18 g/h/d). It is concluded that Balochi lambs perform better than Harnai lambs fed similar rations.

Assessment of damage to skins and hides by external parasitic infestation in Balochistan (2002-03)

The prevalence of specific external parasitic diseases (warble fly, mites and ticks) that affect directly the quality of hides and skins was investigated in this study. For this purpose, information was collected from three sources i.e., i. warble fly infested cases recorded/treated in District Civil Veterinary Hospitals (DCVH) of Balochistan between January to December 2001, ii. direct physical observation of animal flocks, iii. Interviews of animal owners and skin dealers in Quetta, Kucklak and Mastung from August, 2002 to May 2003. Overall highest infestation (2.01%) by warble fly was recorded in native flocks while lower infestation i.e., 0.72%, 0.73% and 1.46% was recorded in slaughter-houses, non-local flocks and DCVHs, respectively. During the survey, overall highest (11.16%) tick infestation was recorded in non- local animal flocks while lower (4.19%) in native animal-flocks. Negligible mite infestation was recorded in native animal-flocks whereas non-local animal-flock were found free from this pest. Warble fly larvae and mites reduce animal skin/hide prices by 10-30% and 50-70%, respectively. The external parasitic infestations can be controlled and treated by dusting, dipping and administration of injectable medicines i.e., Poron solution, Cydectin and Ivergen injection with satisfactory results. To eradicate warble fly infestation, regular spraying and dusting of medicines in the affected animals with Trichlorfon, Segavon and Nagavan powder is effective in Balochistan. Similar practice was also carried out in the past and most of the warble flies were controlled in the Zhob area. Provision of effective and low cost medicines against external parasitic infestation in livestock, adoption of proper animal health management practices and ban on illegal import/export of animals from/to neighbor countries is suggested as desired by the local livestock owners. The skin/hide dealers suggested price fixing on per square foot basis, introducing grading system and establishing a AZRC

tannery for quality skin/hide production in Balochistan.



Figure 1. Warble fly larvae collected from a goat-skin.

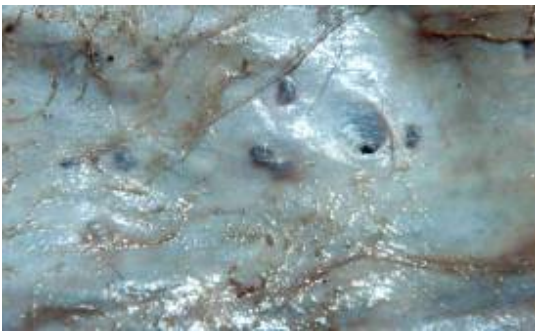


Figure 2. Inner side of a goat-skin perforated due to warble fly larvae.

TECHNOLOGY TRANSFER

The absorption of these technologies by the livestock farmers in Kovak, Dasht and Asghara areas of highland Balochistan through the AZRC demonstration efforts have shown that:

- Supplemental feeding of small ruminants, especially during winter forage deficit period has been adopted by the farmers of highland Balochistan.
- Inputs for health coverage of small ruminants are being made and farmers are widely using anti-parasitic medicine for their sheep/goats.
- The importance of clean and disease free housing of small ruminants is well realized by the farming community and dis-infection of sheds and barns is widely practiced now.
- The importance of reproduction is being realized and use of quality and proto-type uniform color rams for breeding is on the increase among the farming community.

2. CROP SCIENCES RESEARCH PROGRAM

Introduction

Pakistan's population is increasing at an alarming rate of 1.94% per annum. According to Pakistan Economic Survey 2003-04 there are more than 145.95 million people living in Pakistan. Likewise, livestock population is also on hike. Therefore, both food and feed deficits are inevitable. The country's present irrigated farmland would not produce enough wheat to feed an ever-multiplying population. As an alternative, marginal cultivable lands lying in arid/semi-arid areas are required to be utilized which can contribute moderately in overcoming and leveling the acute deficits in food and feed productivity. Therefore, after considerable forethought to the situation, Pakistan Agricultural Research Council (PARC) launched Crop Sciences Research Program (Germplasm Evaluation Program) at the Arid Zone Research Center in 1984-85. Recently, this program has been re-organized into following three units:

- a. PBG Unit
- b. Plant Protection Unit
- c. Horticulture Unit (not yet functional).

a. PBG Unit

Objectives

- Selection of germplasm of wheat, barley, and lentil for cold/drought tolerance and disease resistance for rainfed areas of Balochistan.
- Determination of crop residue potential of selected genotypes for livestock feeding .

ACCOMPLISHMENTS

Following varieties of both cereals and food/forage legumes have been released after a rigorous testing in different agro-ecological zones of highland Balochistan:

Wheat and Barley Varieties: Following high yielding, cold and drought tolerant and disease resistant (Yellow Rust Resistant) one wheat (AZRI-96) and one barley (Sanober-96) variety for highland Balochistan have been approved by Balochistan Seed Council and Federal Seed Registration Department.

AZRI-96 (Wheat): Average grain yield of AZRI-96 (Table 1) is 2000 kg/ha as compared to that of local landrace (1500 kg/ha). Similarly, total dry production (TDM) of AZRI-96 (7900 kg/ha) is also higher (Table 1) than the local wheat (7200 kg/ha).

Promising Lines (Wheat): In addition, another line {K98= DMN// SUT/ AG(ES86-7)/3/OPATA/4/Tx 71A1039-VI*3/ AMI}has been selected which is not only drought and cold tolerant but also yellow rust resistant. It is high grain yielding (2500 kg/ha) with TDM production 7500 kg/ha and flowers in 140 days and attains an average height of 100 cm (Table 2). It tolerates cold upto -17°C. Its test weight is 76.9 kg/hl. Its grain is white in color and protein content is 12.8 %. Similarly, we have also identified another promising line (Cham-6) of wheat from exotic material whose performance against prevalent stresses is very good (Table 2).

Sanober-96 (Barley): The average grain yield of AZRC barley variety, Sanober-96 (Table 1) is also higher (2000 kg/ha) than that of local barley (1500 kg/ha). Similarly, Sanober-96 also produces more TDM (5000 kg/ha) than that of local barley (4500 kg/ha).

Promising Line (Barley): Another promising line (Nal-03 = WI2291/WI2269) has flexibility in its genetic make-up and can be used both as full season and also as short season variety. The Nal-03 can produce 2100 kg/ha grain and 7000 kg/ha TDM when planted as full season variety (Table 2). If it is planted as late as February in the highlands of Balochistan when the area receives late rains during winter, it can give grain production about 700 kg/ha and TDM 2250 kg/ha.

Table 1. Released drought and cold tolerant and yellow rust resistant cereal varieties

	Wheat (Kg/ha)		Barley (Kg/ha)	
	AZRI-96 Local		Sanober-96 Local	
TDM	7900	7200	5000	4500
GY	2000	1500	2200	1600

Table 2. Yield potential of crop varieties under highland Balochistan (in pipeline)

	Wheat	Barley	Lentil (Kg/ha)	
	K-98	Cham-6	Nal-03	ILL8076 ILL8081
TDM	7500	8000	7000	3000 2600
GY	2500	2000	2100	500 460

2. AZRC Cereal Breeder has also helped ARI in releasing a winter barley variety (Soorab-96).

3. Bold-Seeded high yielding, cold and drought tolerant food/forage legumes for highland Balochistan:

Shir-AZ-96 (Lentil): One bold-seeded lentil variety (Shir-AZ-96) released for highland Balochistan is highly cold and drought tolerant, wilt resistant and high yielding. It can give seed yield upto 700 kg/ha while the local ultra small seeded landrace yields 500 kg/ha. Similarly, the new variety gives TDM from 3500-4000 kg/ha in comparison to local lentil's 3000 kg/ha (Table 3).

Promising Lines (Lentil): Two promising lentil lines (ILL-8076 and ILL 8081) have also been evaluated for highland Balochistan (Table 2) which have good desirable traits against the prevalent biotic and abiotic stresses in the target rainfed area .

Table 3. Released drought, cold tolerant and disease resistant food & forage legume varieties

	Lentil (Kg/ha)		Forage Legume (Kg/ha)	
	Shiraz-96	Local	Kuhak-96	
AZRC				

TDM	4000	3000	5000
GY	700	500	500

Kuhak-96 (Forage Legume): One released forage legume variety (Kuhak-96) of *Vicia dasycarpa* (vetch) is suitable for winter planting. It is a good green forage producing variety under the prevailing stress of upland Balochistan. It can provide a good alternate source of feed for small ruminants in the target areas of the province during chilly months of winter when the forage is almost a rare commodity. It can produce seed upto 500 and TDM 5000 kg/ha (Table 3). Presently, no annually sown forage legume variety is available for winter planting in highland Balochistan.

Technology Transfer

*The AZRC crop varieties of cereals and legumes have been disseminated to more than 250 nucleus farmers of different agro-ecological zones of highland Balochistan.

*Barley variety (Sanober-96) is one of the most popular varieties of AZRC which has been adopted by farmers of highland Balochistan widely and especially in Nal area of Khuzdar where it has replaced the local barley varieties and its seed is being sold in Karachi market and also various districts of Punjab by AZRI, Bahawalpur. Its seed has been disseminated to more than 100 nucleus farmers of Punjab.

CURRENT RESEARCH ACTIVITIES

1. Germplasm evaluation of cereals (wheat & barley) and food legumes (lentil) against abiotic (cold & drought) biotic (yellow rust in cereals and Fusarium wilt in lentil) stresses in Balochistan.
2. Breeders Nucleus Seed increase of varieties and promising lines.

FUTURE PLAN OF WORK

1. Continuation of testing of exotic germplasm to have a flow of desirable genotypes in pipeline to avoid disasters brought by stresses like yellow rust, army worm, etc.
2. Higher priority would be given to address the problems of "Sailaba" and "Khushkaba" farming systems by developing suitable crop varieties for the area.
3. Seed multiplication of selected genotypes.

b. Plant Protection Unit

In province of Punjab, Sindh and NWFP plant protection sector establishments are well-developed and manned with highly qualified people. Contrary to this, in Balochistan very insignificant plant protection facilities were available. Keeping in view the international scenario and national activities in plant protection sector, there is a dire need of strengthening plant protection activities at AZRC, Quetta.

Objectives

1. Identify the economically important diseases of vegetables, Orchards and crops.
2. Identify sources of resistant against economically important diseases.
3. Provision of diagnostic services to farming Community.

ACHIEVEMENTS 2002-2004

- The diagnosis of the potato samples indicated the infection of *potato leaf roll virus* and *potato virus Y*.
- The chilies were infected with *cucumber mosaic virus* and *chili venial mottle virus*.
- The symptoms on tomato plants and the presence of white fly indicated the infection of tomato with *tomato leaf curl virus*.

Population dynamics of aphids and thrips was carried out at AZRC and Agric. College, Quetta. Data indicated that the aphid population was higher on wheat than barley i.e. 2 aphids/tiller on wheat and < 2 aphids/tiller on barley. Thrips population was also higher on wheat as compared to barley i.e 3 and 1.5 thrips/tiller on wheat and barley respectively.

About 8 phenotypically different aphids and thrips were collected and identified as:

Apple

Rosy apple aphid (*Dysaphis plantagenia*)

Green apple aphid (*Aphis pomi*)

Black aphid (*Aphis spp.*)

Almond, peach, cherry and apricot

Brown peach aphid (*Lachnus persicae*)

Almond, peach, apricot and plum Green peach aphid *Myzus persicae*

Mint Mint Aphid *Ovatus crataegarius* (Walker)

Barley and wheat Barley thrips, *Limothrips denticornis* (Halliday) Grain aphid, *acrosiphum (Sitobion) avenae* F. and *Diuraphis noxia* (Russian wheat aphid).

3. LAND AND WATER RESOURCES RESEARCH PROGRAM

Introduction

Balochistan, province of Pakistan is by far the largest in size and the smallest in population. Upland Balochistan is located in South-Western (22⁰N to 32⁰N, 66⁰E to 70⁰E) Pakistan. The climate of upland Balochistan is continental semi- arid

Mediterranean, with annual precipitation varying from 200 to 350 mm and a variable proportion of this total fall as moisture of snow and rain in the mid winter period or as intense showers in summer. Cereal crops in particular wheat are grown by most dryland farmers as dual purpose crop, with the grain is used for human consumption and the straw as animal feed. In Balochistan two types of dryland systems are prevailing.

i) Khushkaba: It is a type of farming in which only localized (with in field) run off is generated and crop suffer moderate to severe moisture stress during crop cycle.

ii) Sailaba: It is a type of farming in which water is harvested through ephemeral streams, and crop complete its life cycle on the stored moisture.

Yield expectations are low, ranging from only 100 to 800 Kgha⁻¹ in Khushkaba and 1000 to 1500kg ha⁻¹ in sailaba farming. Farmers expect cultivation 3 - 5 years out of 10 years. In this high risk environment agricultural inputs are minimal.

In the arid uplands of Balochistan, environmental stresses are the main yield limiting factors in crop production. Major stresses are cold and drought in winter and the combined effects of drought and heat and a short growing season during spring.

Research Accomplishments

Agronomic Response of Spring Wheat In Upland Balochistan.

Studies on spring planting material were tested at different sites of upland Balochistan. Out of 104 exotic entries, 9 superior genotypes were screened out with high yielding potential, having early maturity, drought tolerance, and resistant to yellow rust (*Puccinia striiformis*). The exotic selected genotypes had better tolerance to drought and heat stress than the local land race and produced more grain and straw yield. Selected genotypes have great potential to spring planting particularly for the areas of Quetta, Mastung, Kalat, Pishin and Muslim Bagh areas.

The Dryland Arable Farming System of Balochistan.



Barley Production Under Sub-Optimal Conditions In Upland Balochistan:

The livelihood of poor dryland farmers is livestock dependant. Livestock is being grazed on open range lands. Due to over- grazing, rangelands are degraded to a maximum.

Barley is practiced as supplemental feed in irrigated areas. Three years trial data showed that water use efficiency (WUE) of barley varied from 9-14 $\text{Kg ha}^{-1} \text{mm}^{-1}$. Fertilizer helped in increasing WUE and biological yield, but was not economical to pay cost of fertilizer. Improved variety *Arabic abiad* (Syria) gave an increase of 20% in economic gross benefit. Change in crop-livestock system is required to shift the farmers from poor yielding wheat crop to better yielding crop of barley in dryland for sustainability of system and improved livestock production.

Comparison of Wheat and Barley Under Dryland

Wheat:

Results of the study reveal that water use efficiency of the local wheat land race was 8.7 $\text{kg ha}^{-1} \text{mm}^{-1}$. Application of Phosphorous and Potassium fertilizers had little effect on yields. Nitrogen fertilizer application increased straw and grain yields of the local land race by 29% and 24%, respectively. Net returns for wheat production and returns for labor were low.

Barley:

Growth and yield of a number of Syrian land races and varieties were compared to local land race on farmer's fields under dry land conditions. Rainfall during the crop growth varied from 32 to 220 mm, and grain yields varied from 10 to 1250 Kg ha^{-1} , averaging 350 kg ha^{-1} . The Syrian land races generally produced higher grain yields than the local. Application of Nitrogen and Phosphate fertilizer increased yields in almost all the trials.

The water use efficiency of the local barley land race was 11.2 $\text{Kg ha}^{-1} \text{mm}^{-1}$, and when adjusted for differences in water availability, the barley yields were 35% higher than from dry land wheat.

Development of Seed Drill for Rain-fed Farming system

Soil moisture is a limiting factor in dryland crop production system. Animal drawn single row planter being used in dryland was time consuming and was not economical. Sowing at proper time plays an important role in dryland. The Oyjord planter was altered and developed for the scientific need. A tractor drawn 2-6-row semi-automatic, fully adjustable (seed rate, seed depth, and row spacing) and mounted type planter developed and tested successfully. This planter is useful for silt loam and silt clay- loam soils being found in valley bottoms of Balochistan.



Effect of Sowing Dates on Germination of Wheat

In dry land Balochistan people even go dry sowing also. The severe weather conditions, uncertain deficient rainfalls always affect wheat germination, particularly in areas between Loralie and Sorab. A study was carried out to determine the germination percentage on different sowing dates of 13th December, 21st December, 27th December, 3rd January, 10th January, 21st January, 1st February and 7th February. It was observed that germination of wheat increases when it was sown after 21 January and maximum germination was recorded when it was sown on 7th February. Germination was less in the wheat sown after 20th December as compared to the sowing of February; germination of wheat sown in the month January was meager. It is only because of very low temperature in these months and these very low temperatures do not allow wheat seed to germinate. These low temperatures remain up to late January. It is therefore recommended that farmers should wait for February for late sowing, if they are not in a position to sow wheat in the normal season.

Agronomic Testing Of Wheat, Barley and Food & Forage Legumes



The on-farm testing of potential wheat, barley, food and forage legume varieties were carried out to observe the response of lines at different locations in upland Balochistan.

Wheat:

The data of two years reveal that, TDM of Local was recorded as the highest 5601 Kg ha⁻¹ whereas AZRI-96 and ICW were the second and third with 5118.5 Kg ha⁻¹ and 5035 Kg ha⁻¹, respectively. In biomass, Sariab-98 was the highest with 14507 Kg ha⁻¹ where as ICW and L-Zamindar were second and third in terms of biomass with 13885 Kg ha⁻¹ and 10877 Kg ha⁻¹, respectively. Where as in grain production, AZRI-96 was highest with 1480 Kg ha⁻¹ while Local and Sariab-98 remained second and third with 1420 and 1337 Kg ha⁻¹, respectively.

Barley:

According to the data TDM of Wadi-e- Hassa (W.H) was recorded as the highest with 6666 Kg ha⁻¹ where as R-99 and A.Aswad were recorded 6504 Kg ha⁻¹ and 6472 Kg ha⁻¹, respectively and remained second and third. The biomass of W. H was also highest 14497 Kg ha⁻¹ as compared to R-99 and Arabic Aswad (A-As) 6504 Kg ha⁻¹ and 6472 Kg

ha⁻¹ respectively. From grain yield point of view Arabic Aswad remained on top with 3363 Kg ha⁻¹, whereas, Wadi-E-Hassa and R-99 remained second and third with grain yield of 2722 Kg ha⁻¹ and 2654 Kg ha⁻¹, respectively.

Food and forage legumes

Vicia produced highest TDM i.e; 5727 kg ha⁻¹, where as LL2000 and Shir-AZ produced 4985 Kg ha⁻¹ and 4095 kg ha⁻¹ respectively; local land race produced lowest TDM i.e 2842 kg ha⁻¹. From grain point of view Vicia remained on the top with grain yield of 1269 kg ha⁻¹, while LS 2000 and LL2000 produced 1263 Kgha⁻¹ and 1227 kg ha⁻¹ respectively; where as Sher-AZ produced lowest grain yield.

Effect of Seed Rate and Row Spacing on yield of Lentil

A trial was conducted to determine the appropriate seed rate and row spacing in lentil in Khushkaba, as new lines of lentil were introduced that were bold seeded and the appropriate seed rate and row spacing was known. Therefore, two seed rates of 40 and 60 kg ha⁻¹ and two row spacing 30 cm and 50 cm were selected. Interaction of both seed rate and row spacing also reveals that 30 cm row spacing with seed rate of 60 Kg ha⁻¹ produced highest grain yield i.e 656 Kg ha⁻¹, whereas row spacing of 50 cm with seed rate of 60 Kg ha⁻¹ produced more grain yield as compared to row spacing of 30 cm and seed rate of 40 Kg ha⁻¹.

Water Harvesting and Nitrogen Fertilizer Application to Improve Water Use Efficiency

Nitrogen fertilizer application negatively affected the crop yield. Therefore, it is suggested that fertilizer should only be effective in wet years. Economic response to nitrogen can be expected only, if water availability is in the order of 300 mm, sustainability is only 5-25% of years under rainfed conditions in upland Balochistan. The simple water harvesting technology 1:1 on silty clayloam soils gave considerable yield increase, and in sandy loam soils this ratio must be 3:1. The results suggest that considerable increase in upland Balochistan is possible with combination of water harvesting and nitrogen fertilizer use.

Response of inoculation on food and forage legumes

Inoculation with *Rhizobium Leguminosarum* increased straw and herbage yields when water stress was less severe. It suggests that considerable yield can be increased in both food and forage legumes. Higher production could be achieved by development and extension of this technology, restricting inoculum use to years when soil water availability at planting is high.

Water Use Efficiency (WUEp)

1) Importance and improvement

The average annual rainfall of Balochistan is 150-200 mm, which is not sufficient to obtain good crop of wheat. Trials were carried out to improve the water use efficiency at five different locations in upland Balochistan. The results of the data suggest that application of Phosphorous, improved tillage and improved water harvesting (ridging, ephemeral stream diversions and bunding) are advantageous in improving Water Use efficiency (WUE).

2) WUEp of wheat varieties

The experiment was designed to evaluate the water use efficiency of different varieties. Data show that total precipitation of the year was 262 mm. In this precipitation wheat variety AZRI- 931 performed well in total dry matter (TDM) and grain yield, and water use efficiency was also best as compared to other wheat varieties.

AZRI-932 ranked third in TDM, but second in grain yield. Whereas, local land race remain second in TDM and third in grain yield. From water use efficiency point of view, AZRI-931 remained at the top with 12.3 WUEp kg ha⁻¹ in TDM and 4.1 in grains. AZRI-932 performed poor in water use efficiency in TDM, but performed well in water use efficiency of grains.

Catchment Basin Water Harvesting



Catchment basins were established on gentle slope (0.5-1°) in valley bottom soils by mold- board plowing for the upper portion of fields by removing weeds and pulverizing the soil with heavy wooden plank mounted on a three point hitch behind the tractor.

Catchment basin water harvesting is recommended for the valley bottom soils for productivity, improvement and yield stability where traditional form of water harvesting is not possible. Result suggested that only less than and equal to 227 mm annual rainfall in 50 % of the years. If 50 or 67 % of the field was compacted for catchment which comes to 1:1 and 2:1 respectively. An additional 101 and 201 mm of runoff is expected which gives annual receipts of 328 and 528 mm. 1:1, 2:1 and control were compared on farmers field in Dusht, Mastung and Kovak areas during 1986/89 trials. Higher yields were experienced in both 1:1 and 2:1 treatments. Data indicated that 43 mm additional water storage in 1:1, 67 mm in 2:1 and runoff efficiencies of 55 % in 1:1 and 43 % in 2:1.

Agro meteorology

The Khushkaba, sailaba farming system of upland Balochistan is indigenous and needs to be coordinated with the scientific information. Archive met data was imported and AZRC developed software package “BELINDA” used to develop different probabilities for research and planning.

The uncertain rainfall and temperature regimes of upland Balochistan are highly risky for sailaba and Khushkaba farming systems, rains are deficient, summers and winters are severe, crop also suffer terminal cold and yellow rust. The detail

analysis of Khuzdar and Loralai shows 40% of median rainfall during July and August, permitting autumn sowing in six (Loralai) or seven (Khuzdar) years out of ten.



Less than 10% for Quetta, autumn cereals can be expected two or three years out of ten. Cumulative probabilities of spring sowing for Quetta are 93% while it is <60% for Loralai and Khuzdar. Low temperatures delays spring plantation while terminal cold destroys local wheat in Kalat to Loralai areas. Temperature data suggests that at Quetta, spring plantation should be started after 20th January, where as at Khuzdar and Loralai there is no serious restriction for winter sowing. Spring varieties having drought and cold resistance, short season, capable of rapid germination are recommended for the areas. Crop varieties with considerable winter hardness are required for elevation of 1500 meter or above (since Quetta is 1587 m high). Khuzdar and Loralai (1231 & 1431) represent a traditional zone in this respect. Over all old Loralai including Barkhan and Musakhail districts have better rainfall distribution.

TECHNOLOGY TRANSFER

- i) Alteration and Development of Oyjord Seed drill for ridge furrow sowing in dry- lands.
- ii) Catchment Basin Water Harvesting technologies for dry lands.
- iii) Introduction of inoculation for lentils in drylands.
- iv) Introduction of Fertilizers in Uplands of Balochistan.

4. RANGE & FORESTRY RESEARCH PROGRAM

Introduction

Balochistan is a vast arid and semiarid region situated in the south-west of Pakistan between latitudes 25 °N and 32 °N. It is the largest and most sparsely populated province of Pakistan, with an area of 34.7 million hectares. About 80% of the area can be classified as inter-mountainous. The remaining 20% consists of flood plains and coastal plains. The important mountain ranges are Sulaiman, Toba-Kakar, Central Brahui, Kirthar, Chagai, Raskoh and central Makran and Markan coast. The unfavourable topographic, edaphic and climatic conditions in Balochistan have restricted the area of cultivation, leaving most for rough grazing. About 93% of the area of Balochistan is classified as rangelands.

Balochistan ranges provide a diversity of uses, including forage for livestock, wildlife habitat, medicinal plants, watershed, fuel wood, and recreational activity. Rangelands are the major source of feed for 90-95% of sheep and goats. Sheep and goat rearing is the main use of these areas and about 80% of the rural population derive their livelihood from the sale of small ruminants and by products. Nomadic, transhumant, and sedentary are the three major grazing systems in Balochistan. Out of the total area of Balochistan, 21 million ha (60%) is used for grazing. Nearly 12 of the 21 million ha is classified as poor grazing, providing annually only 30-50 kg dry matter (DM) from a hectare, whereas only 2.9 million ha of better rangeland providing 250-280 kg DM from each hectare.

Overgrazing, drought and human disturbances caused severe degradation of rangelands in Balochistan. The degradation processes of rangelands include changes in composition of desirable species, decrease in rangeland bio-diversity and productivity, reduction of perennial plant cover, and soil erosion. A major concern of Balochistan ranges is the progressive reduction of productivity, elimination of desirable species, and how to manage and restore the health of these degraded ranges. Range and Forestry Research Programme of Arid Zone Research Center, Pakistan Agricultural Research Council is carrying out research activities to better understand the vegetation dynamics and improvement potential of arid and semi-arid ranges of Balochistan.

The main objectives of the Range and Forestry Research Programme are:

- To characterize and monitor the rangeland resources.
- To conduct ecological studies on native range species.
- To conduct range restoration and rehabilitation studies.
- To determine the nutritional and anti-nutritional compounds in range species.
- To conduct ecological and agronomic studies on medicinal herbs.
- To evaluate suitable fodder tree species.

Research Methodology

Range & Forestry Research Program of AZRC conducts research activities on a variety of issues like long term rangeland monitoring, evaluation of exotic and local germplasm of potential forage species for range improvement, ecological studies on native range species, seasonal variation in nutritional and anti-nutritional compounds of range species, and evaluation of potential medicinal herbs.

A wide range of germplasm of various species of grasses, shrubs, and trees were collected and range nurseries were established at AZRC. Various species were tested in different ecological zones of Balochistan for adaptability, biomass production, and nutritional characteristics. Studies were carried out to determine the potential for biological recovery of heavily grazed grasslands by protecting the area from grazing. Long-term range monitoring studies were initiated to assess rangeland dynamics and trends in terms of biomass availability and permanent vegetation cover at different sites in Balochistan. Experiments were conducted to determine the above ground seasonal forage production and nutritional characteristics of *Chrysopogon aucheri* and *Cymbopogon jwarancusa*. Experiments were conducted to determine how seed attributes, seed dispersal mechanisms, seed bank dynamics, seed predation, and seedbed micro-habitat influences on the regeneration of *Chrysopogon aucheri* and *Cymbopogon jwarancusa*. Chemical composition of native shrubs and grasses (relative to nutritional needs of sheep, goats) and to relate that chemical composition to water use

efficiency (WUE) as measured by the carbon isotope composition of leaves and stems of shrubs and grasses along a short topographic gradient were evaluated. Studies were also conducted to assess the nutritional status of sheep and goats grazing two rangeland types in Balochistan. These types are *Artemisia maritime* and *Haloxylon griffithii* association represented by the Zarchi (dist. Kalat) range and *Cymbopogon-Chrysopogon* at Tomagh (dist Ziarat).

Efforts are underway for the establishment of medicinal herb garden at AZRC and introduction of potential medicinal herbs and spices as crops in Balochistan

ACHIEVEMENTS

Introduction of *Atriplex canescens* and *Atriplex lentiformis* in highland Balochistan

Atriplex canescens and *Atriplex lentiformis* commonly known as fourwing saltbush and Quail saltbush (Figs. 1 & 2) are exotic halophyte from the western United States. These are perennial drought and cold tolerant shrubs and can successfully be planted in areas with 250 mm annual rainfall.



Fig 1. *Atriplex canescens* plant with dense green foliage

These species start new growth in early spring that continues until late summer when moisture limits further growth. Micro-catchment water harvesting could enhance and prolong growth. A 1.0 m tall *Atriplex canescens* plant with 0.60 m crown diameter would provide about 0.25 kg dry matter as leaf and about 0.72 kg dry matter as wood. The amount of leaf offered each day, supplemented with wheat or barley straw or stubble, is sufficient to maintain the live weight of a sheep.



Fig 2. *Atriplex lentiformis* plants at seed formation stage.

A forage-reserve of 1 ha of *Atriplex canescens* with 2,500 plants would maintain 28 sheep with browse for three months in late summer, autumn, or winter when range vegetation is extremely scarce in highland Balochistan.

Feeding small ruminants on *Atriplex* alone is seldom recommended because of the poor energy value of the leaves and the associated moderate intake. Therefore, to obtain modest live-weight gain, supplementation is necessary either with barley or wheat straw. The protein content of *Artiplex canescens* leaves decreases from 25% in April to 10% in August and gradually increases during winter to about 20%. The natural detergent fiber (NDF) content peaked in May, decreased gradually during summer and autumn and recovered again during winter, whereas acid detergent fibre (ADF) content decreased gradually until September but then remained fairly stable.

Browsing of shrubs in forage reserves is considered to be the appropriate way to use *Atriplex* species, although cut and carry may be used in cases where farmers wish to cut large bushes for fuelwood and to encourage re-growth. Gently sloping valley bottoms of highland Balochistan are the most suitable areas for establishing *Atriplex* forage reserves. A package of *Atriplex* technology has been developed by AZRC that addresses all related aspects of saltbush technology i.e., transplanting techniques and managing saltbush reserves for grazing and fuelwood production.

Introduction of *Salsola vermiculata*: A Self-regenerating fodder shrub

Salsoal vermiculata commonly called saltwort is an exotic Mediterranean arid zone fodder species (Fig.3). This species belongs to the Chenopodiaceae family. It is saline and drought tolerant, a good pasture species across all seasons and is palatable to small ruminants. *S. vermiculata* has the potential of self regeneration and establishment under good rainfall years.



Fig.3. *Salsola vermiculata* - a potential fodder shrub for range improvement in highland Balchistan.

S. vermiculata showed excellent survival under the extreme drought conditions of Balochistan. Forage production ranged from 250-650 kg/ha with an equal amount of wood production. Crude protein content ranged from 15-18%.

***Eragrostis curvula*: A potential grass for Rangeland Improvement**

Cool and warm season exotic grass species were evaluated in different parts of Balochistan for their adaptability and biomass production. In Loralai, *Eragrostis curvula* (weeping lovegrass) showed excellent performance (Fig 4).



Fig 4. *Eragrostis curvula* (weeping love-grass) plantation in Tomagh (Loralai).

This is a warm season, perennial bunch grass. Dry matter production of weeping love grass in Tomagh (Loralai) ranged from 1945 to 2424 kg/ha. Crude protein content ranged from 8 to 10%.

Biological Recovery of Grasslands in Balochistan

Efforts were directed to understand the dynamics of biological recovery of degraded rangelands of Balochistan. Above ground biomass productivity inside enclosure vary from 224 kg/ha to 605 kg/ha compared to outside enclosure of 17 to 279 kg/ha. Grassland at Tomagh has responded more vigorously to protection and biological recovery. Heavily grazed grasslands of Tomagh has potential of biological recovery if protected from grazing at least for two years depending upon rainfall distribution.

Rangeland Monitoring Studies in Highland Balochistan

Long-term range monitoring studies were initiated to assess rangeland dynamics and trends in terms of biomass availability and permanent vegetation cover. The forage biomass data collected from the range sites in a typical mountain region indicate that the rangeland productivity is more a function of seasonal rainfall than the grazing pressure alone. Though the vegetation types (*Artemisia-Haloxylon* shrub steppe) in Hazarganji and Mangochar sites and (*Cymbopogon-Chrysopogon* mixed shrub grassland) in Tomagh range site are considered to be fairly drought resistant but the spring and fall season forage production showed a drastic low value at all sites due to drought during 1998-2002. However, low forage biomass values also indicate heavy grazing pressure during the drought years and therefore, reflect combined effect of both drought and the resultant heavy grazing pressure.

Seasonal Variation in Biomass of *Chrysopogon aucheri* and *Cymbopogon jwarancusa* in Highland Balochistan

Current season growth and nutritional characteristics of *Chrysopogon aucheri* and *Cymbopogon jwarancusa* were assessed on monthly basis at Hazarganji National Park. Above ground current season biomass production of both species peaked in June and then showed a declining trend. The current season biomass of *Cymbopogon jwarancusa* ranged from 27 kg/ha in April to 51 kg/ha in June whereas *Chrysopogon aucheri* current season biomass production ranged from 2 kg/ha in April to 54 kg/ha in June. The trend of current season growth in 2002 was also similar to 2001 except slight increases in biomass due to better rainfall and availability of soil moisture.

The nutrition of both grasses decreased with the advancement of the phenological growth stages. In early spring, both grasses were of higher quality (nitrogen and phosphorous). The concentrations of K and Mg were below the recommended minimum requirements for small ruminants. Therefore, grazing management is required for better utilization of protected grasslands.

Regeneration ecology of *Chrysopogon aucheri* and *Cymbopogon jwarancusa* in grasslands of upland Balochistan

Experiments were conducted to determine how seed attributes, seed dispersal mechanisms, seed bank dynamics, seed predation, and seedbed microhabitats influence the regeneration of *Chrysopogon aucheri* and *Cymbopogon jwarancusa*. *Cymbopogon jwarancusa* was superior to *Chrysopogon aucheri* in several aspects of plant recruitment. *Cymbopogon jwarancusa* produced more filled and viable caryopses than *Chrysopogon aucheri*. *Chrysopogon aucheri* solely dispersed triplet spikelet, whereas *Cymbopogon jwarancusa* dispersed paired spikelets and groups of spikelets (partial racemes, entire racemes, and partial inflorescences). Ant (Tica Verona) predators appeared to have a greater preference for *Chrysopogon aucheri* spikelets than *Cymbopogon jwarancusa* spikelets. Both species had a weakly persistent seed bank.

Both species are capable of natural regeneration when protected from livestock grazing; however, it appears that *Cymbopogon jwarancusa* has a distinct advantage over *Chrysopogon aucheri* during the initial stages of plant recruitment. Recruitment of both species is probably very sporadic because of the variability in the amount and distribution of precipitation within and between years. Regeneration of grasslands

required proper grazing and protection from grazing to ensure seed production and reserves of soil seed bank.

Dietary composition and nutritional status of sheep and goats grazing two rangeland types in Balochistan

Studies were conducted to assess the nutritional status of sheep and goats grazing two rangeland types in Balochistan. These types were *Artemisia maritime*/*Haloxylon griffithii* association represented by the Zarchi (Kalat) and *Cymbopogon*-*Chrysopogon* at Tomagh (Loralai). Forage quality decreased with the advancement of phenological growth stages. Spring forage samples were of higher quality than those of other seasons. Grasses were lower in crude protein concentration and higher in neutral detergent fiber content than forbs and shrubs. From March through October, sheep and goat diets varied in their botanical composition on both sites. Grasses remained a major component of animal diets at Tomagh throughout the grazing seasons. However, sheep and goats consumed a higher percentage of shrubs with the passage of time. Across all grazing seasons, the diets of both animal species were deficient in protein and phosphorus.

Highly variable (both positive and negative) digestion coefficients for lignin were obtained by using sheep and goat rumen liquors. As much as 51.0% of forage lignin in samples was digested. Negative lignin digestion coefficients were also obtained from forage samples. These ranged from -1.0% to 103.0%. Lignin bio-degradation and/or complexing during *in vitro* digestion invalidated its use as an internal marker in digestion studies on these rangelands. The information can be utilized for successful range management including calculation of forage calendar, nutritional value of range plants and the cycle of nutritional requirements of the small ruminants.

Nutrient characteristics of foliage and the availability of water in a rangeland near Quetta

Chemical composition of native shrubs and grasses were determined related to water use efficiency (WUE measured by the carbon isotope composition of leaves and stems of shrubs and grasses) along a short topographic gradient at Hazarganji National Park. Communities at each point of the elevation gradient varied in species composition. At the lowest point, the grasses *Chrysopogon aucheri* and *Cymbopogon schoenanthus* were common. The dominant shrubs were *Artemisia scoparia* and *Sophora griffithii*. As elevation increased, these grasses were replaced by *Bromus spp* at a lower density, and the shrubs were replaced by *Ferula ovina*, *Perowskia atriplicifolia*, *Prunus eburnea* and *Fraxinus xanthoxyloides*, again at a lower density. At the highest point of the gradient, plant density was least and much less than at lower points. *Caragana vlicina*, *Caragana ambigua* and *Ephedra intermedia* dominated with a few scattered grasses.

The $\delta^{13}\text{C}$ data from Hazarganji strongly suggest that more water was available at the bottom of the elevation gradient (less negative $\delta^{13}\text{C}$). The $\delta^{13}\text{C}$ data match the measured increase in non-protein nitrogen in shrubs and grasses with elevation. Plants accumulate non-protein nitrogen, mostly non-essential amino acids, in response to drought. The concentration of non-protein nitrogen would increase while that of total nitrogen will decline as plants mature and as water availability continues to decline later in the year.

The low N:P ratio of both shrubs and grasses is suggestive of an N limitation and is a

common constraint to productivity in rangelands throughout the world. Nonetheless, at the time of sampling, all species, with the exception of the few annual grasses and *Ephedra nebrodensis*, had concentrations of nitrogen in foliage that were greater than the recommended minimum for ruminants. Concentrations of phosphorus and calcium were marginal for grazing ruminants except in a few species and Ca:P ratios were between 1:1 and 2:1 which is ideal for growth and bone formation. All shrub and grass species had lower concentrations of potassium than recommended. Magnesium concentrations were also low in all species.

The preliminary studies of plant nutrition in Hazarganji Chiltan National Park has provided a single example of the effects of water availability on forms of N in forage plants (albeit confounded by changes in species composition along the gradient) and an overview of the variation in nutrient concentrations among species.

Introduction of Medicinal Herbs and Spices as Crops in Balochistan

Herbs can be used in many forms like flavors, spices, perfumes and medicinal ingredients. Most herbs contain essential oils (Volatile oils), which are responsible for the distinctive taste and fragrance. Other major chemical compounds include aldehydes, ketones and alcohols. In Balochistan, there are several medicinal plants, which are used, locally in traditional preparation but they have not been scientifically investigated so far for commercial scale production. Some of the potential aromatic/medicinal herb plants, which have potential to increase the income of local farmers of Balochistan, are Lavender, rosemary, mint, thyme, marjoram, oregano, basil, dill, sage, funnel, and tarragon. Efforts were directed for introduction of new spices/herbs in Balochistan farming systems, promotion of cultivation of medicinal herbs and spices in farming systems, agronomic research on medicinal herbs and spices for improvement in production technology at farmer's fields and establishment of medicinal herb garden.

Experiments on various herbs are underway. Medicinal herb garden was established at AZRC. Fifty five exotic species were raised at AZRC Medicinal Herbs garden. These species have many uses for treating different diseases.

Technology Transfer

Through the integrated efforts of AZRC and Balochistan Forest Department as well as NGO's such as FAO/UNDP Watershed Planning and Management and Integrated Range/Livestock projects, ADB Livestock Production extension Project, FAO Inter-regional Upland Conservation Project, seedling of fourwing saltbush and quail saltbush have been planted in various districts of Balochistan. AZRC is also supplying seeds of *Atriplex canescens* and *A. lentiformis* to various NGOs and line departments for large scale nursery establishment in various parts of cold mountain areas in Balochistan along with technical know-how about nursery raising and planting.

Range and Forestry Research Programme of AZRC in collaboration with OXFAM, Action Aid, and farmers of desert area of Nushki (Balochistan) has successfully planted two *Atriplex* species (*Atriplex canescens* and *A. lentiformis*) at Dhak area in Chagai district. Two nurseries were established near Nushki area for seedling multiplication of *Atriplex* and *Salsola* species.

5. AGRICULTURAL ECONOMICS

Introduction:

Keeping in view the importance of agricultural economic section, it was established during mid 80s. Its role was to work in the field of socioeconomic research on crop-livestock areas independently and to help interact with biological scientists of various disciplines of AZRC. Since the establishment of Agricultural Economic Research Unit (AERU) at Agriculture Research Institute ARI), Sariab, in 1987, the research work on socioeconomic at AZRC has virtually been combined to save financial resources and avoid duplication. The staff strength at AZRC remained not as much of earlier.

Specifically, the section has following mandates:

- 1) To conduct descriptive and diagnostic surveys,
- 2) To identify on-farm problems and farmers' research needs and translate into research priority,
- 3) To evaluate economic/social benefits and cost of new technologies,
- 4) To determine the socio-economic viability of alternative technologies to identify farm level constraints in their adoption, and
- 5) To conduct macro level studies on specific commodities and highlight areas for policy interventions.

A large numbers of research publications are in the credit of agricultural economic section. The abstracts of major studies carried out since 1987 to 2003 are offered in the following pages.

SALIENT FINDINGS

Constraints in dryland Agriculture

Different diagnostic studies on dryland agricultural systems identified the major constraints which include rangelands management and control problems, poor genetic potential of animals and nutritional deficit, etc.

Economic Losses due to Yellow Rust Infestation

Survey on the economic impact of yellow rust infestation in wheat crop estimates grain revenue losses due to yellow rust infestation in three districts (Khuzdar, Kalat and Loralai) were Rs. 123.07 million with corresponding estimated straw revenue losses of Rs. 76.60 million.

Economics of Water Harvesting

Economics of water harvesting results show that at the best, the treatment 1:1 increased net return by 35% in wheat and 7% in barley as compared to the traditional farmer's practices. Correspondingly economic risks were reduced by 30% in wheat and 15% in barley.

Camel Utilization in Balochistan

Camel utilization practices in highland Balochistan reveal that per capita camel availability is about one camel per 14 persons. The average number of camels owned was 5.2, which results in three hectare of total cultivable land per camel. Female camels are used for
AZRC

transportation while 60% of the camel owners preferred using male camel for ploughing, planking and planting.

Women Participation in Agriculture

Results of a survey of women participation in upland Balochistan shows that their participation extends to all aspects of agricultural and livestock production, in addition to which, many contribute supplementary income through home-based income generating activities. In spite of this critical role, the results show that the respondents have little independent access to productive resources, and are by and large excluded from the decision-making process affecting the household.

Marketing of sheep/goat skins in Balochistan

The marketing of goat and sheep skins in highland Balochistan reveals that two major factors affecting the skin prices are seasonality and animal species. Prices for sheep and goat skins received by butchers in winter were 16-22% higher than prices in summer. Sheep skin prices were 38-83% higher than goat skin prices. All butchers sold skins directly to beoparies. Beoparies grade skins by size and used place of origin as extra criterion.

Revenue Losses Due to Illegal Trade

Pakistan suffered a revenue loss of Rs. 25000 million as a result of illegal import/export of both agricultural and non-agricultural commodities among Pakistan, Afghanistan and Iran during 1997-98. The commodities worth of Rs. 44062 million were exported illegally from Pakistan to Afghanistan and Iran. Simultaneously goods of worth Rs.67175 million were imported illegally into Pakistan from Afghanistan and Iran. assuming 18% export duty (10% export + 8% bribe) and 25% import duty (15% custom + 10% bribe), GOP suffered a huge revenue loss of Rs.24720 million in import and export duties due to this illegal trade.

Determination of goat and sheep prices in markets of Balochistan

A market survey of weight, age, gender, body condition and breed was undertaken to examine the effect of these animal characteristics on prices per head during 1998. Three markets, two primary and one terminal were chosen for the study. A quadratic hedonic price model was applied to determine the impact of animal characteristics on price. In the model, the variables were found significant. Live-weight was found to be statistically significant in determining price followed by gender, age and body condition.

6. AGRICULTURAL EXTENSION AND COMMUNICATION SECTION

The main objectives of Agricultural Extension and Communication Section are; Dissemination of AZRC-generated technologies by using different traditional and innovative methods including holding farmers days, publishing pamphlets, using video documentaries and electronic media etc.

ACCOMPLISHMENTS

PARL Model activities.

AZRC

Pilot areas in Dasht, Kanak and Kovak valleys were selected to start transfer technology activities under the PARC's PARL Model scheme. Under the Model, tested technologies are being extended to the farmers through cooperatives or farmers associations. This model is being run by the Regional Research office in Balochistan in close collaboration with the AZRC, provincial agricultural research institutes and NO's including international projects like FAO/UNDP. AZRC developed technologies on dryland agriculture were disseminated in these valleys of highland Balochistan with farmers participation:

A Rapid Rural Appraisal of the pilot areas was conducted by multi-disciplinary team comprising AZRC, AERU,RRO and ARI staff to identify the main problems and suggest possible interventions. About 70 acres of land in various villages of Dasht valley was planted with improved crop varieties of AZRC and ARI adopting improved agricultural practices like seed drill, fertilizer and seed dressing etc. Five Farmer associations were formulated in these pilot areas to coordinate and implement the latest interventions for increasing agriculture production. A package of health cover for the small ruminants developed by AZRC was inducted in these areas by holding veterinary camps. Strategic supplementation was demonstrated to the farmers to increase the livestock production in the area. Spray program on the orchards of different fruit crops was also organized with the cooperation of FAO/UNDP Fruit development project and Agricultural extension departments. Moreover, forage reserve blocks of fourwing saltbush were also established by the cooperative farmers.

Household agricultural production systems

A study on household agricultural production system was carried out in five representative locations of four districts in Balochistan. These districts includes; Khuzdar, Kalat, Quetta and Loralai. A sample of two hundred households, 40 households from each location were interviewed. The major objective was to know the rural household related agricultural activities. The study results were compiled in tabulation form.

Women household agricultural systems

production

This survey was carried out in three districts comprising Khuzdar, Quetta and Loralai interviewing seventy-two women households. The objective of this study was to provide descriptive and diagnostic baseline information, which would be used to assess and monitor the effects that agricultural interventions may have on gender roles. The specific objectives were to 1) identify the specific areas of the farming systems where rural women participate in, and 2) define the relevant socio-cultural factors which limit women's participation in the farming system and to control of household resources and income.

Women's participation in the rainfed farming systems of Balochistan

The results show that women's participation in the rainfed farming systems of Balochistan extends to all aspects of agricultural and livestock production in addition to which may contribute to supplementary income through home based income generating activities. In spite of this critical role, the results revealed that the respondents have little independent access to productive resources and by and large excluded from decision-making processes affecting the household. This is the result of specific socio-cultural,

economic and religious factors, which must be understood and taken into account in the design of interventions.

Agricultural and related statistics of upland Balochistan. (1988)

Secondary data and information gathering is part of the descriptive and diagnostic studies. This report contains data on only upland districts of Balochistan regarding land utilization, crop distribution, tenure, cropped area and yield on district basis, agricultural inputs mechanization, livestock, forestry, credit, wholesale crop market prices etc. Upland Balochistan encompasses the districts of Kachhi, Khuzdar, Kalat, Loralai, Pishin, Quetta and Zhob. Tables on upland Balochistan and total Balochistan are given for comparison. Yearly basis data is normally available in the agricultural statistics, ten years data were made available in this report. The information was collected from various departments and compiled into a single report for the benefit of AZRC scientists and others.

Growth rate for hectareage, production and yield of various crops have been calculated by applying regression the log of either hectareage, production or yield on time($\text{Log } Y = a + bx \text{ time}$, where $b \times 100 = \text{the growth rate}$).

Farmer-managed trials in the kovak valley, Balochistan

Wheat is the most important crop grown in upland Balochistan as it serves dual purpose, grain for human and straw for their animals. In seven years out of ten, dry land farmers in upland Balochistan do not receive sufficient rainfall from the summer monsoon for autumn wheat, yet they have only one variety for both spring and autumn sowing.

Farmer-managed field trials examining the effect of fertilizer and a new wheat variety with twenty farmers in Kovak valley were experimented in 1987. The trial consisted of four treatments with one replication at each farmer land, each location being treated as a replicate in a completely randomized design. Farmer-managed trials comparing an improved spring wheat variety with this local facultative winter type with and without fertilizer (60kg/hect.)

The results were used for cost benefit analysis considering labour data on soil preparation, planting, harvesting and threshing. Net benefits ranged from Rs 250 to Rs 600/ha in these trials.

Barley in the rainfed farming systems of Balochistan (1989).

After wheat, barley is an important rainfed crop in the highland Balochistan. The Arid Zone Research Centre, has conducted research on barley productivity under on-farm field condition in various locations of Balochistan. The results revealed improved variety of barley grain yield are higher than local landrace. Net benefits for an improved barley variety were higher than the local variety. A questionnaire was designed to carry-out survey for:

A survey of barley producers was carried out in upland Balochistan. Three areas chosen

for the survey represented different rainfall levels. Thirty barley growers were interviewed in Khuzdar (Loc.1), 31 farmers from Kalat, Quetta and Pishin (Loc.2), and 25 farmers were interviewed from Loralai and Zhob districts (Loc.3).

The results indicated that barley has early maturity than wheat, so birds damage the crop despite rust, insect and smut attack. Farmers preferred wheat straw to barley straw due to the higher prices of wheat relative to barley as barley market is small and uncertain, and above all wheat is used for household consumption. It is concluded that farmers of the area would grow more barley if the barley yield or barley price increased by 50 to 100 percent.

Ex-ante economic technology evaluation for research and extension program design: sheep production and improvement in Balochistan, Pakistan (1989).

An ex-ante economic evaluation of eight i.e health, flock management, high energy feeding and breeding intervention combinations for the improvement of sheep production in Balochistan were carried out using sheep flock budgeting model. The objective was to provide information for research and extension program design prior to undertaking of a full experimentation program. On-farm testing and evaluation of the interventions included an assessment of the technical viability in the field, economic profitability and risk.

The major limiting factor to increasing sheep and goat productivity in Balochistan is the harsh environment with low and erratic intra-and-inter year rainfall. Important constraints to increase small ruminant productivity, which stem from the harsh environment, are nutritional deficiency, animal disease, poor flock management and poor genetic potential.

The results indicated that out of eight, interventions 1, 2, and 3 involving vaccination, deworming, dipping and flock management were found economically profitable under both good and poor rainfall year scenarios. These three interventions, especially if used in combination, seem viable opportunities to increase sheep productivity in Balochistan. Interventions 4 through 8, which involve feeding, did not prove to be highly economical overall with B/C ratios around 2 and less. In the good rainfall year scenario, interventions 4 through 8 all had a B/C ratio of 1 or greater, but given feed availability. In poor rainfall year scenario, only interventions 7 and 8 had a B/C ratio greater than 1.

Descriptive and diagnostic studies of sheep and goat production in the farming systems of upland Balochistan (1989).

The sheep and goat industry of Balochistan operates within a harsh climatic environment and is characterized by small flock obtaining most of their feed from relatively unproductive rangeland. At present most flocks are poorly managed as secondary enterprises and are used as a store of wealth rather than a commercial business. A survey of farmers was undertaken in Zarchi area of Kalat district and Tomagh in Loralai district representing locations with different ethnic groups. The objective was to obtain data and information on livestock numbers, rangeland ownership and control, and supplementary feeding. The results revealed that sheep and goats are the major class of livestock in Balochistan and numbers have increased substantially. Major constraints are nutritional deficit, disease and health problems, poor flock management, lack of sufficient infrastructure, rangeland management and control problems, and poor genetic potential of animals in Balochistan.

An important step in increasing the long term productivity of sheep and goat industry is the development of an overall strategy by the Balochistan Government to guide the industry taking into consideration of 1) sheep and goat marketing and export trade opportunities, 2) changes into crop land use for more feed production, and 3) the role of research and extension.

Animal raising in highland Balochistan: a socio- economic perspective (1989).

Baseline data covering the socioeconomic life of the animal raisers was covered in this study. A formal survey by a multidisciplinary group of scientists from AZRC was carried out in 1987. Two hundred households, 40 each from Ferozabad (Khuzdar), Kovak (Kalat), Zarchi (Kalat), Dasht (Kalat), and Tomagh (Loralai) were chosen at random. The major concern of this study was to

- 1) Identify the utilization of labour force of animal raisers,
- 1) Documentation of grazing pattern and systems
- 2) Identify constraints and problems of animal raisers.

In the rural areas, the labour force in agriculture is under utilized, so the animal raising enterprise is the option left for the utilization of labour force in the rural households. Most of the lands where crop raising is not possible are used as grazing land. These are generally located in remote and mountainous areas. The three main sheep and goat production systems common in Balochistan are transhumant, nomadic, and sedentary/household types. Among the nomads groups, there are two types; true nomadic and the semi-nomadic. Like nomads, transhumants are two types those moving between the highlands and the plains that practice dryland farming and those moving within the common rangelands and spending their summers and winters according to grazing availability.

It is evident from results that these systems of animal production are undergoing severe pressure to change from traditional modes owing to the combined and associated stimuli of national development, animal overpopulation and degradation of range feed resources.

Livestock production and related statistics in Balochistan (1989).

Livestock production is the major livelihood of the people of Balochistan. Ninety-three percent of the area of Balochistan is unit for cultivation and thus used for livestock grazing. An effort has been made to describe the livestock breeds of Balochistan and data from different sources has been gathered. This will provide an opportunity to exploit their potential in different areas of the province.

The major breeds of cattles are: Bhagnari, Lohani, Rojan, and Red sindhi. The sheep breeds in Balochistan are Balochi, Bibrik, Harnai, and Rakhshani whereas goat breed are Kajli, Khurassani and lehri. The detail information of veterinary hospitals and dispensaries are compiled and presented in this report. Milk and meat production in Balochistan has also been estimated and available in this research study.

Production and marketing of potatoes in upland Balochistan: a preliminary survey (1989).

Balochistan produces about 13% of the total potato of Pakistan. Potato is grown as summer crop in the hilly areas and winter crop in the plain areas of Balochistan. At

present the average potato yield in Balochistan is 10.5 tones per hectare, which is very low, as compared to 25-40 t/ha obtained in major potato producing countries of the world. Three locations i. e Kanak and Mungocher in district Kalat, and Kanmehterzai in district Pishin were surveyed and a representative sample of 5 villages from each of the three locations were selected. The thematic concern was to: 1) To study the existing potato production practices of the farmers, and identify major production constraints, 2) evaluate the cost of production, 3) study the prevailing marketing system, channels and margins, and 4) recommend research priorities and suggest policy measures.

The results indicated that the potato production appears to be declining in Balochistan. The factors contributing to this low productivity include diseased and physiologically poor quality seed tubers, incorrect timing and quantity of irrigation and poor agricultural practices adopted by the growers in upland Balochistan. Extreme price fluctuation discouraged farmers from taking the risk associated with adopting new technologies. Returns were calculated on the basis of overall average yield and prices obtained by the respondents. The net return at producer level was Rs 7832 per hectare and Rs 815/ton which seems adequate. The study concludes that the production can be increased if availability of improved, disease free and certified seed is ensured. The main fields of research might include; selection of higher yielding varieties from exotic material, breeding of higher yielding varieties, analysis of soil, pathological and entomological studies to determine effective methods of control of potato crop etc.

Economics of water harvesting trials with cereal crops in highland Balochistan (1993).

The most limiting factor for crop production in rainfed areas of Balochistan is the skewed distribution of rainfall in both time and space. Annual rainfall in highland Balochistan ranges from 175 to 200mm. Crop production under Khuskaba and Sailaba farming system totally depends either on rainfall or runoff water collected from non-cultivable land to supplement rainfall. A water harvesting technique was experimented under different treatments (Control, 1:1, 2:1, and 3:1 catchment: cropped area) by the AZRC scientists. A study was designed with the following objectives: 1) to compare the water-harvesting techniques with the existing farming practices and 2) to determine to what extent economic benefits are increased and their associated risks decreased. Data from six seasons of wheat trials and four season of barley trials were used. Partial budgets were developed for each crop, season, location and trial, to calculate net benefits and costs associated with the treatments.

Results from wheat trials showed that the 1:1 treatment had 22 percent higher net benefits (Rs 422/ha) than the control (Rs 345/ha) with a 22 percent reduction in the coefficient of variation. The 2:1 treatment had 33 percent lower net benefits (Rs 230/ha) than the control and reduced the variation in net benefits by 10%. In contrast, barley trials showed that the 1:1 treatment yielded 18 percent lower net benefits (Rs 291/ha) than the control. Treatment 2:1 had 14% lower net benefits (Rs 251/ha) than the control and 19% more variation. The reduction in total costs under the 1:1 treatment resulted in higher net benefits than the control.

Marketing of goat and sheep skins in highland Balochistan (1989).

Informal and formal survey information was used to investigate the marketing process of sheep and goat skins, to identify problems faced by intermediaries involved in skin marketing, to identify opportunities to improve marketing efficiency, and to evaluate the potential for developing tanneries in Balochistan Sixty butchers and 35 *beoparis* were interviewed in Quetta, kuchlak and Mastung (group-I), Sanjavi and Loralai (Group-II), Kalat and Khuzdar (Group-III) of highland Balochistan. Beoparis' warehouses in Quetta

city were visited to measure the length and width of 80 sheep and 50 goatskins, which were classified by size (small, medium and large) and by origin (Balochistan, Iran and Afghanistan).

Prices for sheep and goat skins received by butchers in winter were 16-22% higher than prices in summer. Sheep skin prices were 38-83% higher than goat skin prices. All butchers sold their skins directly to *beoparis* (wholesalers) who collect the skin. Across all the areas, only the market margin of goat skins was significant. Price information flowed on one-to-one basis, and there was no agency that monitor skin prices. Because of poor management, most of the skins of highland Balochistan were found of low quality in term of size, thickness, flying cuts and scars. A tannery could be an example of the economic potential for value-added products compared to by-products. This would encourage the producers to produce better quality skins demanded by the tanneries.

Camel survey results in highland Balochistan, (1991).

The camel population in Balochistan has increased very rapidly in the last 20 years, from 46,000 camels in 1965 to 349,000 camels in 1986 which indicates 35% of provincial share. Per capita camel availability is about 1 camel per 14 inhabitants. It is apparent that camels are widely utilized for diverse farming activities and for transportation in the rural and urban areas.

Agricultural economists and livestock specialists of AZRC conducted a descriptive, diagnostic, and comparative survey on camel utilization for draft and transportation at the farm level. An informal survey took place prior to formal survey which comprised 136 questionnaires in three areas of highland Balochistan. The information collected comprises household profile of camel owners, use of camels, number of camels owned, and land ownership. Detailed information was collected on camel demography, production and feeding constraints. The information is compiled describes the usage of camels for agricultural and non-agricultural activities in highland Balochistan. Information on economic transactions: the value of camels by age-group and sex, number of camels bought and sold, qualities looked for in male breeding camels and the income earned from camel services. The management practices for camels used for agricultural and non-agricultural activities are described. Veterinary services available and working conditions of camels are also presented in this report.

Marketing and processing of small ruminants in highland Balochistan (1991).

More than ninety percent of the small ruminants in Balochistan are produced under transhumant and nomadic pastoral systems. This study investigated the livestock and meat marketing practices in upland Balochistan. Three locations in highland Balochistan: Sanjavi, Kuchlak and Zarchi were selected. Twenty-five producers from each location and 10 village dealers, 5 commission agents and 10 butchers were interviewed. Livestock producers were reluctant to allow actual weighing of their animals; therefore, girth and height were used to estimate live weights. Producers have little knowledge about market forces and quality of livestock. The results indicated an average weight of a sheep was 26.4 kg and for a goat was 21.8 kg with estimated farm-gate prices of Rs 512 and Rs 480, respectively. Correspondingly, services of intermediaries in the marketing chain represented 32% (Rs 238/head) and 30% (Rs. 202/head), respectively, of the price paid by consumers.

The main factors affecting the price of animal are species, breed, quality, sex, age, expected carcass weight, skin condition and the supply of animals. The study recommended that extension efforts should make producers aware of market prices and need to plan output more carefully according to seasonal price fluctuation.

Determination of goat and sheep prices in the markets of Balochistan – Pakistan (1998).

This study dealt with an analysis of factors underlying sheep and goat price variation in Balochistan. A market survey of weight, age, gender, body condition and breed was undertaken to examine the effect of these characteristics on prices per head and per kg. Three markets; two primary and one terminal, were chosen for the study. The information was gathered on a weekly basis for 28 weeks, and the price per head data was analysed using linear regression. A quadratic hedonic price model was also applied to determine the impact of animal characteristics on price per kg. Cross correlation analysis was also carried out using weekly average prices of primary and terminal markets.

The explanatory power of the linear model was considered adequate as factors included for 79%, 81% and 82% of goat price variation at Mastung, Kuchlak and Quetta markets respectively and more for sheep. Live-weight was found to be statistically significant in determining price followed by gender, age, and body condition. There was no strong evidence that breed affected price. In the hedonic price model, Kuchlak and Mastung were treated together, and the variables were found significant. The cross correlation analysis showed that prices were relatively closely correlated between markets over time, reflecting trade connections between the primary and terminal markets.

The recommendation made on the basis of study results is to install a weighing machine separately for small as well as large ruminants at the market entry points in all the established markets in Balochistan. This would bring the producers at par with other market agents in terms of price-factor knowledge, at least live-weight, the main price determining factor, should be known to producers at the time of sale.

Socioeconomic systems of pastoralist communities of highland Balochistan, 2000.

While documenting various socioeconomic systems of pastoralists in Balochistan, keeping in view the characteristics of a particular community was classified into three major groups.

1) Nomad pastoralists 2) Transhumants, 3) Sedentary Nomads were further geographically divided into 1) Local, International and 3) Afghan refugee pastoralists and ethnically 1) Baloach, 2) Brahavi, and 3) Pawanda. Transhumants comprises into Pashtoon and Baloch.

Gradual socioeconomic transformation of pastoralists has been a classical feature in Balochistan. All the three traditional classes of pastoralists are subject to transformation in one or other way. Expanding cultivation is generally restricting movement of free roaming animals. In general, all pastoralists are under the influence of modern era development. Their migratory routes are now subject to changes due to better road links. The Afghan problem has close down all international routes for nomadic pastoralists.

Evaluation of farmer's perception on azrc generated technologies

Arid Zone Research Centre (AZRC) has been conducting research on rainfed areas of Balochistan 1) to develop food and forage legume varieties, and 2) selection of suitable evergreen shrubs/trees for improving forage and grazing potential of ranges. After many years of research, AZRC developed high yielding varieties of cereal and forage legumes: wheat (AZRI-96), barley (Sanober-96), lentil (Shir-az-96), and vetch (Kuhak-96). AZRC selected two perennial drought and cold tolerant shrubs: *Atriplex canescens* and *A. lentiformis*. A survey was conducted to carryout the following objectives:

- 1) To evaluate farmers' perception regarding adoption of AZRC technologies,
- 2) To determine economical and social impact of the technologies on the quality of farmer's life,
- 3) To provide feedback to AZRC scientists for future research.

To carryout the objectives, the progressive farmers on AZRC panel were interviewed to obtain their view through using PRA approach. Twenty-one out of 41 farmers who had the access to the seed of AZRC released varieties were interviewed in Killasaifullah, Loralai, Mastung, Khuzdar, and Quetta districts. The farmers mentioned about wheat variety that it is high yielding, cold and drought tolerant, and disease resistant than the local one but wheat straw is comparatively tougher than the local one. Barley variety has very successful story and at present it has replaced local barley in Naal area of Khuzdar district. The introduced variety of vetch did not give encouraging results in highland Balochistan. The farmers of the valley areas realized and appreciated 4wing salt bush technology and are willing to plant shrubs on their land subject to supply of nursery at the farm level.

Diagnostic survey on farming system and production practices (2002)

The study was carried out to understand local land animal farming systems and interaction between them. The major objective was to explore production problems and to suggest possible solutions. A checklist/semi-structured questionnaire was developed to carryout the objectives. Multidisciplinary approach was used to cover possible issues and problems.

The survey results showed that the majority of the area population are engaged in on-farm *sailaba* farming followed by livestock rearing and some families are working in both enterprises to reduce the failure in either enterprise for their survival. More than 90% of the cultivated area is under *sailaba /rod kohi* farming system. Wheat is the major winter crop while sorghum, *mung*, and *moth* are mainly planted in summer season.

7. ARID ZONE RESEARCH INSTITUTE, BAHAWAL-PUR (PUNJAB)

Arid Zone Research Institute (AZRI), Bahawalpur aims at multidisciplinary approach with the following main objectives:

OBJECTIVES

- To evaluate present constraints to agricultural productivity in the desert where the potential for irrigation is either undeveloped or does not exist;
- To establish a regional capability to tackle the problems of arid areas and develop suitable techniques for the best land use in the Cholistan desert.
- To assess the social and economic acceptability of proposed technological

innovations and develop suitable methods for the rapid and effective dissemination of new agricultural information; and

- To ensure self-sustainability of biological systems and environmental protection of fragile arid ecosystems of the Cholistan desert.

AZRI, Bhawalpur has been working for the last more than two decades with following mandate to achieve the mentioned objectives:

Mandate

- Introduction, selection, evolution, adaptation and production technology of the crops (cereals, pulses, oilseeds and fodder), keeping in view the burning issues of arid agriculture of the regions;
- Introduction seed collection, evaluation, adaptation and promotion of range grasses (local and exotic) in the dry and hot conditions of Bhawalpur and Cholistan areas;
- Introduction and development of production technology of arid horticultural plants (ber, falsa, date palm and fig) and distribution of the planting stock of improved varieties of these plants among the farmers of Bhawalpur and Cholistan areas;
- Establishment of nursery of multipurpose trees and shrubs like *Acacia*, *Salvdora*, *Prosopis*, *Albizzia*, *Sommondsia chinensis* and *Atriplex* spp., and establishment of arboretum to demonstrate and motivate farmers to rise these on their own areas for fodder, timber and woodfuel needs; and
- To assess the use of stressed and marginally productive land and water resources for the production of high quality fish protein for human consumption.

For achieving the above mentioned objectives and mandate, the institute primarily focuses on the following four research areas:

- i. Range & Forestry Research Program
- ii. Land & Water Resources Research Program
- iii. Crop Sciences Research Program (It has three units viz, PBG Unit, Horticulture Unit & Plant Protection Units)
- iv. Animal Sciences Research Program

ACHIEVEMENTS

Research achievements according to the above mentioned research areas are as follows:

1. Animal Sciences Research Program

With the addition of one SSO who has recently joined the institute, a new discipline of fisheries/aquaculture has been introduced in the institute and an innovated research activity has been initiated on Saline Aquaculture, i.e rising of fish and shellfish in saline waters. This will help find alternate source of animal protein to better feed the poor and malnourished communities of Cholistan desert. Furthermore, a pragmatic approach of developing demonstration farms at some strategic locations in the arid zone is expected to motivate the local farmers to make small investments for some what higher returns.

2. Crop Sciences Research Program

1. Ten (10) wheat entries were evaluated. The entry Bloyka showed excellent performance and produced significantly maximum yield of 5,667 kg/ha as compared to an existing check variety Inqibal-91 that gave a yield of 4,422 kg/ha.
2. Six advanced lines of chickpea were evaluated. Among these two lines (AZ-2) and (AZ-6) with good yield potential are ready to go in the National Uniform Yield Trial;
3. In case of inter cropping study, growing of 3 rows of wheat and 2 rows of canola rapeseed gave an additional income of Rs.7,500/- and Rs.10,500/ha over traditional farmer's practice of growing pure crops of wheat and canola rapeseed, respectively;
4. Three sowing dates 20th June, 10th July and 30th July were tested in mungbean for grain yield comparison. The crop sown on June 20 appeared the best sowing date which produced significantly higher grain yield than the other sowing dates;
5. AZRI has pooled almost nine improved varieties of grafted ber, viz Soofen, Dehli While, Aloo bukhara, Shereen, Ajooba, Kali das, Karela and Umeri special. The institute has provided almost fifteen thousand scions of above-mentioned varieties to NADRI Project and Agriculture Extension Department, AJK for budding and grafting in the respective areas. Ber is a potential fruit plant which can return an income of approximately Rs.100,000/- per acre in addition to other crops which are inter-cultured in the same unit of land;
6. Four top quality date palm varieties, namely, Dhaki, Basra, Zaidi from D.I.Khan, and Aseel from Khairpur (Sindh) have been introduced at AZRI Farm, Bahawalpur to get true to type suckers for further multiplication in the area.

3. Land and Water Resources Research Program

1. Four varieties of guar were evaluated at different irrigation levels, including control. Application of two-irrigation appeared the best for cvs 2/1 and BR-95 followed by one irrigation as compared to control for obtaining maximum grain yield;
2. Effect of first irrigation at different intervals was studied on wheat. Irrigation was provided after 10,20,30,40, and 50 days interval. The mean grain yield ranged from 2,576 to 3,356 kg/ha. The irrigation interval of 30 and 40 days gave significantly highest yield of 3,356 kg/ha and 3,210 kg/ha, respectively.
3. Yield of wheat was tested under different tillage practices of disc harrow, cultivator, rotavator, and zero tillage. The mean grain yield ranged from 2,733 to 5,152 kg/ha. The crop sown with disc harrow gave the highest yield compared to the other tillage practices;
4. Growth of jojoba was tested under different irrigation methods. The irrigation methods included pitcher irrigation, PVC pipe, plastic bag, pits, furrows and drip irrigation. Maximum plant height (96cm) and crown diameter (107 cm) were obtained in pitcher irrigation technique followed by PVC pipe irrigation technique after the two years of planting time;
5. Maximum plant height and crown diameter were achieved in jojoba with the application of urea fertilizer @ 300 kg/acre followed by 200 and 100 kg/ha.

4. Range and Forestry Research Program

1. Germplasm collection and preservation of high yielding grasses and multipurpose trees/shrubs are underway at both the research farms at AZRI far, Bahawalpur and AZRI farm Cholistan. Exotic and local Acacia like *Acacia ampliceps*, *A. Victoria*, *A. stynophulla*, *A. holosoreceae* (Australian Kikars), *A. farneclana* (Khushbudar Kidar), *A. nilotica* ss. *Cupressiformis* (Kabli Kikar) have shown good potential in desert areas of Cholistan;
2. Establishment of grasses on sand dunes under desert conditions in Cholistan has successfully been demonstrated. Following have shown good yield potential (0.4-0.6 t/ha) *Lasiurus indicus* (Gorkha) *Cenchrus ciliaris* (US Buffel) *Cenchrus ciliaris* (Cv. Bileola) *Panicum antidotale*;
3. A number of economically important and medicinal plants as reported by local herders (ethnobotany) of Cholistan desert are being identified by this institute with the collaboration of Islamia University, Bahawalpur. Most important of these are; *Capparis deciduas* (Karir), *Tamarix aphylla* (Ukan), *Calligonum polygonoides* (Phog), *Salvadora oleoides*(Peelu), *Anticaris linearis*, *Citrus colocythis*, *Clume brackicarpa* etc.
4. Almost 25,000 seedlings of *Acacia ampliceps* (Austaalian Kikar) and *A nilotica*, ss. *Cupressiformis* (Kabli kikar), *Salvadora oleoidus* (Peelu), *Prosopis cineraria* (Jand) and *Simmondsia chinensis* (Jojoba), have been supplied to Pakistan Council of Research in Water Resources (PCRWR), Pakistan Army, Desert Rangers, school/colleges and farmers of Bahawalpur division;
5. Hedgerow inter-cropping using *Sesbania sesban* (Janter) and *Leucaena leucocephala* (Ipilpil) trees species in combination with maize (Kharif) and wheat (Rabi) crops not only enhanced crop and fodder production but also enhanced soil fertility, reduced soil erosion, and provided wood fuel for domestic use from the same unit of land;
6. The best-suited grass for irrigated areas *Pennisetum perpurum* cv. Mott gave fresh biomass of 78 tones/ha. Over 5000 cuttings/stubbles have been distributed among the farmers of the area.

FUTURE THRUST

AZRI, Bahawalpur will continue its research efforts in the following fields in future provided adequate manpower and financial resources are made available.

1. Introduction and evaluation of suitable high yielding drought and disease resistant varieties of cereal, pulses, range grasses, arid horticulture fruits, and fodder trees against biotic and abiotic stresses to improve quality of farmers life by strengthening their farm income;
2. Range Inventory and surveys for assessing health of range resources of Cholistan area. Grazing behavior of different livestock types during different seasons of the year will be studied for managing the livestock properly;

3. Use of stressed, non-productive, and marginally productive land and water resources for the production of high quality fist protein for human consumption;
4. Development of appropriate dry forestation techniques for planting of trees and shrubs for fodder, wood fuel, and shade needs;
5. Agro-forestry research in dry areas, especially developing fodder reserves and silvo-pastures in desert areas;
6. Training to the farmers in raising arid horticultural plants, promotion of pulses, oilseed and fodder crops;
7. Training to the local people of the area, regarding kitchen gardening, food processing, and cottage industry suited to the arid and hot climatic conditions of Bahawalpur region.

8. ARID ZONE RESEARCH INSTITUTE, DERA ISMAIL KHAN (NWFP)

Introduction

A project for the establishment of Arid Zone Research Institute was approved by ECNEC in July 1971 and was put into operation in 1973-74. The headquarters of Arid Zone Research Institute was established at Quetta (Balochistan) while one sub-station was located in each province i.e., Arid Zone Research Sub-Station Umer- Kot in Sindh, Arid Zone Research Sub-Station, Dera Ismail Khan in NWFP and Arid Zone Research Sub-Station, Bahawalpur in Punjab. Later on the Institute was up-graded to the level of Centre and the Sub-Stations were upgraded to Institutes in 1996.

Area

Dera Ismail Khan is the southern most district of NWFP lying between 31°15' to 32°32' N and 70°11' to 71°20' E with an elevation of 600 meter from sea level. D.I.Khan has a total area of 0.896 m.ha, out of which 0.300 m. ha (1/3rd) is cultivated. Of the cultivated land, about one third (0.105 m.ha) is irrigated while the rest 2/3rd (0.195 m.ha) depends upon rainfall for crop water requirement. The soil structures varies from sandy to silt clay from east to west. Most of the clayey soils are irrigated with the floodwater received casually in torrents. This system of irrigation is called *rodkohi*.

Climate

The last ten years average rainfall of the area is 259.2 mm per annum. Out of which 86.9 mm is received during the rabi seasons i.e. (October to April) while the rest 172.3 mm is received during Kharif. The main growing season of the area is Rabi where cropping intensity remains up to 50%. While cropping intensity in Kharif does not exceed above 30%. This may be due to extreme intense temperatures (below 0° C in Rabi & above 49° C during Kharif) low relative humidity i.e., 48.5% and higher wind velocity causing high pan evaporation. The dearth of vegetation cause high level of wind erosion in the loose textured soils.

PROBLEMS OF THE AREA

- Scarcity of moisture/low rainfall
- High temperatures coupled with dry weather
- Poor soils with low fertility

- Salinity, Alkalinity and water logging
- Soil erosion
- Out dated crop varieties with poor quality seed
- Poor range management/over grazing
- Lack of financial resources with the farmers.

MANDATE

- Management of existing natural resources to improve the livelihood of arid area farmers
- Identification of problems of the arid areas and to undertake research for their solution
- Screening of germplasm of cereals and legumes best suited to the local areas.
- Development of more productive /improved technologies and cropping systems for dry land agriculture
- Demonstration and dissemination of developed technologies to the end users/farmers

RESEARCH HIGHLIGHTS

i) Fodder production

Rearing of ruminants is the alternate source of income in arid areas of D.I. Khan but scarcity of fodder is one of the major bottlenecks for its growth. To overcome the problem, grazing/cutting of chickpea, canola and wheat was tested that showed:

- Grazing of chickpea increased aggregate income by 39 % in rodkahi soils. The crop sown during 1st & 2nd week of October was grazed up to 50% plant level after 50-60 days of sowing. Both early and late grazing can affect grain yield negatively
- Local wheat cut at 6-8 leaves stage for fodder in rodkahi soils proved economical & profitable and gave significantly higher yield over other varieties.
- Canola cut at bud stage for fodder/vegetable (saag) decreased the yield by 50% but the aggregate profit increased by 100%. Cutting of secondary branches at flowering stage produced 8 t ha⁻¹ fodder and slight increase in grain yield. The oil content of seed was increased by 2-2.5%.

ii. Range Grasses

Research on 5 selected range grasses for production technologies, nutritional values, drought potential and fodder yield was initiated.

- NB hybrid gave the highest green fodder yield under rainfed condition.
- 50 cm row spacing proved as optimum by giving almost double green fodder yield compared with other spacing
- The transplantation of grasses carried out during the month of August and September showed non-significant variation in green fodder yield.

iii. Varietal Development

- AZRI tested different lines of wheat and chickpea in rodkahi areas for last 5 years. AZRI selection of chickpea (EJML) and wheat (PR-65) gave significantly higher yields over the traditional varieties of both crops.
- 52 entries have been selected from CIMMYT trial for arid and semi arid areas. The selection will be further screened out with the collaboration of CDRI, NARC for agronomic characters and rust resistance.
- Coordination with different sister departments i.e. NIFA Peshawar, NARC and CIMMYT regarding varietal evolution for rainfed areas through NUYT was done.
- The rodkahi areas having loamy soils have a greater potential for groundnut production. Ten lines of groundnut have been obtained from oil seed programme for testing under rod kahi conditions of D.I.Khan.
- To decrease the risk of single crop failure, intercropping of wheat with chickpea crop 1:1 ratio was found more profitable than the crops (chickpea, wheat, lentil and canola) sown alone and other ratios. Intercropping of wheat and chickpea in ratio 1:1 gave additional income of amount Rs. 2000 ha⁻¹ over pure cropping of wheat. Also the wheat chickpea intercropping 1:1 ratio gave the highest yield of wheat.
- The intercropping of local cucumber in chickpea gave 26% more monetary returns as compared with sole crop of chickpea
- Introduction of leguminous crops in the traditional rotation of cereal crops was found beneficial.

Production technologies

- ❖ Use of recommended technologies in chickpea and wheat may increase the yield by 25 and 84.5%, respectively.
- ❖ The optimum time for wheat sowing in D.I. Khan is from 15 to the end of November. Wheat planting in late November may increase the yield by 50% as compared to October planting. The recommended seed rate is 100 kg ha⁻¹ in case of timely sowing in D.I. Khan. Seed at the rate of 100 kg ha⁻¹ increased the yield by 18% as compared with 70 kg ha⁻¹.
- ❖ The optimum time of sowing for chickpea in D.I. Khan is 10-25 October & recommended seed rate is 80 kg ha⁻¹. Seed at the rate of 80 kg ha⁻¹ increased the yield by 60% as compared with 40 kg ha⁻¹. Chickpea planting in October may increase the yield by 42% as compared to November planting. Inoculum use is beneficial in chickpea plantation; it increases the yield by 10%.
- ❖ Row spacing of 30 cm was found optimum for chickpea, and lentil.
- ❖ Results obtained from mungbean experimentation showed that the optimum date of sowing is mid June.
- ❖ Application of nitrogenous and phosphatic fertilizers has non-significant effects on the grain yield of chickpea and wheat in rodkahi area. This may be due to the higher nutrient content of rodkahi soils and rich status of rodkahi waters. However, in rainfed areas fertilizers application of 50-25 NP kg ha⁻¹ increased the yield of wheat by 50%. While for chickpea the optimum dose of fertilizer was found as 20-40 kg NP ha⁻¹, which increased the yield by two folds.
- ❖ Optimum rate of fertilizer for wheat is 50-25 NP kgha⁻¹ in rainfed areas.

- ❖ Optimum rate of fertilizer for chickpea is 20-40 NP kg ha⁻¹ in rainfed areas

Moisture Conservation

- ❖ Use of mould board plough is the best for moisture conservation. It increases the yield by 50% in wheat crop.
- ❖ Application of sand as mulching agent was found the best moisture conservator practice followed by surface stirring after each rainfall. Sand application increased the yield by 10% over control.
- ❖ Similarly, furrow sowing increased the yield by 30, 39 and 48% as compared with flat sowing in wheat, barley, and chickpea, respectively.

Local Flora

I. Mazri (*Nannorrhops ritchieana*)

Mazri is local flora having good economic value. Mazri is the best source of earning amongst the local flora. It is used for making different types of ropes, utensils and handicrafts. It is the alternate source of income of the arid areas inhabitants. This institute conducted a diagnostic survey regarding problems faced by the crop and farmers. Following were the out comes of survey:

- Production technology of the crop is required to be developed through research
- High yielding and favourite varieties are required to be introduced
- The primitive tools are required to be updated so as to increase out put of processing

This institute has taken the following steps:

- ♣ Laid out different experiments on production technology development of the crop at farmers' fields
- ♣ Prepared a project proposal titles "collection, screening and selection of native germplasm of mazri in arid zone of NWFP" and submitted to ALP. After some modifications suggested by the referees, the project has been resubmitted for further processing/ funding
- ♣ Arranged a visit of FMI scientist for remodeling of primitive tools used for Mazri processing. Hope is that it will develop simple machines in near future.

TECHNOLOGY TRANSFER

- Distributed 100 bags of improved variety of chickpea (NIFA-88) and 150 bags of wheat (sulaman-96) on return basis among the farmers of D.I. Khan for replacement of inferior cultivars.
- Canola has been introduced in the area for replacement of rapeseed and mustard traditional sowings. Peoples are adopting the technology.
- AZRI, D.I. Khan arranged a field day on farmer's fields at village Kot Musa. The developed technologies were disseminated through on farm demonstration discussions and speeches.
- Popularized the use of Bio-fertilizers in collaboration with NARC at farmers' fields.
- Dissemination of technology for improving dry land and Rod Kohi farming in D.I.Khan, preparation of leaflets, exhibitions, field days, training, etc.

9. ARID ZONE RESEARCH INSTITUTE, UMER-KOT (SINDH)

Introduction

Arid Zone Research Sub-station, Umer-kot was established in 1981-82 as a part of Arid Zone Research Institute with its head quarters at Quetta. During 1982, an area of 85.46 ha (211 acres) was acquired from Government of Sindh for establishing the Research station. One office building and six quarters (for lower staff) were constructed in 1987 and 1995, respectively. The station was established for carrying out research on dry-land agriculture and improvement of rangeland including sand dune stabilization in Thar Desert. Arid Zone Research Sub-Station was upgraded to Institute in 1996. During last twenty years, the institute has developed the basic infrastructure including staff, residences, injector pumps, some farm machinery, introduction of drip irrigation, sprinkler irrigation, pitcher irrigation systems and research farm, sizeable plantation of range grasses, shrubs and trees, etc. A comprehensive vegetation and socio-economics survey of the Thar area has also been conducted to identify constraints at farm level. Thar is a sandy arid desert comprising of about 22,000 sq kilometers. The Thar is situated on the eastern side of Sindh province bordering with Rajasthan (India). The major portion of the area has high sand dunes with low valleys of fertile lands where cropping is carried out under rain-water. Soil of Thar is generally loamy sand with 2-6% clay, 1.5 to 3.5% silt, 10-30% coarse sand and 65-80% fine sand with under laid rocky strata at few to several meters depth. The climate of the area has streams of differs considerably in to two portions of the district. In the irrigated western portion, it is less hot in summer and less cold in winter as compared to eastern desert area. The Thar area has a tropical desert climate. April, May and June are the hottest months. The maximum and minimum temperature during summer are 41°C and 24°C, respectively. December, January and February are the coldest months with maximum and minimum temperature of 28°C and 9°C, respectively. Rainfall varies from year to year. Most of rain falls in the monsoon months from June through September. Livestock is the mainstay of the people of Thar. About 76% of the human population is engaged in raising livestock and related activities. The Tharparkar district has two distinct areas. The irrigated areas on the western side are known as parker and the desert area to the east is known as Thar. The Thar region is mostly desert. It consists of barren tracts of sand dunes covered with thorny bushes. The only hills are in the extreme south-east corner of Nagarparker ta'alka. These are known as karunjher hills. These are about 20km in length and at heights of about 300m. Wheat, cotton, castor seed, maize, sugarcane, rice, mango, bananas, rapeseed and mustard and vegetables including chilies are the main agricultural crops grown in irrigated areas. Whereas millet, guar, mungbean, sorghum and sesame are the main crops grown under rain fed conditions.

MANDATE

- To establish a regional research capability under the leadership of Arid Zone Research Centre, Quetta to tackle the problems of arid/semi-arid agriculture of Thar and surrounding areas.
- Develop techniques for the best land use in the arid region of Thar and adjoining irrigated belt of lower Sindh. Special emphasis will be given to the following aspects:

- i. Identify constraints in the development of crops, livestock and rangelands in the region.
- ii. Conduct research for finding solutions to the identified problems.
- iii. Collect and analyze the statistical data for the arid zones to determine the economics of various enterprise mixes.

ISSUES/NEEDS

- a) Aridity.
- b) Poor ground water quality.
- c) Low level of vegetative cover.
- d) Migration of people during drought
- e) Low productivity of livestock and cropping system due to aridity and low primary productivity of natural vegetation.

RESEARCH STRATEGY

During the last 20 years the research has been conducted on rain fall .No irrigation system has been introduced, recently few micro irrigation systems have been introduced at AZRI farm in order to grow crops/plants without depending on rainfall.

Technologies transferred

1. Pitcher irrigation system
2. Drip Irrigation system
3. Multiplication of seed of improved and drought resistance varieties of Millet, sorghum and guar varieties.
4. Propagation of different grasses, trees and shrub species.

INFRASTRUCTURE

An area of 85.46 ha (211acres) of Thar Desertland was purchased from Govt. of Sindh by Pakistan Agricultural Research Council for the establishment of Arid Zone Research Sub-Station at Umer-kot. The possession of land was taken on 27-04-1982 and the area was then developed for experimental station. Construction of fencing around the whole farm area and range enclosures (Two Plots 50x50M Size each) was completed for arid land studies. There is no specific Laboratory building for the station however six small residential quarters were built by the end of 1986 out of which three were used as office store and rest house of the farm and remaining three are under use for residential purpose of the staff. However under ARP-II, 1500 sq.ft. office building was constructed in 1996. Station was up graded as Institute in 1996. Soils of the farm are sandy (93% sand) with coarse sand predominant. There was no irrigation facility available and all the research done was purely on rain. During last twenty two years, the institute has been developed in the basic infrastructure including staff residences, one small open surface well, injector pumps, some farm machinery, two vehicle one Toyota Hilux and one Suzuki Jeep, introduction of drip irrigation, sprinkler irrigation, pitcher irrigation systems and research farm in the sizeable plantation of range grasses, shrubs

and trees. A comprehensive vegetation survey and socio-economics survey of the Thar area has also been conducted to identify constraints at farm level.

10. LIST OF AZRC HQs SCIENTIFIC STAFF

Naseer Alam Khan Director General
Babar Raza Kazi PSO

1. Animal Sciences Research Program:

- i. Dr. Shahid Rafque SSO/Program Leader
- ii. Dr. Abdul Razaq SO
- iii. Imran Bugti ASO
- iv. Muhammad Umer F/Fellow

2. Crop Sciences Research Program

- i. M. Anwar Khan SSO/Program Leader
- ii. Abdul Hannan SO
- iii. Jahangir Khan ASO

3. Land & Water Resources Research Program

- i. Ahmad Samiullah SSO/Program Leader
- ii. M. Nadeem Sadiq AAE/SO
- iii. Qazi Mehmood Ali SO
- iv. Amanullah SO
- v. Liaquat Ali ASO

4. Range & Forestry Research Program

- i. Dr. M. Islam SSO/Program Leader
- ii. Dr. Sarfraz Ahmed SSO
- iii. Sohail Aslam ASO
- iv. Hafiz Saif-ur Rehman RF

LIST OF SCIENTIFIC STAFF AT AZRC INSTITUTES

1. AZRI, Bahawal-pur

- i. Ms Rukhsana Anjum SSO/Director
- ii. Mrs. Irshad Begum SSO
- iii. Dr. Javed Afzal SSO
- iv. Taj Naseeb Khan SO
- vi. Amir Ahmed SO
- vii. Ghulam Sarwar ASO
- viii. Jahangir Shah ASO

2. AZRI, Umer-Kot

- i. Dhani Bakhsh Panhwer, Director
- ii. Ghulam Shabbir Bohio SSO
- iii. Fateh Khan Nizamani SSO
- iv. Hamz Ali Samoon SO
- v. Mr. Ali Sher Chandio SO

3. AZRI, D.I. Khan

- i. Dr. Rehmatullah Khan Director
- ii. Akbar Hussain Gurmani SSO
- iii. Abdul Rashid SSO
- iv. Mohammad Arshad Farooq SO
- v. Matiullah Khan SO
- vi. Dost Mohammad SO
- vii. Ashiq Salim SO

AZRC

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