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THE CONDUCT AND IMPACT OF RESEARCH IN THE AGRICULTURAL MANAGEMENT OF THE ARID MOUNTAIN AREAS OF WEST ASIA: THE EXAMPLE OF THE BALOCHISTAN HIGHLANDS, PAKISTAN

by

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This series of research report outlines the joint research findings of the MART/AZR Project and AZRI. It will encompass a broad range of subjects within the sphere of dryland agricultural research and is aimed at researchers, extension workers and agricultural policy-makers concerned with the development of the resource-poor, arid areas of West Asia and North Africa.

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Abstract

Problems specifically associated with, but not necessarily limited to, the conduct of a research program to aid agricultural management of mountainous and highland areas are discussed. These include: The requirement for quantified primary information in the design of a successful research program; The advantage of adopting a partnership arrangement in providing the necessary longterm continuity in a research program; The need for timely re-appraisal of strategic thinking once sufficient results become available; and, the importance of ensuring that the impact of the research process, particularly in socio-economic matters, is evaluated in a timely manner and takes known climatic variabilitity fully into account.

Introduction

The problems associated with improved agricultural production in the arid and semi-arid mountainous areas (>1000m) of West Asia have received little or no effective attention from research workers in the past. Traditional farming systems have depended on the raising of small ruminants in either a nomadic or transhumant manner with some sedentary subsistence agriculture based on winter wheat production. However, with the rapid increase in human population experienced recently in West Asia and in the face of this trend continuing into the forseeable future, governments of countries such as Pakistan are relying upon increased and sustained agricultural production in the future from less developed agricultural areas, such as the arid highlands, to help meet expected food production deficits (GOP 1988).

Agricultural Research Problems Specific to Dry Mountain Areas

The arid mountainous areas of West Asia have ecological characteristics of cold, heat and drought in common which pose a set of specific problems to researchers intent in increasing and sustaining agricultural output. At the core of these problems is the interaction between moisture supply and temperature. In order to grow crops with consistent success in such environments, it is necessary to attune maximum crop development and moisture use with the period in which the influence of temperature constraints are minimized. Furthermore, research designed to monitor independently the direct effects of environmental variables such as heat, cold and aridity will often result in a gross over-simplification of their influence. Rather it is vital to consider the combined interactive processes of the physical environment on crop growth.

One major environmental factor which is characteristic of arid highland areas and has a substantial influence on both crop and animal productivity is the extreme inter- and intra-year climatic variability which can be experienced (for example see Figure 1, Keatinge and Rees 1988). It may be difficult to design an agricultural system which can be functional in a dry but consistent environment; but it is much more demanding to have to design a flexible system for a predominantly dry environment that is also capable of responding to considerable variability in annual rainfall and it's distribution, the timing, duration and intensity of frost, heat and other climatic events. Unfortunately, arid highland areas generally have environments that fall into the latter category. If research programs are to be effective in such areas, environmental uncertainty and risk factors have to be fully taken into account.

Operational Implications: The Example of Highland Balochistan

In order to operate an effective research program in a particular dry mountainous area it is necessary to appreciate that though there may be climatic, social and infrastructural problems that are common to many such areas, the actual research operation occurs in a very specific physical and human environment. AZRI's experience suggests that the research program initially needs to be focussed on specific problems with the expectation of generalizing at a later date, rather than dealing with general issues and hoping for specific local "spin-off effects". Clearly therefore, intimate knowledge of the system for which the research is targeted is a primary requirement before research plans can be properly formulated.

In this paper we discuss conduct and impact issues arising from AZRI's research program in highland Balochistan. We seek to demonstrate that the research strategy adopted by AZRI is beginning to have effective results that may have a substantial impact in increasing productivity and reducing the annual uncertainty of agricultural output in the highlands. In addition, we hope to show that the applied research partnership adopted by ICARDA and AZRI may be a useful example which could be effectively copied in other areas.

The Agriculture of Highland Balochistan

In the arid highlands of Balochistan province of Pakistan, the production of sheep and goats on approximately 20 million hectares of rangeland and subsistence production of winter wheat on a further 125,000 ha of land are the predominant dryland agricultural activities (Irrigated fruit production is also important in economic terms but is only on a very restricted area). Annual productivity of both crops and ruminants is very irregular and generally low because of the harsh and agriculturally marginal climatic conditions.

Most of the people in the area are almost completely dependent on agriculture for their livelihood and the population has approximately quadrupled in size in the last 40 years. This has led to a corresponding increase in the population of sheep and goats from around 1 million head in 1950 to more than 18 million in 1986. Such animal numbers are well above an economically efficient and ecologically sustainable carrying capacity for the rangelands (ICARDA 1990) and thus severe overgrazing, made worse by shrub gathering for fuel, has occurred in a widespread and sustained manner. As a result the productivity of the now highly degraded rangeland vegetation is very low (Figure 2, Arid Zone Research Institute 1990) and in consequence, annual offtake from small ruminants is extremely sub-optimal. Thus, the standard of living of dryland agricultural communities is inevitably low and, compared with the population of Pakistan as a whole, the farmers of highland Balochistan are very disadvantaged.

This deteriorating and distressing situation is probably common to other West Asian countries with similar ecological conditions such as Iran, Afghanistan etc. However, ICARDA in partnership with the Pakistan Agricultural Research Council's Arid Zone Research Institute implemented in 1985 a joint research program in the highlands of Balochistan which seeks to address the problems of low and unsustained dryland agricultural productivity.

Design, Continuity, Direction and Impact of Agricultural Research Programs

A) Design: The need for quantitative primary information.

In the development of a research strategy for dryland agriculture, a shortage of reliable quantitative information is a major drawback in ensuring effective investment of scarce human and financial research resources. Decisions on which research problems should receive priority is a critical problem and often requires extensive survey work before a realistic longterm strategic plan can be formulated (Keatinge et al. 1988).

For example, in highland Balochistan winter wheat is the principal dryland crop grown, while barley covers only five percent of the cereal area. On the surface, this decision by farmers appears not to be very rational in economic and biological terms as barley, traditionally a more efficient and reliable crop in areas of less than 300mm annual rainfall, should be more consistently productive as the average annual rainfall of the Balochistan highlands is closer to 200mm (Kidd et al. 1988). Results from AZRI agronomy trials over the last five years have supported the supposition that barley would be a more productive crop than wheat to grow.

Should AZRI therefore be concentrating its resources on developing increased barley production? In the light of the chronic and increasing deficit in animal feed in Balochistan the answer to this question is probably yes, but AZRI's survey work with cereal farmers and ruminant herders has highlighted the complexity of the issue. Farmers have indicated that without a yield premium of at least 50% they would be unwilling to shift from wheat to barley production. Their reasons include a continuing desire for personal food security, and the small and uncertain market for barley (Table 1, Nagy et al. 1989). This in turn is linked to the need for farmers and herders to appreciate the value of small amounts of supplemental feeding, which has been demonstrated by AZRI to considerably improve potential ruminant offtake (Table 2, Atiq-ur-Rehman et al. 1989). Until this occurs the market demand for barley, which would be an ideal locally produced source of animal feed supplement, cannot create sufficient incentive to attract farmers to change their traditional cropping pattern.

B) Continuity: The advantage of a partnership arrangement.

Once a series of research experiments have been decided to have a high priority for the research institute's program, it is vital that they be continued for a sufficient time period to yield meaningful results. This time period is of course variable depending on the type of experiment; but it is a safe generalization to assume that in uncertain and marginal environments, which are experienced in the arid highlands, more experimental years will be needed to ensure meaningful results than for example, say, irrigated agricultural systems. In a longterm breeding or selection program for example with an expected duration of at least 5-10 years, very dry or extremely cold years in which crop failure is certain can have a negative impact on progress. As these years of harsh environmental conditions are commonly experienced in the arid highlands, how are replacement seed reserves of selected material to be preserved to ensure continuity of the selection program in every growth year? A disrupted research program, in our experience, is often either abandoned or considered in future of much lower priority. This has major implications for the attainment of an institute's research strategy.

In AZRI's case, its research partnership with ICARDA helps to ensure vital program continuity and to reduce research costs in Pakistan. For example, AZRI uses ICARDA's international nurseries specifically targeted for highland areas as the initial basis for its selection nurseries and yield trials of a range of crops. Evaluation of material selected in the first year of testing is then carried out at multiple locations over several years. Seed supply is always a critical determinant of the number of test locations which can be employed in any given year, particularly when lines are being promoted from single row observation nurseries to multi-row replicated yield trials. If a very harsh year occurs, such as happened in highland Balochistan in 1987-88, crop failure at all locations was assured due to extreme drought. Had AZRI then lost all its experimental selected seed it would have negated three years progress in selection. However, one manner in which ICARDA helps the AZRI program is by acting as a seed supply safety net from its headquarters in Aleppo, Syria so that more seed of selected material is almost always available in experimental amounts for continuity of the program in following seasons. The alternative of AZRI having to plant additional copies of each nursery under irrigation would not only be very expensive but also cannot fully guard against the risk of crop loss from sudden cold damage.

C) Direction: How results should influence strategic thinking.

Once sufficient information has been collected and a longterm strategy is devised in which research priorities have been clearly defined, it is important to realize that change in the relative weighting of priorities can and probably will occur. This may well be in response to the perceived timing and size of the predicted impact of an intervention. This will obviously alter as the research process generates results and it becomes evident that one research approach is proving to be more immediately, or more certainly fruitful in the long run, than another.

For example, in 1986 AZRI initiated a series of rangeland management and rehabilitation trials at its substations at Tomagh and Zarchi. These included large scale management trials of native ranges with and without complete and partial protection (deferred grazing) and small scale rehabilitation areas in which new species of fodder bushes were introduced. In AZRI's research plans as late as 1988 the grazing studies were seen to be of a higher priority than the range rehabilitation experiments (AZRI and MART/AZR 1988).

However, this situation was reversed by late 1989 as it transpired from our experimental results that the regrowth rate of native range vegetation was extremely slow even with full protection, that deferred grazing as a management technique appeared to have little promise, and that social grazing-protection techniques were less effective than had been previously contemplated (Figure 2). In direct contrast, range rehabilitation techniques through the creation of small areas of fodder bushes (Atriplex canescens) indicated that the introduced species was well adapted to the environment and could be extremely productive up to 6t/ha/yr of dry matter (Aro et al. 1988). Furthermore, in subsequent growth and digestibility trials with local sheep, the introduced fodder was found to be suitable for use as a winter supplement in maintaining body weight, and had potential for flushing ewes before mating (Atiq-ur-Rehman et al. 1990). In addition, social control of grazing of these planted forage reserves near farmers houses and other well defined sites seems to be much more effective than where improvements are made to the general condition of the range.

Thus, the creation of fodder reserves as a range rehabilitation intervention seems in 1990 to be likely to have a much greater potential impact and be more readily accepted than potential interventions in range grazing management. As a result AZRI's research program in the planned period 1990-93 is now heavily biased in the direction of range rehabilitation, without necessarily cancelling the grazing management experiments. These have been reduced in scope, with the time requirement for the servicing of these trials by scientists also being much reduced (often the limiting factor at AZRI). In the setting of priorities and investment of resources a judicious balance between long and short term experimental return must be maintained, but within this balance change can and should occur at appropriate intervals when the importance of additional research results have been digested. This need for a shifting in the weighting of priorities should not however, be regarded as license to make wholesale changes in an experimental program on an annual basis. These changes should occur only when sufficient data has been collected to fully warrant amendment of strategic thinking, perhaps at two to four year intervals.

D) Impact: The need for socio-economic determination over an adequate time period.

In ensuring that a research program will have sufficient impact to maintain or, better still, increase research support levels for the arid highlands, care must be taken to evaluate the social and economic impact of an intervention over an adequate time period. We have already stressed the importance of inter-year climatic variability on the research process. This is also of considerable importance in the evaluation of farmer acceptability and impact in both social and economic terms.

For example, AZRI has been testing improved catchment basin water harvesting systems for improved crop agronomic management since 1986 (Figure 3, Rees et al. 1989). In the period between 1986 and 1989 both wet and dry years have occurred and the economic benefit of taking some land out of production for water harvesting will obviously vary with the amount and distribution of rain in any one year. However, the crop year 1987-88 was very dry throughout most of Balochistan and a very large majority of farmers failed to get grain from their wheat fields. This will probably recur 2-4 years in ten depending on the specific location (Kidd et al. 1988).

In contrast, in AZRI experimental treatments in which water harvesting treatments had been applied, some plots yielded enough grain (>100 kg/ha) to return sufficient seed for farmers to plant in the following year and provided a good straw yield for animal feed. Such experimental results in a very dry year will have a big impact on the collaborating farming community, as consistency of yield across years is almost a more important parameter than extra yield in a favourable season because domestic food security considerations for family and livestock are critical (Table 1, Nagy et al. 1989.). However, in strictly economic terms, averaging experimental results across years may de-emphasize the results of a specific year such as 1987-88 and as a result underestimate potential research impact. The need therefore for continuous assessment of impact over a number of years and the inclusion of the known element of climatic variability is essential in socio-economic and impact calculations, to avoid premature recommendations and injudicious investment in widespread adoption.

Conclusions

We have attempted to demonstrate in this paper that in the design, conduct and impact of a research program special consideration needs to given to the dry, mountainous environment in which the research occurs. An attempt to transplant into the highlands a research program derived from experience of a less harsh lowland environment, is likely to be ineffective. The problems of mountainous environments are both complex and highly specific. In consequence, agricultural research, though urgently in need of further investment, may be too daunting a task for national governments to fully accept the challenge of providing the required level of human and financial resources. Initially, partnership arrangements between national and international agencies such as ICARDA and ICIMOD can be a fruitful way to demonstrate research impact on a small scale, to convince governments to adequately support the research required for the development of the disadvantaged agricultural communities of the arid highlands.

References

Arid Zone Research Institute. Annual Report for 1989. AZRI, Quetta, 1990.

Aro, R.S.; Sultani, M.I.; and Asghar, M. Introduction of fourwing saltbush (Atriplex canescens) into degraded rangelands in upland Balochistan. MART/AZR Res. Rep. 22, ICARDA, Quetta, 1988.

Atiq-ur-Rehman; Aro, R.S.; Asghar, M.;and Sultani, M.I. Effect of flushing and late-gestation supplementary feeding on fertility and productivity of Harnai ewes. MART/AZR Res. Rep. 27, ICARDA, Quetta, 1989.

Atiq-ur-Rehman; Rafique, S.; Ali, A.; and Munir, M. Nutritive evaluation of fourwing saltbush in growth and digestibility trials with Harnai lambs in highland Balochistan. MART/AZR Res. Rep. 58, ICARDA, Quetta, 1990.

AZRI; and MART/AZR. Research plans for 1988-89. MART/AZR Res. Rep. 14, ICARDA, Quetta, 1988.

Government of Pakistan (GOP). Report of the National Commission on Agriculture. GOP, Islamabad, 1988.

International Center for Agricultural Research in the Dry Areas (ICARDA). High-elevation research in Pakistan: The MART/AZR project annual report for 1989. ICARDA Res. Rep. 158 En, ICARDA, Aleppo, 1990.

Keatinge, J.D.H.; and Rees, D.J. An analysis of precipitation and air temperature records in the Quetta valley, Pakistan: The implications for potential improvement in agricultural productivity. MART/AZR Res. Rep. 9, ICARDA, Quetta, 1988.

Keatinge, J.D.H.; Roidar Khan, B.; Rees, D.J.; Aro, R.S.; and Talug, C. A strategic plan for the PARC Arid Zone Research Institute 1990-2000. MART/AZR Res. Rep. 23, ICARDA, Quetta, 1988.

Kidd, C.H.R.; Rees, D.J.; Keatinge, J.D.H.; Rehman, F.; Samiullah, A.; and Raza, S.H. Meteorological data analysis of Balochistan. MART/AZR Res. Rep. 19, ICARDA, Quetta, 1988.

Nagy, J.G.; Farid Sabir, G.; Shah, N.A.; Afzal, M.; Rees, D.J.; and Keatinge, J.D.H. Barley production and its scope for improvement in the high elevation rainfed farming systems of Balochistan. MART/AZR Res. Rep 26, ICARDA, Quetta, 1989.

Rees, D.J.; Islam, M.; Samiullah, A.; Qureshi, Z.; Mehmood, S.; Rehman, F.; Keatinge, J.D.H.; Raza, H.; and Khan, B.R. Water harvesting and nitrogen fertilizer application as a means of increasing crop water use efficiencies in suboptimal conditions in upland Balochistan. MART/AZR Res. Rep. 31, ICARDA, Quetta, 1989.

Rees, D.J.; Qureshi, Z.A.; Mehmood, S.; Rehman, F.; and Raza, S.H. Catchment basin water harvesting as a means of improving the productivity of rainfed land in upland Balochistan. MART/AZR Res. Rep. 40, ICARDA, Quetta, 1989.

Table 1: Ranking of Reasons Why Farmers do not Grow More Barley in Highland Baluchistan[1].

Farmers Reasons for not Growing More Barley	Top Three Rankings[2]		
	First Reason	Second Reason	Third Reason
	-- % Farmers Responding --		
Grow wheat for food security	97	3	0
No secure barley market	0	47	21
Land shortage	2	16	38
Prefer wheat to barley straw	0	13	9
Wheat price higher than barley	0	13	6
Orchards are more profitable	0	5	20
Barley yields less than wheat	1	2	2
Labour shortage	0	1	2
Not profitable to feed barley	0	0	2
Total	100%	100%	100%

Source: Nagy et al. 1989. MART/AZR Res. Rep. 26.

Notes: [1]Khuzdar, Kalat, Kachhi, Quetta, Pishin, Loralai, and Zhob Districts.

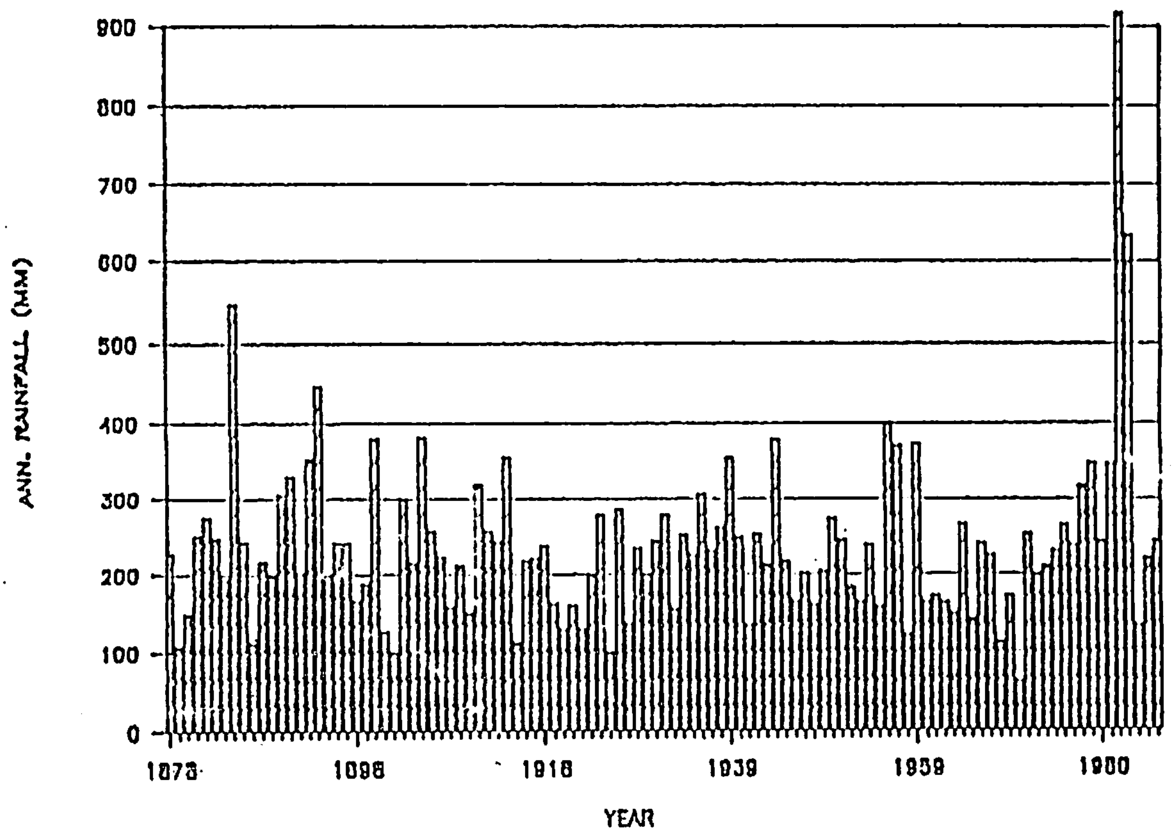
[2]Farmers were asked to choose and rank the three most important reasons as to why they do not grow more barley.

Table 2: Reproductive Performance of Harnai Ewes at Tomagh

1.	Date of breeding		September 15, 1987
2.	Number of ewes at breeding		81
3.	Number of ewes at lambing		81
4.	Number of ewes having lambed		76
5.	Number of lambs aborted		0
6.	Number of lambs born		76
7.	Number of lambs dead (0 - 90 days)		1
8.	Number of lambs weaned (90 days)		75
9.	Fertility rate	#4+#5/#3	94%
10.	Prolificacy	#6/#4	100%
11.	Weaning rate	#8/#6	99%
12.	Number of lambs weaned per ewe put at breeding		0.93
13.	Number of oestrous availed by the ewes to conceive One - 75, Two - 6, Three - 0, Four - 0		
14.	Services/conception		1.14
15.	Average gestation period (days)		155
16.	Sex ratio (male : female)		1 : 1.2

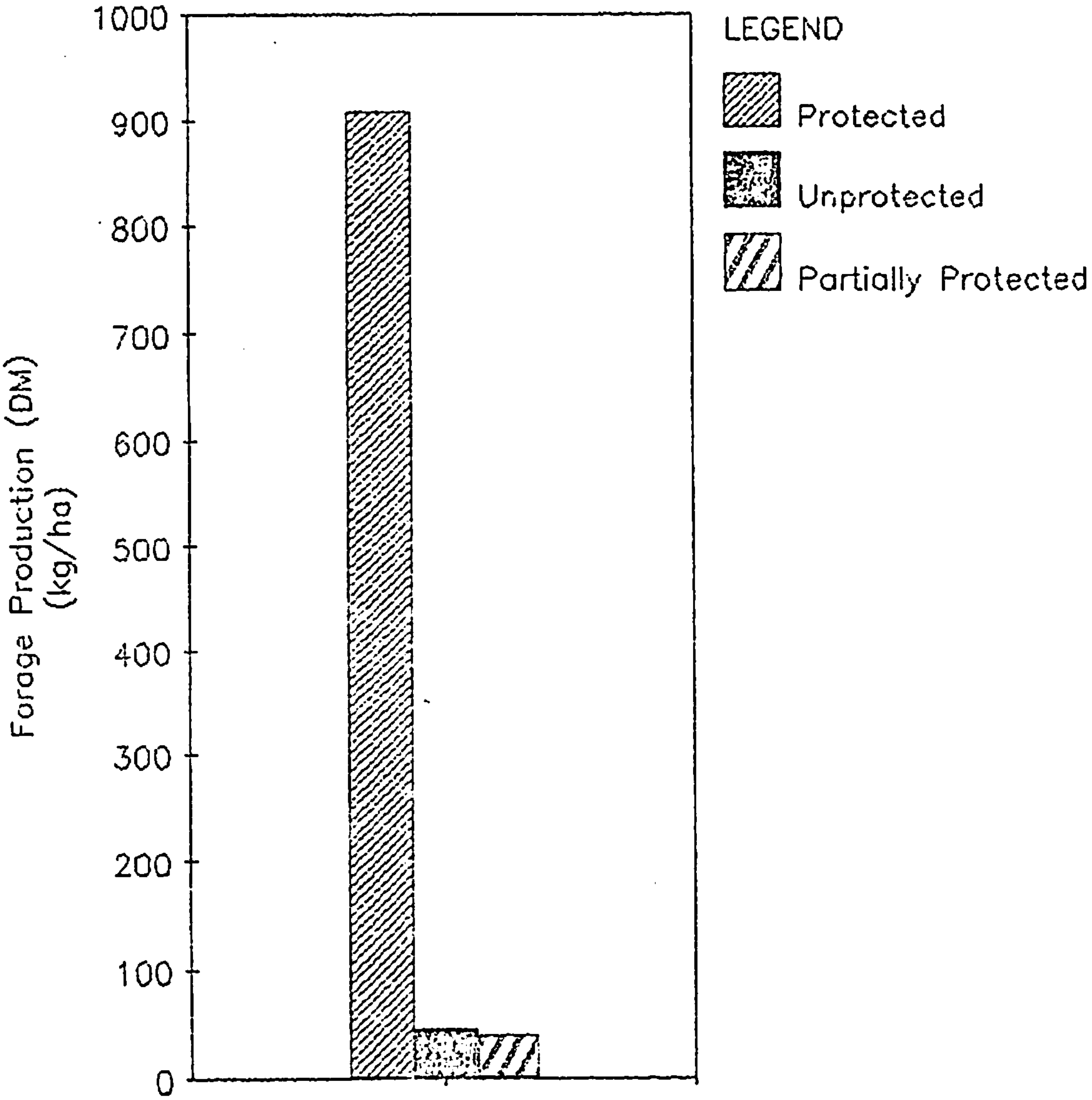
Source: Atiq-ur-Rehman et al. 1989. MART/AZR Res. Rep 27.

Figure 1: Annual Rainfall (mm) at Quetta, Pakistan 1878-1986



Source: Keatinge and Rees. 1988. MART/AZR Res. Rep. 9.

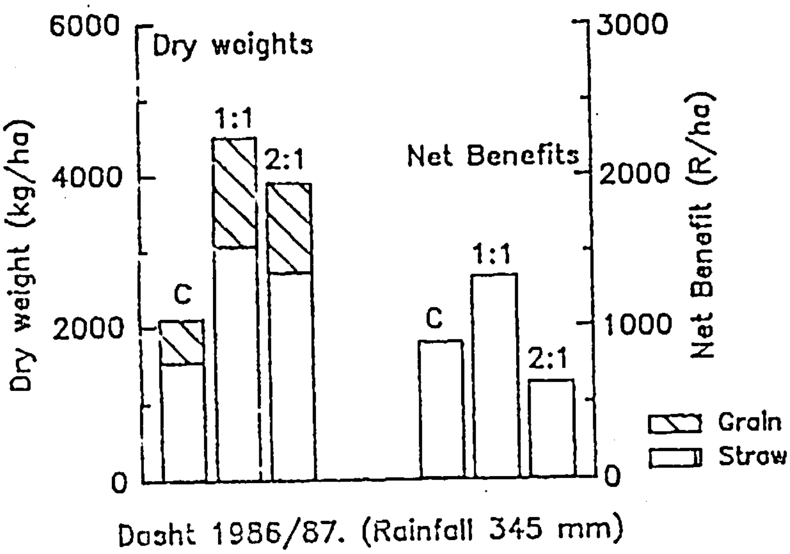
Figure 2: Productivity of Native Range Vegetation (kg/ha/yr) at Tomagh, Pakistan.

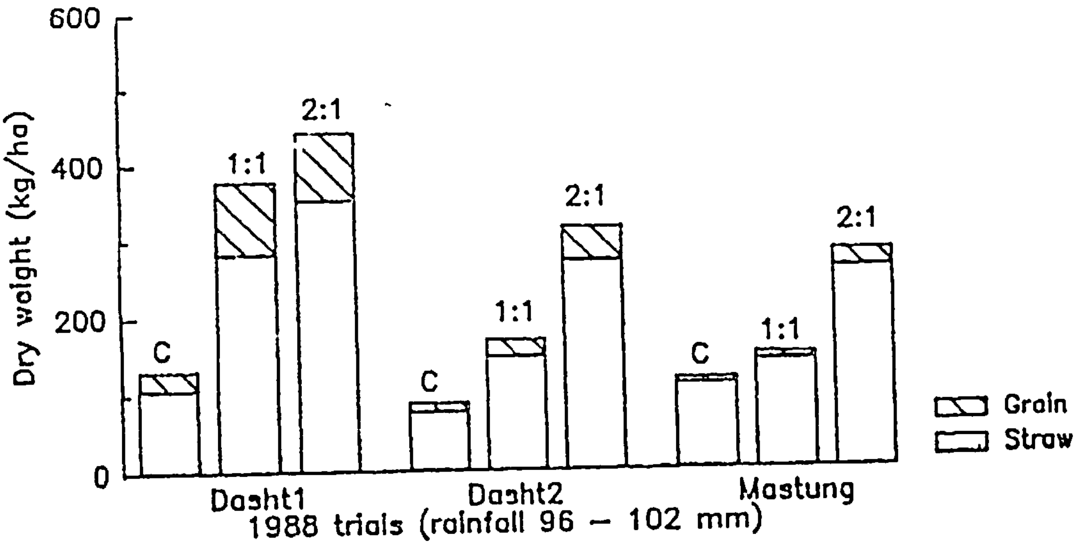


Source: AZRI, 1990.

Notes: [1]Protected treatments are means of six exclosures which have been ungrazed for three years.
[2]Partially protected treatments have been ungrazed for two six month periods in the last three years under a rotational grazing scheme.
[3]Unprotected treatments experience normal grazing pressures from local flocks.

Figure 3: Productivity and Net Benefits of Water Harvesting Treatments with Wheat at Dasht and Mastung, Pakistan in the 1986/87 and 1987/88 Crop Growth Seasons.





Source: Rees et al. 1989. MART/AZR Res. Rep. 24

Notes: 1 US$ equalled approximately 18 Pakistani Rupees.
Treatments
1:1 = Half treated catchment:half cropped area
2:1 = 2/3 treated catchment:1/3 cropped area